# IMPLEMENTATION OF WAVELETS TO DETECTION OF FISH POPULATION

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## ABSTRACT

The influence of climatic oscillations (based on NAO and ENSO) on monthly catch rates of fish population such as blue fish and sea bass (pomatomus population between 1991-2008) were analyzed in Black Sea and Marmara Sea by wavelet transform (Wavelet 1-D and continuous wavelet 1-D) with DMeyer for 7-Levels. Wavelet analysis is an efficient method of time series analysis to study non-stationary data. Wavelet analyses allowed us to quantify both the pattern of variability in the time series and non-stationary associations between fish population and climatic signals. Phase analyses were carried out to investigate dependency between the two signals. We reported strong relations between fish stock and climate series for the 4- and 5-yr periodic modes, i.e. the periodic band of the El Niño Southern Oscillation signal propagation in the Black and Marmara Seas. These associations were non-stationary, evidenced from 1995 to 2008. Warm episodes matched increases of longline catch rates of bigeye during the 1970–1990 time frames, whereas the

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strong 1997–1998 warm event matched a decrease of purse seine catch rates of yellowfin. We discussed these results in terms of changes in catchability for purse seine and longline. The results of this study were compared with former harmonic analyses to explain seasonal effects of NAO and ENSO on fish population.

**KEYWORDS:** Time Series, Wavelet Analysis, ENSO, NAO.

## 1. INTRODUCTION

The influence of climatic oscillations [based on the Indian Oscillation Index (IOI)] on monthly catch rates of two tropical tuna species in the equatorial Indian Ocean was analysed by Menard and his group. In this study they carried out wavelet analysis, an efficient method of time series analysis to study non-stationary data. Catch per unit of effort (CPUE) of bigeye tuna was computed from Japanese longline statistics from 1955 to 2002 in the equatorial Indian Ocean and CPUE of yellowfin tuna was derived from industrial purse seine statistics from 1984 to 2003 in the Western Indian Ocean [1-8], Wavelet analyses allowed to quantify both the pattern of variability in the time series and non-stationary associations between tuna and climatic signals. Warm episodes (low negative IOI values) matched increases of longline catch rates of bigeye during the 1970–1990 time frame, whereas the strong 1997–1998 warm event matched a decrease of purse seine catch rates of yellow fin. Based on a wavelet transform, a new method referred to as maximal wavelet filter (MWF) is proposed to extract temporal structure changes of a climatic oscillation, which varies its pattern corresponding to the changes of the oscillation period by Minobe and his group, (2002). The MWF is a bandpass filter having a narrow pass band, the central frequency of which temporally varies according to the periods of maximal wavelet amplitudes for a specific region. The analysis of the sea surface temperatures (SSTs) gridded from the Comprehensive Ocean–Atmosphere Data Set (COADS) and the newly digitized Kobe collections suggests that BDO pattern in the SSTs also shifted toward the south between the first and last few decades of the twentieth century. Temporal variability of upwelling activity and primary production is examined for a southeastern Australian upwelling system off the Bonney Coast, Nieblas et al, (2009) [9],. Upwelling systems are generally characterized as having high productivity, high biomass, low biodiversity, and low numbers of trophiclink ages from primary to fish productivity. Movement behavior of *Chironomus samoensis* larvae was observed in response to the treatments of carbofuran, an anticholinesterase insecticide, at a low concentration (0.1 mg/l) in semi-natural conditions, Kime et al. (2006) [10], . Two typical movement patterns were selected before and after the treatments, and the variables characterizing movement tracks in two dimensions were analyzed by discrete wavelet transform (DWT) with Daubechie's 4 functions. They demonstrated that the combined use of the wavelets and artificial neural networks would be a useful tool for automatic behavioral monitoring for water quality assessment. Ocean climate, environmental and biological conditions vary on several spatio-temporal scales, (Tourre et al., 2007) [11]. Besides climate change associated with anthropogenic activity, there is growing evidence of a natural global multi-decadal climate signal in the ocean–atmosphere–biosphere climate system. The spatio-temporal evolution of this signal is thus analyzed during the 20th century and compared to the variability of small-pelagic fish landings.

The present paper is related with wavelet applications on two different fishes in Northern Aegean Sea, Marmara Sea and Western part of Black Sea.

## 2. MATERIAL AND METHODS

Monthly total fish stock of sea basses and blue fish recorded in between 1991-2008 have been analyzed. Data belongs to Northern Aegean Sea, Western Black Sea and Marmara Sea.

## 3. ANALYSES

### 3.1 ANALYSES OF SEA BASS POPULATION

Fig.1 (a) shows wavelet 1-D analyses of sea basses population. In recent years there is a significantly increasing trend of population. The years of 2002 and 2003 are El Nino Years. There is local minimum in this period. Fig. 1(b) shows a positive skewness of frequency histogram.

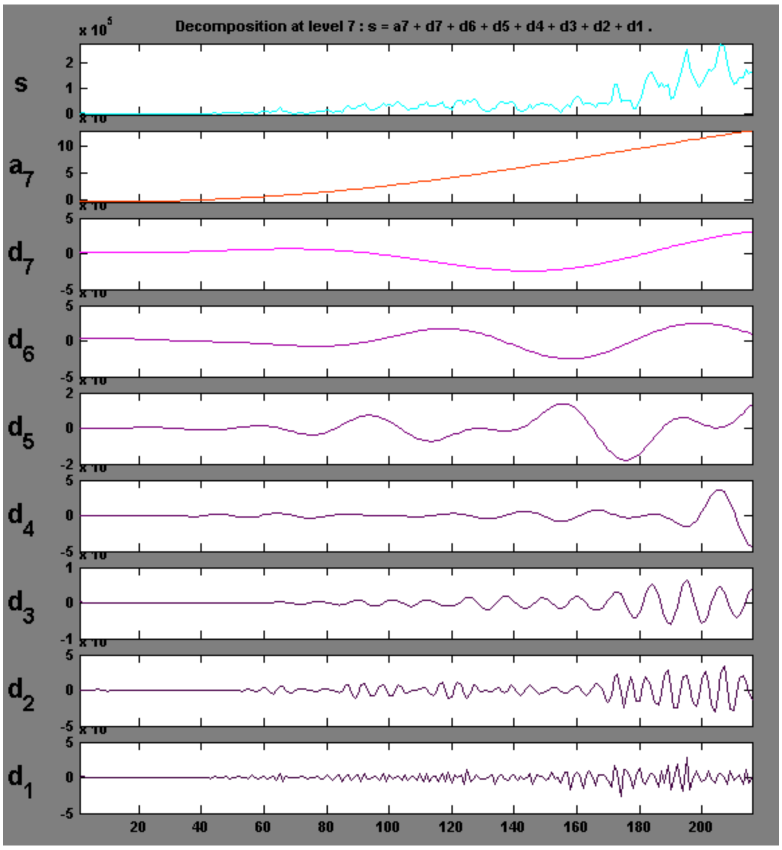
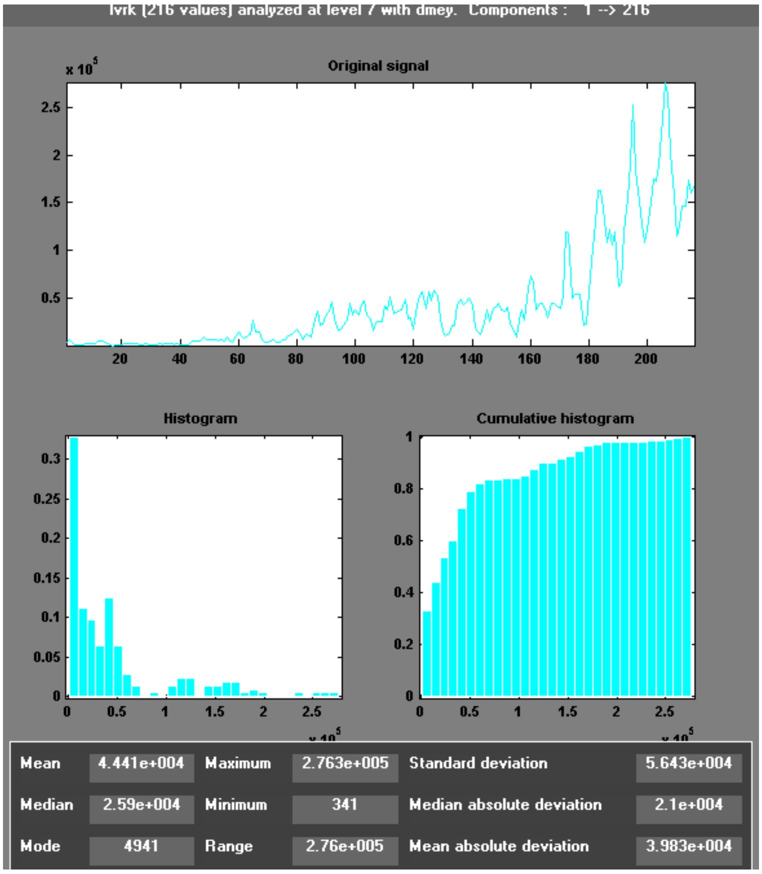


***Fig 1(a) Wavelet 1-D Analyses of Sea Bass Population, 1991-2008, DMayer, Level 1***



Mean 4.441e+004
Maximum 2.763e+005
Standard deviation 5.643e+004
Median 2.59e+004
Minimum 341
Median absolute deviation 2.1e+004
Mode 4941
Range 2.76e+005
Mean absolute deviation 3.983e+004

***Fig 1(b) Descriptive Statistics of Sea Bass Population.***

Periods between 1991-1992, 1994-1995, 1997-1998, 2002-2003 and 2006-2007 correspond to El Nino Years (Ref. 1). Strong major El Nino is observed in between 1197-1998 (Data No: 144). It is effect has been observed at the second part of the period, Fig. 1(c-d).

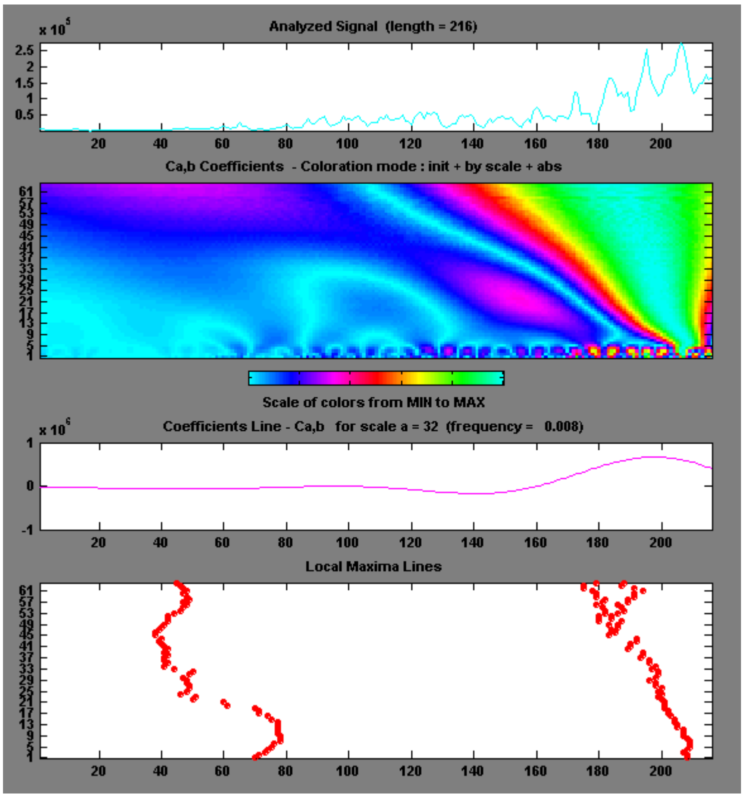


*Fig. 1(c) Continuous Wavelet 1-D Mexh, Sampling 1. Sea Bass Population, 1991-2008.*

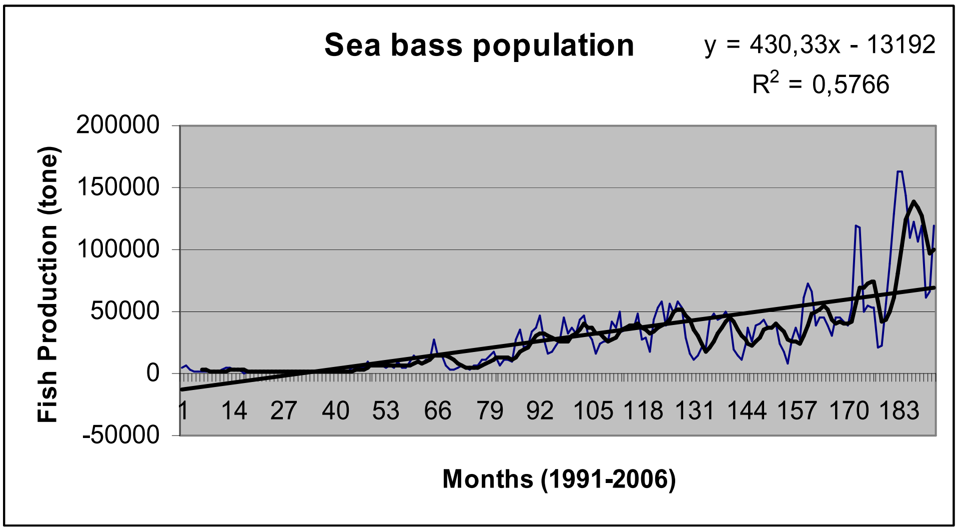


***Fig. 1(d) Moving Average of Sea Bass Population for lag=6months***

Fig. 2 shows monthly NAO variants between 1991 and 2006. Scattering diagram of NAO and Sea Bass present a negative relation, (Fig. 3, $\alpha$=0,10).

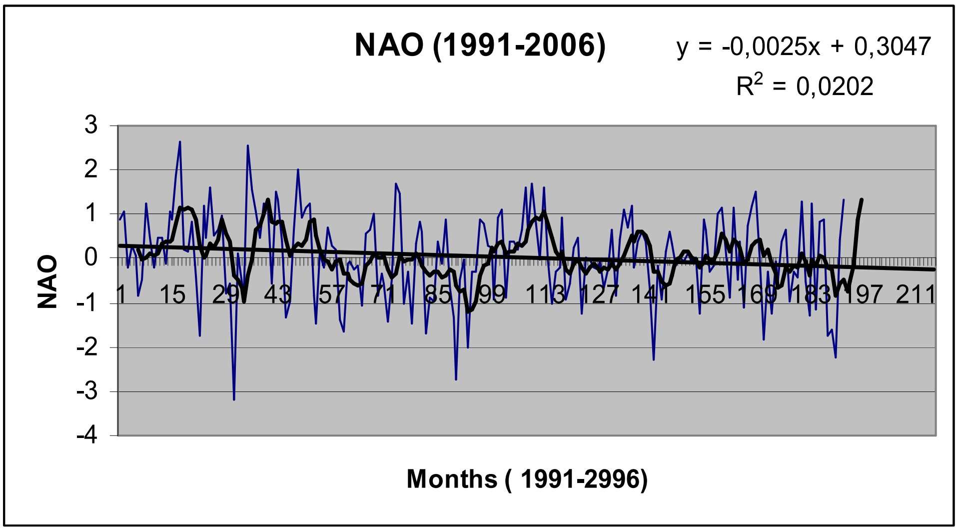


*Fig. 2- Moving Average of NAO values for lag = 6 months and linear trend approximation*

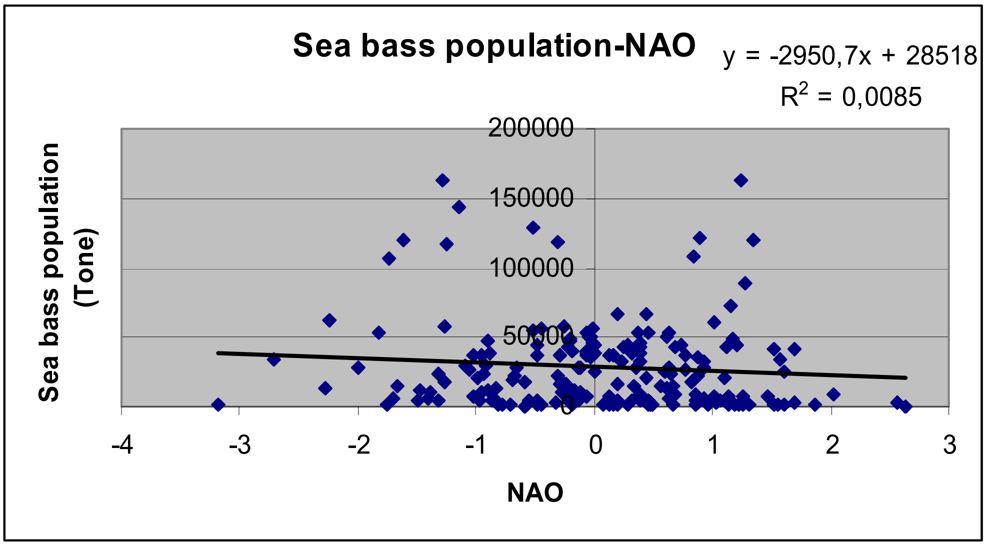


***Fig. 3 Scattering Diagram between NAO and Sea Bass Population (N=192).***

## 3.2 ANALYSES OF BLUE FISH POPULATION

Fig. 4(a) presents wavelet 1-D analyses of blue fish population on the other words stock values at different levels and continuously increasing trend.

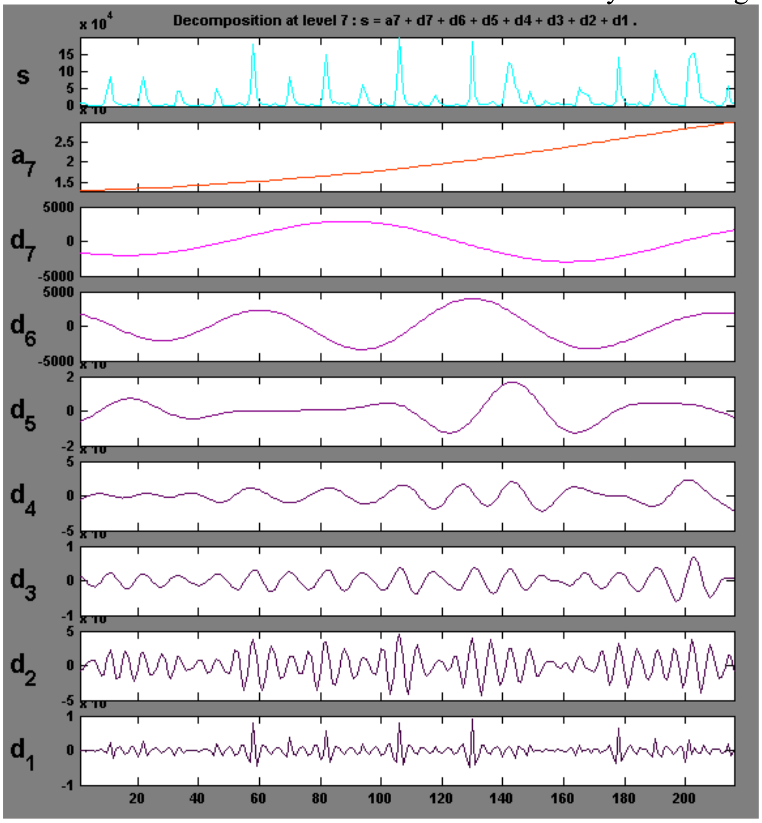
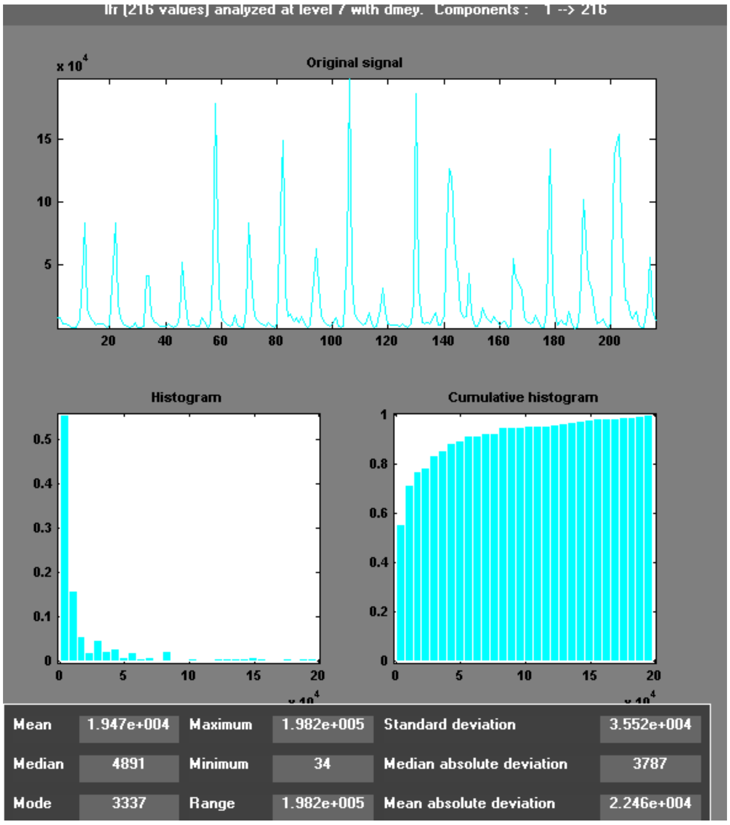


Fig. 4(a) Wavelet 1-D, Blue Fish Population Mexh: (DMeyer, Sampling 1)



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|---|---|---|---|---|---|
| Mean | 1.947e+004 | Maximum | 1.982e+005 | Standard deviation | 3.552e+004 |
| Median | 4891 | Minimum | 34 | Median absolute deviation | 3787 |
| Mode | 3337 | Range | 1.982e+005 | Mean absolute deviation | 2.246e+004 |

***Fig. 4(b) Descriptive Statistics of Monthly Blue Fish Population***

Fig. 4(b) shows a positive frequency histogram. Continuous Wavelet Analyses of blue fish population is presented at Fig.4(c). Long scale events play an important role on population. Data No: 144 correspond the strongest El Nino year (2002-2003). Slightly increasing trend of blue fish production has been observed between 1991 and 2008.

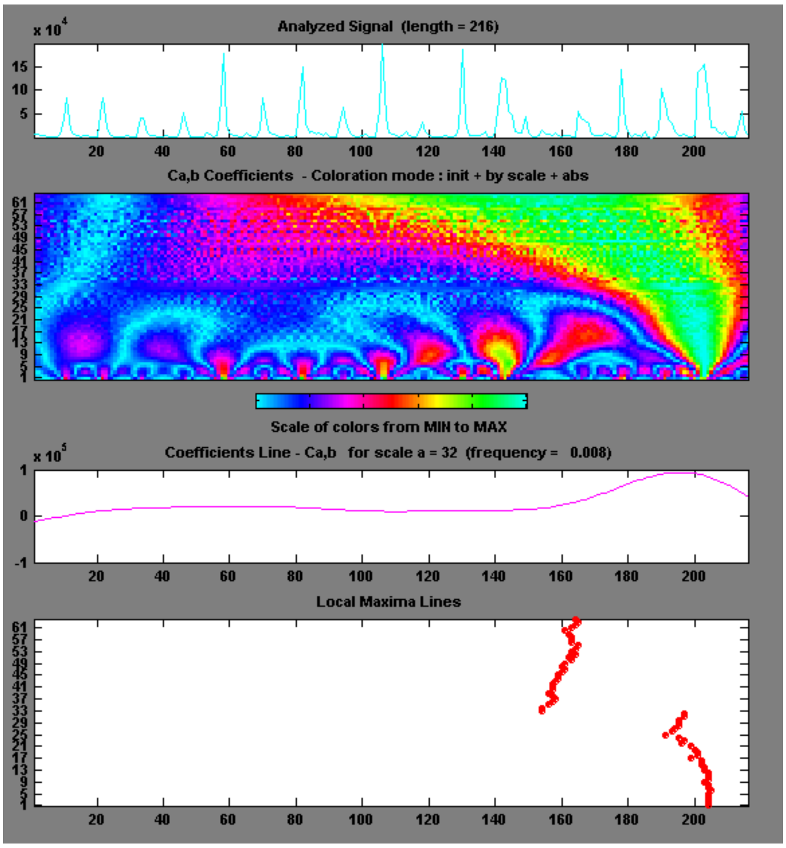

***Fig. 4(c) Continuous Wavelet 1-D of Blue Fish Population Mexh, Sampling 1.***

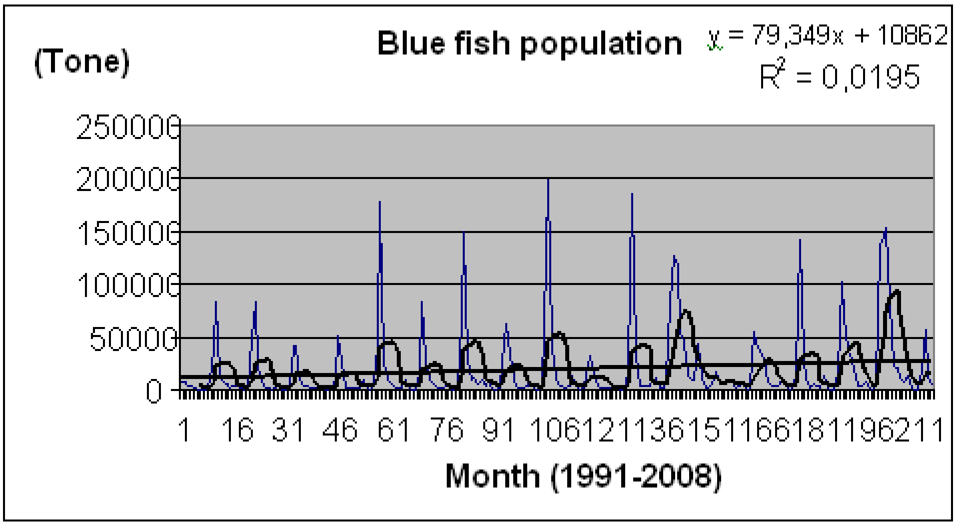

*Fig. 5 Monthly Varieties of Blue Fish Population between 1991-2008.*

Fig.5. presents moving average values and linear trend approximation of blue fish population. Negative linear correlation between NAO and fish production has been observed in Fig. 6, ($\alpha$=0,05). Negative effect of NAO on blue fish production is more than its effects on sea bass.

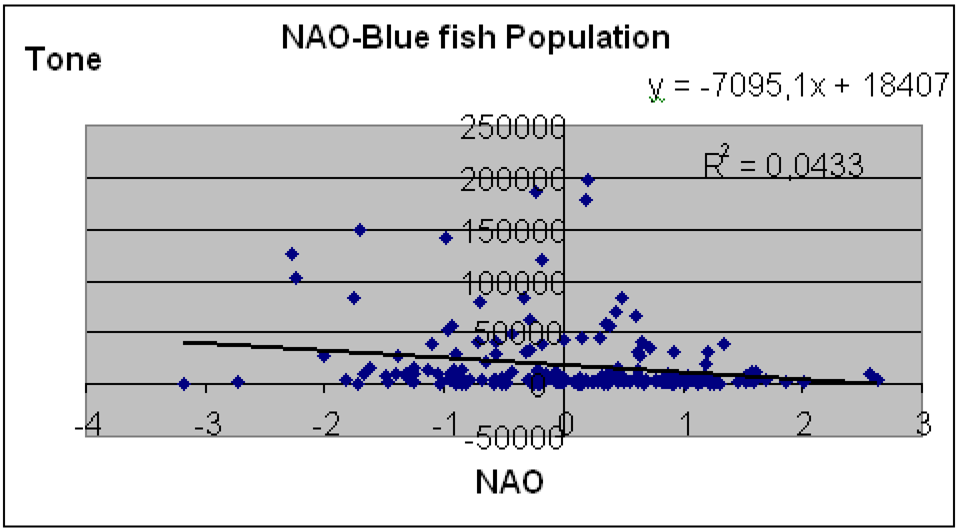

*Fig.6 Scattering Diagram of NAO and Blue Fish Population.*

## 4. RESULTS

This paper is related to analyses of El Nino and NAO fluctuations effects on blue fish and sea bass productions. Negative effects of both events on blue fish population are more than their effects on sea bass population.

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