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## Impact of climate change on tropical tuna species and tuna fisheries in Pacific Island waters and high seas areas



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# Impact of climate change on tropical tuna species and tuna fisheries in Pacific Island waters and high seas areas

## Information Paper for SAN 6003922 (CI-4)

Modelling the effects of climate change on tuna abundance in  
areas beyond national jurisdiction

Developed for Conservation International (CI) as part of the GEF-funded, World Bank-  
implemented Ocean Partnerships for sustainable fisheries and biodiversity conservation  
(OPP), a sub-project of the Common Oceans ABNJ Program led by UN-FAO.

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## Executive Summary

Revised projections about how climate change will affect tuna fisheries in the Pacific Ocean basin have recently been completed by the Pacific Community's Oceanic Fisheries Programme and partners. The new modelling simulates the response of tropical tuna species, and the ecosystem that supports them, to projected changes in sea surface temperature, ocean currents, dissolved oxygen levels and other ocean variables under the International Panel for Climate Change (IPCC) "business as usual" emissions scenario in 2050 and 2100. The modelling indicates that significant changes in the distribution of skipjack, yellowfin and bigeye tuna and South Pacific albacore are expected to occur by 2050. These changes include:

- a strong eastward shift in the distribution of skipjack and yellowfin tuna, resulting in reduced abundance of both species in the exclusive economic zones (EEZs) of Pacific Island countries and territories (PICTs) west of 170E in the Western and Central Pacific Ocean (WCPO);
- a similar but weaker eastward shift in the distribution of bigeye tuna;
- a possible increase in the biomass of South Pacific albacore in the EEZs of PICTs, although the predictions are uncertain due to poor information about likely future levels of dissolved oxygen in oceanic waters; and
- an increased abundance of tuna in high seas areas, resulting in a larger proportion of the catch of each species being made in international waters.

The projected changes in distribution of tuna have implications for management, and monitoring, control and surveillance, of tuna fisheries across the tropical Pacific Ocean, including the possible need for the Western and Central Pacific Fisheries Commission (WCPFC) to assume even greater responsibility for management of the region's tuna resources.

The redistribution of tuna from EEZs to high seas areas also has implications for the economies of PICTs. Conservative, preliminary analyses indicate that government revenue derived from tuna fishing licence fees will decrease in eight of the ten PICTs that currently provide 95% of the tuna caught in the Pacific Island region. These eight PICTs are Federated States of Micronesia, Palau, Papua New Guinea, Marshall Islands, Nauru, Solomon Islands, Tokelau and Tuvalu.

Adaptations are needed to reduce the effects of projected redistribution of tuna catches on government revenue in these eight countries, and to capitalise on projected increased presence of tuna in the other two countries (Kiribati and Cook Islands). These adaptations should include negotiations to assist PICTs to maintain their rights to manage tuna stocks displaced from their waters by climate change.

Investments are needed to gain a better understanding of the effects of climate change on tropical tuna species to guide these adaptations. These investments should identify the distribution, size and behaviour of each tuna stock, and support improved modelling of the response of each tuna stock to climate change.

## Introduction

The importance of fish to Pacific Islanders cannot be over-emphasised - 98% of the 27 million km<sup>2</sup> under the jurisdiction of Pacific Island countries and territories is ocean. The greatest resource for many of these large ocean states is tuna and it is in demand worldwide, with landings of four species from the Western and Central Pacific Ocean (WCPO) (skipjack, yellowfin and bigeye tuna and South Pacific albacore) making up around 70% of the global tuna catch.

Pacific Island countries and territories (PICTs) rely on tuna for economic development, food security and employment. Six PICTs derive at least 40% of all government revenue from tuna fishing licence fees; >25,000 full-time jobs have been created based on tuna; and across the region an additional 100,000 tonnes of fish will be needed for food security by 2030.

Existing studies show that changes in sea surface temperature and other features of the ocean will drive the distribution of tuna species in the WCPO progressively to the east. Finding out how climate change will alter the proportion of tuna catches made within the exclusive economic zones (EEZs) of PICTs, and in high seas areas, is essential for continued sustainable management of this valuable regional resource.

Just as critical is understanding the number, distribution, size and behaviour of tuna stocks. This information will provide a stronger foundation for the stock assessments needed to set sustainable catch limits and harvest strategies, as well as establish a new basis for assessing the effects of climate change on the distribution and abundance of the four tropical tuna species.

**The Impact of climate change on tropical tuna species and tuna fisheries in Pacific Island waters and high seas areas<sup>1</sup>** and the companion report **Current knowledge, key uncertainties and future research directions for defining the stock structure of skipjack, yellowfin, bigeye and South Pacific albacore tunas in the Pacific Ocean<sup>2</sup>** address both areas.

## Key findings

The key findings of the report on the impact of climate change on tropical tuna species and tuna fisheries in Pacific Island waters and high seas areas are:

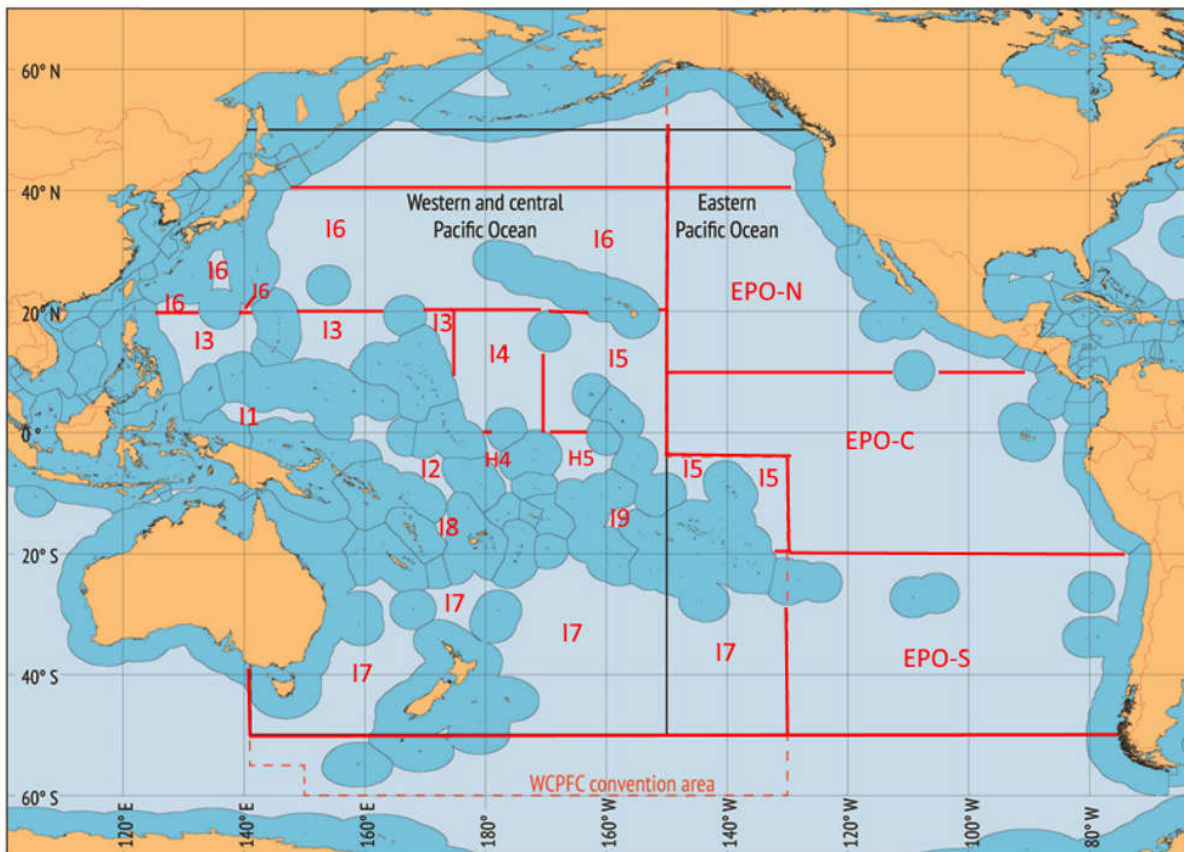
- climate change is already affecting the ecology and behaviour of tuna in the WCPO;
- the latest climate change modelling is showing that the distributions of tropical tuna

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<sup>1</sup> Senina, I., Lehodey, P., Smith, N., and Hampton, J., et al. 2018. Impact of climate change on tropical tuna species and tuna fisheries in Pacific Island waters and high seas areas. Final Report (CI-3) for Conservation International project SAN 6003922.

<sup>2</sup> Moore, B., Hampton, J., Pilling, G., and Smith, N., et al. 2018. Current knowledge, key uncertainties and future research directions for defining the stock structure of skipjack, yellowfin, bigeye and South Pacific albacore tunas in the Pacific Ocean. Final Report (CI-3) for Conservation International project SAN 6004150.

- species are expected to move eastward;
- changes in the relative abundance and distribution of skipjack, yellowfin and bigeye tuna will affect the benefits to the economies of PICTs derived from purse-seine fishing; and
- there will be winners and losers in the short-term (until 2050):
  - the relative abundance of skipjack and yellowfin tuna in the EEZs of PICTs west of 170°E (e.g., Federated States of Micronesia, Marshall Islands, Nauru, Palau, Papua New Guinea, Solomon Islands) and in international waters (high seas) areas I1, I2 and H4 (Figure 1) are projected to decline
  - the relative abundance of tuna species is expected to increase in the EEZs of most (but not all) PICTs east of 170° (e.g., Cook Islands, Fiji, French Polynesia, Kiribati, Niue, Samoa, Tonga, Vanuatu) and in all other high seas areas (Figure 1).



**Figure 1:** Map of the exclusive economic zones of Pacific Island countries and territories, and International Water (IW) high seas areas, for the tropical Pacific Ocean.

## Impact on Pacific Island economies

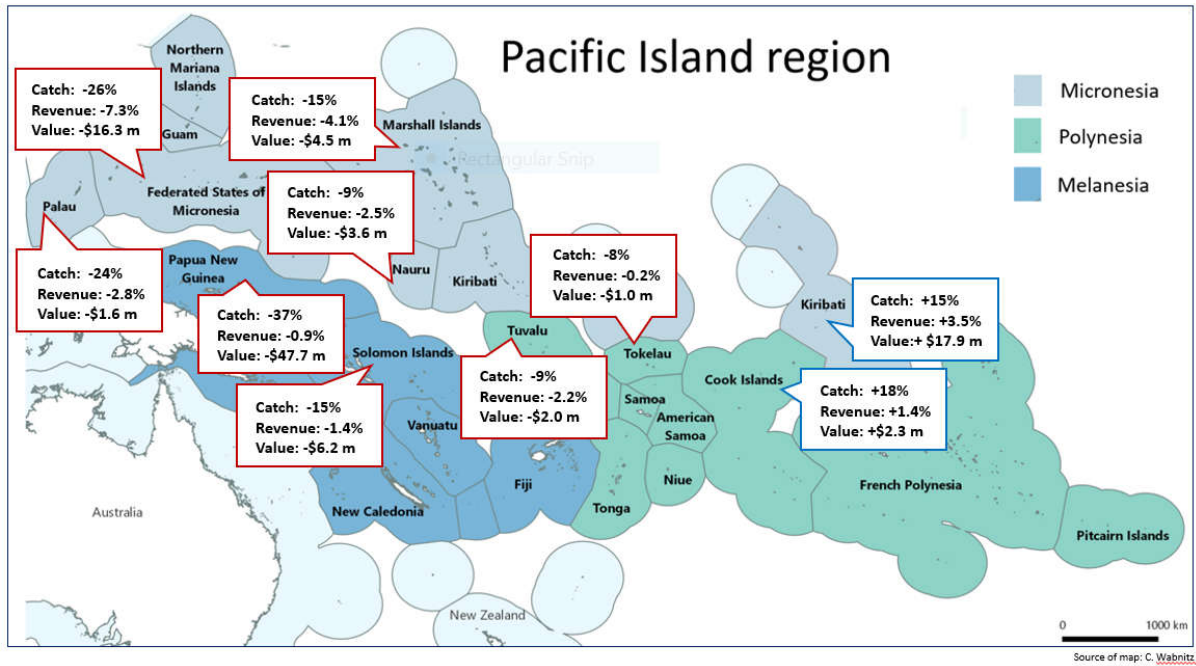
Analysis of the ecosystem modelling and economic data suggests:

- the decreases in relative abundance of tuna in the EEZs of eight of the 10 PICTs which supply 95% of all tuna caught in the Pacific Island region (Federated States of Micronesia, Palau, Papua New Guinea, Marshall Islands, Nauru, Solomon Islands, Tokelau and Tuvalu) are expected to cause proportional declines in the contributions of purse-seine fishing licence fees to total government revenue (Figure 2);
- two countries (Kiribati and Cook Islands) with EEZs further to the east than the other eight PICTs are expected to gain licence revenue until 2050 (Figure 2); and
- overall, the total annual value of fishing licence revenue for all 10 PICTs combined in today's terms is expected to decrease from \$465 million to \$403 million, i.e., >\$60 million per year (Appendix 1).

## Implications for fisheries management

Analysis of the ecosystem modelling output through a governance lens suggests:

- WCPFC and the Inter-American Tropical Tuna Commission (IATTC) may need to assume more responsibility for sustainable management of tropical Pacific tuna resources as tropical tuna species move eastward into high seas areas;
- Overfishing is still the greatest threat to the industrial tuna fisheries in the WCPO during the first half of this century;
- During the decades ahead, the combination of warming sea surface temperatures, and shifting food webs and spawning areas, are expected to play a larger role in determining the abundance of tuna stocks;
- All fisheries management agencies will benefit from reducing the uncertainty associated with determining how climate change is most likely to affect the abundance of tuna resources, and how the effects of climate change are likely to interact with the effects of fishing on tuna resources; and
- priority investments to reduce this uncertainty involve:
  - identifying the number, distribution, size and behaviour of stocks of each species of tuna across the entire tropical Pacific basin;
  - using the improved understanding of stock structure in stock assessments; and
  - modelling the effects of climate change on each stock to determine what if any changes in management might need to be considered to incorporate the effects of climate change on the growth, survival and distribution of fish comprising each tuna stock.



**Figure 2:** Projected percentage change in the combined catch of skipjack, yellowfin and bigeye tuna, and the contributions of fishing licence fees to total government revenue, in the exclusive economic zones of the 10 Pacific Island countries and territories (PICTs) that produce 95% of the tuna in the Pacific Island region. Projected changes to the value of licence revenue in present-day terms are also shown. Red indicates PICTs where decreases are expected; blue indicates PICTs where increases are expected.

### Recommended adaptations

In many ways, Pacific Island countries are already leading the way in adapting the management of tuna to climatic variability and climate change. The sound management practices across the region which have ensured that none of the four species of tuna are overfished, and that over fishing is not occurring, help to ensure that climate change impacts are not exacerbated by fisheries. In addition, the purse-seine vessel day scheme operated by the Parties to the Nauru Agreement (PNA) is one of the best examples worldwide of rights-based management that adapts to changing stock distributions over time.

Additional adaptations that promise to help maintain the contributions of tuna fishing and processing to Pacific Island economies as tuna are redistributed progressively to the east include:

- finding ways to add value to tuna, thereby setting the stage for higher licence fees, which should help to maintain the present-day contributions of licence fees to government revenue even if fewer licence days are sold in the future;
- adding value to tuna to also increase the contributions of domesticated tuna fishing and processing to gross domestic product;
- planning for future changes in the locations of transshipment of tuna catch, which could assist Kiribati and Cook Islands to create new service industries based on tuna;

- developing more energy-efficient tuna fishing operations, particularly if national fleets need to fish further afield as tuna distributions change, both to reduce greenhouse gas emissions and to make fleets more resilient to inevitable increases in oil prices;
- establishing negotiations to assist Pacific Island countries to maintain the rights to manage tuna stocks displaced from their waters by climate change, noting that this adaptation will be underpinned by the recommended investments to identify the spatial structure of tuna stocks and modelling the responses of each stock to climate change.

The final adaptation is considered the most pressing and important at a regional scale – given the extraordinary dependence that PICTs have on tuna for economic development, employment and food security, it is essential that these small island developing states maintain jurisdiction over the tuna currently caught from their waters, regardless of where the tuna move in response to climate change.



**Appendix 1:** Projected changes in licence revenue from the purse-seine fishery, in terms of dollar value and as a percentage of all government revenue, in 2050 relative to 2016 due to the effects of climate change on the combined biomass of skipjack (SKJ), yellowfin (YFT) and bigeye (BET) tuna in the exclusive economic zones (EEZs) of 10 Pacific Island countries and territories (PICTs).

PICT (EEZ)	2016			Change (%) in combined biomass of SKJ, YFT & BET tuna by 2050**	2050			Change 2016-2050	
	Total Gov't revenue (USD m)	Tuna licence fee revenue (USD m)*	Contribution of licence fees to total Gov't revenue (%)		Total Gov't revenue (USD m)	Tuna licence fee revenue (USD m)	Contribution of licence fees to total Gov't revenue (%)	Tuna licence fee revenue (USD m)	Contribution to total Gov't revenue (%)
<b>EEZ west of 170E</b>									
FSM	133.9	63.2	47.2	-26	117.6	46.9	39.9	-16.3	-7.3
Marshall Islands	64.7	29.2	45.1	-15	60.2	24.7	41.0	-4.5	-4.1
Nauru	56.0	27.8	49.6	-9	53.4	25.2	47.1	-2.6	-2.5
Palau	50.7	6.8	13.4	-24	49.1	5.2	10.6	-1.6	-2.8
Papua New Guinea	5366.7	128.8	2.4	-37	5319.0	81.1	1.5	-47.7	-0.9
Solomon Islands	411.9	41.6	10.1	-15	405.7	35.4	8.7	-6.2	-1.4
<b>EEZ east of 170E</b>									
Cook Islands	143.8	12.8	8.9	18	146.1	15.1	10.3	2.3	1.4
Kiribati	217.5	118.3	54.4	15	235.4	136.2	57.9	17.9	3.5
Tokelau	13.6	13.3	98.0	-8	12.5	12.3	97.8	-1.0	-0.2
Tuvalu	39.0	23.4	60.0	-9	37.0	21.4	57.8	-2.0	-2.2
<b>Total</b>		465.2			403.5				

\*Source: Pacific Islands Forum Fisheries Agency; \*\* based on modelling of effects of climate change on virgin biomass.