THE IMPACTS OF CLIMATE CHANGE ON THE FISHERIES SECTOR IN THE WESTERN AND CENTRAL PACIFIC OCEAN

By Leontine Baje

Rising global temperatures from increased greenhouse gasses in the earth's atmosphere will result in declines in the productivity and food security of our oceans coupled with economic losses from fisheries by 2050 and 2100. This article discusses the different scenarios of these greenhouse gas emissions and associated temperature rises, and their implication on the tuna biomass in the Western and Central Pacific Ocean. The next generation of climate science for finer scale assessments to support climate change attribution and to build the negotiating power of Pacific Island countries is also highlighted, including an avenue where vessels at sea can play an important role in the monitoring of oceanographic conditions.

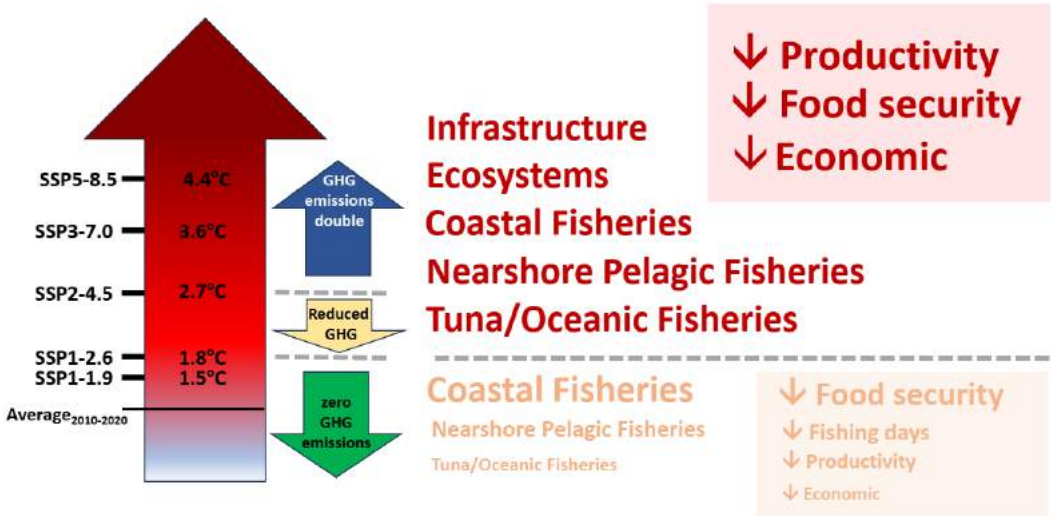
With the advent of warming seas, how will Pacific tuna fisheries be affected?

Climate change is an existential global threat. In the Pacific where most islands are low-lying, entire communities, cultures, and livelihoods are at imminent risk from the impacts of global warming. Is there also a risk for the tuna fisheries in the western and central Pacific Ocean (WCPO)? These fisheries contribute significantly to the supply of tuna for world markets and the economies of Pacific Island countries and territories (PICTs). The level at which global warming compounds the effect of naturally-occurring fluctuations in climate which influence the movement of tuna stocks, is important to understand and to determine what is attributed to the change in climate from greenhouse gas emissions.

To project medium to long-term impacts of climate change, the Intergovernmental Panel on Climate Change (IPCC) has developed a suite of possible scenarios that describe the likely evolution of Green House Gases (GHG) emission referred to as "Shared Socioeconomic Pathways" (SSPs). The SSPs range from achieving net-zero emissions by 2050 (SSP-1.9) which is also called the Paris Agreement, through to SSP-8.5 where the production of GHGs double by 2050 (Figure 1). Generally, as global temperatures rise, coupled with increasing GHGs emissions, the more severe the impact that will be felt in the fisheries sector.

Current average global temperatures have increased by 1.06°C since the pre-industrial era (1880-1900), by an average of 0.08°C per decade. The rate of warming since 1981 is more than twice as fast: 0.18 °C per decade. The SSPs that achieve net-zero carbon emissions by 2100 project an average increase in global temperatures of up to 1.8°C (green arrow). Under these scenarios, impacts

Figure 1: Shared Socio-economic Pathways (SSP) with corresponding global temperatures



Note: The graphic indicates different scenarios of zero, reduced or doubling of greenhouse gas emissions and the likely associated impacts on the western and central Pacific Ocean and fisheries.

on Pacific fisheries are expected, including significant degradation of coastal habitats, shifts in species distribution and exacerbation of productivity losses resulting in losses in economic performance and increases in food security risks.

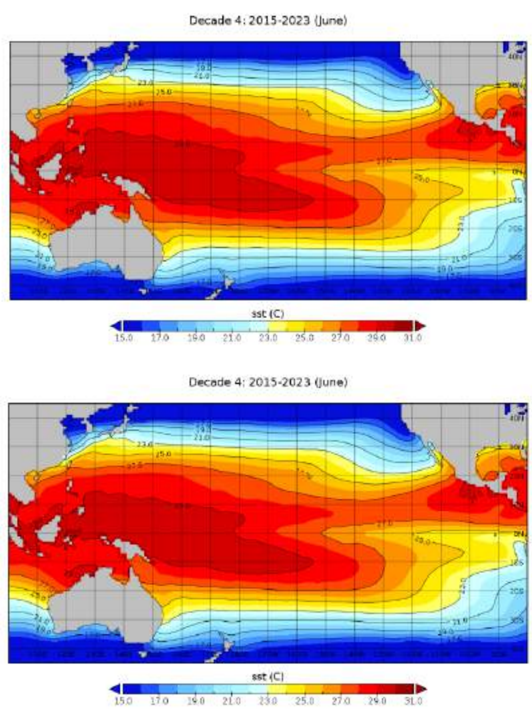
The SSPs that project a reduction in GHG emissions but do not achieve zero emissions by 2100 (yellow arrow) or project an increase in GHG emissions are expected to result in severe impacts on marine ecosystems and disruptions to economies and food systems that are reliant upon them. Therefore, achieving the net-zero GHG emission scenarios (the green arrow in Figure 1) will be the most effective means to achieve minimal disruption to Pacific fisheries, economies and livelihoods from climate change.

Expansion of the warm pool

According to the US National Oceanic and Atmospheric Administration (NOAA), records of global temperatures observed show an increase of 0.08°C per decade over the past century. More recently since 1981, the level of warming is more than twice as fast at 0.18 °C per decade.

From the Indian Ocean to the west Pacific stretches the warmest region of ocean in the world with sea surface temperatures of about 28°C. Known as the "warm pool", this area is not only a habitat of tunas and a driver of their recruitment but is also a major driver of global weather conditions. Along with this trend of increasing global temperatures, an expansion in the size of the warm pool is also observed. Comparisons of the area of the warm pool in the Pacific between the periods 1985-1994 and 2015-2023 show the expansion in its size. This will directly impact the distribution of tuna stocks.

Figure 2: The average warm pool area for the period between 1985 and 1994 and 2015-2023



Note that the mean for these decade blocks removes the annual variation due to La Nina (contraction) and El Nino (expansion).

Impact on tuna fisheries

The impact on the different tuna species skipjack *(Kasuwonus pelamis),* yellowfin *(Thunnus albacares)* and bigeye *(Thunnus obesus)* can be modelled against the different SSPs scenarios to show changes in distribution that can be attributed to climate change.

In Figure 3, the top panel shows the average distribution of biomass for skipjack, yellowfin and bigeye at the present day (2010-2019). Under the worst-case scenario of doubling of GHG emissions by 2050 resulting in 4.4°C warming (middle panel), the models predict an eastward shift of biomass particularly for skipjack and yellowfin. If there is a reduction in GHG emissions (but not achieving net-zero emissions by 2100) resulting in 2.7°C warming (bottom panel), the tuna biomass distributions will be characterized by a more moderate eastward shift and latitudinal expansion of tuna biomass distributions in WCPO. These projections were achieved with basin-scale 2-degree longitude x latitude models. While they are useful for looking at basin scale patterns in redistribution, they are not well-suited to EEZ scale analyses.

Overall, an eastward equatorial shift of fishable biomass for all three species under both scenarios is expected, the severity of which is dependent on the degree of global warming. A shift to sub-tropical high-seas areas can also be expected. The projections indicate that skipjack and yellowfin tuna are more susceptible to the changes than bigeye.

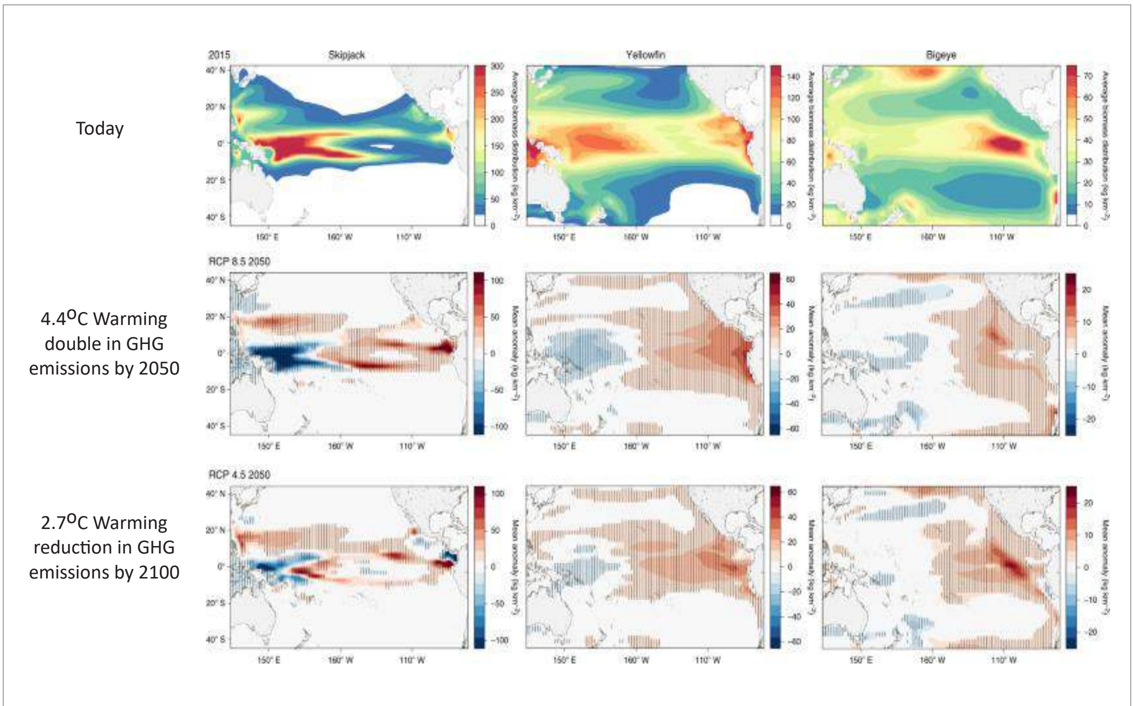
In the case of South Pacific albacore *(Thunnus alalunga)* under the increasing emissions scenario, a redistribution of biomass shows a development of similar eastward shift, with the highest negative impacts (-20% relative to historical values) localized in the western area of known spawning grounds around 25°S. Thus, the significant impacts on adult biomass are expected to be delayed compared to the other three tuna species and predicted to occur after 2050.

The economic impact of climate change is also determined by the severity of global warming. If the net-zero emission scenarios are met by 2100, losses will be minimal in the sale of access fees across the region. If, however, net-zero emissions are not achieved by 2100, the eastward and sub-tropical redistribution of biomass is expected to impact the economic benefit for purse-seine fishing between an average of USD 12 million and USD 90 million per year depending on the severity of the global warming. This equates to an average loss of up to 13% in government revenue for Small Island Developing States (SIDs) in the Pacific.

New prediction models are being developed

The next generation of models under construction are utilising new 1-degree resolution climate models. These will be able to project at the country or exclusive economic zone (EEZ) scale impacts of climate change to forecast more immediate term impacts, previously not achievable.

Figure 3: Tropical tuna biomass models



Note: Figure 3 indicates tropical tuna biomass modelled for the present (2010-2019) and according to global warming scenarios of doubling of emissions by 2050 and reduction of emissions by 2100. In the two global warming scenarios, the blue indicates less biomass than the current situation, and the red indicates more biomass.

Figure 4: Molecular sampling equipment

Sampling at point of capture or during unloading *Match head size*

The strength of the next generation of models is dependent upon national and fishing industry contributions. The industry can support climate change modelling by using echosounders and other instruments already onboard to record the state of the ocean whilst in transit to fill in gaps in ocean observation.

At the national or country level to support the EEZ scale projection of changes in biomass distribution, the scaling-up of biological sampling (including new molecular methods) will allow for more precise estimation of population dynamics parameters and the influence of the climate on them (Figure 4). Being able to forecast the impact of climate is dependent upon an accurate representation of current conditions to accurately predict future conditions. The implementation of e-reporting and e-monitoring to reduce the time-lag between catch and catch-reporting will also support finer-scale projections of climate impacts.

In summary, climate change impacts are already observable in the Pacific Ocean and likely disrupting current fisheries dynamics. Achieving net-zero GHG emissions by 2100 (and preferably by 2050) is more likely to contain the redistribution of tuna biomass within the western and central Pacific Ocean. Current management frameworks for the purse-seine and longline fisheries are likely sufficient to ensure sustainability of stocks and economic returns to participating Pacific Island Countries. Maximizing national and regional negotiating power will be key to achieving net-zero emissions. This will require investment in up-skilling national and regional agencies in climate awareness. Partial reduction of GHG emissions by 2100, or increase in GHG emissions, will result in significant redistribution of tuna biomass into the high-seas and result in losses to Pacific Island economies.

This will result in greater emphasis on:

- Loss and damage and "climate justice";
- Securing high-seas access rights to tuna resources;
- Development of tools that guide strategic investments to build resilience in the fisheries sector to climate change impacts and to maximise economic returns from tuna;
- Climate-responsive fisheries management; and
- Scale-up fisheries and ocean monitoring at the EEZ scale to meet the needs for higher-skilled projection and forecasting models.

Note:

This article was developed with support from Dr. Simon Nicol, Dr. Inna Senina and Dr Patrick Lehodey. For further information on the Pacific Community's work on climate change or information on how you can help support data gathering towards improved climate modelling, please contact Dr Simon Nicol (simonn@spc.int) and Dr Hau Halafihi (tuikolongahauh@spc.int).

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