METHODOLOGY

Traditional methods

Two methods are traditionally used to assess the past and present consumption of fish in a country[5]. A third one is mainly used to address the evaluation of the future fish consumption.

The first method was used by the FAO to provide provided current fish consumption (net supply and consumption per capita) in its publication *Fish and fishery products apparent consumption* (FAO, 1999h). For this standard method, human fish consumption per capita for a country is derived from the net supply divided by the number of inhabitants:

Fish consumption per capita = Net supply / Number of inhabitants

Net supply corresponds to production (captures + aquaculture), to which imports and stock adjustments[6] are added, and exports and non-food uses (all fish not used for human consumption) subtracted[7]:

Net supply = Captures + Aquaculture + Imports – Exports + Δ stocks – Non food uses

This method makes it possible to follow the evolution in the demand for fish in a given country on a yearly basis. It requires only data relating to production, the fish trade, and in certain cases, fish stocks. The simplicity of this method means that calculating consumption is possible in nearly all of the countries in the world, as long as data for production and trade are available. Its principle use lies in measuring to what extent animal protein requirements are being met in developing countries.

The second standard method assesses human fish consumption from consumer panels[8]. It is based on sampling methods where the population is stratified in order to define consumer choices depending on revenue, age, and location. Results are extrapolations from samplings. The main objectives of these surveys are to provide industry and retailing sectors with information related to types of commodities consumed, place of consumption (in or outside the home), place of purchase (supermarkets versus retailers), changes in consumers' preferences, etc (Broomfield, 1999). They are also designed and implemented to identify market opportunities for new products.

The third method is used to estimate the future fish consumption in a country. This method is based on an estimation of the supply and demand and the utilization of a clearing price mechanism to close the model[9]. The future supply is defined by past trends of captures and aquaculture production and consists of a projection of these past tends into the future. The future demand is mainly derived from projections of the GDP per capita where fish consumption is a function of the household income (see Annex 3). Trade variations are the result of adjustment of supply and demand through the price elasticity mechanism.

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[5] For a detailed presentation of methods, see http://www.fao.org/es/ess/consweb.htm
[6] Due to the low level of stock (mainly frozen fish) of the EUR-28 countries, the stock variation component has not been used in this study.
[7] In this equation, all the variables are expressed in live weight. It is thus necessary as a preliminary to convert imports and exports in net weight into live weight.
[8] See Papageorgiou and Girard (2000) for a presentation of some consumer panel surveys in Europe.
[9] See Anon. (1999n), Ye (1999), Wijkström (1999) and De Negris (2002) for an application of this method.

Difficulties with these traditional methods

The utilization of the first method to assess the present consumption leads to three major difficulties:

- Changes in fish consumption are mainly changes in the type and form of commodities rather than changes in the species10 themselves, but this method does not give consumption results in terms of commodities, nor groups of commodities. It is therefore difficult to assess consumption and define a trend without knowing the type of commodities involved in it.
- Industry changes are also modifications of the type and form of commodities. Industry aims are to produce commodities and for that purpose it can use different types of fish depending on their availability. Again, the method doesn't address the production of commodities, which is a better indicator of seafood production in a country than production from captures or aquaculture because it represents what is effectively supplied to the market for human consumption[11].
- Production data from captures and aquaculture are expressed in live weight while imports and exports are expressed in net weight. In many cases, after applying conversion factors, some groups of species show a negative net supply, which in reality is impossible.

The second method, the consumer panel surveys, doesn't address the question of supply. It focuses on consumption and the type of commodities without any interest in knowing where the fish is processed and where it comes from. There is also the question of whether the sampling results adequately reflect national consumption patterns.

The third method, used to estimate future consumption, reveals four main difficulties.

- Regarding projections and future fish consumption, it is common in economics to define levels of both supply and demand and try to match them with price changes due to their certain elasticity (Robinson, 1982 and 1984; De Negris, 2002). This method can be applied at a country level where price information is available. It can also be implemented at a supra-national level where prices show some evidence of a homogeneous market. Unfortunately, Europe doesn't show a high level of homogeneity in its fish markets. Furthermore, inside countries like Spain or Italy, regional expressions of preferences for fish lead to intra-national market segmentation. Because of this, and also the absence of price co-integration for the main species, it is difficult to make some price aggregation at the EU level and to define at the same geographical scale price elasticities regarding demand and revenues12 (Boude *et al*., 1997; Guillotreau, 1994a, 1994b and 1997; Zabala, 1998; Peredy *et al*., 2000).
- The second point is that the price of fish depends mainly on the final form of the commodity: a whole salmon is five times less expensive than salmon fillets and 10 times less than a smoked salmon. Furthermore, aggregated prices are irrelevant in analysing a consumer market when there is a change in the composition of the consumption. This is particularly true for the future member states that will face a significant increase of their purchasing power and will therefore orient their fish consumption toward fresh/chilled and frozen marine fish and prepared/preserved commodities.
- A third difficulty with this method is that it is only based on past trends with the assumption that the future is contained in the past and will follow the same pattern. Little or no information from the most recent trends, which is not visible in the "species" time series, is taken into account; neither are the forecasts of important elements that are outside the range of observed values. This leads to an overestimation of the growth rate since the constraints to growth are omitted or not well defined. Based on markets experts

[10] Except maybe for Salmon in Europe in the 1980.
[11] In opposition to what is for non-food use purposes.
[12] Important differences in revenues between North and South, West and East Europe are also against the utilization of revenue price elasticities.

and an extensive review of professional and academic articles, the present study has defined both trend patterns and growth constraints.

- The last difficulty relates to the utilization of the GDP to estimate the demand function for fish. It is true that on average developed countries eat more fish than developing countries and in this case GDP per capita can be one basis for the consumption function. But, at the European level, for instance, inhabitants of Spain and Portugal have a lower GDP per capita than those of France and Germany although the former eat nearly twice as much fish as the latter.

Presentation of the method of the study

The shortcomings of the first two methods (as discussed above) in giving a complete picture of consumption from production to consumer, through processing and trade, have been addressed in the method used in this report by establishing links at the country level between consumers' choices and industry production. This study uses commodity production instead of capture and aquaculture production to define the net supply (using the common imports and exports categories). Estimation of future demand is done through the analysis of the past and recent trends of the commodities consumption and also based on experts' knowledge and literature review. Price and household revenues information are integrated into the consumer's present and future preferences.

The results are presented for each country in the second part of this report. The first part of the report presents the consolidated results that are the sum of the individual country results. Overall, the results obtained for the consumption per capita using production of commodities instead of production from captures are quite similar or slightly above. By knowing that commodity production does not adequately account for fresh fish production that doesn't undergo any change, it is possible that fish consumption is underestimated in countries where fresh fish is of significant importance.

Architecture of the model

The aim of the model used in this study is to project up to 2030 the future net supply and the subsequent fish consumption per capita. To achieve this, a simple model was built. This model was applied to define both food use and non-food use consumption. It was also applied at a country level to define for each group of commodities the net supply (see below the list of commodities). The following sequence of steps highlights how the model works.

1- Estimation of the past and present (1989-1998) fish consumption (FC) for each group of commodities. The equations below are quite similar to the ones that are traditionally used with the FAO method, except that the components and results are in units of commodities instead of units of species. Fish consumption per capita of the commodity group i, where i = 1… n, is based on:

$$FC_i\ (t) = NS_i\ (t)\ /\ Population\ (t) \qquad \forall i$$

where NS_i represents the net supply at time t for commodity group i and is defined as follows:

$$NS_i\ (t) = Prod_i\ (t) + Im_i\ (t) - Ex_i\ (t) \qquad \forall i$$

where $Prod_i\ (t)$ represents the production of commodity group i at time t, and $Im_i\ (t)$ and $Ex_i\ (t)$ are the imports and exports.

The total consumption TC of all groups of commodities is therefore:

$$TC\ (t) = \Sigma NS_i\ (t)\ /\ Population\ (t) = \Sigma\ [(Prod_i\ (t) + Im_i\ (t) - Ex_i\ (t)]\ /\ Population\ (t)$$

2- Estimation of the future fish consumption:

Per capita future consumption is projected on the basis of: 1- past trends; 2-recent consumption trends identified from consumption surveys and analysis; 3- experts' estimations of fish consumption (mainly fish mongers and fish traders); 4- political and economic events that will affect standards of living (see below for detailed explanations).

Based on the combination of elements that have an impact on future fish consumption, a global growth rate R_i for the period 1999-2030 is subjectively defined for each category of commodities (1 to n). The consumption of commodity group i in 2030 is calculated from:

$$FC_i\ (2030) = FC_i\ (1998)\ x\ (1 + R_i)$$

The annual growth rate r_i is derived from the global growth rate using the geometric average formula:

$$r_i = ln\ [FC_i\ (2030) / FC_i\ (1998)] \qquad \forall i$$

The annual growth rate r_i is used to calculate fish consumption in 2005, 2010, 2015, 2020, 2025 and 2030. For the estimation of the consumption of each commodity group commodities i at the time t + d, where d represents the number of years added to t (1998), the following equation is used:

$$FC_i\ (t + d) = FC_i\ (1998)\ x\ (1 + r_i)^d$$

Based on the fish consumption and the projection for the population at the time t + d, the fish net supply for each commodity group i is defined as:

$$NS_i\ (t+d) = [FC_i\ (t+d)\ x\ Population\ (t+p)]$$

So, for a given country, at time t + d, the total net supply TNS is the sum of the net supply of each commodity group i:

$$TNS\ (t+d) = \Sigma\ [FC_i\ (t+d)]\ x\ Population\ (t+p)$$

At this stage, three main assumptions are introduced. The first one relates to the production of commodities that involves aquaculture products. When there is an increase in aquaculture production:

$$Prod_i\ (t + d) = Prod_i\ (t)\ x\ (1 + ra_i)^d$$

Where the growth rate ra_i of each commodity group i affected by the aquaculture growth is estimated subjectively based on recent trends in the processing of aquaculture species[13]. In practice, 95 percent of commodity production is assumed to remain constant.

The second assumption relates to exports when there is a surplus coming from increased aquaculture that is not absorbed by the national market. In that case:

$$Ex_i\ (t + d) = Ex_i\ (t)\ x\ (1 + ra\text{-}m_i)^d$$

where $ra\text{-}m_i$ represents the differential growth rate that results from the increased production of some groups of commodities less their consumption in the country. In practice, 95 percent of exports are assumed to remain constant.
The third assumption relates to imports that are considered to adjust the net supply derived from balancing consumption with production and exports:

[13] The surplus of the aquaculture production is channeled into different groups of commodities.

$$Im_i\ (t + d) = NS_i\ (t+d) - Prod_i\ (t + d) + Ex_i\ (t + d) \qquad \forall i$$

When the aquaculture production is stable up to 2030, the equation can be simplified as:

$$Im_i\ (t + d) = NS_i\ (t+d) - Prod_i\ (t) + Ex_i\ (t)$$

From these two last equations (depending on the status of aquaculture), the import growth rate of each commodity group i can be calculated on the same basis as consumption:

$$Im_i\ (2030) = Im_i\ (1998)\ x\ (1 + R_i)$$

The annual growth rate r_i is derived from the global growth rate using the geometric average formula:

$$r_i = ln\ [Im_i\ (2030) / Im_i\ (1998)]$$

The growth rates of consumption, production, imports and exports of commodities, together with the growth rate of aquaculture are provided for each country.

Building the database

The construction of the database was based on the following steps:

Geographical definition of the study that takes into account the enlargement of the European Union, while the temporal definition of the study takes into account the data from the 1989 to1998.

Development of a database nomenclature for capture and aquaculture production of species (live weight), and production, imports and exports of commodities (net weight).

Development of a table of conversion factors to convert net weight into live weight (from FAO, 1996e; Caillard, 1997).

Development of a table of commodities/species conversion to express commodities in their original species form (or group of species).

Definition of primary and secondary data to be collected, based on the hierarchy we assigned to the different components and flows implicated (see figure Annex 1).

Requests to the organizations responsible for compiling and distributing the national and European statistics.

Progressive standardization of the data as they were delivered (harmonization according to the FAO nomenclature for Species and OECD nomenclature for products).

Table 1: OECD and FAO nomenclatures used

OECD nomenclature (commodities classification)	FAO nomenclature (species classification)
Crus., mol. & other aquatic inv., prepared	Freshwater fish
Crus., mol. & other aquatic inv., prepared	Diadromous fish
Crustaceans	Marine fish, pelagic, tunas
Fish, cured	Marine fish, pelagic, small
Fish, fillets	Marine fish, demersal
Fish, fresh/chilled	Marine fish, others
Fish, frozen	Crustaceans
Molluscs	Molluscs

OECD nomenclature (commodities classification)	FAO nomenclature (species classification)
Prepared/preserved fish	Cephalopods
Fish/marine mammal, fat, oil	Aquatic animals
Flour, meal unfit for human consumption	Aquatic mammals

Separation of what is intended for human consumption from that which is intended for other uses such as animal food or for aquaculture (fish flours and oils) with the following difficulty: certain species, and in particular the small pelagic ones, are sometimes intended for human consumption and sometimes for the manufacture of flours and oils, which results in a certain imprecision in the use of certain species and thus of equivalences between the products and the species.

Analysis of the global coherence of the results obtained and of their feasibility/realism.

Deriving assumptions about future trends/projections

The assumed growth rates for each commodity group within each country were derived using the following steps:

Relevant literature was found and studied in order to establish a foundation for projections about future consumption of seafood, its production (capture fisheries and aquaculture) and related international trade.

Enquiries were undertaken with the main participants in the commerce of fish and fish products in Europe (wholesalers and institutes that study food consumption).

Deriving projections for each of the countries studied (each country assumptions are presented in detail in the part 2 of the report):

a. The assumed growth rate in consumption is derived from information in existing consumer panel surveys, documentation, interviews and observed trends in net supplies. At the country level, consumption will follow historical patterns for most of the commodities unless there have been recent changes in consumption habits or predicted economic and political changes (e.g., the adhesion to the EU should raise incomes of Eastern countries). In this case the growth is adjusted according to the most likely situation.

b. Capture fishery production is considered constant, given the stability during the last ten years. Although stocks of some key species are currently at low levels (and hence catches are also at low levels), recovery plans are in place and are expected to return catches to around the average levels observed over the period of the data used in the analysis (1989-98).

c. Aquaculture production increased considerably during the last ten years and is expected to grow during the coming 30 years. The growth rates assumed for the projections were based on the growth rates observed during the last ten years, with limits - upper and lower - in order to take into account the increasing environmental constraints applying to the European coastline and the difficulties that some aquaculture companies have experienced during the last years.

d. Commodity production, due to the fact that there are still some strong links between capture and processing in most of the European countries (with a few exceptions like German or the Netherlands), is considered to remain constant up to 2030, unless there are some increases in the aquaculture sector.

c. Imports of fish and fish products are considered as responding to meet consumption needs. Thus, when consumption reaches a level that national production cannot assure, imports will increase. The need for aquatic feeds for aquaculture production has also been accounted for. This means for example that the foreseen increase in cultured salmon occurs in parallel with an increase in the imports of fishmeal as the capture of small pelagics is considered to be static/constant.

d. The opposite situation applies to exports. The projections assume that exports will take place when the assumed national fish consumption will not absorb the national production. Re-export trends are not taken into account in the study, and are considered to be constant.

Brief discussion of the methodology

The method employed, which relies on a considerable number of assumptions primarily regarding changes in consumption, is largely based on national trends in fish consumption, and excludes economic factors such as changes in income and price of competing protein sources (e.g. chicken, pork etc). To develop a model that included these factors for each species in each country would have been a considerable task involving substantially more data than were available. Further, the use of such a model would require assumptions regarding future income levels, and the supply of the alternative protein sources for each country and each year. As a result, an even greater number of assumptions would have been required, resulting in potentially greater errors in the projections.

The assumption of constant catches does not affect the estimates of consumption, because it is assumed that any shortfall is made up from imports. If EU stocks do not recover, and European catches remain at low levels, then the model will have underestimated the level of imports. An important assumption, therefore, is that imports will continue to be available, and hence not be subject to reductions due to stock mismanagement. Overexploitation of stocks that supply the imports may result in an overall reduction in the availability of supply, which may in turn constrain consumption. To model such an eventuality would require detailed bioeconomic models of the fisheries that supply the EU. The development of such models was well beyond the scope of this analysis.

The model as it stands can be readily subjected to parameter changes in order to test its sensitivity to the key assumptions or if new information regarding consumption trends arises.