

## The possible influence of climate variability and fishing activity on the annual fishing conditions of Grey mullet (*Mugil cephalus* L.) in the Taiwan Strait

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The Grey mullet (*Mugil cephalus* L.) is a cosmopolitan species that is distributed in tropical and temperate zones at latitudes 42°N–42°S (Thomson 1963). It is one of the most important commercial species of fish in the coastal fisheries of Taiwan. A cohort analysis was performed to estimate the population number and instantaneous rate of fishing mortality by age of Grey mullet in the Taiwan Strait (TS) in 1958–2004. Since 1986, annual catches considerably dropped and continually remained at an extremely low level during the period despite the high fishing intensity. The population number of Grey mullet aged > 4 y has declined since 1986 and decreased to 20 000 individuals in 2004, constituting only 0.01% of the maximum level in 1981. The Grey mullet stock probably lost the reproductive potential because of severe recruitment overfishing since 1960s. Overexploitation of the Grey mullet stock reduced its spawning biomass to age 3–4-y groups, and environmental changes during the past 2 decades have likely driven the stock to consecutive years of poor recruitment and its current low level in the TS. Based on a long-term variability of sea surface temperature (SST) in the TS, it implied that variations of SST in winter caused by climate variability and climate change have a major role in affecting the abundance and migration behavior of Grey mullet in the TS.

The long-term unique long-term (1967–2009) records of catch per unit effort (CPUE) of Grey mullet in the TS was further used to investigate the influences of multi-timescale climatic indices on the annual catch of grey mullet. The CPUE of Grey mullet showed fairly good correspondence with the annual PDO index ( $R^2 = 0.82$ ,  $p < 0.01$ ). The PDO may play a role in affecting the migration of grey mullet, but increases in SSTs may be a main reason for the decreased catches after 1980.

This study is to estimate exploitable biomass and recruitment of grey mullet stock in the Taiwan Strait. Cohort analysis was employed to estimate population number and the instantaneous rate of fishing mortality (F) by age for 1958–2004. The population number of grey mullet in the Taiwan Strait decreased from late 1960s to early 1970s due to the high instantaneous rates of fishing mortality in 1960s. Since 1986, annual catches sharply dropped and continuously remained at a very low level these years despite of the high fishing intensity, which indicates that overfishing has existed since 1960s. The population number of age group over age 4 has decreased since 1986 and reduced to be 20 thousand individuals in 2004, which is only 1/100 of the maximum level of 2 million individuals in 1981. It seems that the grey mullet stock has lost the reproductive ability due to the severe recruitment overfishing.

Keywords: Grey mullet, Climate change, Pacific Decadal Oscillation, Cohort analysis, Wavelet analysis