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A Review of the Fishing Capacity Concept

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Abstract:

A brief introduction to the concept of fishing capacity, and its related terms, is given. The paper goes on to discuss overcapacity as theoretically defined in literature. The level of overcapacity that appears to exist is then addressed through a series of empirical estimates on a global scale using various models and assumptions. Selected European fleet data is analysed using one of the models, based on a volume/value of landings per capacity unit ratio. The limited use of the model is acknowledged and is hence extended to incorporate cost and revenue data. The current lack of available cost data, and optimal capacity targets, limits the progress of this analysis and results only serve as an illustration of its possible use.

Keywords: Fishing capacity, overcapacity, capital productivity ratios, and cost/revenue ratios.

1. INTRODUCTION

The problem of overcapacity in fisheries is common and there has hence been a move towards improved management measures in order to rebalance exerted fishing pressure on available fish stocks. In some cases this has been sought through the control and reduction of *fishing capacity*. However, in order to create effective management measures one has to be able to correctly define and measure fishing capacity and ensure that the concept can be correctly linked to the concepts of fishing effort and fishing mortality. In order to estimate the level of *overcapacity* that currently prevails in any given fleet will require management to define an *optimal* or *target capacity*.

Although the overall work currently undertaken deals with the whole concept of fishing capacity, and its related terms, the focus of this conference paper is to deal with overcapacity concept only. Recent global overcapacity models and estimates are reviewed. Preliminary capital productivity and cost/revenue ratios based on earlier empirical models are then applied to European fishing fleet data.

2. DEFINITION OF FISHING CAPACITY TERMS

As mentioned above, this paper does not intend to consider the concept of fishing capacity at any great length. In order to understand the overcapacity concept, however, a brief introduction to a few definitions currently considered is given below, limited to those proposed by a FAO Technical Working Group[1] (FAO 1998) consultation. Further discussion of the fishing capacity concept will be available in forthcoming publications of the current work undertaken, which highlight its complex and highly variable interpretations.

The TWG (FAO 1998, p 2) proposes the following fishing capacity definition:

"The ability of a stock of inputs (capital) to produce output (measures as either effort or catch). Fishing capacity is the ability of a vessel or fleet of vessels to catch fish".

The TWG (FAO 1998, p 10) further adds that:

"Fishing capacity is the maximum amount of fish over a period of time that can be produced by a fishing fleet if fully utilised, given the biomass and age structure of the fish stock and the present state of the technology".

That is,

$$Y_c = Y(E_c, S) \qquad (1)$$

where Y_c is current yield or catch, E_c is the current effort generated by a fully utilised fleet (100% capacity utilisation), S is fish stock biomass, the fishing fleet is the stock of inputs, and assuming that management

[1] Referred to as TWG in this paper.

objectives are related to sustainability of the resource. Although the TWG does not consider an economic definition, the proposed definition is considered to be consistent with economic theory.

The TWG (FAO 1998, p 2) considers an optimal level of capacity that fisheries management may attempt to reach through certain management measures. This optimal capacity can be defined as:

"The desired stock of inputs that will produce a desired level of outputs…..and will best achieve the objectives of the management plan".

The TWG proposes that a generic level of optimal capacity would lie between the biological optimum of maximum sustainable yield (MSY) and the economic optimum of maximum economic yield (MEY). Hence, the level of optimal capacity in various fisheries will not have an absolute point but will instead lie somewhere between these two points, its exact position depending on the precise configuration of the specific fishery.

Since optimal capacity will be very fisheries-specific, the TWG (FAO 1998, p 11) proposes that in general terms it may be more appropriate to define a target capacity, defined as:

"The maximum amount of fish over a period of time (year, season) that can be produced by a fishing fleet if fully utilised, while satisfying fishery management objectives designed to ensure sustainable fisheries".

That is,

(2) $$Y_T = Y(E_T, S)$$

where Y_T is target yield or catch, E_T is target effort generated by a fully utilised fleet, and S is the fish stock size.

3. The Overcapacity Concept

3.1 Theoretical approach

The term overcapacity, also referred to as *excess capacity* in some literature, can be defined in either biological or economic terms. Biologically, it can be thought of as the level of fishing capacity at maximum efficiency that produces a level of fishing mortality that threatens to reduce the fish stock biomass below the MSY (Porter 1998). However, due to scientific uncertainties regarding the state of the spawning biomass, biological fishing overcapacity has commonly not been observed until fish stocks have already been seriously overexploited.

Porter (1998) observes that from an economic perspective, overcapacity can be thought of as the level of fishing fleet capacity that, when translated into fishing effort at maximum efficiency, reduces yield below the MEY. Since the level of MEY is lower than the MSY level, overcapacity in economic terms will tend to be observed first, one possible indicator being the reduction in firm profits. It is acknowledged, however, that it is still possible for overcapacity to exist without noticeable reductions in profits, for example in cases where profits are sustained by high market prices during periods of reduced landings.

Holland and Sutinen (1998) state that if potential capacity is larger than optimal capacity, overcapacity exists. Overcapacity is believed to be the result of the rational response by fishers to a perverse incentive system (FAO 1998). That is, fishers and vessels with access to the fishery have the ability and desire to produce more effort and catch than is optimal due to the 'race to fish' phenomenon. Additionally, Smith and Hanna (1988) state that an excess in capacity is likely to be the result of various factors, including weather, competition, other fishing alternatives, and factors affecting fish stock availability.

The TWG (FAO 1998, p 11) expresses excess capacity based on equation (1), as

(3) $$\text{Excess capacity} = \frac{(Y_C - Y_T)}{Y_T}$$

where Y_c is the current yield or catch (at or below the MSY level) and Y_T is the target yield or catch. Thus, as Munro (1998) points out, excess capacity can be deemed to exist if, for example, a target yield for the season is 10,000 tonnes (equivalent to the TAC) whereas the fleet, if fully utilised, is able to catch 15,000 tonnes.

FAO Fisheries Department (1998) adds that in order to assess the extent of overcapacity, one must compare existing capacity in the fleet to an optimal or desired level as defined by management. Due to the mobile nature of fisheries, this comparison can be undertaken on a fish stock, fishery, regional, EEZ, or global basis.

A further measure of overcapacity, as defined by the TWG (FAO 1998, p 40), can be thought of as

(4) $$OC = \frac{Q}{TAC_{max}}$$

where Q is the potential catch by the current fleet given current fish stock conditions and TAC_{max} is the allowable catch given current fish stock conditions, set to allow for factors such as fish stock fluctuations. This static measure, however, is limited by the fact that it is a measure of only the current fleet and does not account for possible exits or entrants, accounting for the dynamic dimension of the fishery.

In order to assess the extent of overcapacity, the catch-per-unit-effort (CPUE) and the level of fish stock is critical, since over time it will be an important determinant of how the optimal capacity level changes with fish stock fluctuations (Holland and Sutinen 1998). Since this relationship is empirical, finding a universal solution for all fisheries is improbable.

It is acknowledged that overcapacity often prevails in fisheries and that fleets seldom operate at full capacity. Valatin (1992) stresses, however, that a fleet may in fact exhibit overcapacity during certain parts of the season when catching possibilities are not optimal, whereas the same fleet may be operating closer to full capacity during periods of favourable catches and market conditions.

Gulland et al. (1990) recognise the important impact that time available for fishing has on fishing mortality. The degree to which restrictions on fishing time are necessary will thus provide some measure of the level of overcapacity that exists. They further propose various methods for estimating whether overcapacity exists in a given fishery or fleet. These include estimates of fishing mortality ratios (F values), fishing time ratios, harvesting rate ratios, and fish hold ratios, calculated using actual and target/potential levels for each set of variables.

Smith and Hanna (1988) add that overcapacity, or the level of *overcapitalisation*, is a situation where the potential capacity of a fleet to catch fish is greater than their actual catching success. A definition of overcapitalisation in this respect can be viewed in a situation where fleet marginal costs of effort exceed fleet marginal returns, but the capacity of the fleet keeps growing. This is because the marginal costs are lower than marginal returns of some vessels in the fleet.

Mace (1997, p 4) observes:

"Overcapacity to mean either excessive amounts of capital in the form of fishing vessels and gear (i.e. overcapitalisation), or excessive number of participants, or both".

From an economic perspective she equates overcapacity with an excessive quantity of vessels and gears that are not fully utilised. From a conservation and social perspective, Mace (1997) considers overcapacity in a fishery to be a situation where too many people depend on the fishery for their livelihood. The severity by which a fishery is judged to be overcapitalised depends on whether the aim of capacity control measures is to maximise physical yield, income, employment, etc. (Garrod and Whitmarsh 1991).

Buck (1995) identifies the conflicting perspectives of overcapitalisation. Some argue that the term may be applied to any industry where excessive capital investment exists. In a purely static sense, fisheries can hence be seen as being overcapitalised when more capital is applied than is necessary for the most efficient operation. However, the fishing industry is not static, and the appropriate level of capital depends on a number of highly variable and unpredictable factors (e.g. oceanic conditions affecting fish biomass on a yearly basis). To measure the extent of overcapitalisation at any point in time may therefore be problematic, and a simple comparison of invested capital to total harvests will oversimplify a complex and highly intricate industry (Buck 1995).

3.2 Empirical estimates

As discussed above, the concepts of overcapacity and overcapitalisation can be addressed in various ways, depending on differing management perspectives and the specificity of individual fisheries. In order to estimate the level of overcapacity on a specific level aggregation (fish stock and fishing fleet) an optimal or target capacity has to be set, in biological, economic or social terms. Without a specific capacity target in mind any efforts by management to reduce overcapacity may be jeopardised. For example, the Gulland et al. (1990) report acknowledged that an average 40% reduction in fishing mortality was required to allow EU stocks to recover, but no equivalent fishing fleet capacity target was put forward to achieve this reduction.

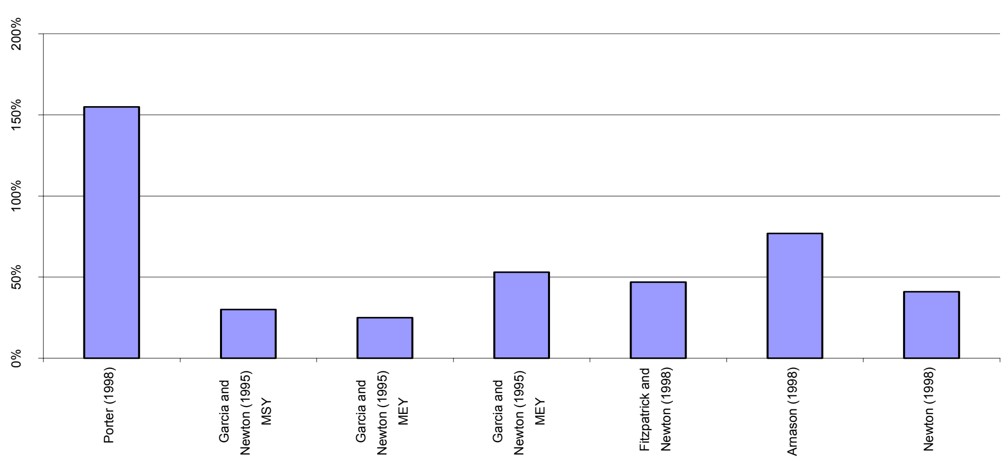
A series of recent overcapacity estimates have been calculated on a global scale and are summarised in Table 1 below. A detailed discussion of the underlying models and assumptions for each estimate can be found in section 3.3. It is acknowledged that any changes made to underlying assumptions may have a considerable impact on the overcapacity estimates, such as assumed levels of technological advances, fishing capacity targets, and levels of fleet and fish stock aggregation.

Table 1. Global overcapacity estimates and models.

Name	Overcapacity estimate	Model
FAO (1993)	US$54 billion	1989 cost and revenue data
Milazzo (1998)	US$14 billion US$ 20 billion	Annual global fishing subsidies Annual global fishing subsidies
Porter (1998)	155%	GRT increase and technological advances since 1970
Garcia and Newton (1995)	30% 0% US$ 46 billion US$ 21 billion 25% 53%	1989 selected landings - MSY 1989 total landings - MSY 1989 cost and revenue data - total costs 1989 cost and revenue data - operating costs 1989 total landings - MEY, revenues cover operating costs 1989 total landings - MEY, revenues cover total costs
Fitzpatrick and Newton (1998)	22% 47%	New additions/refits (1992-97) Including Garcia and Newton (1995) minimum MEY estimate
Arnason (1998)	77%	Catch/GRT ratio comparison between 1992 world fleet and Icelandic fisheries
Newton (1998)	19% 41%	Catch/GT based on 1983 and 1995 catch and fleet size levels Including Fitzpatrick and Newton (1998) new additions and refits estimate

A selection of the overcapacity estimates is graphically presented in Figure 1 overleaf.

Figure 1. Global overcapacity estimates.



3.3 Description of overcapacity models

In economic terms, FAO (1993) and Milazzo (1998) have highlighted the shortfall that currently exists in the global fishing industry. FAO (1993) estimate a deficit of US$ 54 billion, using cost and revenue data for world fisheries in the late 1980's, with capital costs at US$124 billion and revenues at US$70 billion. The majority of this shortfall is believed to be covered by subsidies. Milazzo (1998) estimates global fishing subsides to be in the order of US$14 billion to US$20 billion. Such estimates can be an indication of the level of overcapacity that exists assuming that the desired capacity level is one that results in costs and revenues being equal, without the support of subsidies.

FAO (1993) also use the replacement value (or investment in the fishing fleet) to acknowledge global overcapacity. In 1989 the replacement vale of the global fishing fleet was approximately US$320 billion. Using a return on capital of 10% the opportunity cost of capital is estimated to be around US$32 billion per year, or 46% of revenues of US$70 billion. Fitzpatrick and Newton (1998) conclude from these results that over-investment and overcapacity exist and suggest a halving of the capital requirement to a more sustainable level.

Similarly, a current OECD study of government financial transfers may also serve as an overcapacity indicator. OECD (1999) points out that total financial transfers in the European Community represented some 26% of catch values in 1996, whereas financial transfers in Canada in the same year represented around 58% of catch values. Other countries such as Norway and Iceland receive less support, with financial transfers in the order of 5% and 3% of catch values respectively, in line with views that these countries manage their fisheries more effectively.

Porter (1998) uses a model where it is assumed that overcapacity first appeared to exist in 1970, based on a decline in landings, and believes that the subsequent increase in fishing fleet capacity should be an indication of its current level of overcapacity. He quotes from an anonymous source that *"we could go back to the 1970 fleet size and we would be no worse off - we would catch the same number of fish".*

Using FAO data, Porter (1998) shows that between 1970 and 1992 there has been a 91% increase in GRT worldwide. Due to technological advances in developed OECD countries, he assumes an annual 3% increase in GRT, a 66% increase over the given period. This has led to an effective GRT increase of 151%. Between 1993 and 1997 there has been a GRT reduction of 9%, following 12% GRT being scrapped and 3% GRT being added. A total 4.5% reduction is assumed since new vessels are believed to have twice the fishing capacity of the older vessels. Using a 2% per annum increase in GRT due to technological advances, a total increase of 10% over the given period is assumed. Porter (1998) therefore estimates that the overall growth since 1970 to be about 155% in terms of GRT.

FAO Fisheries Department (1998) criticise this estimate on the basis that there is no specific evidence of overcapacity in 1970 and that landings have in fact increased by 50%, mostly through the development of underdeveloped fisheries. They also point out that the estimation seems to be based on the overfished fisheries in the North Atlantic, North Pacific and the Mediterranean, hence assuming that local overcapacity in these areas was an indication of existing global overcapacity.

Garcia and Newton (1995) have undertaken the most comprehensive analyses of overcapacity in global fisheries for the 1970-89 period. Using FAO cost and revenue data from 1989 they estimate the level of overcapacity with respect to MSY and MEY targets. The following tables summarise the results.

Table 2. Development of fleet size, volume of landings and value of landings, 1970-89.

Year	Fleet size (GRT)	Total landings (tonnes)	Selected landings (tonnes)*	Value of total landings 10^9 US$)#
1970	13.5 million	59.2 million	42.9 million	28
1989	25.3 million	86.4 million	61.3 million	58
annual % increase	4.6	2.4	2.3	n.a.
total % increase	87	46	44	107

Note:
*Selected landings represent 70% of total landings and exclude five main pelagic low-value species. There is little evidence to show increased capacity directed to the excluded species.
#Deflated 1978 values.

Landing and revenue rates per GRT are subsequently calculated, representing an index of capital productivity.

Table 3. Capital productivity ratios, 1970-89.

Year	Total landings /GRT	Selected landings /GRT	Value of total landings /GRT (10^3 US$)
1970	4.4	3.2	2.1
1978	3.3	2.8	1.8
1989	3.4	2.4	2.3

To allow for technological advances they re-calculate the rates using 'corrected' fleet sizes for 1970 and 1989.

Table 4. Capital productivity ratios using corrected GRT, 1970-89.

Year	Fleet size (GRT)	Technology coefficients	Corrected GRT (GRT*)	Selected landings/ GRT*	Total landings/ GRT*
1970	13.5 million	0.69	9.3 million	4.6	6.4
1989	25.3 million	1.59	40.2 million	1.5	2.1

They fit their data to a traditional Fox model[2] in order to estimate the level of overcapacity that exists with respect to an MSY target level. The results are shown in Table 5 below.

[2] The model is based on an exponential growth curve (see Garcia and Newton 1995 for further details).

Table 5. Overcapacity estimates with respect to the MSY level in 1989.

	Selected landings (tonnes)	Corrected GRT (selected landings)	Total landings (tonnes)	Corrected GRT (total landings)
1989	61.3 million	40.2 million	86.4 million	40.2 million
MSY target	58 million	30.5 million	83 million	42 million
%	106	132	105	96

The results indicate that the world resource of selected species is exploited beyond the MSY level with an overcapacity of at least 30%. If a more precautionary approach were applied a larger capacity reduction would be required. With respect to total landings the world resource appears to be exploited around the MSY level, with the inclusion of fluctuating pelagic species assisting to conceal the overcapacity problem. These results are based on the assumption that the global fishing fleet is perfectly mobile amongst all global stocks.

Garcia and Newton (1995) further their analysis to consider overcapacity with respect to MEY. Using FAO (1993) cost and revenue data for 1989 they show that total costs of US$116 billion and operating costs of US$91 billion incurred by the world fleet are much higher than the revenues of US$70 billion for that fleet.[3] This evidence points toward a global deficit of US$46 billion with respect to total costs and US$21 billion with respect to operating costs, a deficit that is consistent with FAO (1993).

In order to make world fisheries sustainable on an economic basis, using 1989 fleet size levels, costs per GRT will require a reduction of 43%, ex-vessel fish prices should increase by 71%, or a combination of the two. Alternatively, the deficit can be reduced through fleet capacity alone, so that cost functions intersect with the revenue function. For revenues to cover operating costs fleet capacity needs to be reduced by some 25%, from 40.2 million to 30 million GRT. For revenues to cover total costs a 53% reduction is required, for a fleet size of 19 million GRT.

Fitzpatrick and Newton (1998) analyse the increase of the global fleet between 1992-97. They state that there has been a 3% GRT increase during the period. Using an average replacement ratio of 3:1 to account for new additions to the fleet (compared to older vessels built before 1980) they estimate there to have been a 14% increase in capacity over the period. To account for refits of vessels built after 1980 they estimate a further 8% increase in capacity, giving an overall capacity increase of 22% for the period. On the basis of such an adjustment to offset new additions and refits, and the minimum global reduction of 25% estimated by Garcia and Newton (1995) above, a total 47% fleet reduction is required. This is consistent with their interpretation of the FAO (1993) replacement value analysis that indicates a need to cut the capital requirement by half.

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[3] The revenue value of US$70 billion for the global fleet of 40.2 million corrected GRT is consistent with a Maximum Sustainable Revenue (MSR) of US$71.4 billion for the entire world resource of traditional species (at 1989 prices) for a fleet size of 42 million corrected GRT. It can therefore be concluded that the situation prevailing in 1989, both in terms of fleet size and economic yields correspond to the MSR level.

Arnason (1998) analyses the use of catch/GRT ratios to estimate the level of overcapacity. According to the above analysis by Garcia and Newton (1995) a reduction of some 50% of the world fishing fleet is required. Arnason (1998) believes this estimate to be too conservative. Using a FAO 1992 global fleet estimate of 26 million GRT and an optimal sustainable yield of 80 million tonnes, a 50% reduction in fleet size would give a ratio of around 6 t/GRT. However, in better managed fisheries such as Iceland, this ratio is somewhere in the region of 12-15 t/GRT. To achieve the same level of capital productivity whilst yielding 80 million tonnes the fleet size needs to be reduced to around 6 million GRT. With a global fleet of 26 million GRT the optimal fleet size would represent some 23% of the fleet size in 1992, a fleet reduction of 77%.

Newton (1998) discusses the need for precautionary reference points since error in MSY estimates can be of the magnitude of 10-30%. Using a FAO (1997) estimate of 30% effort reduction on demersal stocks, and a 20% effort reduction on pelagic stocks[4] to account for MSY error, a catch reduction of 14 million tonnes would be required, based on 1995 catch levels of 83 million tonnes. The reduced catch level of 69 million tonnes is equal to the catch level in 1983. In order to achieve the same rate of capital productivity in 1995 as in 1983 (3.2 t/GT), this would require a corresponding decrease in fishing capacity. With the application of precautionary reference points, for the rate of capital productivity to be maintained, a fleet size reduction of 5 million GT, or 19%, would be required. Adding to the 22% reduction required to offset new additions and re-fits (Fitzpatrick and Newton 1998) this would require a total capacity reduction of 41%.

4. CAPITAL PRODUCTIVITY RATIOS

To extend the overcapacity discussion, European landing and fishing fleet statistics are applied to the models. Due to current lack of available and consistent cost and revenue data for all fleets, and the lack of defined MSY and MEY targets in European fisheries, the model applications are to date limited to comparatively simplistic capital productivity ratios, as defined by Garcia and Newton (1995).

Capital productivity ratios, in terms of catch or landing volumes per vessel tonnage (GT/GRT), have been utilised to analyse the development of the global fleet (Garcia and Newton 1995, Arnason 1998, Newton 1998). The ratio can be used to consider whether existing fleet size is well balanced with regard to sustainable catches and landings, and whether reductions in fleet size are required. However, the ratio may not necessarily indicate whether a fleet is operating in an economically efficient manner. For example, a fleet may not appear to have excess capacity in terms of catch volumes but may still be overcapitalised due to the low value of those catches. Given current data availability, a rather simple analysis may also like to consider the value of catches or landings per GT/GRT.

The following table summarises the results of analyses based on selected European fishing fleet statistics from a recent Concerted Action (1998) report. The underlying Garcia and Newton (1995) capital productivity methodology is applied to the data. As well as considering tonnage as a measure of fleet capacity, engine power in terms of kW is also included in the analysis. The reason for this is that engine power is officially used as a capacity indicator in EU fleet statistics and due to measurement discrepancies of tonnage, as a

[4] FAO (1997) did not provide an estimate for pelagic stocks.

result of GT/GRT conversions, the kW estimate may serve as a comparative indicator. A complete set of the data used, in the form of Excel worksheets, is enclosed in Appendix B.

Table 6. Capital productivity ratios based on Concerted Action (1998) total landing volumes (metric tonnes), total landing values (Euro millions), GRT, and kW statistics.

Country	Total landing volumes /GRT 1997	Total landing values /GRT 1997	Total landing volumes /kW 1997	Total landing values /kW 1997
Belgium	1.18	3.95	0.41	1.38
Denmark	18.6	4.86	4.43	1.16
Finland	4.90	1.11	0.54	0.12
France	3.52	5.34	0.62	0.94
Germany	3.09	2.37	1.33	1.02
Greece	1.38	2.44	0.23	0.41
Iceland	16.7	6.11	n.a.	n.a.
Ireland	5.31	3.22	1.53	0.93
Italy	2.00	6.93	0.31	1.06
Netherlands	3.06	2.51	1.09	0.90
Norway	31.1	12.3	1.28	0.51
Portugal	1.72	2.53	0.51	0.75
Spain - atl.	2.70	3.85	0.89	1.26
Spain - med.	1.25	2.72	0.15	0.32
Sweden	7.07	2.33	1.41	0.47
UK	4.34	3.86	n.a.	n.a.
Total[#]*	5.50	4.39	0.91	0.80

Note:
[#] ratio is calculated using the sums of total landings and total GRT/kW of all countries.
* kW ratios exclude Iceland and UK data.
Iceland and UK data are for 1996.
Spain -atlantic data is for 1994.
Finland, Germany, Netherlands and Sweden tonnage measurements are in GT.

Graphical presentation of the results can be viewed overleaf. Although not included in this paper, a similar analysis limited to EU DGXIV fleet and landing statistics supports these findings.

For the selected European fleets in Table 6 the volume/GRT ratio is 5.50 in 1997. This can be compared to the Garcia and Newton (1995) global estimate of 3.4 t/GRT in 1989. The value/GRT ratio can also be compared to the earlier global estimation. For the selected European fleet the ratio is 4.39 for 1997 data. The global estimate for 1989 data is 2.11[5].

Using the same criteria as Arnason (1998), the required fleet reduction in order to reach the same capital productivity ratio as in better-managed fisheries (e.g. 12 t/GRT) can be estimated. Whilst continuing to land the 1997 level of 12.12 million tonnes[6], a fleet size reduction from 2.19 million GRT to around 1 million GRT is required, or a 54% reduction.

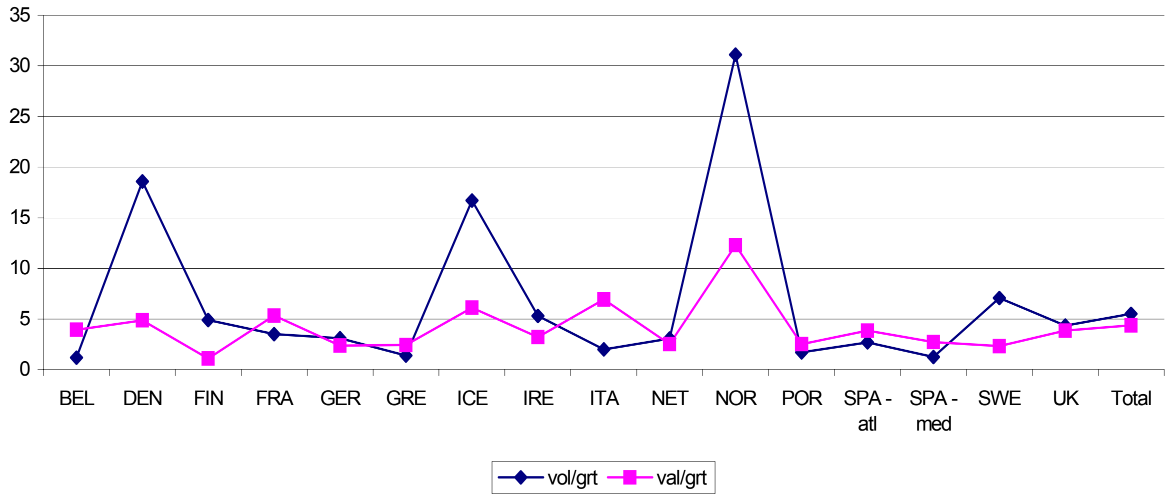
The kW ratios seem to be generally consistent with GRT ratios, the one exception being Norway. This variation is a possible indication of a fishing fleet of predominantly small vessels with large engine power, in relative terms, assuming that data interpretation is accurate.

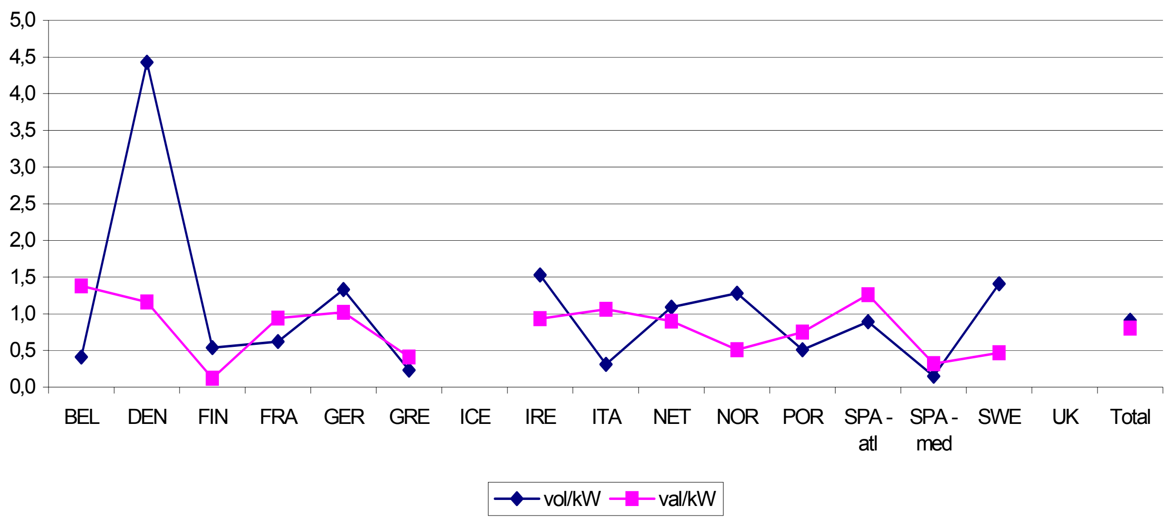
[5] This value is attained by applying an exchange rate of US$1.09=Euro1 (FT spot rate 23/3/1999) to the earlier estimate in Table 3.
[6] See Appendix B.

Together with Norway and Iceland, the Danish fishing fleet has one of the highest ratios. This may be an indication of better management of their fisheries, although it may also indicate that fleets limit their fishing to certain fish stocks (e.g. pelagics). Denmark, for example, is the one of the few European countries that concentrates on industrial fisheries and the large catch volumes are clearly indicated by the high productivity ratio. Using Danish fishing industry account statistics (SJFI 1995, 1996 and 1997) it can be shown that industrial fisheries are responsible for around 75% of total catches over the three years. In terms of catch value, industrial fishing only amounts to some 30% of total revenues. A marked ratio reduction in terms of value is also viewed for Denmark in the figures below.

This highlights the limitation of the capital productivity ratio, as defined by Garcia and Newton (1995), at least in the Danish case. Although the Danish fleet seems to be outperforming many other countries due to its high productivity ratio it may not necessarily be the most economically efficient and may still be overcapitalised with respect to revenues. Likewise, Garcia and Newton (1995) global overcapacity estimates found that when total landings (including pelagics) were compared to MSY targets, no overcapacity seemed to exist. The inclusion of economic considerations is therefore suggested.

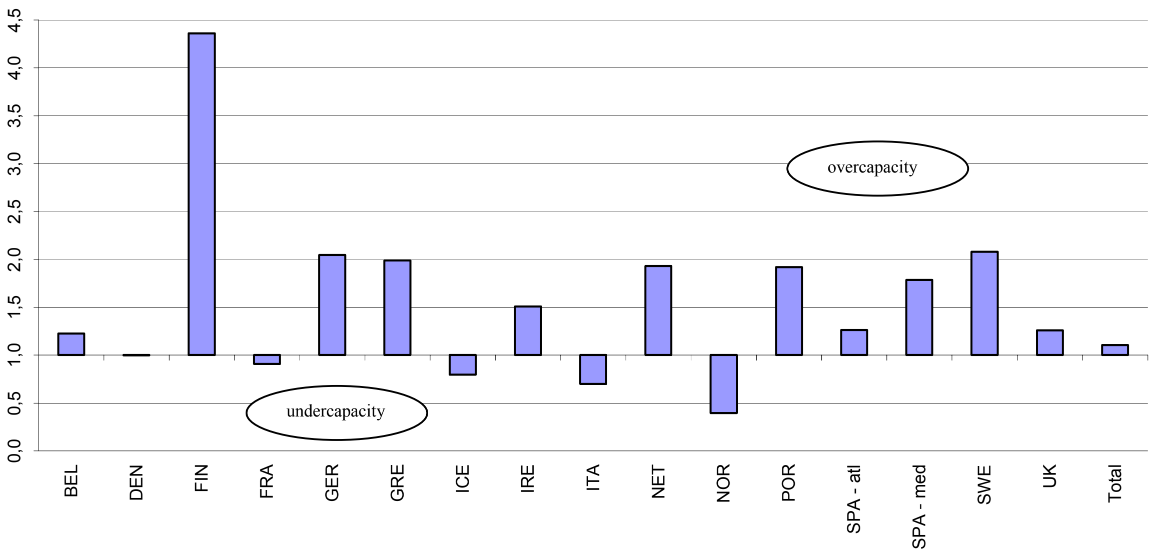
Figures 2 and 3. GRT and kW ratios for volume and value of landings by the selected European fleet in 1997.





5. COST/REVENUE RATIOS

To further attempt overcapacity analyses, details of both costs and revenues may want to be considered.



This may assist to limit the problems experienced by simply using volume of fish caught per fishing capacity unit as an indicator of overcapacity. Details of cost and revenue data on national levels are currently unavailable, although data exists for individual fleet segments of most European countries. Since this paper attempts to consider levels of overcapacity on a more global scale, some rather unrealistic assumptions have to be made in order to progress this methodology.

For illustrative purposes, Danish fishing industry costs for the period 1995-97 are used[7]. An average cost/GT ratio of 4.85[8] is calculated and is used in the analysis below, together with ratios presented in Table 6. Over- and under-capacity can be assumed to exist on the basis that a ratio of 1 indicates an optimal capacity level, where costs equal revenues.

The results are presented in Table 7 and Figure 4 below.

Table 7. Cost/revenue ratios based on Concerted Action (1998) total landing value ratios and Danish cost data (SJFI 1995, 1996 and 1997).

Country	Total landing values /GRT 1997	Total costs/GT 1995-97*	Cost/revenue ratio 1997
Belgium	3.95	4.85	1.23
Denmark	4.86	4.85	1.00
Finland	1.11	4.85	4.36
France	5.34	4.85	0.91
Germany	2.37	4.85	2.05
Greece	2.44	4.85	1.99
Iceland	6.11	4.85	0.79
Ireland	3.22	4.85	1.51
Italy	6.93	4.85	0.70
Netherlands	2.51	4.85	1.93

[7] The SJFI cost data account for fuel, ice, maintenance, raw materials and auxiliaries, sales, rent of plant and equipment, insurance, miscellaneous, depreciation, labour, and remuneration costs.

[8] See Appendix B.

Norway	12.3	4.85	0.39
Portugal	2.53	4.85	1.92
Spain - atl.	3.85	4.85	1.26
Spain -med.	2.72	4.85	1.79
Sweden	2.33	4.85	2.08
UK	3.86	4.85	1.26
Total[#]	4.39	4.85	1.10

Note:
[#] ratio is calculated using the sums of total landings and total GRT of all countries.
Iceland and UK data are for 1996.
Spain -atlantic data is for 1994.
Finland, Germany, Netherlands and Sweden tonnage measurements are in GT.
*Based on 1995-97 SJFI fishing industry account statistics.

Figure 4. Cost/revenue ratios based on Concerted Action (1998) total landing value ratios and Danish cost data (1995-97), indicating levels of over- and under-capacity.

It is clear that cost data for Denmark can not be assumed to be of the same magnitude in other European countries and hence no further speculation should be made on the above results. It is interesting to note, however, that in the Danish case there appears to be a close to optimal capacity where costs equal revenues.

6. CONCLUSIONS

The results are obviously of limited practical use although it does highlight a further methodology of estimating overcapacity. Details of cost and revenue data for all national fleets are required in order to analyse this methodology further. The cost assumptions made will obviously determine how over- or under-capacity is interpreted. In order for such an analysis to portray a realistic picture of the industry, levels of government supports (subsidies) should also be considered.

Since full information is not generally available the idea to link cost and revenue with some form of capacity indicator is proposed. This may allow more flexibility when assessing various fleets and fleet segments. It may also mean that estimates can be more easily related to efforts of fleet capacity reduction, as opposed to estimates purely based on economic data. As mentioned, the concept of fishing capacity is complicated and hence the indicator used can take many forms, and may further affect results of subsequent analyses.

The paper concludes that there are several methodologies of estimating overcapacity on global or regional scales. To date, the application of such methodologies on European fleets are constrained by cost data availability and lacking optimal capacity targets.

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APPENDIX B. DATA SPREADSHEETS

1997 fleets	Belgium	Denmark	Finland	France	Germany	Greece	Iceland	Ireland
landings value (mEuro)	87,0	474	26,7	908	166	271	754	177
volume landings (1000t)	26,0	1.814	118	598	216	154	2.059	292
no. Vessels	144	4.830	3.987	6.255	2.324	20.359	792	1.198
total GRT (1000)	22,0	97,5	24,0	170	70,0	111	124	55,0
total kW (1000)	63,0	409	219	961	162	657		191
grt/vessel	153	20	6	27	30	5	156	46
kW/vessel	438	85	55	154	70	32		159
volume/grt	1,18	18,6	4,90	3,52	3,09	1,38	16,7	5,31
value/grt	3,95	4,86	1,11	5,34	2,37	2,44	6,11	3,22
volume/kW	0,41	4,43	0,54	0,62	1,33	0,23		1,53
value/kW	1,38	1,16	0,12	0,94	1,02	0,41		0,93
cost/value ratio	122,64	99,76	435,96	90,80	204,52	198,79	79,41	150,71
			in GT		***in GT***		***1996 data***	

1997 fleets	Italy	Netherlands	Norway	Portugal	Spain-atl	Spain-med	Sweden	UK	Total
landings value (mEuro)	1.559	354	1.125	297	2.190	304	116	794	9.603
volume landings (1000t)	449	431	2.844	202	1.538	140	351	892	12.124
no. Vessels	16.100	440	13.645	11.440	18.889	5.796	2.305	8.073	116.577
total GRT (1000)	225	141	92	118	570	112	50	206	2.185
total kW (1000)	1.468	394	2.226	397	1.738	955	248		10.088
grt/vessel	14,0	320	6,71	10,3	30,2	19,3	21,6	25,5	
kW/vessel	91,2	895	163	34,7	92,0	165	108		
volume/grt	2,00	3,06	31,1	1,72	2,70	1,25	7,07	4,34	5,55
value/grt	6,93	2,51	12,3	2,53	3,85	2,72	2,33	3,86	4,39
volume/kW	0,31	1,09	1,28	0,51	0,89	0,15	1,41		0,91
value/kW	1,06	0,90	0,51	0,75	1,26	0,32	0,47		0,80
cost/value ratio	70,00	193,07	39,46	192,07	126,13	178,62	207,98	125,76	110,38
		in GT			***1994 data***		***in GT***	***1996 data***	***kW ratios exclude UK & Iceland***

Source: Concerted Action Report (1998): Economic performance of selected European fleets
Note: Data represent about 20% of total number of vesels, and over 40% of GRT, kW, and production value in the included countries

Denmark	1995	1996	1997	Ave
Volume of catches (mt)/vessel	1.151	990	1.127	
Value of catches (Euro 1000)/vessel	232	247	293	
Total costs (Euro 1000)/vessel	231	249	272	
Vessel no.	1.868	1.751	1.609	
gt/vessel	47,3	52,0	55,8	
days at sea/vessel	150,4	169,7	163,6	
total volume of catches (mt)	2.149.134	1.734.190	1.812.539	
total value of catches (Euro millions)	433	432	472	
total costs (Euro millions)	431	437	437	
total gt	88.356	91.052	89.782	
total days at sea	280.947	297.145	263.232	
volume of fish for consumption (mt)	608.594	466.291	381.494	
volume of fish for reduction (mt)	1.540.540	1.267.899	1.431.045	
total (mt)	2.149.134	1.734.190	1.812.539	
value of fish for consumption (Euro millions)	300	309	308	
value of fish for reduction (Euro millions)	121	113	150	
total (Euro millions)	421	422	458	
costs/gt	4,88	4,80	4,87	4,85
revenue/gt	4,90	4,75	5,25	4,97
cost/revenue ratio	99,70	100,99	92,70	97,80

Source: SJFI Fiskeri-regnskabsstatistik 1995, 1996 and 1997
Note: only includes vessels over 5 GT, representing approximately 35% of registered vessels and more than 98% of total output of the sector