# SOCIO-ECONOMIC INDICATORS FOR THE ADRIATIC SEA DEMERSAL FISHERIES

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## ABSTRACT

This paper analyses the state of demersal fisheries in the North and Central Adriatic Sea (FAO Geographical Sub Area (GSA) 17) from an economic and social point of view. The analysis is performed using a set of 25 socio-economic indicators. Indicators represent a valid tool to support the decision making process in fisheries management. Economic indicators include 6 indicators on economic performance, 8 on productivity, 4 on costs and prices, and one general indicator summarising economic sustainability. From the social point of view, 5 indicators plus one general indicator summarising social sustainability are defined. Particular attention is devoted to the selection and analysis of sustainability indicators. The standard distinction among environmental, economic, and social sustainability has been held in this paper. Trends of these indicators are analysed using the so-called Traffic light system. Reference values are set according to their percentile value in the following series: > 66th percentile, 66th-33rd, and < 33rd percentile. Based on each specific indicator, the three standard colours, green, yellow, and red, are assigned to the three areas defined by the reference values at 33rd and 66th percentiles. The analysis is performed by using data available from the IREPA monitoring system along the Italian coastline on three Operational Units: bottom trawlers less than 12 metres, between 12 and 18 metres, and more than 18 meters. The period under consideration goes from 1996 to 2004. The results highlight critical conditions for the demersal fishery in the GSA 17 from the economic and social points of view, due to decreasing productivity. Even though many socio-economic indicators show low levels during the period under consideration, the sustainability indicators are not in the critical area and the fishery sector cannot be classified as unsustainable.

**Keywords:** socio-economic indicators, reference points, sustainability, traffic light system

## INTRODUCTION

Indicators represent a valid information and communication tool within the decision making process in fishery management. The identification, assessment, and evaluation of indicators are discussed and treated into many scientific and technical documents.

An indicator has been defined as: "*a variable, pointer, or index related to a criterion. Its fluctuation reveals variations in key elements of sustainability in the ecosystem, the fishery resource or the sector and social and economic well-being. The position and trend of an indicator in relation to reference points indicate the present state and dynamics of the system. Indicators provide a bridge between objectives and actions*" [1].

Indicators are useful to draw an accurate picture of fisheries from a biological, economic and social point of view. Moreover, an evaluation of the state of fisheries through time can be obtained by comparing indicators to appropriate reference points. As reported in [2], these values should be associated with either a critical or an optimal state, where the former identifies a limit which is necessary to avoid (LRPs, limit reference points) and the latter a target to be attained by the system (TRPs, target reference points). Nevertheless, LRPs and TRPs are not identifiable for many indicators, or the data needed for estimation are not available in many fisheries.

An attempt to define a general list of indicators and reference points in fishery was made by FAO in the Technical Guidelines for Responsible Fisheries [3]. Among the reference points proposed, only in a few

cases TRPs were defined in accordance to general concepts in fishery sustainable literature, such as MSY (Maximum Sustainable Yield) and MEY (Maximum Economic Yield), while the most part of them was defined by the indicators historical level. However, the use of historical levels represents a very suitable method for highlighting the presence of trend and evaluating the state of fisheries through time.

Results obtained from the analysis of indicators and reference points can be represented in a clear and easily understandable way by using the so called "Traffic Light" method. This method has been used by Caddy to define a management system based on the precautionary approach for those fisheries characterized by scarcely available data [4]. Moreover, it is able to provide an immediate overlook of the state of fisheries by associating a colour to each value of the indicator along its historical series.

This paper analyses the state of demersal fisheries in the North and Central Adriatic Sea (FAO Geographical Sub Area (GSA) 17) from an economic and social point of view by using data coming from the IREPA (Institute of Economic Research in Fishery and Aquaculture) monitoring system. A period of 9 years, from 1996 to 2004, has been analysed by using two types of indicators: indicators to evaluate the status of the fisheries and indicators to measure fisheries sustainability. For the first group, historical levels of the indicators have been used as reference values, while for the second group ad hoc LRPs have been identified. Results are showed by a traffic light representation.

## GSA 17 DEMERSAL FISHERIES

The Adriatic Sea may be considered as a semi-enclosed basin within the Mediterranean Sea. It is characterised by an extended continental shelf in the Northern and Central part while the continental slope is mostly found in the Southern part. The moderate slope and soft sea bottom, which covers a large area moving away from the coast and which is for the most part sandy, muddy and alluvial, have made the Adriatic particularly suitable for trawl fishery, both bottom and beam trawling for demersal species, mid-water pair trawl for small pelagic fish and dredgers for clams.

Two Geographical Sub Areas (GSA) have been defined in the Adriatic Sea for management purposes by FAO [5], GSA 17 (North and Central Adriatic) and GSA 18 (Southern Adriatic). This study covers the 764 km of the Italian coastline covered by the FAO-GSA 17 (Fig. 1), and is focused on the bottom trawl fleet operating there.

In 2004, 990 bottom trawl vessels were active in this area, with a gross tonnage of 29,145 GRT and an engine power of 171,890 kW, representing a quota of 23% of the total fleet in terms of number and 53% in terms of GRT. In the same year, 35,224 t of fish, around 30% of total landings, for a value of 196 MEuros were produced by this fleet segment [6].

The data used are from the IREPA (Institute for Economic Research on Fisheries and Aquaculture) monitoring system for the years from 1996 to 2004. The IREPA monitoring system for economic data on the Italian fishery sector is based on three main modules: fishing effort and activities, landings and prices by species, and economic data. All the data within these modules are collected through a National Monitoring System based on a unique sample. A number of vessels are monitored each week and elementary data are later expanded to the universe (the whole Italian fleet) using statistical sampling procedures (for more details, see [7,8]).


**Figure 1. FAO Geographical Sub Area 17 (North and Central Adriatic Sea)**

## METHODOLOGY

The analysis of the demersal fisheries in the North and Central Adriatic Sea (GSA 17) has been performed by using a set of 25 socio-economic indicators. A distinction has been held between indicators evaluating the status of the fisheries and indicators measuring fisheries sustainability. The selection of indicators was based on data available from the IREPA monitoring system for Italian GSAs defined by FAO [5].

Table I displays the list of the economic indicators on the status of fisheries and their description. They include 6 indicators on economic performance, 8 on productivity and 4 related to the market (costs and prices). As for the evaluation of economic performance, traditional indicators based on the return on the capital invested and indicators related to the quota of revenues directed to production factors have been used. A number of indicators has been used in the evaluation of productivity as well. They can be divided into two groups, physical and economic productivity indicators, where the former are expressed in terms of landings and the latter in terms of revenues. The last four economic indicators, related to market variables, are to measure the evolution of landings prices and of the most relevant costs in demersal fisheries, specifically maintenance and fuel costs.

**Table I: Economic indicators on the status of fisheries and description.**

| INDICATOR | DESCRIPTION |
|---|---|
| | |
| Added Value/Revenue | percentage of revenues which is directed to salary, profit, opportunity cost and depreciation. |
| Gross Operative Margin/Revenue | percentage of revenues which is directed to profit, opportunity cost and depreciation. |
| ROS (Return on Sale) | percentage of revenues which is directed to profit and opportunity cost. |
| ROI (Return on Investment) (%) | percent ratio of net profit plus the opportunity cost in relation with the investment. |
| Revenue/Invested Capital (%) | percent ratio of revenues in relation with the investment. |
| Net Profit per vessel (000 €) * | average net profit of each vessel. |
| | |
| Landings per vessel (ton) | average production of each vessel in terms of weight of landings. |
| Landings per GRT (ton) | average production in terms of weight of landings for each capacity unit (GRT) of the vessels. |
| Landings per day (ton) | average production in terms of weight of landings for each day at sea. |
| CPUE (kg) | average production of each effort (GRT*days/N.vessels) unit in terms of weight of landings. |
| Revenue per vessel (000 €) * | average production of each vessel in terms of market value. |
| Revenue per GRT (000 €) * | average production in terms of market value for each capacity unit (GRT) of the vessels. |
| Revenue per day (000 €) * | average production in terms of market value for each day at sea. |
| RPUE (€) * | average production of each effort (GRT*days/N.vessels) unit in terms of market value. |
| | |
| Average price (€/kg) | average market price of landings. |
| Fuel cost per vessel (000 €) * | average fuel cost of each vessel. |
| Fuel cost per day (000 €) * | average fuel cost for each day at sea of a vessel. |
| Maintenance cost per vessel (000 €) * | average maintenance cost of each vessel. |

* Deflated by Italian consumer price index for the entire community.

From a social point of view, 5 indicators have been defined. As listed in Table II, two indicators on labour productivity, an indicator on the ratio between human and physical capital, an indicator on the number of people employed and one on their average salary have been used for the analysis.

**Table II – Social indicators on the status of fisheries and description.**

| INDICATOR | DESCRIPTION |
|---|---|
| | |
| Landings per crew (ton) | average production in terms of weight of landings for each man employed. |
| Revenue per crew (€) * | average production in terms of market value for each man employed. |
| Crew/GRT | ratio between man employed and GRT employed. |
| Salary per crew (000 €) ** | average salary obtained by each man employed. |

* Deflated by Italian consumer price index for the entire community.
** Deflated by Italian consumer price index for workers and employees.

As for the evaluation of fisheries sustainability, two specific indicators have been defined from an economic and social point of view. The approach followed in this paper is based on the consideration that natural, economic and human resources are involved in fisheries contemporarily, and fisheries sustainability is possible only if the availability of all kinds of resources is ensured in the long term.

From an economic point of view, this means safeguarding the ability of the sector to attract investments by protecting its profitability. Therefore, the level of economic sustainability can be measured by comparing the profitability of investments in fishery to those in other sectors. In this paper, the traditional indicator for profitability, represented by the return on capital invested (ROI), is compared to the average rate of the Italian Treasury securities with a long term maturity (Buoni del Tesoro Pluriennali (BTP)). The indicator of economic sustainability (ESI) is then obtained as a difference between the two rates of profitability. When the value of ROI is lower than or very close to the BTP rate (the value of ESI is negative or very close to zero), investments in public bonds are preferable to investments in fishery and the status of the fisheries under investigation cannot be considered as economically sustainable.

The approach described above can only be partially applied for measuring social sustainability. The availability of human resources in fishery cannot be treated as that of other economic resources, and comparing the labour remuneration in the fishery sector to those of other economic sectors would result in a mistake. The labour market in Italian fisheries is characterized by an excess of supply, especially due to immigration from Mediterranean developing countries. Moreover, the level of flexibility of labour market is not comparable to that existing in capital market. People employed in fisheries is generally not able to move to other sectors and should work even for low wages and poor safety conditions.

In such a context, the role of trade unions and safety laws assume a particular importance, and the minimum salary level, when defined in the trade unions agreements, can be considered as the minimum level at which an economic sector is socially sustainable. Therefore, the difference between the average salary per man employed and the minimum salary stipulated by the Italian laws (Contratto Collettivo Nazionale di Lavoro (CCNL)) can be used as an indicator of social sustainability (SSI). A value close to zero for the SSI highlights the presence of a status of social unsustainability for the fisheries under investigation.

All the indicators described above have been estimated along a period of 9 years, from 1996 to 2004, for the Italian demersal fleet operating in FAO-GSA 17. This fleet is composed of three groups of vessels considered homogeneous in the economic structure and in terms of landings composition by the IREPA

monitoring system: bottom trawlers less than 12 metres, between 12 and 18 metres, and more than 18 meters. Unfortunately, historical data are not available at that level of detail, and the analysis has been performed by considering the demersal fleet as a whole.

In order to effectively interpret the information obtained from the indicators, some reference values are generally applied. In this paper, historical data are analysed through a traffic light representation, which assigns a colour to each value. By adopting the standard three colours approach - where green, yellow and red colours are associated respectively to "good", "intermediate" and "bad" conditions - two reference values need to be defined.

These values are generally associated with either a difficult or an optimal (or sub-optimal) situation. The former (LRPs, limit reference points) identifies a limit which is necessary to avoid, while the latter (TRPs, target reference points) represents a target to be attained by the system [2,4]. For the sustainability indicators ESI and SSI, LRPs have been associated respectively to the average rate of the Italian BTP and the minimum salary foreseen by the Italian CCNL for fishery sector. As ESI and SSI are calculated by subtracting the LRPs from the indicators, the related reference values, used to separate the red from the yellow area within the traffic light representation, are set to zero. A second reference value, useful to define the boundary between the yellow and the green area, is associated to the mean value of the indicator historical series.

A different approach has been used in the definition of reference values for the socio-economic indicators listed in Tables I and II. In this case, LRPs or TRPs are not easily identifiable, and their estimation generally requires the use of specific tools and data, which are not available for many fisheries. Nevertheless, very simple and immediate reference points can be calculated by considering the indicator historical levels (as suggested in [3]). In this paper, reference values for the socio-economic indicators are set according to their percentile value in the following series:

- > 66th percentile
  - for productivity and performance indicators – 'good', green colour assigned
  - for costs indicators, 'bad', red colour
- 66th - 33rd, 'intermediate', yellow colour, and
- < 33rd percentile
  - for productivity and performance indicators – 'bad', red colour
  - for costs indicators – 'good', green colour assigned.

## RESULTS

The analysis has been performed on a period of 9 years from 1996 to 2004. The results show a negative trend in the investigated period from both an economic and social point of view. Specifically, the year 1999, 2002 and 2003 show the worst performance for the demersal fisheries in that area, while an improvement in the state of fisheries is highlighted by the indicators estimated on the last year.

The negative trend is mainly due to reduced productivity. This can be clearly understood by looking at Table III with respect to the indicators on physical productivity. Landings per vessel and landings per days show a declining trend by changing the colour from green in the first three years to yellow in the intermediate period, and to red in the end part of the historical series. However, in 2004, a relevant increase in the values of these indicators is registered. Landings per vessel and per day show an increase of about 16%, and more than 18% respectively. A reduction in productivity, particularly for the years 2002 and 2003, is highlighted also by the other two indicators on physical productivity, CPUE and landings per GRT. By these indicators, the improvement in productivity registered in 2004 assumes greater evidence. Ladings per GRT are in yellow, while CPUE is in green.

**Table III – Results of the traffic light method applied to economic indicators for FAO-GSA 17**

| INDICATORS | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|---|---|---|
| **Economic sustainability (ROI - Risk_free_rate) (%)** | 4.68 | 7.35 | 5.57 | 1.23 | 6.25 | 8.27 | 5.68 | 6.00 | 8.54 |
| | | | | | | | | | |
| •Added Value/Revenue | 0.68 | 0.68 | 0.66 | 0.60 | 0.59 | 0.59 | 0.60 | 0.60 | 0.57 |
| •Gross Operative Margin/Revenue | 0.30 | 0.31 | 0.26 | 0.19 | 0.24 | 0.26 | 0.25 | 0.27 | 0.29 |
| •ROS (Return on Sale) | 0.25 | 0.25 | 0.21 | 0.13 | 0.20 | 0.21 | 0.19 | 0.19 | 0.22 |
| •ROI (Return on Investment) (%) | 13.74 | 14.11 | 10.49 | 5.94 | 11.84 | 13.44 | 10.63 | 10.28 | 12.82 |
| •Revenue/Invested Capital (%) | 55.30 | 55.58 | 50.89 | 46.21 | 60.65 | 64.43 | 55.19 | 54.02 | 58.00 |
| •Net Profit per vessel (000 €) | 43.88 | 50.34 | 38.14 | 17.88 | 34.38 | 40.49 | 31.85 | 28.95 | 33.72 |
| | | | | | | | | | |
| •Landings per vessel (ton) | 49.16 | 53.95 | 49.52 | 40.10 | 43.39 | 44.06 | 33.87 | 30.58 | 35.37 |
| •Landings per GRT (ton) | 1.23 | 1.28 | 1.23 | 1.01 | 1.32 | 1.27 | 0.98 | 0.91 | 1.18 |
| •Landings per day (ton) | 0.31 | 0.34 | 0.31 | 0.30 | 0.28 | 0.25 | 0.21 | 0.20 | 0.24 |
| •CPUE (kg) | 7.75 | 8.02 | 7.61 | 7.69 | 8.47 | 7.25 | 6.09 | 5.90 | 7.99 |
| •Revenue per vessel (000 €) | 204.94 | 214.05 | 196.75 | 162.27 | 185.54 | 202.57 | 174.85 | 161.63 | 157.97 |
| •Revenue per GRT (000 €) | 5.13 | 5.08 | 4.88 | 4.07 | 5.64 | 5.84 | 5.05 | 4.80 | 5.27 |
| •Revenue per day (000 €) | 1.29 | 1.33 | 1.22 | 1.23 | 1.18 | 1.15 | 1.11 | 1.07 | 1.07 |
| •RPUE (€) | 32.29 | 31.83 | 30.25 | 31.11 | 36.23 | 33.31 | 31.42 | 31.16 | 35.67 |
| | | | | | | | | | |
| •Average price (€/kg) | 4.34 | 4.21 | 4.30 | 4.45 | 4.82 | 5.33 | 6.13 | 6.45 | 5.57 |
| •Fuel cost per vessel (000 €) | 27.45 | 29.00 | 28.31 | 28.83 | 39.60 | 41.40 | 34.38 | 30.96 | 36.33 |
| •Fuel cost per day (000 €) | 0.17 | 0.18 | 0.17 | 0.22 | 0.25 | 0.23 | 0.22 | 0.20 | 0.25 |
| •Maintenance cost per vessel (000 €) | 7.71 | 9.56 | 9.47 | 7.25 | 8.55 | 9.31 | 8.88 | 8.01 | 8.23 |

The negative trend in productivity also applies to the indicators on economic productivity. Increasing prices are not high enough to compensate for the reduction in physical productivity. A partial compensation is registered for the year 2002, when the average price of landings increased by 15%, from 5.33 €/kg to 6.13 €/kg. The effect of price is highlighted by the predominance of the yellow colour in that year for the economic productivity indicators, in spite of red for the physical productivity ones. In 2004, the group of economic productivity indicators show a similar behaviour to that of physical productivity with a red colour for the indicators parameterised by number of vessels, and days at sea, and a green colour for those parameterised by GRT and effort. Given the strong reduction in the average price, this improvement in economic productivity can be justified uniquely by an increase in physical productivity.

The analysis of the productivity indicators allows to make a distinction between the critical period in 1999 and the other one in 2002-2003. While the latter was due to a decrease in productivity, as reported above, the former was due to the effects of the Balkan War on the Adriatic fisheries. In the first period of the war, the negative effects were limited to changes in the fishing activity routes. Later, the presence of explosive devices in the Adriatic Sea resulted in a period of temporary withdrawal of fishing activity to allow for their removal. This involved almost the whole demersal fleet and produced a relevant decrease of days at sea in that year. As a result of the low activity level of the fleet, productivity per unit of GRT shows a red colour both in physical and economic terms. However, productivity per day, which is not affected by variations in activity, does not show any reduction. In fact, its values are very close to the ones registered in the previous period. For these indicators, the table shows a yellow colour in physical terms and a green colour in economic terms.

Besides the decreasing productivity, another negative effect on the economic performance of the fisheries investigated was determined by increasing costs. An increase higher than the inflation rate was registered by the indicators on fuel costs. Fuel costs represent about a half of the total costs for the demersal fleet. From a cost prospective, the periods 2000-2001 and 2004 are identified as the most critical ones, while an intermediate condition, shown in yellow colour, is associated to the period 2002-2003. The indicator on the fuel cost per day is of particular interest. A change in its level starting in 1999 is shown in the table. It is related to a constant increase of fuel price, which started in the spring of 1999 and is still continuing.

A change in level from the period 1998-1999 is shown for the economic performance indicators as well. In detail, the quota of revenues directed to the production factors (added value on revenues), in terms of profit, salary, interest on the invested capital, and depreciation, registered a reduction of 6 percentage points, from 66% in 1998 to 60% in 1999. In the last year of the period under investigation, a further

reduction of this quota to 57% of revenues has been registered. These variations are strictly correlated to increases in total costs, and more specifically to fuel cost. In 1999, profits were the production factor penalized the most by the critical condition in which the fisheries were. The gross operative margin on revenues, which does not include the quota of revenues directed to salary, shows a relevant reduction from 26% in 1998 to 19% in 1999. In the following years, this percentage increased. Therefore, the effects of the negative trend shifted from profit to the remuneration of labour.

The economic sustainability indicator, obtained subtracting the average rate of the Italian Treasury securities from the rate of profitability of demersal fisheries, shows a good performance reaching in the last year the second highest value of the period investigated. In 2004, a difference of 8.54 percentage points was registered between investments in these fisheries and no risk investments. Based on this result, demersal fisheries in FAO-GSA 17 can be considered sustainable from an economic point of view.

From a social point of view, the indicators on labour productivity show results similar to those described above with respect to the economic performance (Table IV). In the periods 1999 and 2002-2003, critical conditions in productivity per man employed are shown both in terms of landings weight and of landings value. As explained above, the reduced productivity and the related negative economic performance were due to a special event in 1999, the Balkan War; while in the period 2002-2003, they resulted from the negative trend in productivity started in 1998. The average salary per man employed was negatively affected by this trend as well. The related indicator, with the exception of the year 1999, shows a clear declining trend by changing the colour from green in the first three years to yellow in the intermediate period, and to red in the last two years.

Finally, the social sustainability indicator, obtained as a difference between the average salary per man employed and the minimum salary foreseen by the Italian CCNL, shows a declining trend and a value close to unsustainable in 2004. In that year, the average salary perceived by the people employed in these fisheries exceeded the minimum salary of just 2.900€. The yellow colour, shown in Table IV, suggests that demersal fisheries in FAO-GSA 17 cannot be classified as sustainable nor as unsustainable from a social point of view.

**Table IV – Results of the traffic light method applied to social indicators for FAO-GSA 17**

| INDICATORS | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|---|---|---|
| **Social sustainability (Salary - Minimum_salary) (000 €)** | 11.26 | 9.43 | 8.39 | 5.31 | 7.05 | 7.25 | 5.40 | 5.12 | 2.91 |
| | | | | | | | | | |
| •Employed persons GSA 17 (num.) | 11305 | 10693 | 11862 | 12290 | 10839 | 10061 | 9477 | 9226 | 8596 |
| •Landings per crew (ton) | 14.27 | 14.10 | 12.50 | 10.01 | 12.34 | 12.06 | 9.25 | 9.10 | 11.67 |
| •Revenue per crew (€) | 59.48 | 55.95 | 49.68 | 40.52 | 52.76 | 55.45 | 47.78 | 48.11 | 52.15 |
| •Crew/GRT | 0.086 | 0.091 | 0.098 | 0.100 | 0.107 | 0.105 | 0.106 | 0.100 | 0.101 |
| •Salary per crew (000 €) | 22.45 | 20.62 | 19.58 | 16.50 | 18.24 | 18.44 | 16.73 | 16.46 | 14.86 |

## CONCLUSIONS

The analysis performed by using the traffic light tables highlighted the presence of a negative trend throughout the period under investigation both for the economic and the social indicators. The worst performance were in the periods 1999 and 2002-2003, while an improvement in the state of fisheries was registered in the year 2004.

The negative trend in economic performance, which culminated in the critical period 2002-2003, was mainly due to reduced physical productivity and increasing costs. Changes in productivity are probably due to an excess of fishing effort exercised on marine resources. A more detailed analysis could be obtained by integrating the set of socio-economic indicators presented in the paper with biological indicators on the status of fishery resources. From a cost prospective, the most relevant factor affecting the performance of the demersal fisheries is represented by the constant increase in fuel prices, which started in the spring of 1999 and is still continuing. Therefore, two causes of potential economic

unsustainability can be identified for the fisheries under investigation during the years 2002 and 2003: fishing effort level and fuel cost.

Nevertheless, the economic sustainability indicator shows a good performance, especially in the last two years of the period analysed. The lowest value for this indicator was registered in 1999 when the rate of profitability in demersal fisheries was just 1.23 percentage points above the rate of Treasury securities. This condition of unsustainability was due to the effects of the Balkan War, which determined a relevant decrease of days at sea for the demersal fleet.

Profit was the production factor penalized the most by the exceptional event which took place in the year 1999. In the following years, the effects of the negative trend in the economic performance shifted from profit to the remuneration of labour, determining a potential factor of unsustainability from a social point of view. In fact, the average salary per man employed declined, and so did the social sustainability indicator which lowest value was registered in 2004.

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