

Possibilities of GGOI in the Ecuadorian waters affecting by the Humboldt Current derived from the Antarctic Ocean

○Mikio Naganobu^{1,2}, Telmo De la Cuadra², Mario Hurtado Dominguez², Alvaro Romero², Masafumi Yagi³ and Kunio Kutsuwada³

¹JICA, ²Instituto Nacional de Pesca, Ecuador, ³Tokai University, Japan

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El Niño / La Niña events (ENSO) occur in the Ecuadorian waters. The Humboldt Current derived from the Antarctic Ocean and the Panama Current from the northern part meet at the waters and the Equatorial Front is formed. Both ocean currents flow west as the South Equatorial Current with countercurrent (Figure 1). These dynamic oceanic environments strongly influence marine ecosystems and ultimately the fishery (Jiménez 2008; De la Cuadra 2010; Ormaza-González *et al.* 2016). In Galapagos Islands, the Galapagos penguins decrease according to the El Niño event (Boersma 1998) (Figure 2). Pinchagua (Pacific thread herring, *Opisthonema* spp.), a coastal catch species, has a strong correlation with PDO (Pacific Decadal Oscillation) (Figure 3). The sustainably accumulated Ecuadorian fishery data are valuable on ecological changes in the waters (Romero *et al.* 2018).

Ecuadorian fishing grounds are affected by the amplitude of the north-south variation of the Equatorial Front. The Equatorial Front phenomenally corresponds to fluctuations in the power of the Humboldt Current. However time series data on the ocean is limited. Therefore, focusing on atmospheric variation, we devised Guayaquil - Galapagos Oscillation Index (GGOI); strength of surface winds determined from sea-level pressure differences between Guayaquil (data; Jan 1962 - Dec 2016) and Galapagos Islands (Baltra Is. data; Jan 2004 - Dec 2016). The distance between both stations have about a thousand kilometers wide. This is the same distance as the Drake Strait located between the South American continent and the Antarctic Peninsula. We apply the idea of DPOI (Drake Passage Oscillation Index) (Naganobu *et al.* 1999).

GGOI showed extremely characteristic variation (Figure 3). It suddenly declined in 2006 and lasted low. It rose sharply in 2015 and returned to before 2006. It is difficult to show the result of clear fluctuation because the data period is short at the present time. On the other hand, variability of GGOI is similar to PDO. GGOI is nearly identical to the Ecuadorian Front. Given the high correlation between PDO and pinchagua variation, GGOI is likely to be an ideal environmental index on the regional scale between Guayaquil and Galapagos. Based on sustained data collection and analysis in the future, it can be expected that the effectiveness of GGOI will be clarified. Particularly for the fisheries ecosystem affecting by the Humboldt Current, GGOI has the possibilities to be a specific variation index as the lower waters of the Antarctic Ocean.

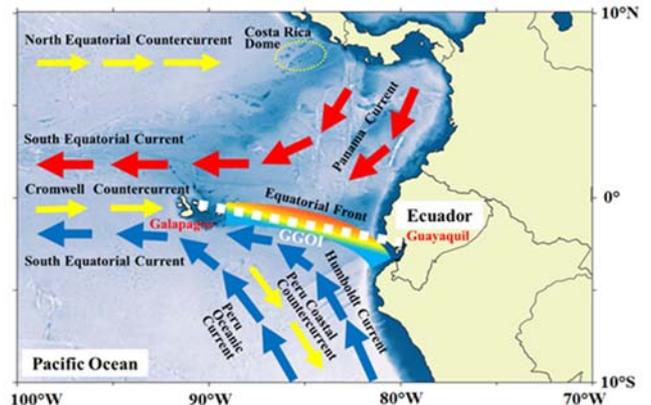


Figure 1: The Ecuadorian waters have a typical El Niño event. The waters are characterized the formation of the Equatorial Front which encounters the Humboldt Current from the Southern/Antarctic Ocean and the Panama Current from the north. The Equatorial Front and GGOI show almost the same position.

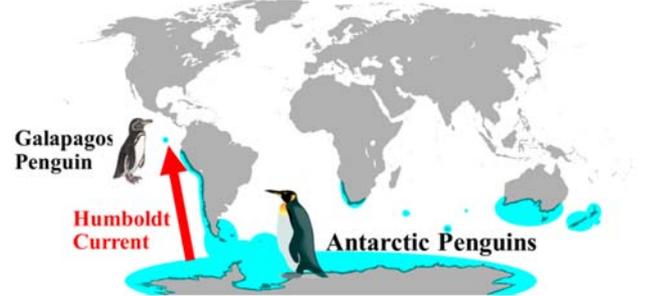


Figure 2: The waters of the Galapagos Islands where Galapagos penguins inhabit are closely related to the Antarctic Ocean through the Humboldt Current. Breeding patterns of penguins are adversely affected by El Niño events (Boersma 1998).

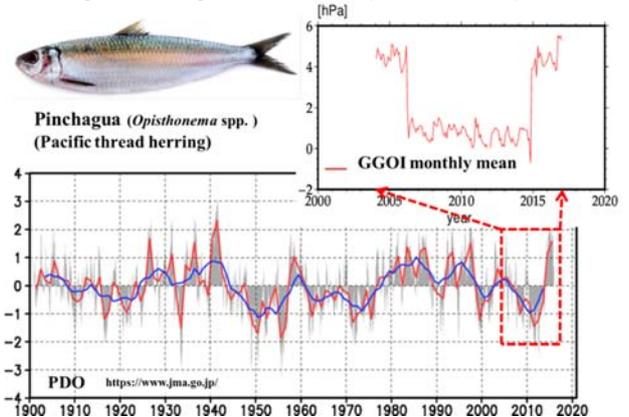


Figure 3: These dynamic marine environment effects strongly influence the marine ecosystem and eventually the fishery (Jiménez, 2008). Reproductive factor (sexual maturity) of Pinchagua, Pacific thread herring (*Opisthonema* spp.) is strongly affected by PDO fluctuation (De la Cuadra 2010). GGOI has possibilities of a variation index in the Ecuadorian waters.