Chapter 5
Impact of Climate Change on Regional Tuna Fisheries

Climate change is likely to affect regional tuna fisheries in two major ways: by raising average ocean surface temperatures to levels currently experienced during medium-intensity El Niños (Timmermann and others 1999) and by increasing year-to-year climate variability. Such change may not have an equivalent today. The impacts are likely to be pervasive, affecting the distribution, abundance, and catchability of tuna fisheries (box 5):

- *Decline in primary productivity.* Primary productivity in the central and eastern Pacific would decline due to the increased stratification between warmer surface waters and colder deeper water (and consequent reduction in upwelling). Productivity in the western Pacific could rise.
- *Decline in tuna abundance*. The decrease in upwelling would lead to a decline in the bigeye and adult yellowfin population (the species targeted by the longline fleet). The abundance of purse seine–caught skipjack and juvenile yellowfin is not expected to be affected.
- *Increased pressure on longline fishing.* Given the continued high demand for sashimi and the possibility that prices may rise with a decline in catches, it is likely that longline fishing pressure on adult yellowfin tuna will increase to compensate for

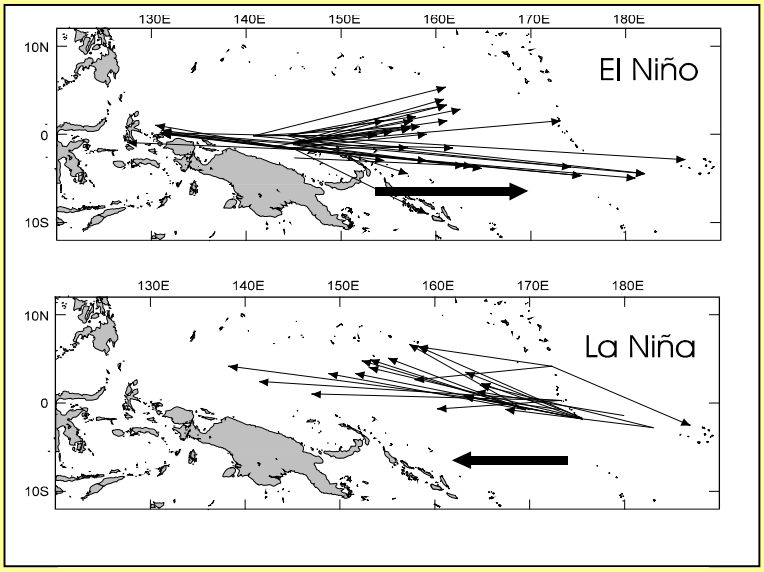
Box 5. Tuna Fisheries and Climate Variability

The distribution of tuna fisheries is affected by the location of the Western Pacific Warm Pool (WPWP), an area of warm surface waters (more than 28°C) that produces virtually all of the tuna caught by purse seine (a fishing method used to collect surface tuna for canning), while catch of tuna by longline (a method used to collect deep water tuna for the *sashimi* market) is more widely distributed over the whole tropical and sub-tropical Ocean. By itself the WPWP is nutrient poor. By contrast, the colder waters of the central equatorial Pacific generate an upwelling of colder, nutrient-rich waters. These two ocean areas meet in a zonal band called the "cold tongue," the primary productivity of which is strongly affected by ENSO variability. During El Niño years the WPWP can extend eastward into the central Pacific by nearly 4,000 kilometers.

Tuna fisheries, particularly skipjack fisheries, move with the WPWP. During El Niño years, countries in the Central Pacific, such as Kiribati and Samoa, experience higher purse seine catches. Countries in the Western Pacific, such as the Solomon Islands and Marshall Islands, enjoy higher catches during La Niña years.

In addition to this geographical displacement, El Niño also influences the abundance of tuna. El Niño years tend to result in higher than average abundance of skipjack a few months later, while La Niña years generally result in higher abundance of adult albacore in the subsequent years. Yellowfin and bigeye abundance are also likely influenced by the ENSO variability. However, as these species are more widely distributed and have extended spawning grounds in both east and west tropical Pacific, the relationship with ENSO is more complex.

Movement of Tagged Skipjack Tuna in the Central and Western Pacific



Source: Lehodey et al. (1997); Lehodey (in preparation)

the decline in adult bigeye abundance, leading to unsustainable exploitation if the fishery is not well managed.

- *Spatial redistribution of tuna resources*. The warming of surface waters and the decline in primary productivity in the central and eastern Pacific would result in a redistribution of tuna resources to higher latitudes (such as Japan) and toward the western equatorial Pacific.

- *Increase in climate variability*. Climate change could increase the intensity and frequency of annual climate variability (Jones and others 1999). The likely impact would be an increase in the annual fluctuations of the spatial distribution and abundance of tuna. It is possible that more frequent cold events (such as strong La Niña episodes) could compensate for the decrease in productivity under an El Niño mean state. In addition, even though it is difficult to know what a strong El Niño would mean in the future (box 6), it is likely that such an extreme event could lead to a dramatic decline in productivity in the eastern Pacific.

Box 6. The Likely Future Climate

Likely future climate	***Correspondence with present climate***
Mean state	Moderate El Niño
Moderate El Niño event	Strong El Niño event
Strong El Niño event	Unknown, extremely warm event
Moderate La Niña	Current mean state
Strong La Niña	Moderate La Niña

- *Higher impact on domestic fleets.* Distant water fishing fleets should be able to adapt to changes in the spatial distribution and abundance in tuna stocks. But domestic fleets would be vulnerable to fluctuations of tuna fisheries in their Exclusive Economic Zones. Countries in the central Pacific, such as Kiribati, are likely to be more adversely affected than those in the west. Kiribati's high dependence on tuna fisheries renders it the more vulnerable to these changes, and points to the need to closely collaborate with other coastal states in minimizing the impact of year-to-year fluctuations.