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Review on economic indicators

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1. Introduction and concepts

This paper is not solely a literature review but also a paper that forwards reflections on the issue economic efficiency looked at by use of indicators. The aim is to identify the information that will be used to assess the economic performance of the selected cases. The use of indicators requires at least four steps:

1. Criteria used for assessment of economic efficiency
2. Identification and specification of indicators
3. Reference points
4. Interpretation and assessment of outcome and decisions (e.g. the traffic light system)

Often there is some confusion about the concepts economic efficiency and economic indicators. While the economic efficiency concept is, theoretically, well established, see for example Cohen and Cyert (1965), the use of indicators is a convenient analytical tool to structure information but not a theoretical concept in itself. Theory is linked to item 1 above because for example optimal factor allocation or comparison between two options are, in theory, obtained in specifically defined ways and the measurement of the outcome requires certain indicators and certain criteria for assessment. Before an assessment is performed categorization of the problem considered is helpful. It may be fruitful to compare fleet segments while it may not necessarily be fruitful to compare salmon fishery with salmon farming. The criteria used for assessment should be founded on economic theory about economic efficiency. However, criteria could also be “soft” in the sense that they are based on value judgments for example employment or investment rates. A long list of such criteria can be found in the literature and often the criteria are adapted to the case (categorization) that is under consideration.

The concept economic efficiency is clearly defined in the neo-classical micro economic theory, and is further explained in section 2. In theory a fishery is ‘economically efficient’ if the resource rent is maximized. Other economic indicators are not providing information about economic efficiency as such but only about the state or the development of the system from an economical point of view. These indicators could be either socio-economic (macro economic) or business economic indicators. It is not always easy to distinguish between the macro economics, micro economics, socio-economics and business (private) economics. Another problem is what concerns society and what concerns agents in terms of consumers and producers (companies). However, the concept economic efficiency originates from micro economics, and from this origin has implications for socio-economics and business economics.

This literature review is based on peer review articles and grey literature. Most of the information, however, is to be found in the grey literature.

2. Pareto optimality

Economic efficiency defined from an economic perspective is called *Pareto efficiency* if it is impossible to reallocate goods and production factors in such a way that somebody is made better off without making somebody else worse off (Varian 1999, p. 19). The implication of this is that if it is possible to make somebody better off without making somebody worse off the situation is *Pareto inefficient*. This is the *strong* Pareto condition. The *weak* Pareto condition says that if the gain by one agent, groups of agents etc. is sufficiently high to compensate the loss of another agent, groups of agents etc. then it is Pareto efficient.

Often heard phrases, when dealing with performance of fisheries, are: ‘One vessel is more economic efficient than an other one is’, or ‘the vessel has become more economic efficient’. This is not wrong linguistically, but such phrases collide with the definition of economic efficiency stated above as they describe states of the system that are in most cases economically *inefficient*. Therefore, the terms ‘economic efficiency’ and ‘economically efficient’ are in this paper used with clear reference to the economic definition and linguistic phrases as the one given above are avoided.

While it is important to have Pareto efficiency in mind in economic evaluations, it is hard if not impossible to obtain *strong* Pareto efficiency in practice. What is possible in practice, however, is to use the *weak* Pareto criterion to judge whether society, the industry or the consumers are better off than before without harming somebody else. This entails that compensation is possible but not necessarily carried through in practice. The literature on Pareto efficiency or Pareto optimality form basis for the theory of welfare economics which form basis for fisheries economics.

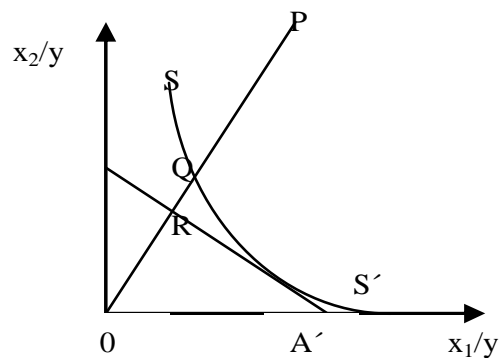
The economics of fisheries is characterized by externalities (Andersen 1983, Gordon 1954, Scott 1955, and Hardin 1968). In Pareto efficient allocations of goods and production factors such externalities are taken into consideration or internalized. The Pareto criterion has wide use, ranging from the entire society down to evaluation of the welfare of subsectors based on a single agents’ welfare. How the criterion is used in practice is a question of delimitation. If, for example a fisherman can improve his welfare (profit) without inflicting losses in welfare (profit) on other fishermen the system is moving towards Pareto efficiency. Because of the embodied externalities in fisheries the improvement in one fisherman’s profit is happens on the expense of other fishermen, and therefore his improvement is Pareto inefficient if he is not able, potentially, to compensate the harmed fishermen, which he is not in fisheries that are subject to overfishing and open access.

3. Data Development Analyses (DEA)

Efficiency measurement begins with Farrell (1957) who defined total economic efficiency concept based on the combination of the following two components: a technical efficiency (the capacity to obtain maximal output given a set of inputs), and an allocative efficiency (the capacity to use inputs in optimal proportions given their prices). Felthoven (2002) and Pascoe and Herrero (2004) use DEA framework to estimate efficiency in fisheries; and a whole issue of Marine Resource Economics edited by Vestergaard (2005) has been devoted to capacity efficiency issues using DEA.

Farrel showed a simple example with two firms which use two inputs (x_1 and x_2) to produce a single output (y), within Constant Return to Scale (CRS). In the following Figure $S'S$ is a unit isoquant and firms operating on $S'S$ are fully efficient. A firm operating in P is inefficient as it employs higher inputs to generate the same output, as the firms on the isoquant. The technical efficiency of the firm is measured by the ratio OQ/OP ; while the allocative efficiency is measured by the ratio OR/OQ . The product of both measures represents the economic efficiency which is measured by the ratio OR/OP .

Figure 1. Efficiency measures: technical and allocative efficiency



Data Envelopment Analysis (DEA) model, a mathematical programming model, estimates, following Farrell's idea, the efficient isoquant from sample data by means of a non-parametric piece by piece linear convex isoquant. The application of DEA model to fisheries is used to estimate efficiency measure; however, one of the main restrictions of characterizing efficiency through DEA framework is that it provides an efficiency measure in relative terms given that estimates efficiencies related to the most efficient isoquant. DEA framework provides an efficiency measure by comparing each individual production unit - a vessel - against all other units. In this sense, the efficiency of each vessel is obtained by comparing its output and input use ratio with the "best use or practice". The so-called best use is related to the one that assure the highest input/output ratio. This relative efficiency measure could not satisfy the so-called Pareto economic efficiency.

4. Fisheries economics and economic efficiency

Because of the externalities in fisheries it is necessary to distinguish between the individual fisherman's efficiency and the efficiency of the industry (society). The individual fisherman may become more efficient from his own viewpoint if he can increase his profit. There is reason to believe that each fisherman is efficient in the sense that his use of production factors (fishing effort) is determined by the intersection between his marginal costs (exclusive externalities) and the price he will get for the fish. But exactly because of externalities the whole industry is inefficient. This problem is well known from the fisheries economics literature and dealt with in figure 2.

Figure 2 shows the so called *Gordon-Schaefer model* (Gordon 1954) but is on top of that loaded with further information that is explained below. The Gordon-Schaefer model is constituted by the

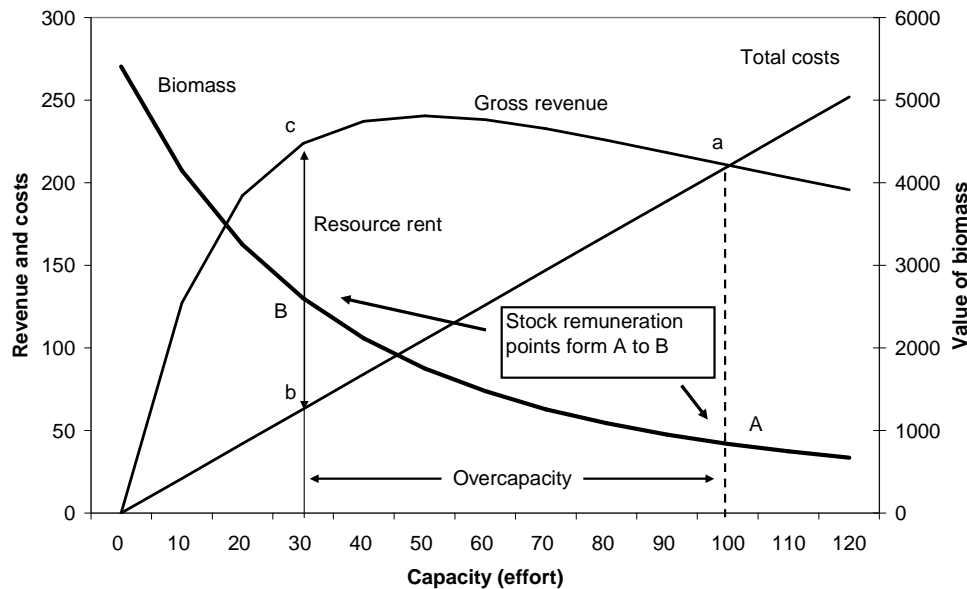
gross revenue curve and the total cost curve for the entire fishing industry. In its simple form the entire industry is composed by one species harvested by one fleet composed of homogeneous vessels. The gross revenue curve is the (biological) Schaefer yield curve of a fish stock multiplied with the price of the fish normalized to 1. The total cost curve is composed by all the homogeneous vessels' costs. If the vessels are non homogeneous some vessels would earn higher profits than others (infra marginal producer rent).

It is shown in the literature that because of the externalities discussed above "equilibrium" of the fishery is determined by the intersection between the gross revenue and the total costs (at point a in figure 2). This is often called the *open access equilibrium* because this is how the fishery will adjust if no restrictions are imposed. At this point each single vessel is "efficient" from the fisherman's point of view because its own marginal cost is equal to the price of the fish. It cannot be seen from figure 1, but it is important to notice that even though the earnings of the total industry in point a equals 0, the individual vessels can actually earn a high profit, the level of which is determined by its opportunity costs i.e. what the capital (and labour) could earn elsewhere. However, the entire fishery is economically inefficient.

If the fishery is restricted for example by restricting the number of vessels or the amount of catch (quota) the entire fishery can earn more money. If capacity is restricted to 30 compared to 100 the open access equilibrium in figure 1 the distance between gross revenue and total cost for the whole fishery (the distance between points b and c in the figure) is maximized. The distance between gross revenue and costs is defined as the resource rent although it includes consumer and producer rent.

In principle the fishery is Pareto efficient if the resource rent is maximized. Therefore the resource rent is a key variable with respect to economic efficiency for the whole fishery.

Figure 2. Socio-economic efficiency including the concepts of resource rent, overcapacity, and remuneration of the biomass



Economic efficiency determined by the resource rent cannot be extracted from statistics but has to be calculated by use of bio-economic models that include information about the fish stocks and the fishing vessels. On vessel level the profit can be extracted from the recorded statistics, but the vessels' contribution to the resource rent of the whole industry also has to be calculated by taking the net profit of the vessels after deduction of all costs and then subtract the opportunity profit. The fish stock is embodied in this measure. Therefore, the calculation of the maximum resource rent requires explicit information about the fish stock and its capacity to produce yield.

Thus, economic efficiency for a whole fishery cannot be determined without knowledge about the yield of the fish stock. This requires biological information based on fish stock assessment that produces information about the development of the stocks. The information about the spawning stock biomass is published by, among others, the International Council for the Exploration of the Sea (ICES). This information makes it possible to calculate the development of stock biomasses and the yield as a function of fishing mortality. Assuming that fishing mortality is a linear function of fishing effort the stock development as a function of effort is shown in figure 2.

If the spawning stock biomass is considered a capital input in the same way as vessel capital, the biomass capital could be remunerated in a parallel way. The fish stock remuneration could be viewed as a payment to society for the common property of the fish stock and this remuneration could be added as a cost to the effort costs. If the remuneration is a constant percentage of the stock value, the remuneration will differ with stock size. For example in point A in figure 1 it is low relative to the remuneration in point B.

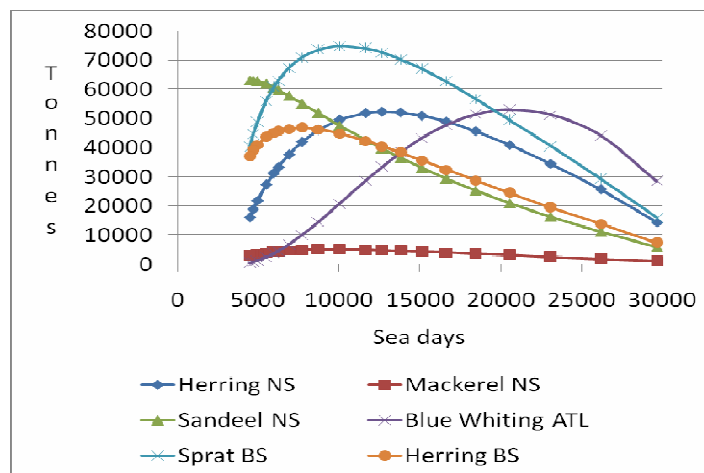
If, on the other hand, the percentage is determined according to the yield of the stock (landings) in proportion to the stock, the percentage should be high in point A and lower in point B. The yield in proportion to the (low) biomass in point A in figure 2 is 25 % while the yield in point B is 8 %. If the opportunity cost of capital is 8 % the stock should be increased to the corresponding level. The calculated remuneration of the stock could be subtracted from the total profit recorded for the fishery in question, and this efficiency measures would provide some information about state of the fishery.

In many cases only point estimates of the fish stocks are available. In these cases it is still possible to calculate the remuneration to the stock, although not with the same degree of precision as if the stock development is known.

Most fisheries are, however, not representatives of the ideal one-stock one-fleet situation described above. Usually several stocks and fleets compose a fishery. That makes it impossible to arrive at an optimal solution in which the resource rent is maximized and reference points such as Maximum Economic Yield (MEY at point c in figure 1) or the biological reference point Maximum Sustainable Yield (MSY, at the peak point of the gross revenue curve in figure 2) are reached.

The more common situation where a fishing fleet is exploiting several stocks at the same time is shown in figure 3 and 4. Figure 3 shows the yield curve (landings curve) of different stock as a function of sea days. The yield curves are calculated by use of a Gompertz¹ function (Conrad and Clark, 1994) and the associated number of sea days as a function of the landings of the different species is calculated by use of the EIAA model (SEC 2004). The case shows an example of large pelagic trawlers. It is assumed that the fleet is not able to exploit the species sequentially (one by one), which even more pronounced is the case in demersal fisheries.

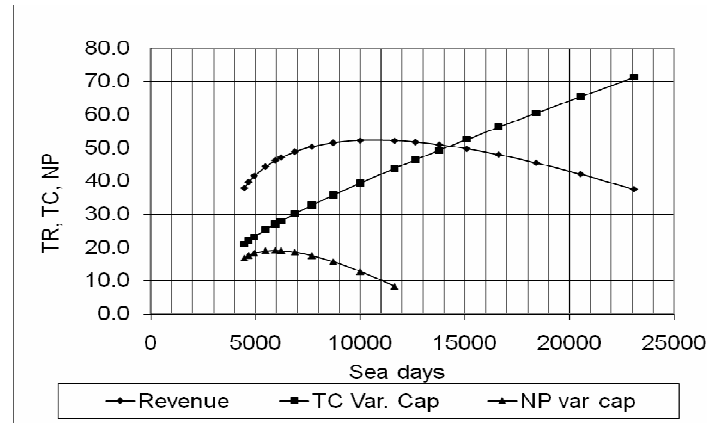
Figure 3. Sea days as a function of landings



¹ Benjamin Gompertz ([March 5, 1779](#) - [July 14, 1865](#), [London, England](#)), was a [self educated mathematician](#).

It is noted from figure 3 that the peak points (MSY) of the yield curves cannot be obtained for all the species at the same time. If the yield curves (landing) are multiplied with the fish prices and aggregated and the cost of producing sea days are taken into account one arrives at the picture shown in figure 4.

Figure 3. Gross revenue, total variable costs and profit for a fleet segment



Aiming at maximizing the resource rent the figure shows that the optimal number of sea days for this segment is around 6000 days. Figure 4 can be compared with figure 2. They show the same features but the underlying assumption are different in particular with respect to the level the various species are exploited. Some are exploited above and some below their biological reference points MSY.

Finally, with reference to conventional economic theory individual fishermen maximize their profit when the marginal costs are equal to the price of the fish. This means that it is possible for (some of) the individual fishermen to earn high profits even in cases where the resource rent is dissipated. These profits are recorded in cost and earnings statistics but it is not possible without knowledge about the opportunity costs to determine the extent to which this profit includes resource rent.

The most appropriate criteria to assess economic efficiency are discussed below but before that a look at indicators and where they are used is carried out.

5. Indicator systems

Indicators systems are often addressed in relation to sustainable, precautionary and responsible fisheries (FAO 1995a, 1995b, 1995c, 1996, 2001a, 2001b, 2003, 2005). Therefore, the indicator systems are developed to cover several dimensions. The indicator systems described in this section are not fisheries specific, but developed to address a range of issues within four dimensions:

1. Ecological
2. Social

3. Economic
4. Institutions/governance systems.

Economic indicators are thus part of a broader system, which is described by different indicator systems that in a sense are variations on a theme.

The approach of FAO and OECD generally includes more than only economic indicators as these bodies focus on sustainability of fisheries including, primarily from a biological and economic point of view, but with increasing focus on social and institutional aspects. FAO, in particular, has put emphasis on biological indicators in the Code of Conduct for a responsible fishery (FAO 1995a) that originates from the UN conference in 1992 (the Rio declaration. Agenda 21, United Nations Conference on Environment and Development, 1992).

A framework developed by FAO to address issues about sustainable fisheries is the Sustainable Development Reference System (SDRS). With respect to fisheries the relationship between conventional fisheries management schemes and the SDRS system is presented in table 1. For a fishery system comprising markets, fish resources, fishing fleet and fishermen an objective about sustainable fisheries may be set up. A management plan would need to include several steps to pursue the objective. In the SDRS indicators are defined to host information about monitoring the development towards this objective. Reference points are needed for assessment, and interpretation is required to arrive at decisions and implementation. Hence information is structured in a clear way to make interpretation and decision making easier.

Table 1. The relationship between conventional management plans and SDRS

Fishery	Fisheries management plans	SDRS
	Objectives	
Markets, Resources	Monitoring	Indicators
	Assessment	Reference points
Fleets, People	Decision	Interpretation
	Implementation	

FAO (1999)

For management purposes indicator systems produces information for different sorts of analytical assessment frameworks.

One approach widely used for example by the OECD, FAO, and the European Environmental Agency (EEA) on the four dimensions is the *Drivers, Pressures, State, Impact and Responses (DPSIR)* framework. The DPSIR framework was developed by the OECD in the 1980s to structure information and is useful because it identifies cause and effect relationships, allowing for the separation of issues through the different DPSIR categories defined as:

1. Driving forces are the underlying causes that lead to environmental pressures
2. Pressures affect the state of the environment

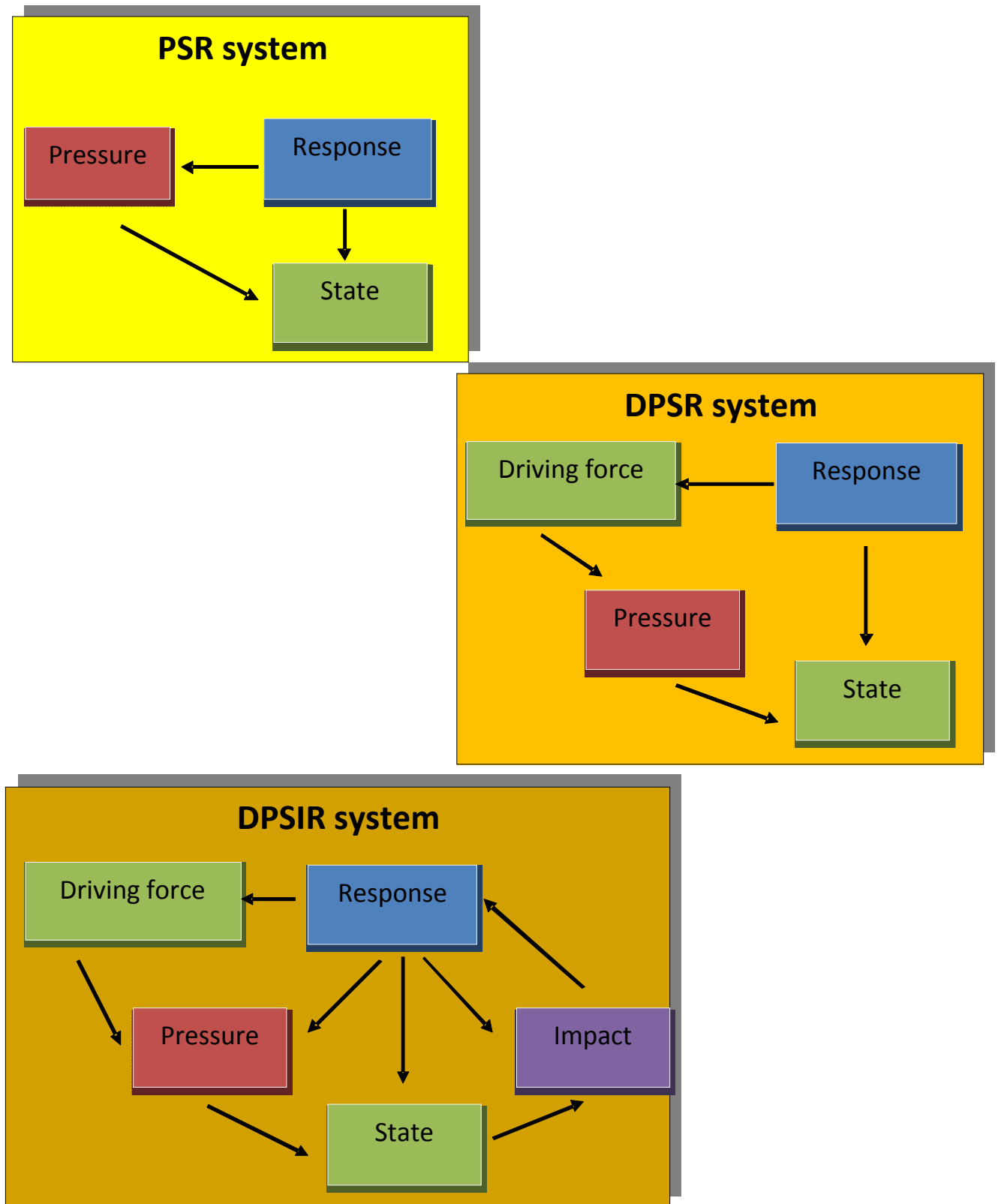
3. State refers to the state of the environment in terms of quality of natural resources;
4. Impact refers to the effect that a pressure has on the state of a natural resource and on user groups
5. Response relates to the social response via policies, laws, programmes and research

The PSR (Pressure, State, Response) framework was developed in the 1970s², and subsequently adopted by the OECD's State of the Environment (SOE) group. The European Commission's indicator development follows this framework. Some organizations prefer variants of the PSR model; for example, the UN Commission for Sustainable Development (UNCSD) bases its indicator set on the Driving force-State-Response model (DSR or DPRS), which allows for a better inclusion of non-environmental variables, (Jesinghaus 1999), see Figure 5.

In broad terms, the PSR framework aims to identify the pressure on the environment from human and economic activities, which lead to changes in the state or environmental conditions that prevail as a result of that pressure, and may provoke responses by society to change the pressures and the state of the environment.

² by the Canadian statistician Anthony Friend

Figure 5. Indicator systems



According to the pressure-state-response (PSR) framework that has been developed and used extensively within OECD, see for example OECD (2000), the indicators can be classified as shown in table 2. For the three dimensions the table shows what the cause of the pressure is. The next column shows how the state of the system could be measured and, finally, what actions could be taken to alleviate the pressure.

Table 2. PRS system applied to three dimensions

Dimensions	Pressure	State	Response
Ecosystem (resource and environment)	- Total catch - fish consumption	Stocks status	TAC and quotas
Social	- Fishing effort - Number of vessels - Growth rate of number of fishers	Number of fishers	
Economic	- Subsidies - Excess fishing capacity - Profitability	- Profitability - Sector employment	Economic incentives & disincentives (e.g. subsidies, taxes, buy-back)

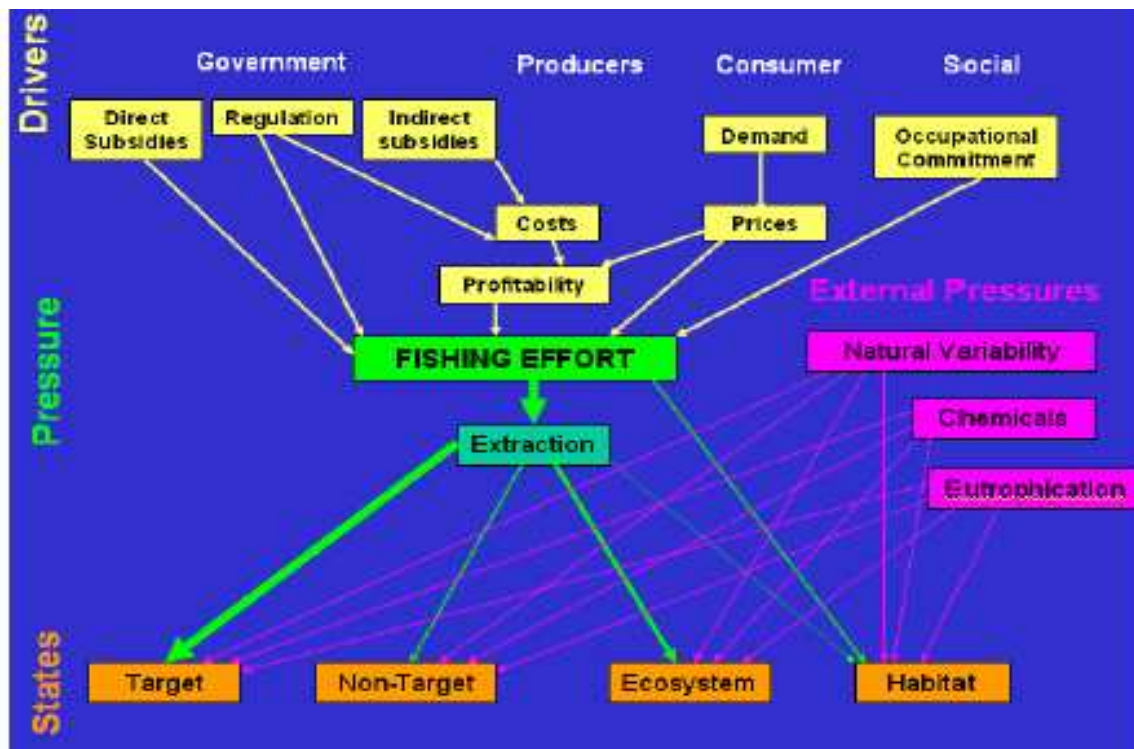
Le Gallic (2002)

The information systems DPSIR etc. require information about: 1. Criteria; 2. Indicators; and 3. Reference points. The following section addresses this area with examples from the economic dimension.

An example the DPSIR framework applied the Basque trawlers operating in the North East Atlantic is shown in Figure 6; although it is easily extrapolated to other fisheries. This example comes from ELME project.³ The figure provides a summary of the cause and effect relationships using States, Pressures and Driving Forces indicators.

³ European Lifestyles and Marine Ecosystems, by EU (EC/DG Research: Contract GOCE-CT-2003-505576)

Figure 6. DPSIR model applied to trawlers in North East Atlantic.



6. Economic indicators

6.1 Definition and use of indicators

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” (Accadia and Spagnolo 2006)

OECD defines indicators as: Indicators are data or combination of data collected and processed for a clearly defined analytical or policy purpose (Le Gallic 2002). The OECD applies economic indicators in the annual reports Review of Fisheries in OECD countries

Examples of economic indicators etc. can be found in FAO (1999), as shown in table 3. The criteria (or the name of the indicator) show the specific criterion that is enlightened by the indicator. The indicator and the structure columns show the type of information that could be produced to enlighten the criteria. Finally, the reference point column shows reference point that could and should be defined to be able to interpret and assess the system. These reference points can show both a state and a development. The concepts maximum sustainable yield (MSY) and the Maximum Economic Yield (MEY) are suitable as reference points as they are set up independent of time. These are points to pursue. For indicators showing developments for example in employment, the

annual development of the indicator could be compared to a stationary reference point, produced by using an average number over a number of years (historical level).

Table 3. Examples of economic criteria and indicators

Criteria	Example of Indicator	Structure	Reference Point
Harvest	landing by-catch	by species; age groups by area by fishery sub-sector	MSY historical level policy target level
Harvest capacity	GT (decked vessels) No of boats (undecked vessels) total effort	by fleet type by fishery segment age composition of vessels fishing mortality/species	capacity or effort of MSY policy target level
Harvest value (in constant prices)	total deflated value (landed price)	by species groups by sub-sector & fishery	selected historical level
Subsidies	tax rebates grants	by sub-sector by fleets/fishery	historical level zero level target level
Contrib. to GDP	fisheries GDP national GDP	by species groups	historical level
Exports	export/Harvest value	by species groups by fishery segment	historical level
Investments	market or replacement value depreciation fleet age composition	by fleet type by fishery	historical level
Employment	total employment	sub-sector fleet/fishery	historical level realistic policy target
Net returns	(profit + rent) net return/investment value of entitlements	by sub-sector by fishery	historical level MEY
Effort (mainly at fishery level)	no of vessels; Fishing time amount of gear used employment	by fishery segment in physical or monetary terms	

FAO (1999)

As regard the EU fisheries specifically, the data collection regulation (DCR) from 2001 (Council reg. 1543/2000 and Commission reg. 1639/2001) includes a number of economic indicators as shown in table 4 and 5 but no reference points. These indicators are similar to the indicators used in the annual economic report about the economic performance of selected European fleet segments (AER) and the associated EIAA-model. The regulation 1543/2000 is currently under revision, and prior to this an extensive work has taken place. Some of the proposals about economic indicators have been prepared in the “Paris workshop” and these are included in table 4 as well. The differences are rather in the name than in the contents of the variable with the aim to clarify the type of information that the name refer to. The complete list of indicators in DCR and the AER/EIAA is included in the appendix 1

The DCR operates with a minimum programme (MP) and an extended programme (EP), and table 4 shows the MP. The extended programme prescribes that the information should be collected on geographical levels that are disaggregated with respect to where the fish is caught.

The extended programme's fleet categorization is shown in appendix 2 with respect to the type of information.

Table 4. Economic variables and indicators used in the EIAA compared to the EC data regulation and the revisions proposed by the Paris workshop

Cost and earnings input to the EIAA from the AER	Review of economic indicators (Paris workshop)	
	Indicator required by EC 1639/2001	Proposed revised heading by the workshop
Gross revenue/value of landings	Income – Turnover	Gross revenue (of which gross value of landings)
Fuel costs	Fuel costs	
Vessel costs	Repair and maintenance	
Crew share	Crew (incl. Social costs)	
Other running costs	Other running costs	Other costs
Depreciation	Fixed costs	Capital costs
Interest	n.a. under the minimum program	
Invested capital	Investment (asset)	The value of capital
Prices/species	Prices/species	

Source: Commission Regulation (EC) no 1639/2001, appendix XVII (section j) and Report of the workshop ‘Economic Indicators’ Paris 10-14 May 2004, IFREMER.

Table 5. Other economic indicators

AER/EIAA	Indicator required by EC 1639/2001
Employment on board (FTE)	Employment Full time/part time/FTE
Effort (sea days)	Effort relevant unit accounting for technology and time
Invested capital (mEUR)	Invested capital
Fleet - number of vessels	Fleet – number of vessel
Fleet - total GT	Fleet - total GT
Fleet - total kW	Fleet - total kW
	Fleet in age
	Fleet according to gear used

With the aim of narrowing the scope for economic efficiency indicators, the following is based on the AER/EIAA approach.

The first best socio-economic indicator is the resource rent over a number of years discounted to net present value. However, this indicator is for practical purposes in-operational as it requires a model to be calculated and extensive data input in terms of economic and biological information which is not available on a wider scale.

The second best indicators on a socio-economic level are indicators as described in the FAO and OECD work. They are operational but not founded on economic efficiency theory.

At the business economic efficiency level, profit and the Return on Capital (ROC) are the first best indicators. However, it requires not only estimates of profit but also of the invested amount of capital, and in many fisheries (fleets) it is difficult or impossible to get reliable information about vessels capital. This is also the case in many other branches – not only in fisheries. In these cases the Return on Revenue (or Sale) ROS, often named operating profit margin, is used as indicator. On a socioeconomic level contribution to the gross Domestic Product (GDP) or the value added are considered first best indicators. The value added indicator is an approximation to GDP as the value added is easily estimated as crew wages plus remuneration of vessel capital plus profit (including remuneration of owners).

The economic indicators used in the Concerted Action EAEF (Economic Assessment of European Fisheries, <http://stecf.jrc.cec.eu.int/20>) apply to both the data collection of the AER and to the EIAA model. Emphasis has been put on a few well defined indicators that have been divided into indicators of known concepts from vessels accounts (economic indicators) and indicators of interest from a socio-economic point of view (other economic indicators), as shown in table 6 (will be produced from appendix 3) concerning the AER and the EIAA. Difficulties as to how to assess investments, although included in the list, have caused that an indicator such as 'return on capital' have been avoided. Result from EIAA calculations are basically presented by use of the same indicators as in the AER.

Table 6. Economic indicators used in the EAEF

Annual Economic Report	EIAA
Value of landings	Value of landings
Gross value added	Crew share
Gross cash flow	Gross cash flow
Net profit	Net profit
	Gross value added
	Op.profit margin (%)
	Classification (words)

From a socio-economic point of view remuneration of capital and labour is of interest. The Gross Added Value expresses the Added Value that the segment contributes to the National Economy. This includes: salaries, profits, opportunity cost of capital and depreciations. It can be obtained by deducting the fixed and variable costs (except the labour costs) from the total landing value.

Another interesting indicator is the value added per kg of fish, which consists of dividing the Gross Added Value by the total kg of fish landed. This indicator offers a view of the economic importance of the landings in volume terms. Both indicators are complementary, and in need of each other, for a robust analysis.

6.2 Long-term indicators and discount rates

Production surplus models such as the Gordon-Schaefer model predicts a long run bio-economic equilibrium where Catch Per Unit of Effort (CPUE) equals the ratio of the cost per unit effort a to price per unit harvest p , i.e. $CPUE = a/p$. Time series for catch and effort, as well as for effort costs and fish prices, are important sources of information that may be used in cases where fisheries independent stock assessment is not undertaken. CPUE time series should be used with great care as indicators of stock changes due to the unknown stock-output elasticity and efficiency changes, see SECXXX (2006) from which the text is derived.

In the short term (i.e. next year), constant assumptions can be made about the structure of a given fleet and that fleet's activity. The longer term is indicated by either a static equilibrium solution or a dynamic solution. In the former, as used to indicate a "recovered state" in the EIAA model⁴, no information can be given as to the length of time it would take to achieve that state, or even if that state can be achieved (especially given assumptions about a constant fleet). Hence, an indication of profitability of a fleet at a snapshot in time (i.e. "now") for any potential future scenario carries obvious misinterpretations. In the dynamic solution, a path (typically by year) to some future

⁴ The "recovered state" in the EIAA model indicates the quotas of each individual stock where they have reached an equilibrium level at which they can be fished at F_{pa} (i.e. the fishing mortality at which levels of recruitment give a 95% probability of avoiding stock collapse).

situation is given. This can account for changes in activity (i.e. changes in effort allocation by gear/species/area) and can take account of changes in fleet structure. These will clearly be dependent on the management options modelled and assumptions made. However, in the dynamic case, economic indicators over time can be presented that allow the assessment of the full effects of management measures on fleets to be ascertained. With respect to the biology, time to recovery given scenarios for alternative fishing mortalities (or time to some other target) can be provided (e.g. North Sea Cod recovery evaluations). These can indicate the probability of recovery at each time step and as such the uncertainty associated with recovery.

In the dynamic case, typical indicators such as gross revenue, intermediate consumption, gross cash flow and net profit can be used, as a yearly path is evident. In addition, a comparison of net present values (NPV) is possible in the dynamic case. In comparing the present values of alternative management strategies in order to achieve a policy objective (e.g. a recovery program or MSY for stocks), it is common to discount net benefits that will accrue in the future compared to net benefits that can be achieved at present. Discounting is included because investment in fisheries must compete with other investment opportunities with a positive rate of return. A second argument is the assumption that future generations are better off. In the case of fisheries this means at least constant catches, in an overuse situation an expectation of higher stocks and catch possibilities in the future. This needs to be addressed by the social planner. Typically, a cost-benefit analysis will discount streams of net benefits and compute the NPV as a single number. The theory is that standard discounting is meant to ensure that the present value of net benefit calculations provides a meaningful indication of whether the efficiency criterion is satisfied or not. If NPV of two alternatives is equal but is made up of two different streams of annual benefits, secondary reference point could be applied complimentary. For example is stability to prefer to variability.

There are many arguments for and against discounting future benefits and costs; especially controversial is the choice of the discount rate (as the outcomes are highly sensitive to the rate). The discount rates for people are normally very high which means above 20%, see Harrison, Lau, and Williams (2002) and Hillis and Whelan (1992) while the socio-economic discount rates are much lower, for example below 6% before tax. HM Treasury (2003) proposes a discount rate at 3.5%

When evaluating policies, the market interest rate can be used as the discount rate but do not really reflect all long-term effects. High discount rates favour myopic policies that continue to exaggerate unsustainable resources whereas discount rates that are too low can fail to capture the efficiency argument because other opportunities to invest the capital are more profitable. Sensitivity of the outcomes of a range of discount rates (e.g. 2-7%) can be undertaken in order to illustrate the possibilities. The alternative management strategy that achieves the highest NPV (with constraints for other criteria – such as sustainability) is as such the “best” choice.

7. Reference points

7.1. Operating profit margin intervals

The ‘Op. profit margin’ and ‘Classification’ indicators are based on Operating profit margin defined as net profit in proportion to gross revenue, see Table 7. The indicator is well known from business economics and is often used instead of ‘return on capital’ which is defined as gross revenue minus variable costs in proportion to invested capital. The reference points for these indicators are the intervals in which they lie.

Table 7. Reference points used in EIAA

Classification	Operating profit margin	
	(Net profit / gross revenue)	
Profitable	5%	and more
Stable	-5%	and up to 5%
Unprofitable	-5%	and below

In the EIAA reports the classification is elaborated in the presentation of projected results. The operating profit margins of the base line years and the projected year are compared to show the impact of the proposed quotas for the projected year. The interval from minus 5 % to 5 % indicates that the fishing activity would continue in the short, medium and long run even if the fixed costs (interest and depreciation) cannot be covered (negative net profit). In the long run these costs must be covered and the economic performance is deemed unprofitable if the operating profit margin is minus 5 % and below. The criteria of $\pm 5\%$ are arbitrarily fixed.

Further to highlight the economic repercussions in the short run an ‘impact indicator’ has been defined.

‘Impact’ = Impact of the TAC in YEAR+1 on operating profit margin compared to current YEAR

- ‘Worsened’ = Segment was making losses, losses now greater
- ‘Improved’ = Segment was making losses, losses now smaller
- ‘Lower’ = Segment was making profits, profits now lower
- ‘Higher’ = Segment was making profits, profits now higher
- ‘-’ = No significant change.

8.2 Break-even as reference point

The break-even concept shows the required landings value needed to cover fixed cost, given the contribution to the margin per unit landings value. The break-even landings value is then the value

that breaks even between contribution margin and fixed cost entailing zero net profit. The break-even landings value in proportion to the realised landings value is an indicator of overcapacity or undercapacity respectively in business terms. In an overcapacity situation the fixed costs are too high to be covered by the contribution margin from the landings, and indicate that capacity ought to be reduced and *vice versa*.

The extended list of indicators in the EIAA, cf. Appendix I.3, includes estimates of the 'break-even' value of landings, partly to show the required value of landings to break even i.e. cover fixed costs, and partly to estimate 'overcapacity' by use of the 'break-even' information in combination with the actual or projected value of landings.

The definition of break-even is: $Break\text{-}even\ Revenue = Current\ Fixed\ costs / (Current\ Cash\ Flow / Current\ Revenue)$.

When the Break-even revenue and the actual revenue is compared an indication of the change of the fixed costs in order to comply with break-even is obtained. Assuming that fixed costs are a proxy for capacity an indication of over and under capacity is provided. The result does not indicate whether a required change in fixed cost actually is possible, only that it is necessary.

The applied definition of overcapacity is: $Over\text{-}capacity = 1 - (Revenue / Break\text{-}even\ Revenue)$

A potentially informative use of the break-even indicator would be to estimate, for each fleet segment, the catch required to break even assuming the status quo catch composition for each segment. The break-even catches for each stock could be summed over fleet segments giving an indication of the degree of imbalance between the fishing capacity at break-even and resource availability.

8.3 Economic Sustainability Reference Points

The economic sustainability depends on the capability of the sector to attract money. To guarantee the investment of financial resources in the long term, it is necessary to protect the fishery investment profitability. So, the economic sustainability could be measured by comparing the profitability of the fishery investments in vessel capital and fish stocks on one hand and in alternative sectors on the other.

The possibility to invest in more profitable economic sectors, or with the same profitability with less risk, determines a reduction in the investments in the fishery and compromises its sustainability in the long term.

A feasible indicator to measure the economic performance of a fleet segment could be the ROI (Return on Investment). The ROI indicates the percentage ratio of net profit plus the opportunity cost in relation to the investment.

In order to effectively interpret the information obtained through the indicator, some reference points (RP) must be applied. These points can refer to either a sub-optimal (in-efficient) or an

optimal (efficient) situation. The former identifies a limit which is necessary to avoid, while the latter represents a target to be pursued.

The indicator suggested to measure the economic sustainability is calculated by comparing the investment profitability rate (ROI) for a specific fleet segment within a specific geographical area with the theoretical risk free rate, for example the long-term treasury bonds rate.

The difference between these two rates allows for an evaluation of the profitability of an investment in the fishery with regards to a risk free investment. When the ROI value is lower than (or very close to) the long-term treasury bonds rate, i. e. when the economic sustainability indicator is negative or very close to zero, it is not profitable to invest in the fishery and the financial resources will be directed to public bonds or to more profitable alternative investments.

In case of limited information on invested capital it is possible to use other more easily available information's from vessel owner statements to create an indicator for economic sustainability. The development of own capital (equity) reflects the stability of a company. It is not possible to stay in business in the long run with decreasing own capital over many years. Additionally, a large amount of external capital compared to a low amount of own capital means higher risks of bankruptcies in case of lower catch possibilities than expected.

8. Remuneration of spawning stock biomass (SSB)

Remuneration of the biomass (resource rent), e.g. the spawning stock biomass (SSB), is parallel to remuneration of man made capital. While little information about stock biomass is available information about SSB (older age groups) could be extracted from ACFM reports and allocated to specific fleet segments according to the share of their landings relative to total EU landings.

The value of the spawning stock biomass (VSSB) could be determined by use of fish prices or the net profit (resource rent), if this information is available. The interest rate used to calculate remuneration could correspond to the level used in public investment projects (e.g. roads, bridges) or probably lower. Reference points could be based on VSSB(current) or the VSSB(precautionary), cf. Figure 1, points *A* and *B*, respectively. In well-managed fisheries the resource rent $b - c$ reflects the remuneration of the biomass of a single species. In fisheries characterised by overcapacity e.g. the intersection between gross revenue and costs at point *a*, the resource rent is dissipated. Ideally, the resource rent should be estimated and included as an opportunity cost of fishing, but such an exercise is data demanding.

An alternative is to use the current VSSB and the precautionary VSSB in combination. Using the VSSB indicators in combination produces a reference point. For a well managed fleet segment or stock the $\frac{VSSB(current)}{VSSB(precautionary)} = 1$, while the $\frac{VSSB(current)}{VSSB(precautionary)} < 1$ in a fishery that is not

managed in an optimal way. The indicator and the reference point are basically of ecological nature. The relevance with respect to economics is connected with the valuation of the stocks.

The EIAA model is prepared for possible estimates of remuneration of the fish stocks i.e. includes measure for resource rent. The value share VSSB of the fish stocks allocated to each fleet segment is calculated in proportion to the segment's quota share of the total TAC. The issue requires further development and is not presented as part of the EIAA results in published reports for example SEC (2004) 1710.

9. Aggregation

There are two different aspects on the level of aggregation used for economic indicators: the levels at which economic indicators are used within the models and the level at which the results are presented.

In an economic perspective the ideal indicator is the resource rent, which means that only one indicator and reference point is required for presentation. The underlying model, however, requires and produces a large number of indicators.

The level needed for the use of economic indicators in the models depends on the type of model used. In the EIAA model for example, totals per fleet segment are used to predict the effects of TACs on the economic performance of fleets. In dynamic simulation models working on fisherman's level a fisherman's behaviour is modelled by means of comparison of economic indicators of different fishing strategies.

Since all of the economic models are used for management purposes, the output indicators should fit the data needs for managers. In case of stable fleets, total economic indicators will be sufficiently indicative for developments in the economic performance, but in case of changing fleet structure, other levels of aggregation (per vessel, per kW, per GT) might be more indicative for the actual developments.

10. Interpretation

Once indicators are produced and reference points decided the performance of the system can be interpreted. A widely used method that does not refer to fisheries is the traffic light system. The system works with green, yellow and red colours. The system has been applied to FAO's Geographical Sub Areas 17 and 18 (GSA 17, 18) in the Mediterranean, see Accadia and Spagnolo (2004), and the following tables show the results.

The list of indicators is comprehensive and reference points in terms of absolute or relative numbers have to be determined in advance. Apart from that, the relative development over time of the indicators can in itself be used as reference points. The development of fuel prices, for example, can be viewed in this way. Increasing fuel prices will then be marked with red while decreasing and sufficiently low (in a historic perspective) fuel prices will be marked with green.

Compared to the first best indicators mentioned above the advantage of using a large number of indicators is that it is pinpointed where in the systems problems occur.

Traffic light method applied to economic indicators for FAO-GSA-17

INDICATORS	1997	1998	1999	2000	2001	2002	2003	2004
Economic performance (ROI - Risk_free_rate) (%)	3.57	1.74	0.89	8.80	10.10	8.87	12.09	14.24
•Added Value/Revenue	0.67	0.66	0.63	0.68	0.66	0.65	0.65	0.63
•Gross Operative Margin/Revenue	0.30	0.23	0.20	0.30	0.28	0.29	0.30	0.31
•ROS (Return on Sale)	0.23	0.16	0.14	0.25	0.23	0.24	0.24	0.26
•ROI (Return on Investment) (%)	10.33	6.66	5.60	14.39	15.27	13.82	16.37	18.52
•Revenue/Invested Capital (%)	44.75	41.71	41.27	56.51	65.11	58.12	66.95	71.21
•Net Profit per vessel (000 €)	60.79	38.82	27.19	82.79	68.94	62.69	63.94	71.61
•Landings per vessel (ton)	340.26	306.99	296.37	358.09	310.86	287.09	276.34	283.38
•Landings per GRT (ton)	4.49	4.31	4.16	4.95	5.59	5.15	5.73	5.88
•Landings per day (ton)	2.02	1.83	1.97	2.05	1.67	1.60	1.75	1.84
•CPUE (kg)	27.55	26.22	28.62	29.09	31.21	29.91	35.16	38.48
•Revenue per vessel (000 €)	291.38	268.84	239.86	337.87	302.82	274.30	267.73	280.90
•Revenue per GRT (000 €)	3.85	3.77	3.37	4.67	5.44	4.92	5.55	5.83
•Revenue per day (000 €)	1.73	1.60	1.59	1.94	1.63	1.53	1.69	1.83
•RPUE (€)	23.59	22.96	23.17	27.45	30.40	28.58	34.06	38.15
•Average price (€/kg)	0.91	0.95	0.89	1.06	1.13	1.14	1.18	1.24
•Fuel cost per vessel (000 €)	37.63	35.87	38.08	47.71	44.76	40.40	39.69	43.92
•Fuel cost per day (000 €)	0.22	0.21	0.25	0.27	0.24	0.23	0.25	0.29
•Maintenance cost per vessel (000 €)	11.92	11.26	9.18	11.78	11.48	10.72	10.76	14.14

Traffic light method applied to social indicators for FAO-GSA-17

INDICATORS	1997	1998	1999	2000	2001	2002	2003	2004
Social sustainability (Salary - Minimum_salary) (000 €)	3.70	4.77	3.78	8.20	8.08	4.66	4.82	2.84
•Employed persons (num.)	1178	1109	997	837	762	744	876	915
•Landings per crew (ton)	46.81	42.37	43.40	54.34	51.82	45.90	47.00	47.07
•Revenue per crew (€)	40.08	37.11	35.13	51.27	50.48	43.86	45.54	46.66
•Crew/GRT	0.096	0.102	0.096	0.091	0.108	0.112	0.122	0.125
•Salary per crew (000 €)	14.89	15.96	14.97	19.39	19.27	16.00	16.15	14.80

11. Conclusion

The following list is organised according to the items required by an indicator system. First the criteria are listed. The criterion is the name of the type of information that is wanted. Secondly, the indicators are listed, and these describe the exact type of information that is needed to describe the criteria. Thirdly, the reference points describe what type of information the indicators are compared with. Fourthly, the interpretation includes decision rules to reject or approve hypothesis.

The information should be provided on fleet segment level according to the levels specified in the DCR (see appendix 3). This means that level one is vessel length, level two is fishing techniques etc.

12.1 Criteria (name)

1. Economic efficiency
2. Harvest
3. Fish prices
4. Gross cash flow (profit margin)
5. Net profit
6. Contribution to GDP (gross value added)
7. Employment
8. Effort
9. Fleet capacity

12.2 Indicators

- Economic indicators all measured in €:
 - Value of landings
 - Variable costs e.g. fuel, provision, repair
 - Crew share e.g. payment to the crew including skipper
 - Gross cash flow (value of landings minus variable costs and minus crew share)
 - Fixed costs (interest payments and depreciation, insurance, administration etc.)
 - Net result e.g. value of landings minus all costs
 - Gross value added (socio-economic indicator) e.g. remuneration of labour and capital (contribution to gross domestic product).
- Other economic indicators

- Landing of fish by species (tonnes)
- Employment on board measured in persons or full time employment
- Effort measured in sea days or kw-days
- Invested capital measured in €
- Fleet capacity measured in number of vessels, GT and kW

12.3 Reference points

1. Maximum economic yield (MEY). This equals maximizing of the resource rent. It is calculated from the short run profit margin (gross cash flow) or the long run net profit. The MEY is an optimal “steady state” situation for a fishery from an economic point of view.
2. Net present value (NPV). The method takes all future in- and outgoing payments and discounts those to a certain point in time usually the present year. It is expressed in absolute values or as a percentage.
3. Return on investment (ROI). Is calculated taking the change in gross cash flow in proportion to the investment. It applies NPV and is expressed as a percentage.
4. Return on capital (ROC). Gross cash flow in proportion to the total invested capital in vessels. It is expressed as a percentage.
5. Operating profit margin (OPM). This is calculated taking gross cash flow in proportion to gross revenue. It is expressed as a percentage.
6. Break even revenue (BER). Is calculated taking the gross cash flow in proportion to the gross revenue and divide the fixed costs with this coefficient.
7. Overcapacity by use of MEY is calculated taking difference between the current number of vessels and the calculated number of vessels at MEY in proportion to the current number of vessels. If possible GT and kW could be applied.
8. Overcapacity by use of BER. It is calculated taking the proportion between the current gross revenue and the calculated BER and subtract that coefficient from 1.
9. Other reference points for example for the development in harvest or the employment are calculated by taking the average value of these indicators for a pre-defined historical period.

12.4 Interpretation

The first seven reference point combines information about output and input in a fishery and requires calculations. The reference points under item eight are dealing with indicators separately and are therefore less data demanding. On the other hand these reference points are also more difficult to interpret as the interpretation is not based on economic theory but on political goals.

The choice of reference points depends on the problem that is addressed and the availability of data. The best but also the most data demanding reference point is the MEY. The closer the fishery gets to MEY the more efficient it is with respect to usage of production factors.

The NPV is convenient once two or more scenarios are compared. The one with the highest NPV are usually the one that should be favoured on the expense of the other(s). It is useful for comparison of different management regimes.

The ROI reference point is useful to investigate changes in the fishery caused by changes in investment for example in vessels and fishing gear. The ROC and the OPM are relevant to assess changes in management. The ROC is more data demanding than OPM. OPM has been used for a number of years by the STECF in the assessment of economic repercussions of the quota management.

The interpretation of ROI, ROC, and OPM requires decision rules. Usually these calculated for the fishery is compared to the same type for other sectors or to agreed conventional figures. These percentages could be for example 5%. The ROC and the OPM further have the advantage that they could be produced over time and therefore also historical reference points of these could be used in the interpretation.

The easiest overcapacity reference point among item 6 and 7 is the BER-based reference point. It requires calculation but is less data demanding.

As regards the reference point under item 8 they are less data demanding and requires little processing. They appear directly from the indicators. A convenient way to interpret these indicators is to use the traffic light system. Once the reference points are calculated by taking the average of a certain period the colours can be determined, and a picture can be produced.

Finally it should be mentioned that having produced the entire assessment of the whole system the DPSIR system could be applied.

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Appendix 1

Regulation 1639/2001 Appendix XVII (section J)

Economic information per fleet segment as defined in Appendix III (Minimum Programme)

General description	Minimum ¹ programme First priority (annual)
Income (turnover)	Total and per species
Production costs: - crew (include social cost) - fuel - repair and maintenance - other operational costs	Total and per production cost category
Fixed costs	Average cost, calculated from investment
Financial position	Share of own/foreign capital
Investment (asset)	
Prices/species (*)	Value, tonne
Employment	Full time/part time/FTE
Fleet	- No - gt - kW - age - gear used
Effort	Relevant unit accounting for technology and time

1. There is a misprint in the regulation (says extended)

(*) Quarterly basis everywhere.

Appendix 1 cont...

Regulation 1639/2001 Appendix XVIII (section J)

Data needs for basic economic evaluation per fleet segment (Extended Programme)

General description	Extended programme (Second priority)
Landings per species	Seasonal (monthly) Stock (by ICES areas) Market category Regional differentiation (level 3, Appendix I)
Income (turnover)	Subsidies (annually) Regional differentiation (level 3, Appendix I)
Production costs: - crew - fuel - repair and maintenance - other operational costs	Further subdivision of operational costs Regional differentiation (level 3, Appendix I) Differentiation of remuneration to crew according to Position
Fixed costs	Regional differentiation (level 3, Appendix I)
Financial position	Rents to external institutions Regional differentiation (level 3, Appendix I)
Investment (asset)	By type of investment: hull of vessel, various engines and refrigeration/freezing, storage and lifting equipment
Prices/species	Monthly By market category Regional differentiation (level 3, Appendix I)
Employment	Skill/education Distinction per vessel size, regional differentiation
Fleet	Size categories of fleet segments regional differentiation (level 3, Appendix I)
Effort	Regional differentiation (level 3, Appendix I)

Appendix 2

Indicators used in Concerted Action EAEF (Economic Assessment of European Fisheries)

AER (Annual economic report)		EIAA	
Report text	Appendix (time series)	Summary (over time)	Extended (one year)
<i>Economic indicators mEUR</i>			
Value of landings	Value of landings	Value of landings	Value of landings
Gross value added	Fuel costs	Crew share	Fuel costs
Gross cash flow	Other running costs	Gross cash flow	Other running costs
Net profit	Vessel costs	Net profit	Vessel costs
	Crew share	Gross value added	Crew share
	Gross cash flow		Gross cash flow
	Depreciation		Depreciation
	Interest		Interest
	Net profit		Net profit
	Gross value added		Gross value added
			Op.profit margin (%)
		Classification (words)	Classification (words)
<i>Other economic indicators</i>			
Employment on board (FTE)	Employment on board (FTE)		As to the left
Invested capital (mEUR)	Invested capital (mEUR)		
Fleet - number of vessels	Effort (1000 days at sea)		
Fleet - total GT (1000)	Volume of landings (1000t)		
Fleet - total kW (1000)	Fleet - number of vessels		
	Fleet - total GRT (1000)		
	Fleet - total GT (1000)		
	Fleet - total kW (1000)		

Appendix 3

Regulation 1639/2001 Appendix IV (section C)

Detailed disaggregation of vessels for capacities (Extended Programme)

Vessel length (level 1)		< 10 m	10 - < 12 m	12 - < 18 m	18 - < 24 m	24 - < 40 m	≥ 40 m
Type of fishing technique							
Level 2	Level 3	Level 4					
Mobile gears	Beam trawl	North Sea < 221 kW					
		North Sea ≥ 221 kW					
		Outside North Sea					
	Demersal trawl and demersal seine	Bottom trawl					
		Danish and Scottish seiners					
		Polyvalent					
	Pelagic trawl and seiners	Pelagic trawl					
		Pelagic seiner and purse					
		Polyvalent					
	Dredges						
Polyvalent mobile gears							
Passive gears	Gears using hooks	Longlines					
		Other gears using hooks					
	Drift nets and fixed nets						
	Pots and traps						
	Polyvalent passive gears						
	Polyvalent gears						

Source: Commission Regulation (EC) no 1639/2001 Appendix IV (section C)

Appendix 3 cont...

Regulation 1639/2001 Appendix III (section C)

Basic segmentation of vessels for capacities (Minimum Programme)

Vessel length	(level 1)	< 12 m	12 -< 24 m	24 -< 40 m	≥ 40 m
	Type of gear (level 2)	Fishing technique (level 3)			
	Mobile gears	Beam trawl Demersal trawl and demersal seiner Pelagic trawl and seiners Dredges Polyvalent			
	Passive gears	Gears using hooks (1) Drift and fixed nets Pots and traps Polyvalent			
	Polyvalent gears	Combining mobile and passive gears			

(1) This segment is aggregated for all passive gears.

Note 1: If a gear category contains fewer than 10 vessels, then the cell can be merged with a neighbouring length category to be specified in the national programme.

Note 2: If a vessel spends more than 50 % of its time using a specific type of fishing technique, it should be included in the corresponding segment.

Note 3: Length is defined as length overall (LOA).