

Climate variability and climate change impacts on oceanic fisheries: Marshall Islands

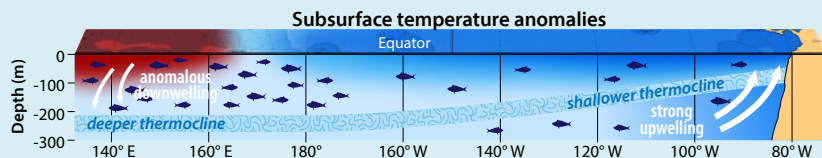
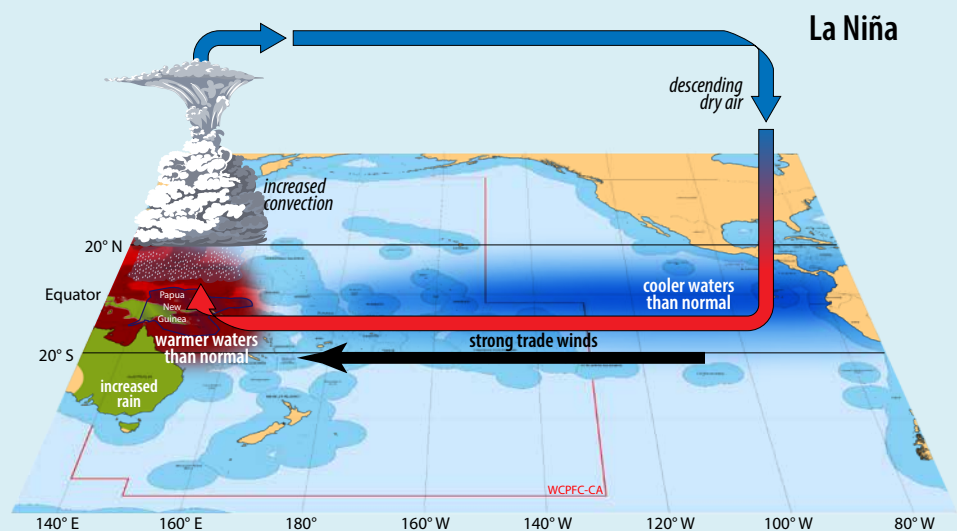
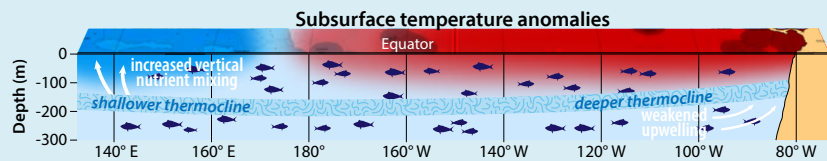
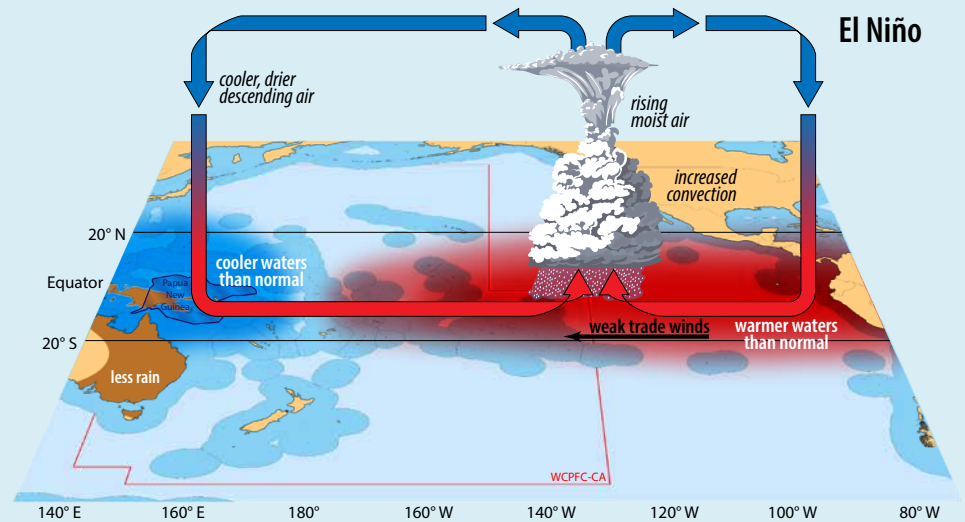


The ocean-climate system impacts oceanic fisheries in the western and central Pacific Ocean (WCP0) on different spatial and temporal scales. Short-term impacts can result from climate variability, such as El Niño and La Niña events, while long-term effects can be attributed to climate change. This brief aims to inform Marshall Islands about the impacts of climate variability and climate change on the distribution and abundance of tuna and tuna fisheries, as well as other components of the oceanic ecosystem. This brief also suggests possible adaptation strategies that can be implemented to strengthen Marshall Islands' resilience to climate change.

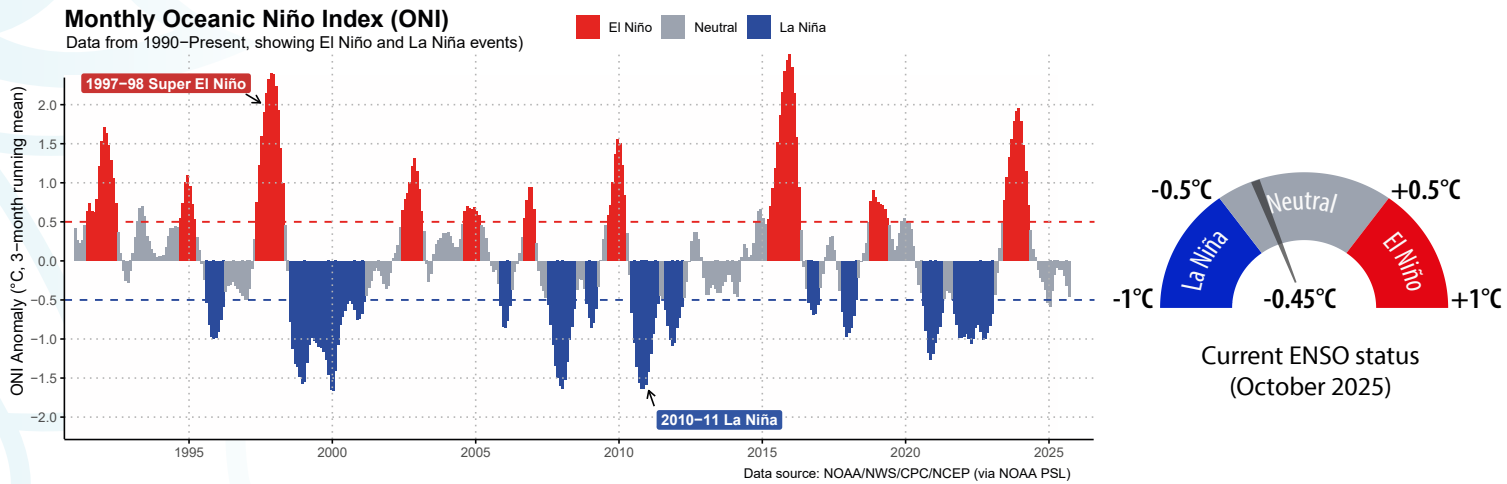
What are El Niño and La Niña?

El Niño and La Niña are climate patterns that profoundly affect the climate and the oceanic resources of the Pacific. El Niño conditions typically feature warmer-than-average waters across the mid-Pacific, weakened trade winds, increased rainfall in the eastern Pacific, and reduced rainfall in the western Pacific. La Niña conditions are generally the opposite of El Niño, characterised by warmer surface waters and increased rainfall in the western Pacific.

The occurrence of either climate pattern is often referred to as an El Niño-Southern Oscillation (ENSO) event, and one or the other typically occurs every two to seven years, lasting from 12 to 15 months. However, no two events are ever the same. Since 2000, there have been seven recognised El Niño and seven La Niña events. Note that either El Niño or La Niña events may occur consecutively and do not necessarily alternate. When an ENSO event occurs, it follows a general timeline of beginning between May and September, peaking in October to January, and ending between February and June. The "Oceanic Niño Index" (ONI) is a useful indicator of the state of the ENSO. ONI values highlight periods when sea surface temperatures (SSTs) are either warmer or cooler than normal. These are usually indicated in red for El Niño (more than 0.5 °C above normal) and in blue for La Niña (less than -0.5 °C below normal), when these conditions persist for at least five consecutive seasons.

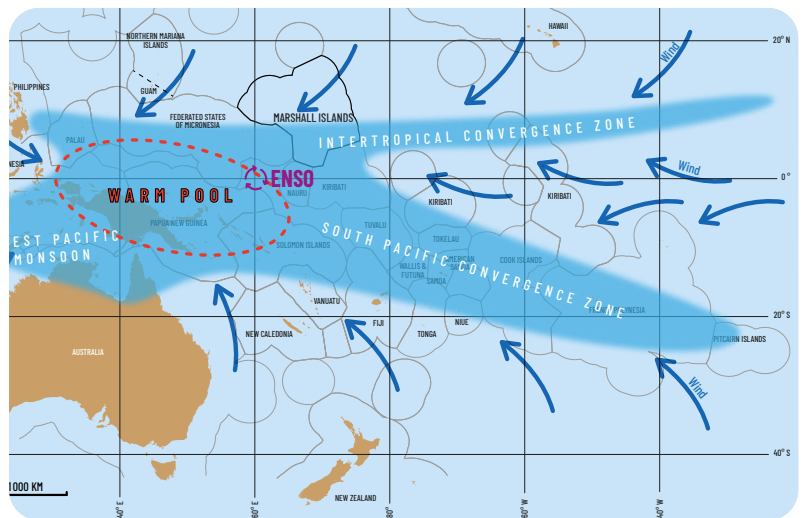


The recent history of El Niño and La Niña events



Marshall Islands and important climate processes in the region

Marshall Islands consist of two groups of atolls and islands in the northwest Pacific Ocean. The atolls are rarely more than 200 metres in width and have a mean height of about 2 m above sea level, and are among the most environmentally vulnerable countries in the world. Subsistence agriculture and small-scale industries limited to tuna processing, handicrafts, and copra are the mainstays of the economy. The islands are affected by various climate phenomena acting across multiple spatial and temporal scales and are vulnerable to the impacts of climate variability and climate change. Climate variability refers to the natural fluctuations in climate conditions around the average climate over a given period. Unlike natural variations, climate change is the long-term shift in global weather patterns driven by human activities. Here, we focus on the impacts of the most influential drivers: variability in climate (El Niño and La Niña) and climate change.



Marshall Islands and some important regional climate processes

How do ENSO events impact Marshall Islands?

El Niño and La Niña phases of the ENSO influence Marshall Islands' climate, tuna fisheries, and other oceanic resources in different ways. During El Niño events, the eastward flow of water causes significant drops in sea levels and upwelling, which in turn lowers sea surface temperatures. Severe droughts and more intense typhoons also occur. During La Niña events, enhanced trade winds pile up water in the western tropical Pacific, resulting in high sea levels leading to inundation of low-lying coastal areas. More rainfall and higher water temperatures also occur.

The offshore fisheries in Marshall Islands target three tuna species – skipjack, yellowfin, and bigeye. ENSO events, which lead to changes in ocean conditions, influence tuna movements and distributions. The eastward displacement of warm water - tuna's preferred habitat, during El Niño, results in the shifting of purse seine fishing activities and trans-shipment to the east. Conversely, the enhanced easterlies during La Niña shift fishing activities to the west, increasing trans-shipments and purse seine fishing in Marshall Islands.

Coastal fisheries in the Marshall Islands target demersal fish, such as surgeonfish, rabbitfish, and snappers, nearshore pelagic fish, and invertebrates. ENSO impacts on weather and climate patterns affect mangrove forests, seagrass meadows, and coral reefs. For instance, periods of severe drought combined with low mean sea levels following strong El Niño events can cause seagrass death and mangrove dieback due to a combination of soil moisture stress and the loss of periodic inundation during neap tides. The opposite is true during La Niña.

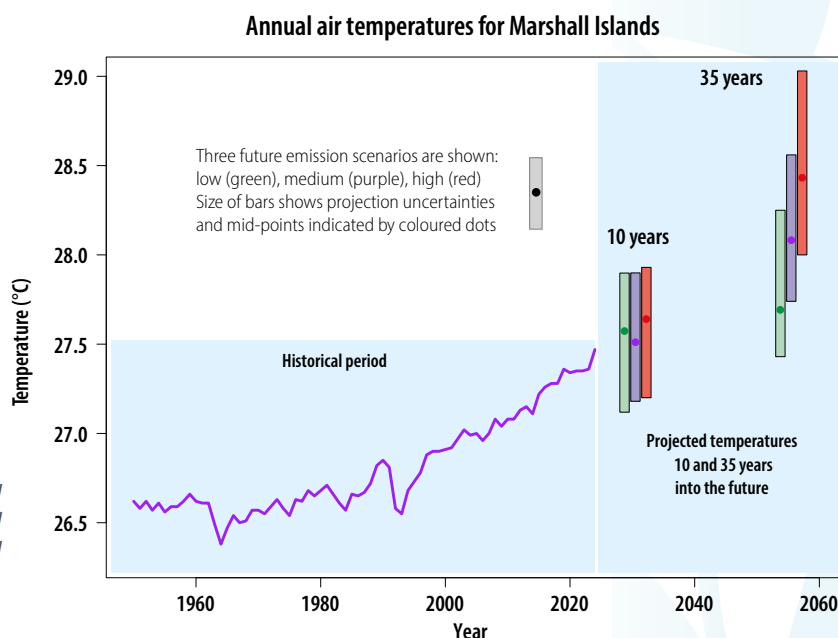
On weather and climate	El Niño	La Niña
Temperature	↓	↑
Rainfall	↓	↑
Tropical cyclone intensity	↑	↓
Sea level	↓	↑
On oceanic fisheries	El Niño	La Niña
Skipjack catches	↓	↑
Yellowfin catches	↓	↑
Bigeye catches	⊖	⊖
Purse seine fishing activity	↓	↑
Longline fishing activity	⊖	⊖
On coastal ecosystems	El Niño	La Niña
Coral bleaching	⊖	⊖
Mangrove growth	↓	↑
Seagrass growth	↓	⊖

How is climate change expected to impact Marshall Islands?

Marshall Islands experience relatively high annual average temperatures, which are projected to increase under different future greenhouse gas emission scenarios. This will likely signal the potential for extremely uncomfortable conditions for human and marine life. Due to the natural climate variability, there will still be relatively warm and cool years and decades, although projections indicate a warmer climate, which will influence more warm years and decades on average.

Sea levels in Marshall Islands have been increasing at a rate of 5 mm per year since 1993. Due to the projected increase in frequency and inter-annual variability of ENSO events, the magnitude and frequency of sea level rise episodes during La Niña will increase. The extensive flooding associated with extreme rainfall during La Niña will force Marshallese to periodically or permanently migrate to the capital, Majuro, putting more pressure on the limited resources and space. Furthermore, storm surges and sea level rise are expected to exacerbate coastal erosion that will adversely affect coastal zones and coastal fisheries, and have cascading effects on food security and livelihoods. Overall, Marshall Islands will experience the following changes by 2050, under two carbon emission scenarios relative to average conditions between 1995 and 2014.¹

The historical and projected mean annual air surface temperature for Marshall Islands relative to 2005 (1995–2015) based on three carbon emission scenarios.



Environmental indicator	Medium emission	High emission
Air temperature	+0.7 to 1.1°C	+0.9°C to 1.6°C
Sea surface temperature	+0.6 to 1.1°C	+0.8°C to 1.5°C
Sea level	+0.1 to 0.3 m	+0.2 to 0.4 m
Ocean pH	-0.1	-0.1

As the ocean warms, tuna move to areas with preferred environmental conditions. Thus, the projected shift of high abundance areas for skipjack, yellowfin, and bigeye tuna to the central and eastern Pacific and high seas. The projected increase in skipjack biomass and shifts in fishing efforts may increase tuna transshipment, bolster economic growth, and boost local employment.

Warming leads to coral bleaching; thus, the projected increase in water temperatures will worsen the situation, as was experienced during the 2014 – 2017 heat waves in Marshall Islands. Likewise, the projected occurrence of intense typhoons will damage coastal habitats, affecting coastal fisheries and livelihoods. The following are the projected changes in Marshall Islands under the medium and high carbon emission scenarios by 2050.

Environmental indicator	Medium emission	High emission
Oceanic habitat and fisheries		
Spawning habitat area	+110%	-4%
Skipjack tuna	+3%	+1%
Yellowfin tuna	-2%	-10%
Bigeye tuna	-1%	-2%
Coastal habitats		
Mangrove forest area	0%	0%
Seagrass meadow area	-6%	-7%
Coral reef area	-2%	-2%
Coastal fisheries		
Fish biomass	-23%	-27%
Coastal fisheries catch	-12%	-17%

¹ Carbon emission scenarios are plausible future development pathways of human greenhouse gas and aerosol emissions that will determine the possible climate futures.

Climate change, tuna, and resilience

Climate-driven distribution shifts of key tuna species will cause abundance fluctuations, influencing purse seining and longline fisheries. Decline in biomass will have significant effects on food security and the livelihoods, while increased skipjack biomass will periodically boost Marshall Islands' economy.



Skipjack tuna is caught by purse seine and pole and line vessels. Significant catch increases are expected. However, the projected extreme ENSO events will cause substantial interannual variations in catches and transshipment.

Central Pacific



Marshall Islands

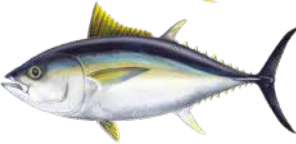


Yellowfin tuna is caught by purse seine and longline vessels. The projected distribution shifts towards the central and eastern Pacific will slightly decrease its biomass.

Central Pacific



Marshall Islands



Bigeye tuna is caught by purse-seine and longline vessels. Distribution shift to high seas is expected, which will slightly decrease its biomass in Marshall Islands.

Central Pacific



Marshall Islands



Possible adaptations for Marshall Islands to consider in the changing climate

The impacts of climate change threaten the capacity of the marine and coastal systems that support livelihoods, protect coastlines, and sustain the economy. Thus, a need to reduce community vulnerability and increase the ability to adapt in the face of imminent change (resilience). Some of the adaptation strategies that Marshall Islands may consider include:

Economic development

1. Strengthen agreements with distant water fishing nations to operate in Marshall Islands' EEZ and require them to land a proportion of their catches for local consumption and small-scale commercial fishers.
2. Improve the loading technology at Majuro Port to increase tuna handling for more transshipment.

Food security

1. Shift from coastal to offshore fishing for subsistence and small-scale commercial fishers
2. Improve mangrove reforestation to increase coastal protection and bolster local fishery productivity and resources directly provided by mangroves.

Livelihoods

1. Diversify livelihoods based on fisheries, aquaculture, and tourism, and strengthen the early warning systems.
2. Install nearshore networks of fish aggregating devices (FADs) to improve access to pelagic fish for subsistence and small-scale commercial fishers.



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