

Global Warming Could Have a Tremendous Effect on the World Fisheries Production

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Abstract: A new evidence for the regime shift has been found as to the tuna populations in the northwest Pacific to show that the regime shift is the universal principle throughout fish groups not only at lower trophic levels but at higher levels. The regime shift has been driven by the cyclic climate change resulting from a shift in the patterns of overturning in the northern North Atlantic. Global warming may shut down one of the two downwelling sites linked to formation of the North Atlantic Deep Water, NADW, and destroy the system of regime shift itself.

Key words: regime shift, tunas, 65-70-year cycle, thermohaline circulation, North Atlantic Oscillation, global warming

1. REGIME SHIFT AS A UNIVERSAL PRINCIPLE

Although regime shift, cyclic structural shift on the global, interdecadal, scale of the climate-marine ecosystem, has been widely recognized for the marine populations at the lower trophic levels such as zooplankton, sardines, anchovies and herrings, it has been deemed that fishes at the higher levels like tunas are not directly influenced by the climate change but their biomass is controlled density-dependently through the regulation of fishing effort (Kawasald, 1999).

In order to examine if the tuna populations are really resistant to the climate change, I have analyzed data for the Japanese small-scale tuna longline fishery operated by fishing boats under a tonnage of 20 in the northwestern Pacific Ocean (Kawasaki, unpublished). Figure 1 shows interannual changes in catch per day's fishing (three-year running mean) of four tuna populations between the years 1974 and 1997, which reveal that the biomass of the bluefin and albacore was at a low level in the mid to late 1980s but has been increasing since around 1990, while that of the bigeye and yellowfin had peaks at around 1990 with decreasing thereafter. The changes in biomass of the bluefin and albacore and those of the bigeye yellowfin are almost in phase but of different sign.

The relation between the fluctuation pattern of the former two populations and that of the latter two is similar to that between herrings and sardines which occur throughout the world oceans (Kawasaki, 1991). The new evidence for the regime shift as to the fishes at higher trophic levels strongly suggest that the climate change has a direct impact on even the piscivorous fishes, without passing through the food chain, showing that the regime shift is a universal principle which is common to most fish groups.

2. MECHANISMS CONTROLLING THE REGIME SHIFT

Tsuboi (1986/87) in the Far Eastern sardine and Baumgartner et al. (2000) in the Californian sardine documented very long-term variability and found a significant peak at a period of 65-70 years. Schlesinger and Ramankutty (1994) analysed global mean temperature records and identified a temperature oscillation with a period of 65-70 years which is the results of oscillations for the North Atlantic Ocean. It was suggested that the oscillation arises from predictable internal variability of the ocean-atmosphere system.

According to Dickson et al. (1996), a convective renewal of intermediate and deep waters in the Greenland Sea and Labrador Sea contributes significantly to the production and export of north Atlantic Deep Water (NADW), thus helping to drive the global thermohaline circulation. The intensity of convection at each of the two sites and the hydrographic character of their products have been subject to major interdecadal change. The evolution of winter convective activity was in phase but of different sign at the two sites. There is a strong evidence of a direct impact of the shifting atmospheric circulation on the ocean, which is the ocean's response to forcing by the North Atlantic Oscillation, NAO.

The NAO is a large-scale alternation of atmospheric mass between the Icelandic Low and the Azores High centers of action. The index of NAO variability is the difference in pressure between its two cells, measured between Iceland and Azores, which shows signs of a 70-year period (Figure 2). The global synchrony of variations in many fish groups throughout the trophic levels is supposedly driven by fluctuations in the formation rate of the NADW.

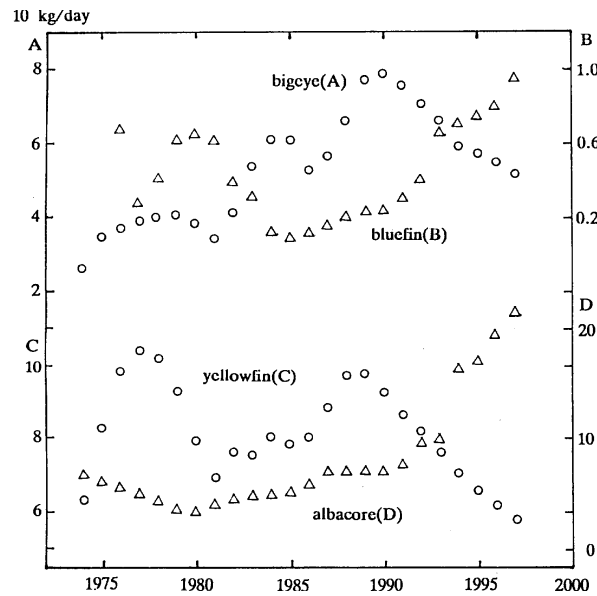


Figure 1. Interannual change in cpue (3-year running mean) of the four tuna populations in the northwest Pacific between the years 1974 and 1997 (Kawaski, unpublished).

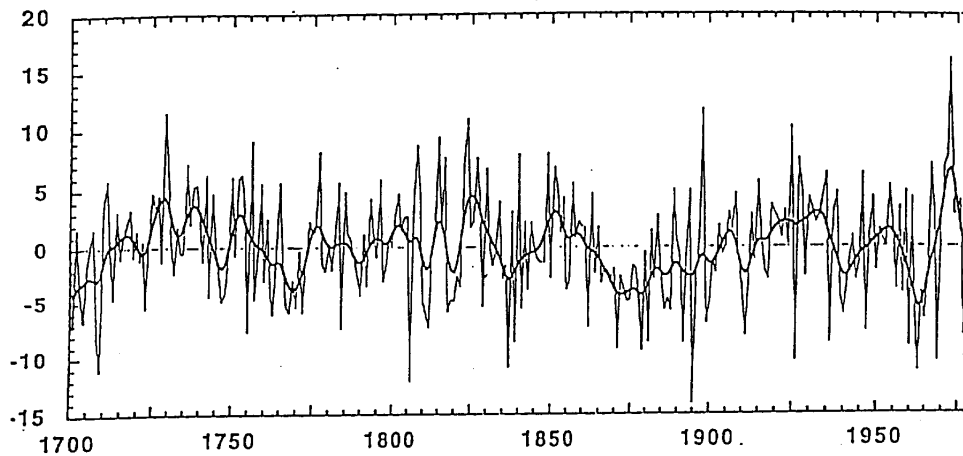


Figure 2. The winter NAO index reconstructed from tree rings. Source: Dickson et al. (1996)

3. GLOBAL WARMING WILL DISRUPT THE ORDER OF NATURE

Rahmstorf (1990) stated that global warming could switch off one of the two main sites of convection linked to the formation of NADW in the Greenland Sea and in the Labrador Sea. Global warming is expected to warm the surface waters and increase precipitation in higher latitudes, both of which reduce water density and move the Atlantic closer to the threshold.

The crucial question is how closer? Wood et al. (1999) simulated the shutdown in Labrador Sea convection and the

associated collapse of the Labrador Current, which occur between the years 2000 and 2030. The regime shift has been driven by the cyclic climate change resulting from a shift in the patterns of overturning in the northern North Atlantic. Global warming could have a tremendous effect on the regime shift and in turn on the fisheries production throughout the world oceans.

A suggested pathway which begins with the global warming and ends in the decline in fisheries production is indicated in Figure 3.

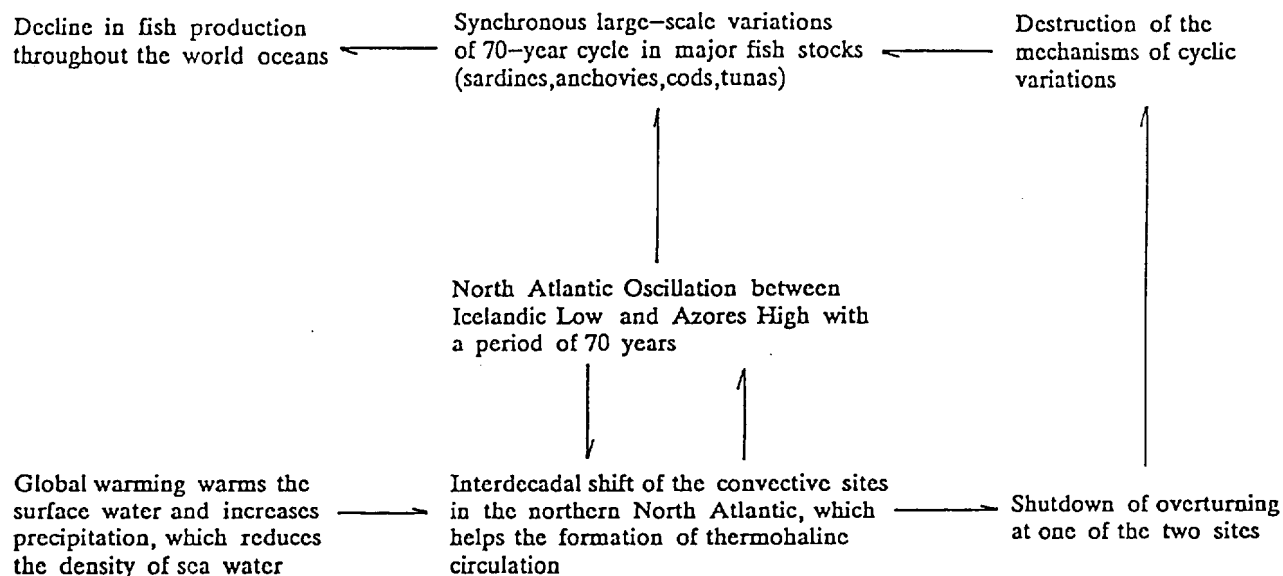


Figure 3. A pathway beginning with global warming and ending in decline in fish production throughout the world oceans.

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