FORECASTING ANCHOVY CATCHES IN NORTHERN CHILE: A NON LINEAR MULTIVARIATE APPROACH*

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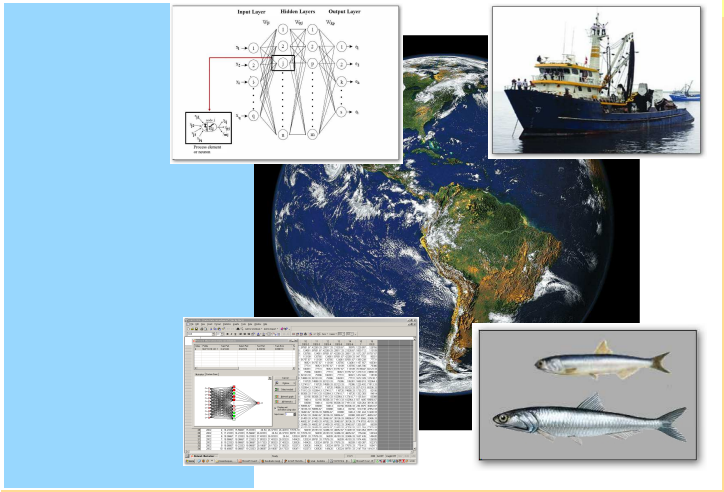

The average Chilean fish landings in the past 30 years is about 4.8 million tons per year and the pelagic fisheries in northern Chile (mainly composed in sequence by anchovy and sardine catches) represent about 40%. These fisheries are closely associated with fishing effort changes and environmental fluctuations such as cold-warm regime shifts (interdecadal fluctuations), *El Niño* events (interannual fluctuations) and coastal trapped waves (intra-seasonal fluctuations) (Yáñez *et al.*, 2008).

A problem associed with ecosystemical information is their complexity and non-linear behaviour, the variability of species, composition and abundance, affected directly by environmental changes are also affected by the presence of predators, competitors and parasites. In ecology, the application of artificial neural networks (ANN) for modelling starts at early 90's, when data rarely meet parametric statistical assumptions and where non- linear relationships are prevalent, in that cases, they perform better than linear models and generalize well to new data inputs (Özesmi *et al.*, 2006).

A first approach to the northern Chile pelagic fisheries non-linear modelling was presented by Gutiérrez *et al* (2007), using an univariate ANN model considering anchovy catches of the previous six months. The objetive of this work is to evaluate the performance of ANN forecast models for anchovy in northern Chile considering the monthly environmental variables, fishing effort and anchovy catches between 1963 and 2005.

In order to discard the "noise" in the input layer a previous analysis of the data was carried out, using principal components analisys and a non-linear cross correlation technique. The model used is a feed forward multi layer perceptron architecture, trained with the Levenberg-Marquardt algorithm.

The results involved ANN models (M1 and M2) with the sea surface temperature (SST) in Antofagasta, the SST in the Niño3+4 region, and the anchovy catches (M1), and additionally the fishing effort (M2) as inputs. The Antofagasta SST lag (-6, -7, -8 months) seemed to be related to the anchovy recruitment, while the SST in the Niño3+4 region lag (-3, -4, -5 months) seemed to be related to coastal trapped waves affecting the anchovy availability.

The external validation process showed an R^2 index higher than 70%, RMS lower than 20000 t, and the standard error of prediction was lower than 25% for both M1 and M2 models.

The correlation among the estimated and observed anchovy catches in the external validation phase suggested that calibrated models captured the general trend of the historical data and therefore these models could be used to carry out an accuracy forecast (Fig. 1).

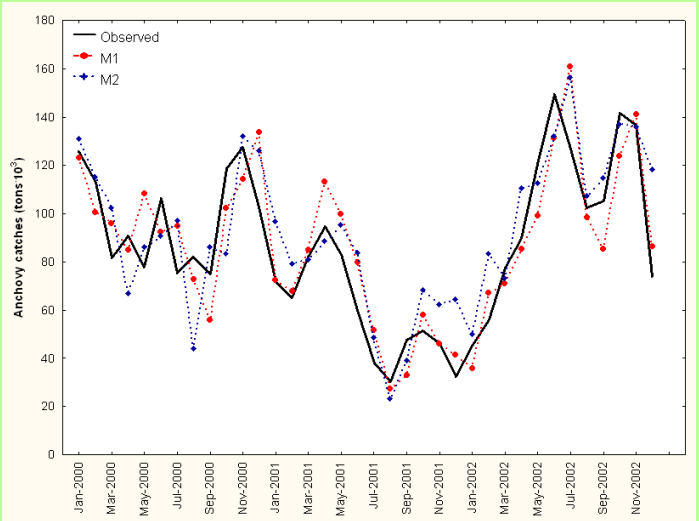

Figure 1. Observed and estimated anchovy catches in the external validation phase (2000-2002) for M1 (in red and M2 (in blue) models.

Gutiérrez, J., C. Silva, E. Yáñez, N. Rodríguez & I. Pulido. 2007. Monthly match forecasting of anchovy *Engraulis ringens* in the north area of Chile: Non-Linear univariate approach. Fish. Res. 86, 188-200.

Özesmi, S., C. Tan & U. Özesmi. 2006. Methodological issues in building, training, and testing artificial neural networks in ecological applications. Ecol. Model. 195, 83-93.

Yáñez, E., S. Hormazabal, C. Silva, A. Montecinos, M.A. Barbieri, A. Valdenegro, A. Ordenes & Fabian Gómez. 2008. Coupling between the environmental and the pelagic resources exploited off North Chile: Ecosystem indicators and conceptual model. Latin American Journal of Aquatic Research, in press.

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