

## CASE STUDY: Fish populations respond to climate conditions

Fishing is a way of life in the Pacific Islands. Subsistence fishers ply the waters of every inhabited and many uninhabited shores, seafood consumption is high, providing a primary protein source, and fishing is prominent in cultural traditions. There are many stories, chants, and songs about fish and fishing throughout the Pacific region. In Polynesia, the most famous perhaps are those of Maui and his legendary fishing hook.

In addition to their importance to traditional practices and food security for island communities, open-ocean fish populations in the Pacific play an increasingly dominant role in global fish production. The Western Pacific Regional Fishery Management Council estimates the annual catch of skipjack tuna (*Katsuwonus pelamis*), yellowfin tuna (*Thunnus albacares*), bigeye tuna (*T. obesus*), and South Pacific albacore tuna (*T. alalunga*) at about 2.7 million metric tonnes. These tuna species are highly migratory and range throughout the Pacific, and adults tolerate a relatively wide range of conditions (Brill, 1994). Yet climatic conditions greatly influence the productivity and geographic range of Pacific tuna populations (Miller, 2007).

Tuna have been shown to respond to El Niño - Southern Oscillation (ENSO) events. Sea-surface temperature influences tuna productivity and optimal development through different life stages (Lehodey et al., 1997; Lehodey 2001; Lu et al., 2001). ENSO-related shifts create a disadvantage for local fishers who, unlike large-scale commercial fleets, cannot follow the tuna to more productive waters thousands of miles away.

Due to projected ocean warming and other climate-associated changes in marine ecosystem productivity, it is projected that over the 21st century tuna distributions “are likely to shift progressively towards the central and eastern Pacific” (Bell et al., 2011). Currently, in the Western North Pacific sub-region, the domestic tuna fisheries of Federated States of Micronesia and the Republic of the Marshall Islands are valued at US\$2.67 million and \$2.44 million annually, respectively (Bell et al., 2011). The contribution of tuna fisheries to these economies may well lessen as the projected shift in populations takes place.

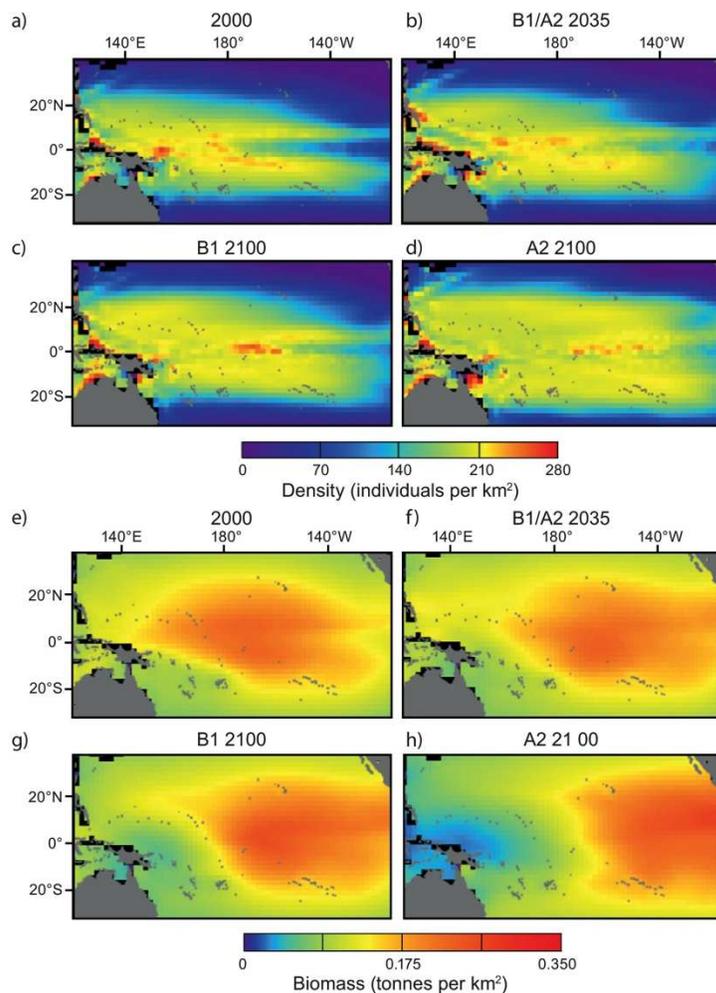
*Oh the great fish hook of Maui!  
Manai-i-ka-lani 'Made fast to the  
heavens' its name;  
An earth-twisted cord ties the hook.  
Engulfed from the lofty Ka'uiki.  
Its bait the red billed 'Alae,  
The bird made sacred to Hina.  
It sinks far down to Hawai'i,  
Struggling and painfully dying.  
Caught is the land under the water,  
Floated up, up to the surface,  
But Hina hid a wing of the bird  
And broke the land under the water.  
Below, was the bait snatched away  
And eaten at once by the fishes,  
The Ulua of the deep muddy places.*

**“Chant of Kualii’l,” ca. 1700AD  
(Westervelt, 1910)**



**Fish hook collection, Bishop Museum, Honolulu, HI. Photo (entitled, “hooked”) courtesy of Debbi Hunt, available under a Creative Commons (BY-NC-SA) license.**

**Figure 4.15. Projected distributions (density) for skipjack tuna larvae recruits from the SEAPODYM model (a) in 2000; (b) under the B1/A2 emissions scenario in 2035; (c) under B1 in 2100; and (d) under A2 in 2100. Also shown are estimates of total biomass (tonnes per km<sup>2</sup>) of skipjack tuna populations based on average (1980–2000) fishing effort in (e) 2000; (f) under B1/A2 in 2035; (g) under B1 in 2100; and (h) under A2 in 2100. Figure used with permission, from Lehodey et al. (2011).**



The complexity of marine ecosystems makes it difficult to predict how climate change will alter discrete “strands” of the food web upon which tuna and other large pelagic fish depend. There are indications that, in addition to change in sea-surface temperature, changes in ocean circulation and ocean chemistry will heavily influence productivity throughout the region (Le Borgne et al., 2011; Polovina et al., 2011). By the end of this century, the total primary production and fish catch is projected to increase by 26% in the subtropics and decrease by 38% and 15% in the temperate and the equatorial zones, respectively (Polovina et al., 2011). This projected decrease, in combination with shifting fish populations, may have a significant and unequal economic impact on Pacific Island sub-regions. One cannot place a monetary value, however, on how these projected changes in pelagic fisheries will impact the Pacific Island way of life.