The Economics of Aquaculture with respect to Fisheries

95th EAAE Seminar
Civitavecchia (Rome), 9-11 December 2005

Edited by
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RESPONSIBLE FISHERIES THROUGH AN INVESTIGATION INTO SMALL PELAGIC FISHERY IN THE ITALIAN ADRIATIC SEA

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Abstract

The FAO Code of Conduct for Responsible Fisheries aims at establishing principles and criteria for the elaboration and implementation of national policies for sustainable fisheries management and development.
This objective consists in the identification of correct policy measures on the fish market, which have a strategic consequence on Maximum Sustainable Yield.
The paper provides an investigation into small pelagic fishery in some areas of the Italian Adriatic Sea through the time series method; the investigation is applied to landed captures and prices. The analysis approach is based on annual data acquired empirically.
The study focuses first on the main dynamics in the period 1976-1986. In particular, historical data concerning market quantities and prices are analyzed.
This paper emphasizes the role of business strategy, which is focussed on processing and product quality. Quality can be considered a tool for responsible fisheries and at the same time an opportunity for producers' organizations to quote better prices.

Keywords: responsible fisheries, small pelagic fishery, fish market policy, time series, quality.

JEL classification: Q22, C32

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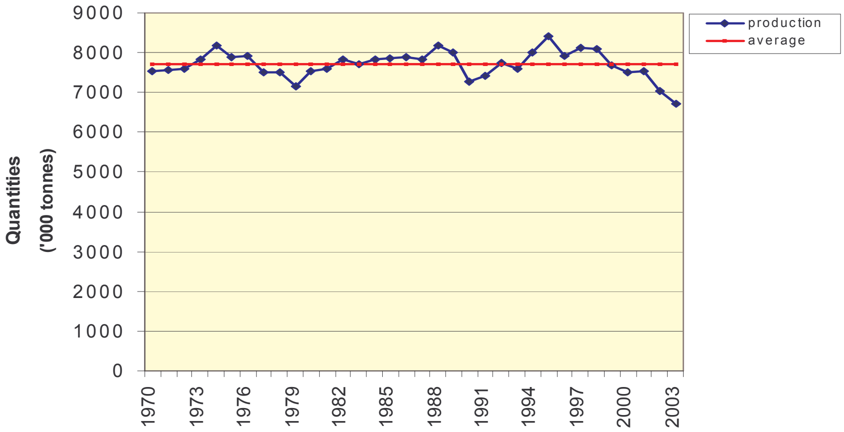
This contribution is the result of their joint work. However, Adele Finco and Guido Di Pronio are responsible for the drafting of paragraph 2.2, 3 and 4; Gabriele Sirolla is responsible of paragraph 1 and Michela Occhionero of paragraph 2.1. The conclusion section have been drafted jointly.

1. Scenario analysis

1.1 Europe

The production of the European fishing industry from 1970 to 2003 was on average 7.7 million tons comprising both sea fishing and aquaculture (Fig. 1).

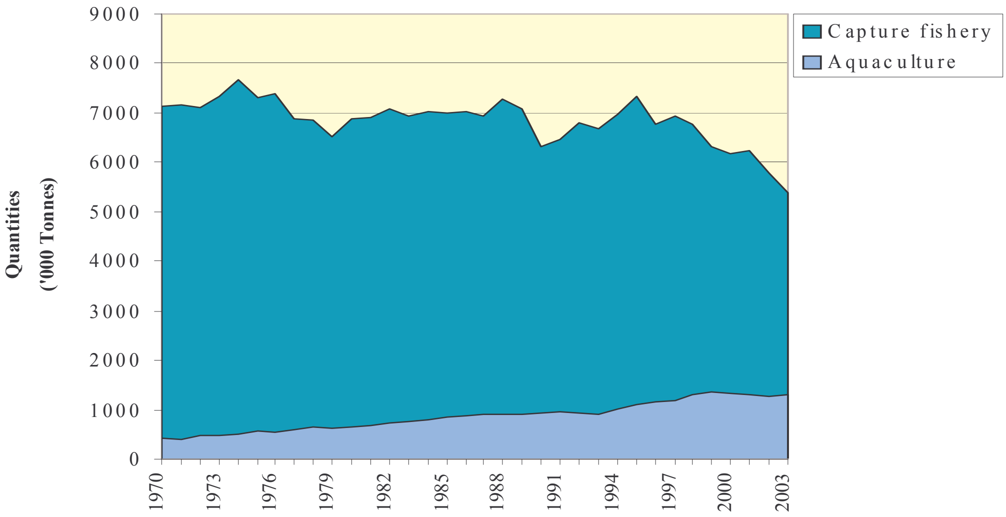
Figure 1: Evolution of Europe-15 total fish production over time



Source: GFCM-FAOSTAT data processing

There is a clear decline in performance in recent years which can be attributed to sea fishing. In fact this sector shows a certain cyclicity in production, with a decrease in recent years which led to a historic minimum of 5.4 million tons in 2003 (Fig. 2).
The phenomenon of aquaculture is, on the contrary, constantly increasing. In 2003 production grew by 68% compared with 1970, although a declining trend was sometimes registered in the time span considered.

Figure 2: European capture fishery and aquaculture production



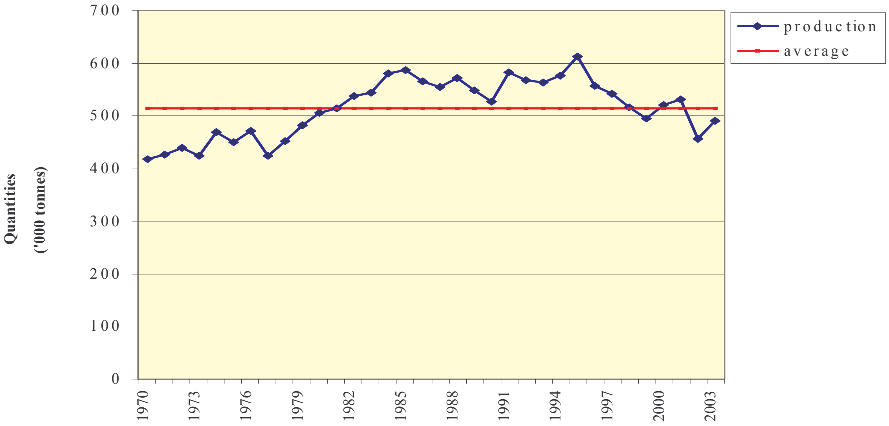
Source: GFCM-FAOSTAT data processing

A percentage analysis of the incidence of aquaculture on total European fishing production shows that this kind of production went from a minimum of 6% in the first year to a maximum of 19% in the last year.

1.2 Italy

The situation in Italy approximately reflects the overall European situation (Fig. 3).
However it is important to underline the different percentage impact of aquaculture compared with total production, which in 1999 reached a maximum quota of 42%.

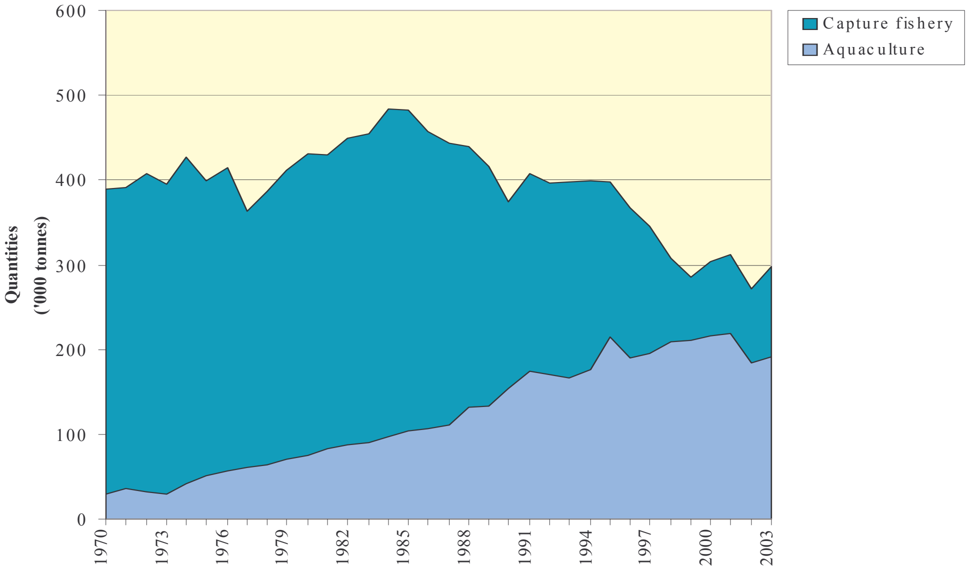
Figure 3: Evolution of Italian total fish production over time



Source: GFCM-FAOSTAT data processing

In line with the European context, the trend in fish farming has grown constantly since 1970 (Fig. 4) although in 2002 and 2003 there was a negative variation of 16% and 12 % respectively compared with 2001.
Despite this decline, aquaculture products represented 40% of total production in 2003, thus contributing with a 63% share to the overall turnover in the sector.

Figure 4: Italian capture fishery and aquaculture production



Source: GFCM-FAOSTAT data processing

Strong foreign competition and weak demand have caused a decline in the amounts of trout and eel from fisheries. A sharp reduction in the output of clams and mussels also occurred, largely due to bad weather conditions which caused a decline in production equal to 30,000 tons in comparison with the previous year (2002).
*The most important production of domestic aquaculture is still shellfish farming, mainly consisting of mussels (*Mytilus galloprovincialis*) and Philippine clams (*Tapes philippinarum*). The introduction of the latter to the lagoons of the north Adriatic in the 80s determined a great development in production (Boatto and Pellizzato, 2005).*

Of all the fish species, trout has the highest output with 38,000 tons, followed by bass, gilthead, mullet, eel and sturgeon (ISMEA, 2005).
The analysis of domestic sea fishing shows the characteristics of production and highlights the amount of pelagic fish caught in Mediterranean waters, in particular in the Adriatic (Table 1).

Table 1: Italian production of sea fish catch by category and year

'000 tons

	2001	2002	2003	Average
marine fishing	312	272	298	294
pelagic	106	87	99	97
% pelagic/marine fishing	34	32	33	33
small pelagic	88	69	68	75
small pelagic in Adriatic (%)	55	54	55	55
% small pelagic/pelagic	83	79	69	77
% small pelagic/marine fishing	28	25	23	25

Source: GFCM-FAOSTAT data processing

Global production in 2003, in terms of volume, amounted to 99 thousand tons of pelagic fish, 90 thousand tons of shellfish (of which 42 thousand clams and 43 thousand mussels not from fisheries) and 43 thousand tons of demersal fish.
The three-year average of pelagic fish production is 33% of the overall amount of sea fishing. Small pelagics represent 69% of the entire group thanks to 68,000 tons caught in

2003; anchovies (around 44 thousand tons) and sardines (around 16 thousand tons) dominate the hauls on the main Italian fishing fleets, especially along the Adriatic coastline.
Anchovies (*Engraulis Encrasicolus*) and sardines (*Sardina Pilchardus*) together amount to 25% of the total national haul, even if in terms of turnover their contribution is much lower (around 130 million euros, i.e. 8.2% of the overall turnover) due to the low average price for these items, which ranged from 0.99 €/kg for sardines to 1.53 €/kg for anchovies in 2003 (ISMEA elaborations of IREPA data).
As can be logically expected, sardines and anchovies are not relevant only to the Italian coastline and it was therefore necessary to focus attention on the whole Adriatic basin through a brief descriptive analysis. This was followed by a methodological analysis of Italian Adriatic production, which contributes about 55% of the total Italian small pelagic catch (Table 1).
Total landings of small pelagic capture fishery for Adriatic coastal countries[2] reached their highest levels in the 1980s followed by a decreasing trend, particularly marked in the case of the anchovy (*Engraulis encrasicolus*) and sardine (*Sardina pilchardus*), the two main target species of small pelagic fishery.
Pelagic catches dominate the marine fish landing, particularly in East Adriatic fishery, even though from the mid 1980s the contribution of pelagics to total fish landings decreased remarkably as a consequence of the successive downsizing of anchovy and sardine stocks and, more recently, of the economic changes which have taken place in the countries on the East coast (Mannini and Massa, 2000). Anchovies and sardines were strongly affected by factors of various origin which had a significant impact on small pelagic fishery performance, such as subsidised production during part of the 1970s and 1980s (Bombace, 1993; Cingolani et al., 1998, 2000; Jukić–Peladić S., 2001; Finco et al. 2005), anchovy recruitment failures (Bombace, 2001; Cingolani et al., 1996), and socio-economic changes affecting the sardine fishing industry in the East Adriatic (Kapedani, 2001; Jukić–Peladić, 2001; Marcéta, 2001). Unlike small pelagic fishery, demersal landing developed and persisted above average from the 1980s, beginning to decline only in the second half of the 1990s (Mannini et al., 2004).
In Italy, in terms of market price, anchovies are considerably more valuable than sardines.
The descriptive analysis underlined the necessity to further investigate the reasons which determined or at least influenced the phenomena observed on the graphs.

2. Material and methods

The statistical sources used, taking the diverse local conditions into account, were ISMEA, IREPA, Consorzio Pesca Ancona (Ancona Fishing Consortium), OP Pesca Cesenatico for fishing production[3] and IREPA for the average yearly prices. It is worthwhile noting that the statistical sources studied (FAOSTAT, EUROSTAT, IREPA, ISMEA) show some incongruities which are at times remarkable, thus causing a number of difficulties for data processing and comment.
It can be generally underlined that FAO data are underestimated in comparison with Italian statistical sources.

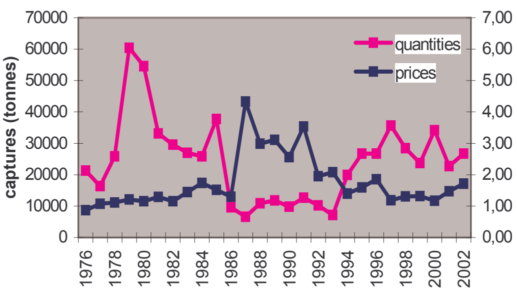
[2] Albania, Croatia, Italy, Serbia and Montenegro, Slovenia and the former Yugoslavia.
[3] The fish haul quantities refer to fresh fish landings which are assumed to be sold to the wholesale market.

2.1 Descriptive analysis

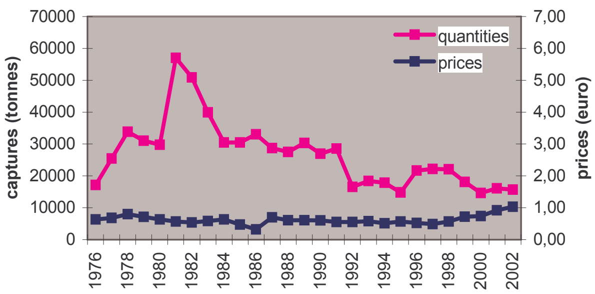
Figures 5a e 5b show the dynamics of supply in the Adriatic sea highlighting the landed quantity of the catch and the prices of small pelagic fish in the time span considered. Considering the Adriatic as a whole some peaks can be seen for the catches of anchovies (1979-80) and sardines (1981) which are in the region of about 60 thousand tons per species per year. It's simple to observe that the prices of anchovies are in line whit market laws after the second half of the 80s. In the opposite side, price trend of sardines is fairly stable during the period 76-'02.
The prices of anchovies in the time span considered went from a minimum 0,87 €/Kg to a maximum of 4.33 €/Kg whereas the prices of sardines shown variation intervals from 0,32 to 1,03 €/kg.

Figure 5: Dynamics of captures and prices of anchovies and sardines in the Adriatic Sea (1976-2002)

a – Dynamics of captures and prices of anchovies



b- Dynamics of captures and prices of sardines



Source: GFCM-FAOSTAT data processing

This trend, already common in the Adriatic, emerges with greater relevance in the two locations considered.
In 1979 Ancona had a catch of over 3 thousand tons of anchovies and more than 5 thousand sardines.
During the same years Cesenatico reached an amount of 25 thousand tons of anchovies and sardines, equivalent to 21% of the entire basin. The biggest fish hauls were of anchovies, which then declined drastically in the following years.

2.2 Time series analysis

This work focuses on the available time series analysis (from 1976 to 2002) of anchovy and sardine fishery at the level of Italian Adriatic production and, more locally, on the Ancona and Cesenatico based small pelagic fishery[4]. The available variables were:

- landed quantities;
- average annual price at landing.

The basic assumption of time series analysis is that those factors which have influenced the economic performance of the fishery in the past, will continue to act in a similar way in the future. Thus the analysis aims to identify critical factors, for

[4] For the Italian series, FAOSTAT-GFCM sources were taken into account. For the analysis of local series, national and local statistical sources were used.

forecasting purposes and for fishery planning and monitoring needs. The trend in itself does not include all aspects of dynamics as they can also depend on other effects. Depending on the circumstances the trend can be established using graphs, with the adaptation of a mathematical curve to the values observed or with moving averages. The trend is not the only component which influences these data; there are two further important factors, classified as irregular cyclic and seasonal components (Accadia e Placenti, 2002; Kanjilal et al., 1999).
The processing steps in the time series analysis were as follows:

1. Preliminary analysis: the primary and secondary differences and the ratios between consecutive data are calculated. The difference variation intervals should be small and the ratios almost uniform in order to ensure a better adjustment of the mathematical curve to the empirical data. The result of this analysis determines the type of curve which best fits the time series considered[5].
2. Identification of the trend. There are three different types of curve[6]:

   linear model type: $Y_i^* = b_0 + b_1 X_i$ (1)

   quadratic model type: $Y_i^* = b_0 X^2 + b_1 X + b_2$ (2)

   exponential model type: $Y_i^* = \log b_0 + \log b_1 X$ (3)

3. Calculation of the MAD index[7].

[5] The following types of interpolation curve emerge: primary differences = linear interpolation; second differences = quadratic interpolation; consecutive relations = exponential interpolation.

[6] Where 1) $b_0 = \frac{\sum_{i=1}^{n} y_i}{n}$ $\quad b_1 = \frac{\sum_{i=1}^{n} x_i y_i}{\sum_{i=1}^{n} x_i^2}$

X_i represents i-eth years of the time series. The model foresees the recodification of years.

Where 2) $\begin{cases} \sum X_i^2 c_0 + n c_2 = \sum y_i \\ \sum X_i^4 c_0 + \sum X_i^2 c_2 = \sum X_i^2 y_i \end{cases}$ $\quad c_1 = \sum X_i y_i / \sum X_i^2$ $\quad c_2 = \frac{\sum y_i - \sum X_i^2 \left[\frac{\sum X_i^2 y_i - \sum y_i}{\left(\sum X_i^4 - \sum X_i^2\right)} \right]}{\left[\frac{\sum X_i^2}{\left(\sum X_i^2 - \sum X_i^4\right)} \left(\sum X_i^2 - n\right) + n \right]}$

Where 3)

$$\log b_0 = \frac{\sum \log y_i}{n} - \bar{x} \log b_1 \qquad \log b_1 = \frac{\sum (x_i \log y_i) - \frac{\left(\sum x_i\right)\left(\sum \log y_i\right)}{n}}{\sum x_i^2 - \frac{\left(\sum x_i\right)^2}{n}}$$

[7] MAD stands for Median Absolute Deviation:

$$\text{MAD} = \frac{\sum_{i=1}^{n} \left| y_i - y_i^* \right|}{n}$$

The MAD Index is Interpolation by the least-squares method allows for the identification of the trend best fitting the data. Formally:

4. Removal of the trend component and identification external phenomena[8].

In this way it is possible to observe not only the incisiveness of the single components on the time series, but also to highlight which external events, and in what year, determine its course.

3. Results and discussion of statistical data

As far as results of the analysis of time series are concerned, figure 6 shows the diagram of the anchovy and sardine catch quantities in the Adriatic sea.
The charts include: the trend in empirical data (Y_i), the course of the trend (Y_i*), and the dynamics of external events (Y_i/Y_i*).
The trend is different for the two species: linear for sardines, and quadratic for anchovies (Fig. 6a, 6b). In the latter case the variations are more accentuated since they follow a parabolic course.
Once the trend components are removed, the relevance of cyclical-irregular events can be seen. These strongly characterise the Yi phenomenon (catch quantities).

Catch quantities
From an analytical point of view, the models of the interpolated curves representing the quantities of fish catch are:

Adriatic Sardines $Y_i^* = -\ 818{,}04X_i + 26631{,}19$ MAD=5173,07
(4)

Adriatic Anchovies $Y_i^* = 96{,}15 * X_i^2 - 307{,}80 * X_i + 18431{,}34$ MAD =9447,01
(5)

In relation to the Adriatic Sea, the most important results which are provided by the graphical analysis are (Fig. 6a, 6b):

$$\sum_{i=1}^{n}\left(Y_i - Y_i^*\right)^2 = Minimum$$

Y_i* represents the theoretical-mathematical data while Y_i represents the corresponding empirical data. If the MAD value is lower than the unit, an optimal conformity of theoretical values with empirical data will occur. In cases of perfect adherence to the data, MAD equals 0.

[8] The components of times series data are: trend component, cyclical component, irregular component seasonal component. The cyclical and irregular component are that left over when the other components of the series (trend, seasonal) have been accounted for. In the case study the seasonal component do not compare.
Formally we have:

Yi = Ti*Ci*Ii a)

where: Yi = empirical data Ti = trend , Ci = cyclical component Ii =irregular component

Then from a): Yi/Yi* = Ti*Ci*Ii/Yi* b)

but Yi* = Ti, then we get

Yi/Yi* = Ci * Ii c)

- the unquestionable presence of upward peaks of production in the 80s;
- the difference in trends between the two species: sardines have a descending trend, whereas anchovies have a concave-quadratic trend.

Attention is now focused on the time series analysis of the local areas (Fig. 6c, 6d,6e, 6f).
In the case of Ancona, time series analysis for the catch quantities is very irregular due to the presence of numerous peaks.
It is necessary to underline the analogies and differences in the trend for the two species.
In both cases it is clear (Fig. 6c, 6d) that fish captures were influenced by external events; this is further confirmed by the respective values of the MAD index.
By drawing a curve, the choice falls in both cases on the quadratic type. Formally, this means that:

Ancona Sardines $Y_i^*=0,24*X_i^2-107,33*X_i+1746,024$ MAD =738,75 (6)

Ancona Anchovies $Y_i^*=8,44*X_i^2+132,49*X_i+2171,13$ MAD =871,4 (7)

Interesting differences can be seen in the two graphs: decreasing and very flat for 6), increasing in 7), especially in the last part of the series.
In the case of the final part of the series for sardines the trend considerably mitigated the influence of the externals factors (Fig. 6c) while for anchovies the trend only partially mitigated the effect of external events (Fig. 6d).
The graphical analysis of the time series for Cesenatico fishing port (Fig 6e, 6f) was of great interest because of the significant upward peak in the catch during the 80s, in particular with reference to anchovies.
A possible interpretation is that during those years there were subsequent or overlapping external phenomena capable of influencing the fishing hauls.
The following period (after the 80s) sees a strong decline which seems more justified by the trend itself than by other components.
In short, in the second part of the series the performance of the two species differs: while for sardines data analysis forecasts a continual decrease in the catch, anchovies show a more stable trend suggesting future growth. It is necessary to point out that after 1988 the quantity of anchovies caught has settled at around 1,000 tons.
The analytic approach clearly supports what has already been stated: the trend of the series referring to the two species tends to be different with a quadratic interpolation curve that is convex for sardines and concave for anchovies.
From a mathematical point of view, the interpolation models are respectively as follows:

Cesenatico Sardines $Y_i^*=-10,75*X_i^2-244,93*X_i+4708,73$ MAD =891,79 (8)

Cesenatico Anchovies $Y_i^*=14,85*X_i^2-186,89*X_i+1109,14$ MAD =1095,34 (9)

Prices

The analysis of the prices series, together with that of the quantities series, allowed very interesting considerations.
The interpolation curve is always quadratic: concave for sardines, convex and characterised by many fluctuations for anchovies (Fig. 7).
These curves, in relation to the prices time series of the, are formally expressed as follows:

Adriatic Sardines Y_i*=0,0018*X_i^2+0,0032*X_i+0,51 MAD =0,08 (10)

Adriatic Anchovies Y_i*=–0,009* X_i^2+0,015*X_i+2,31 MAD =0,51 (11)

We observe the MAD index is lower than the unit that means optimal conformity of theoretical values with empirical data.
Interesting elements of analysis arise on examining the price figures for anchovies (Fig. 7b, 7d, 7f). The prices are relatively stable in the decade 1976 -1986. After this period the prices search equilibrium demand-supply.

The quadratic interpolation model is able to capture the empirical data trend very well. This is further confirmed by the MAD index which is always under the unit value.
The analysis shows that at a local level, the interpolation models are:

Ancona Sardines Y_i*= - 0,0024X_i^2 – 0,0073X_i+0,80 MAD =0,13 (12)

Ancona Anchovies Y_i*= - 0,01X_i^2 – 0,03X_i+2,3 MAD =0,56 (13)

Cesenatico Sardines Y_i*= - 0,0005X_i^2 – 6,26e $^{-0,5}$$X_i$+0,47 MAD =0,07 (14)

Cesenatico Anchovies Y_i*= - 0,009X_i^2 – 0,018X_i+1,76 MAD =0,36 (15)

In the light of statistical evidence, the relevance of an external phenomenon that affects the whole Adriatic basin in the decade between 1976 and 1986 can be inferred.

It could be suggested that the phenomenon is due to the direct intervention of AIMA[9], with the guaranteed price approach and the withdrawal of surplus production which also involved the Adriatic sea-fishing sector. Initially AIMA intervention concerned both sardines and anchovies (EEC regulation no. 100/1976[10]). Later the initiative was limited only to sardines (EEC regulation no. 3460/85[11]). This public intervention stopped at the end of the 80s. The AIMA intervention was applied to 10 ports along the Adriatic coast, some of which were greatly involved in this policy.

In the abovementioned decade the catch quantities of anchovies and sardines increased considerably. Prices, on the other hand, became almost stable in all the cases examined.

Public intervention guaranteeing prices changed the behaviour of fishermen who were encouraged to maximise their fishing. It is difficult to assess today the effects that this initiative had on the stocks of small pelagic fish although it can be observed that in the period after the intervention pelagic stocks reported a sharp decline. However, it is important to bear in mind that statistical analysis is based on the catch brought ashore and therefore the possible intervention of other phenomena should not be excluded (e.g. biological cycles, wars, etc).

[9] The State agency for intervention on the agricultural market (AIMA), now called AGEA, was the government body in charge of carrying out intervention on the agricultural market. It was set up in 1950 with the aim of protecting producers from price imbalances due to surplus offer.

[10] The 100/76 EEC regulation states that any unsold amount of anchovies and sardines must be withdrawn by AIMA at a price fixed according to pre-set criteria.

[11] The 3460/85 EEC regulation sets the end of the intervention on anchovies and extends intervention on sardines.

Figure 6 - Results of the time series analysis for quantities in the Adriatic Sea, Ancona and Cesenatico

Fig. a - Time series analysis of the captures of sardines in the Adriatic

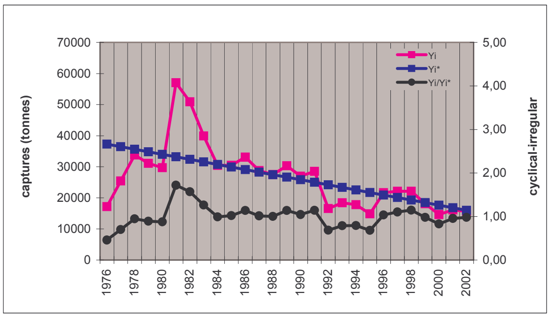


Fig. b - Time series analysis of the captures of anchovies in the Adriatic

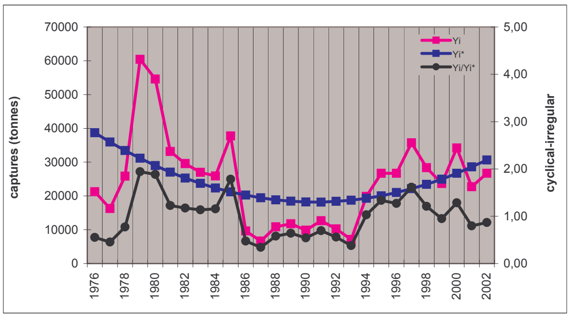


Fig. c - Time series analysis of the captures of sardines in Ancona

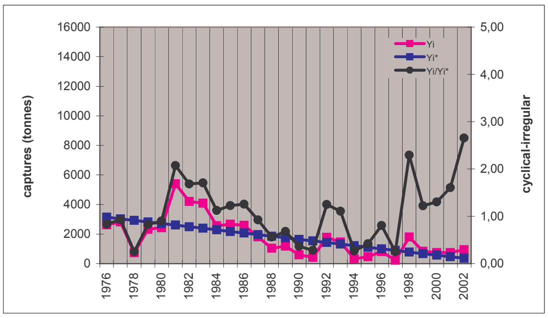


Fig. d - Time series analysis of the captures of anchovies in Ancona

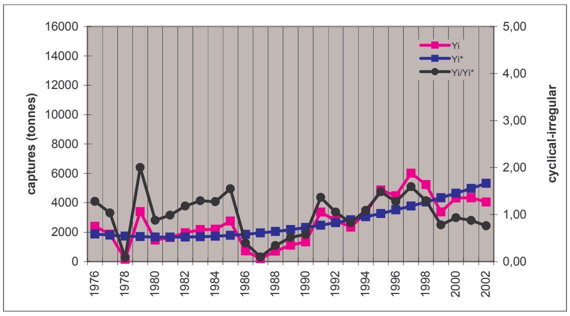


Fig. e - Time series analysis of the captures of sardines in Cesenatico

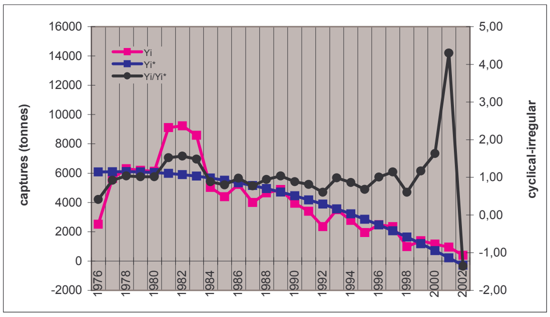
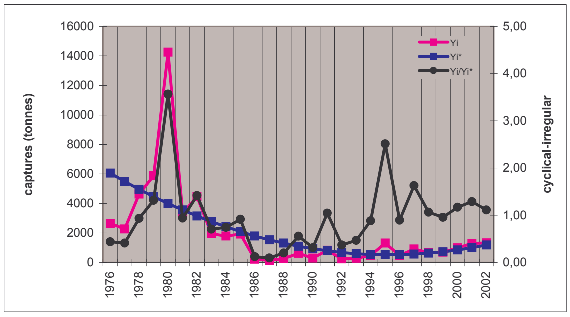


Fig. f - Time series analysis of the captures of anchovies in Cesenatico



Source: data processing (CNR and local fish markets data)

Figure 7 - Results of the time series analysis for prices in the Adriatic Sea, Ancona and Cesenatico

Fig. a - Time series analysis of the prices of sardines in the Adriatic

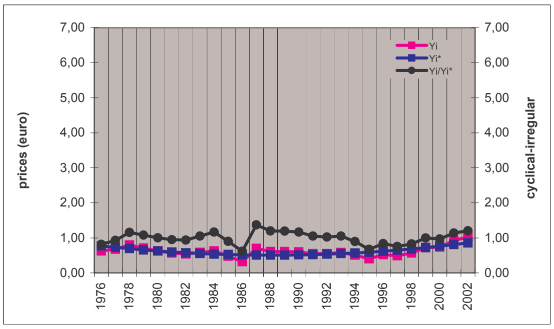


Fig. b - Time series analysis of the prices of anchovies in the Adriatic

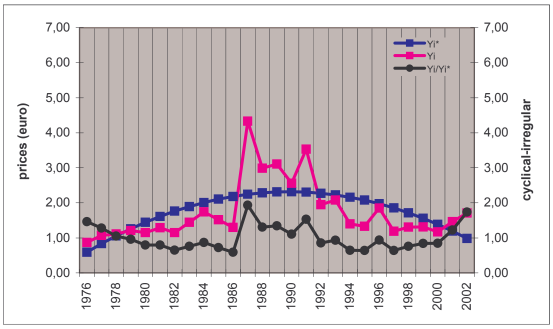


Fig. c - Time series analysis of the prices of sardines in Ancona

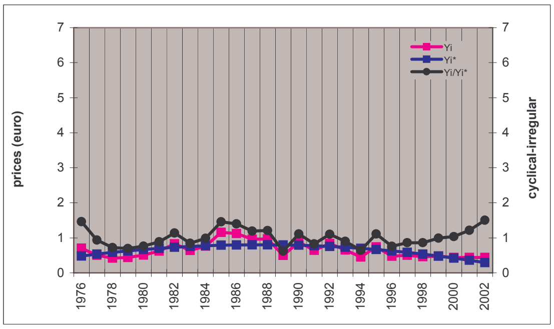


Fig. d - Time series analysis of the prices of anchovies in Ancona

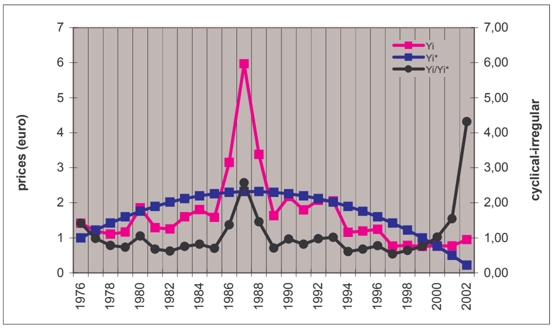


Fig. e - Time series analysis of the prices of sardines in Cesenatico

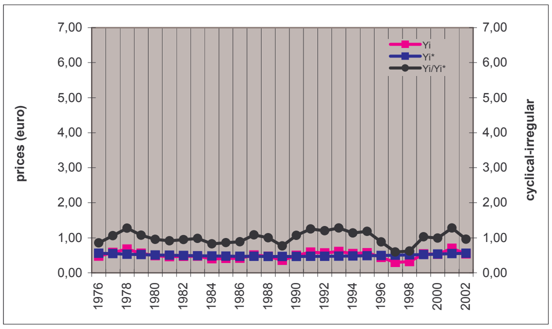
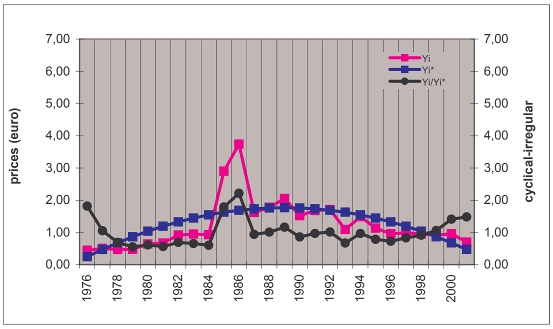


Fig. f - Time series analysis of the prices of anchovies in Cesenatico



Source: data processing (IREPA, ISTAT and local fish markets data)

4. Quality strategy on the Ancona market: opportunities for sustainable fishery

According to Chamberlin (1933) and Lancaster (1975), quality can be considered as product differentiation. Even companies producing primary goods such as agricultural and fishing firms try to distinguish their product by "qualifying it". As a consequence, markets adapt and diversify not only in terms of their own internal structure but also in terms of the capacity to diversify their own products. Samuelson and Nordhaus (1987) state that "every product is an imperfect surrogate of rival goods giving place to imperfect markets".

Therefore we find markets with perfect competition systems characterised by homogeneous products, a monopoly characterised by a single product, and imperfect markets, that is, monopolistic competition and oligopoly with diversified products.

In imperfect markets, and particularly in monopolistic competition systems, operating conditions are different from a monopoly because a number of enterprises operate instead of only one. It is also possible to implement a price discrimination policy since the goods, although partially replaceable, can be diversified from the point of view of quality. (Messori, 1992).
Monopolistic competition can thus count on a specific clientele for which, to a certain extent, it is possible to impose a price. This is called "fidelity system" of a share of final consumers (Sillani et al., 1997).
On the basis of this hypothesis, Bertrand's model attempts to examine markets which trade non-homogeneous and differentiated goods; this model contrasts with the well-known Cournot model used in the study of markets with identical goods.
The Bertrand model demonstrates how firms can make a profit by selling differentiated goods. If the products are homogeneous, the Bertrand model firms set a price which is equal to the marginal cost. With differentiated products, the Bertrand model equilibrium price is greater than the marginal cost. Economists consider products to be differentiated if consumers deem that they are in some way dissimilar. The reason why differentiation allows a business to ask a higher price is based on the fact that it makes the demand curve less elastic. This means that any given price reduction fixed by a competitor reduces the demand for the product of the firm in question to an extent which decreases as the two goods become less replaceable.
Prices are, therefore, usually higher when products are differentiated in comparison to when they are identical, all other conditions being equal (Perloff, 2001; Saccomandi, 1999).
Quality differentiation, although leading to higher prices, is always desirable from the customer's point of view as it is an important guarantee in terms of foodstuff safety.
In particular, the quality of the fish, guaranteed by a brand certificate, allows a sustainable use of this resource and at the same time a satisfactory income for the fisherman.
Italian fishing markets have recently organised a system of product differentiation based on quality guarantee and certification. The case of the Ancona fishing port is interesting, since the wholesale market for small pelagic fish has been able to prevail over the retail market with "price maker" strategies supported by agreements with large distribution networks.
The production market, although a primary market, proves to be an imperfect one that is similar to a monopoly competition or an oligopoly.
In the period 2000-2002 the landed catches in the Ancona marine fish registered a relative countertrend compared with previous years. These positive variations are mainly due to anchovies, for which a traceability and supply chain system has already been set up, which deals with the processing (filleting) and commercialization of fish products through the large distribution networks.
As from January 2001 the production market in Ancona has implemented a quality improvement plan, leading to the creation of the brand *"Pesce Fresco di Qualità – Consorzio Pesca Ancona"* – ("*Quality fresh fish – Ancona Fishing Consortium")*.
The brand is based on a disciplinary regulation which adopts a self-check system to make fishermen responsible for the protection of sea fish stocks, hygiene, safety and environment. If they comply with this regulation, producers must guarantee certain technical and structural requisites concerning their fishing boats, and must adopt responsible fishing procedures. Maximum quotas of fish haul are fixed for every fishing boat in order to limit fishing and consequently ensure the reproducibility of fish stocks. Fishing for anchovies and sardines is limited to four days per week. In February and March, given the high demand

from Spain and Greece for this type of fish, one extra fishing day is allowed each month. In the period from September to December, due to greater catches, a reduction in fishing hours is set. Moreover the port must impose a period of “biological closure” of the fishing season every year for certain types of fish in order to facilitate breeding.
This strategy seems to be able to keep a balance between supply and demand, reducing the risk of a slump in prices on the local market.
The supply of a quality product which can be distinguished from the conventional production of rival markets, can be an excellent strategic choice from the point of view of the market and marketing, while at the same time help to maintain the sustainability of the sector. The certified brand could even be extended to a larger geographical area such as that of the whole Adriatic basin.

5. Remarks and conclusions

Adriatic small pelagic fishery along the Italian coast is related to some important facts of both biological and economic origin. One of the most important features of any renewable natural resource, such as fish, is productivity and small pelagic species are known to be characterized by relatively high production, defined as the increase in biomass of a species population over a given period of time. At the same time, environmental factors are believed to play a critical role in pelagic environments, causing long term fluctuations in fish stock productivity (Lluch-Belda, et al., 1989; Shannon et al., 1988).

The sustainability objectives for natural fish stocks can be incorporated in the general management objectives aimed at reducing overfishing of the main fish stocks and regulating the quantity of fish landed catch as well as the tools and technologies used.

Small pelagic fishery is an important resource within the multispecificity of Adriatic and Mediterranean resources and needs responsible management based on the awareness and self-awareness-raising of producers.

Past economic policies had a negative effect on the preservation of this resource. This is shown very clearly in the statistical analysis carried out.

It is necessary to remember that some public intervention, such as that carried out by AIMA[12] aimed at supporting fishery in the period 1976-1986, had a considerable influence on the production market and thus on the capture fishery performance, probably leading to increased fishing. Such production dynamics had clear repercussions on the market, typically determined by supply and demand, but in this case distorted. The effects of financial support can be considered one of the external cyclic-irregular factors that, together with others, may explain the fluctuations in landed quantities and price dynamics. Time series analysis is a valuable tool for understanding the exploitation dynamics of capture fishery resources and also for the formulation of responsible management policy. This paper attempts to highlight some aspects of Adriatic (Italian) small pelagic fishery by using available economic data, also focusing on the influence that economic policy measures can have on the production process.

The two species examined, anchovies and sardines, which constitute the largest quota of small pelagic fish, show different development over time. This can be linked to biological cycles and to the dynamics of their markets.

It should also be remembered that in the decade between 1972 and 1982 important commercial factors affected the catch of these fish. In 1972 export relations were set up with the former Yugoslavia, and in particular with Croatia, for sardines (*Sardina Pilchardus*), as a number of fish manufacturing firms (around 18) began producing tinned sardines (S. Jukic Peladic, 2001).

This activity ceased when many of these Croatian firms closed down.

In conclusion we feel we can state that market and surplus production intervention policies which were applied in the past but which, in others forms, are still implemented today through the structural regulations for fishing, do not have positive effects on the process of sustainability of this resource[13]. On the contrary policies for quality can have positive

[12] The former governmental agency for intervention on the agricultural market.

[13] Council Regulation (EC) No 104/2000 of 17 December 1999 on the common organisation of the markets for fishery and aquaculture products. It aims at guaranteeing a new balance between supply and demand, strengthening

effects both from the point of view of rational management of the catch and product differentiation to increasing the value of the product. There is also no doubt that considering the difficulty involved in fishing, increased production in aquaculture gives us an opportunity to reduce exploitation of sea resources. In any case it is crucial to implement a quality and traceability system in the fish supply chain, obviously including aquaculture, in order to reach sustainability. At the same time the economic aims of the producers are not disregarded since, by offering a quality which is recognisable on the market, they also obtain a producer's surplus.

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