

## The production of fishmeal and fish oil from Peruvian anchovy

### Peruvian anchovy

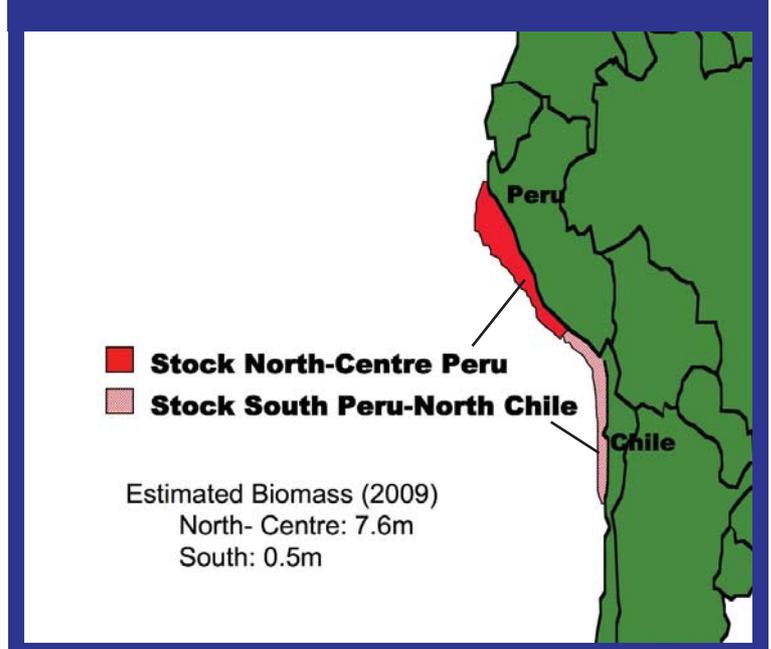


### STOCK DESCRIPTION

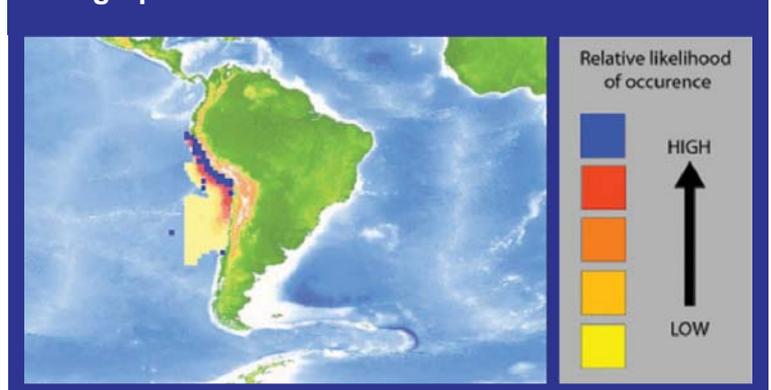
Latin name – *Engraulis ringens*.

**Species description** – marine, pelagic, coastal, mainly within 80 km of coast, but occasionally as far out as 160 km. Form huge schools, chiefly in surface waters. Entirely dependent on the rich plankton of the highly productive coastal upwelling caused by the Peru or Humboldt current. Feed on plankton by filter-feeding of diatoms, copepods, euphausiids, fish eggs and dinoflagellates. Breed throughout the year along entire coast of Peru, with a major spawning in winter/spring (August to September). A lesser spawning occurs in summer (February and March) and throughout the year off Chile; with peaks in winter (May to July) and the end of spring (especially December). Attains about 8 to 9 cm length in 5 to 6 months, 10 cm in 12 months and 12 cm in 18 months. Longevity about three years, reaching a maximum of 20 cm.

### Distribution of anchovies



### Geographical distribution



**Species distribution** – along the entire Peruvian and the northern part of the Chilean coast between 03°30' S and 37°00' S, mainly within 60 miles of the coast. The largest concentrations are distributed between 04°00' S and 16°00' S.

## HISTORY OF THE PERUVIAN ANCHOVY FISHERY

### 1950s

Private firms begin to specialise in processing anchovy to produce fishmeal and fish oil. Improved fishing technology and increased demand for livestock feed propel fishmeal as a valuable global commodity.

Peruvian fishing fleet became equipped with sonar equipment to locate fish shoals.

Lightweight nylon nets introduced to fishing industry to replace less efficient cotton nets.

Anchovy accounted for about half of the world's fishmeal production.

### 1960s

Peru becomes the world's leading fishing nation in terms of volume.

Fishmeal processing plants peak at 154 plants.

In 1964, Peru harvests 18% of total world fish catch, and produced about 40% of total world supply of fishmeal.

Fish products account for 25 to 30% of total export earnings, and become leading export sector.

Anchovy account for 99% of fishmeal production.

Signs of overfishing on north and central coasts appear in the mid 60s. Fishing fleets begin to explore untapped fishing grounds of the south coast.

Fishing companies try to remain competitive by increasing investment in new, larger fishing boats.

Industry now able to process 16 million tons of anchovy annually.

### 1970s

1970. FAO (Food and Agriculture Organisation of United Nations) warns that maximum sustainable yield for anchovies could not exceed 9.5 million tons annually.

Anchovy catch rises above 12 million tons in 1970, and 10 million in 1971.

Annual catch of anchovies falls to 4 million in 1972 and 1.3 million in 1973.

Numbers of seabirds also greatly reduces.

The Peruvian Anchovy Industry struggles economically.

### 1980s

The anchovy population remains low for most of the decade.

The biomass of other pelagic species such as sardines increases.

Anchovy catch drops further at the start of the decade, with an all time low of only 22,000 metric tons in 1984 following a strong El Niño.

Government and Industry work together to bring about a recovery of the stocks to provide a viable fishery.

### 1990s

Extensive research is conducted into the anchovy population and strict quotas introduced, as well as closed seasons to allow for spawning. Reduction in the numbers of juveniles caught.

Stocks begin to recover.

1997/1998 brings one of the strongest El Niños ever recorded resulting in a sharp decline in the biomass.

Control measures ensured a rapid recovery.

### 2000s

Despite another El Niño in 2002/03 the biomass remains healthy.

Independent surveillance of landings.

Maximum Catch Limits per Vessel (MCLV) introduced. Improved protection of artisanal fishing and the environment. Parachute payments and pensions for those who retire from fishing. Government tackles corruption and abuses of rules to protect fishery and crews. Higher fines. Illegal licences revoked.

Ecosystem based approach to stock management initiated.

## STOCK SIZE/HEALTH

The anchovy stock in the waters off Peru (and Chile) is the world's largest fishery. It is located within the exceptionally productive Humboldt Large Marine Ecosystem (LME). The population fluctuates as a result natural events, mainly climatic - which occur in seasonal, annual, internannual and interdecadal scales. One of the most dramatic affecting the LME is the occurrence of El Niño.

In normal conditions the Humboldt Current flows northwards along the coast of Peru. It is a deep cold-water current and as it meets the coast it rises to the surface, replacing the surface waters and bringing with it nitrates and phosphates from the seabed. The result is nutrient-rich waters bathed in strong sunlight. Phytoplankton proliferates rapidly, providing the basis of a highly productive food chain that leads to substantial fish populations.

El Niño is a natural disturbance of normal weather patterns and brings warm waters and heavy rain along the equator to the coast of Peru. They are often at their most intense around Christmas, hence the name El Niño or Little Jesus. During an El Niño, the water temperatures along the Peruvian coast can be as high as 28–29 °C, compared with a normal 14–23 °C, and the interface with colder water can be pushed down to a depth of some 200 metres. The upwelling of deeper waters continues, but they are warmer and nutrient poor. The nutrient-rich waters of the Humboldt Current are trapped and do not reach the surface. As a result, the phytoplankton is greatly diminished which impacts on the rest of the fish food chain'.

In 2008 the sustainability of Peru's fisheries and marine ecosystem was ranked best in the world in a paper entitled *Ranking maritime countries by the sustainability of their fisheries* by Suzanne Mondoux, Tony Pitcher and Daniel Pauly, published in the Research Report, 'A Comparative Assessment of Biodiversity, Fisheries and Aquaculture in 53 countries' exclusive economic zones' from the Fisheries Centre of the University of British Columbia, Volume 16 Number 7. Peru scored 6.42 on the sustainability rating, with the next highest rated country at 5.10.

## The Geographic setting



## FISHING EFFORT

The Peruvian anchovy fishery produces 30% to 35% of the world's fishmeal and fish oil.

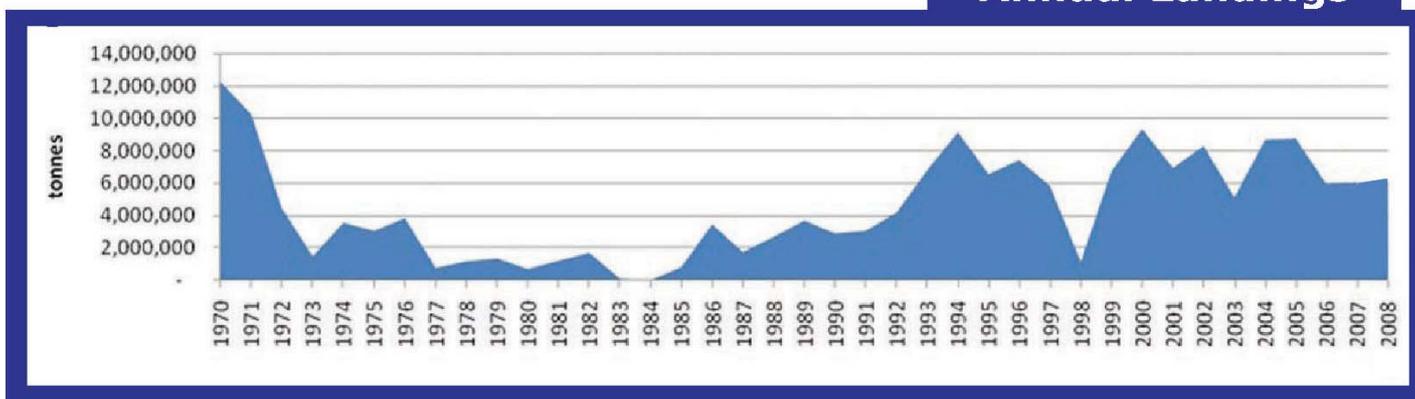
The purse seine fishing fleet operates mainly in the area from Paita (6°30') to the southern maritime limit – the delineation between Peruvian and Chilean waters. The major ports are Chimbote, Pisco, Supe, Callao and Ilo.

**Gear** – the purse seine is the predominant net type used in the Peruvian anchovy fishery. Purse seines are usually about 400 metres long and twenty or more fathoms deep.

**Vessels** – purse seine boats are used in the capture of Peruvian anchovy.

**Scale of fishing effort** – before the introduction of Maximum Catch Limits per Vessel (MCLV) in 2009 there were about 1000 fishing vessels of which about 500 were industrial vessels and of these about 250 had a capacity of 300 to 600 cubic metres. The balance is made up of smaller wooden vessels and artisanal craft. The impact of MCLV on numbers and sizes of vessels cannot yet be fully assessed. Fisheries employs about 10,000 people.

## Annual Landings



## ADAPTIVE MANAGEMENT OF THE FISHERY

Government control of fisheries in Peru is managed by the Ministry of Production and the Vice-Ministry of Fisheries. They are kept informed and advised on fisheries in Peruvian waters by the marine research institute IMARPE which is recognised as a world class authority by UN FAO, UNESCO, ICES and CIAT. IMARPE co-operates with the Chilean Fishery Research and Development Institute, IFOP, to monitor the southern fishery that straddles the Peru–Chile border. Both administrations use this data for coordinated management of the shared resource.

Anchovies are a pelagic, fast growing and short-lived species. The population fluctuates considerably as a result of climatic events. IMARPE says that it is not possible to calculate a long term optimal catch and that it is essential to manage this fishery in an adaptive, flexible and rapid manner.

IMARPE conducts acoustic surveys to assess the fish populations three times a year; plankton surveys to estimate fish abundance based on egg and larvae density; and oceanographic and plankton productivity in situ. Further data flowing in for analysis from the satellite or in situ monitoring includes information on the spatial distribution, size structure & school depth of the fish and water temperature; and, from the ports, daily real time verification of landings. The Vice-Ministry of Fisheries uses this information to regulate fishing in Peruvian waters. Many of the regulations and decrees apply specifically to the anchovy fishery and control, for example, fishing periods, fishing areas and total allowable catches. All managerial decisions are signed by the Minister of Production.

Peru's anchovy resources are divided into two areas:

- The north/centre resource covers the entire coastal zone from the northern border to parallel 16° south.
- The southern resource (south of parallel 16° south) covers the coastal zone of Peru to northern Chile. This resource is exploited by both Peru and Chile.

## MAIN MANAGEMENT CONTROLS

The Peruvian government imposes a range of management controls including:

### BIOMASS CONTROLS

- Statutory seasons when the fisheries are open and closed.
- Annual and seasonal total catch limits.
- Only artisanal boats are permitted to fish within five miles of the coast.
- Rapid closure when limits are reached or more than 10% juveniles in catch.
- Maximum catch limits per vessel (MCLV), a form of catch share.

### BY-CATCH CONTROLS

- By-catch limit 5% (actual 2007 3.6%. IMARPE)
- Minimum mesh size of 1/2 inch (13mm)

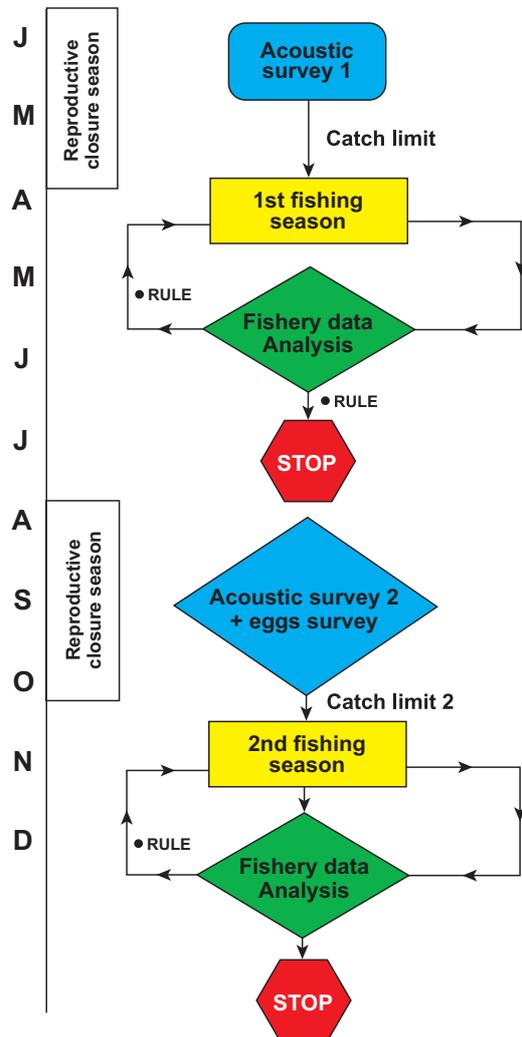
### UNLOADING

- Formal declaration of hold capacity.
- Closed entry to new fishing boats
- Licences required to fish within the 200 mile limit and to land catch
- Security sealed satellite tracking of all boats operating outside the 5 mile limit
- 24 hour independent recording of landings at 134 unloading points
- Fines and revoking of licences for breaches of rules

There are additional controls and information systems - many imposed to protect the landings of fish for direct human consumption:

- The Ministry of Production will publish every day on its web site ([www.produce.gob.pe](http://www.produce.gob.pe)) the name of the vessels authorised to go out fishing as well as the vessels prohibited to do so.
- The receiving plants are not authorised to land fish coming from vessels without valid license or from artisanal vessels.
- The plants must stop receiving fish if there is any failure in their processing equipment as well as in their equipment to protect the environment.
- In order to prevent deterioration of the raw material, fish transportation in bulk in artisanal boats or trucks is prohibited.
- Fish landing from artisanal vessels through the system of pumps and pipes is prohibited.

## Rapid decisions on closures



### Management criteria

Decision flow diagram:

If landings > catch limit = final closure

If juveniles > 10% = provisional closure

Fast decision making process: 36 hours

## MANAGEMENT MEASURES CONTINUED -

### EXAMPLE OF FISHERY CLOSURES TO PROTECT THE STOCK

**Statutory seasons/closures** – fishing stops during January, February and March to protect the growth of anchovy juveniles. A fishing closure from July/August to October protects the spawning stock.

#### **EXAMPLE: 2007 Peruvian Open Seasons – Quota of 3 million tonnes in three steps.**

The decree authorising the opening of the anchovy fishing season in the North/Centre region (i.e. between the northern border and parallel 16°S) was published on April 4, 2007.

Fishing was authorised in three different sessions with different quotas attached to each session:

- 1) from April 10 at 00:00 hours until April 14: 500 000 tonnes
- 2) from May 2 at 00:00 hours until May 11: 1 million tonnes
- 3) from June 1st at 00:00 hours onwards [no final date specifically mentioned]: 1.5 million tonnes.

This open season is subject to existing conditions:

- All vessels must have a valid fishing permit and use nets of minimum 13 mm,
- Minimum fish size: 12 cm with 10% tolerance in the number of animals
- If the presence of juveniles exceeds 10% in the daily landings of a port, fishing will be stopped in this port for a minimum of three days.
- Fishing within five miles of the coast line is prohibited, the vessels travelling through this zone are prohibited to stop and must keep a minimum speed of 2 knots,
- Each vessel is authorised only one sailing per day
- All vessels must have on board an operating satellite positioning system.

**Maximum Catch Limits per Vessel (MCLV)** - were introduced in 2009 in both the North/Centre and South stocks. There is a fix percentage of the overall catch assigned to each vessel: for example for steel vessels in the North /Centre depending on the catch history and the hold capacity of each vessel - 60% or 40%; and for wooden vessels - based on their best annual catch - 100%.

Before the introduction of MCLV there was an 'Olympic race' at the start of each fishing season when too many boats rushed out and caught the entire quota in less than 50 days fishing per year with consequent congestion at ports and fishmeal plants. The main objectives of the MCLV and other decrees introduced at the same time are to achieve more efficient use of the oversized fleet and to better distribute fishing effort throughout the fisheries seasons, so reducing stress on the stock. Further objectives are to improve production of artisanal fishing, safety of crew, impact on the environment and the quality of fishmeal. The new regulations are also designed to promote investment, competitiveness and increased supply for human consumption. They include parachute payments and pensions for those who retire from fishing.'

'Already sea bird and sea lion populations are monitored as indicators of the higher predatory species of the anchovy and there is a five million tonne minimum spawning biomass to protect the anchovy stock itself. Marine Protected Areas are planned.'

## OTHER RELEVANT POLICY, REGULATION AND INITIATIVES

### **Peruvian policy is based on five principles:**

- Protection of eco-systems
- Preservation of biodiversity
- Sustainable use of marine resources
- Implementation of clean technologies
- Social justice

Measures relevant to the anchovy fishery and the production of fishmeal and fish oil include:

**Maximum Permissible Limits (MPLs) for effluents and emissions** – As part of Government policy to introduce clean technologies, Peru introduced MPLs on emissions in 2009 and on effluents several years before that. All fishmeal plants have to comply with these.

**Pisco and Chimbote effluent** – In 2004 a scheme, Apropisco, was introduced at the port of Pisco which comprises the treatment of effluent at each of the seven fishmeal plants (which is the case for every plant) and then the treated effluent is pumped to a central station from where it is pumped far out to sea. Then in 2007 a decree was introduced to implement a similar scheme at Chimbote (Ferrol Bay) for all sea product factories - that is treated waste from fishmeal, freezing and canning - as well as treated mining waste and faeces. This project is expected to commence in 2010.

**Voluntary codes** – Peruvian fishery companies representing over 70 percent of the trawlers have organised themselves into the Sociedad Nacional de Pesquería (SNP) and developed an Ethical Code of Conduct that has responsible fishing as a central theme, including strict compliance with regulations. A Fishing Behaviour Code has been established which covers the owners of plants and vessels, technicians of plants, skippers and crew members.

**Anchovy for human consumption is a state policy** – there is a commitment against child malnutrition. By law, a minimum of 8 per cent of all food purchases by the Peruvian state destined to social programs have to be anchovy and/or squid.

**Increase added value products** – there is new investment in human consumption applications, including canning of anchovies.

**Commitment to reduce the social impact of MCLV** – includes: financial support, training programs and a pension scheme for early retirement.

## LOOKING TO THE FUTURE

### **Ecosystem based management (EBM) and the impact of climate change -**

The evaluation and monitoring of the anchovy stock under the great variability of the Humboldt system is a permanent challenge.

Recent scientific studies of global warming in the ocean have shown that the South East Pacific region is one that has not registered a Sea Surface temperature (SST) increase during the last 50 years as has happened in most other regions. This may be because this region is in a cold interdecadal period which overrides the small SST increase globally.

Nevertheless Peru is now in the process of implementing an ecosystem approach that will evaluate the impact of fisheries on the ecosystem as a whole under the project name Peru Ecosystem Projection Scenarios (PEPS). This looks at how a warmer world may affect atmospheric forcing and ocean circulation and productivity. One hypothesis is that it may drive stronger coastal upwelling by increasing the land sea temperature gradient and that it may weaken the trade winds by weakening the high to low latitude temperature gradient. PEPS then predicts the planktonic ecosystem response and models pelagic/ benthic dynamics as driven by regional hydrodynamics. It also examines CO2 emission scenarios.

### **Ecosystem based measures in place -**

- Five million tonnes from spawning stock for the ecosystem
- Sea bird and sea lion populations are monitored as indicators of the higher predatory species of anchovy

Marine Protected Areas are to be implemented.

## REDUCTION FISHERIES' ECONOMIC ROLE IN THE NATIONAL ECONOMY

Eight per cent of Peru's exports (2008) are earned by its fisheries. Fishmeal and fish oil from the anchovy fishery represent three-quarters of these earnings. Fisheries in Peru directly or indirectly employ some 100,000 people.

Total 2008 fishmeal and fish oil exports reached 1.81 million tonnes, valued at \$2.01 billion US dollars, of which fishmeal represented 1.56 million tonnes, valued at \$1.61 billion (FOB basis) and fish oil 253,000 tonnes, valued at an estimated \$397 million.

## PROCESSING/MANUFACTURE

**Factories** – About 100 operational processing plants with a capacity of 9,000 metric tons of raw material/hour. About 12,000 persons are employed in processing jobs.

**Methods** – the process of wet reduction begins with the offloading by pumps of whole anchovy from the holds of the seine vessel. The fish are then steamed and the resulting mass of solids and liquids conveyed to the press. Oil and water containing dissolved and suspended solids is then squeezed from the mass leaving a damp intermediate known as press cake. The cake is then mixed with condensed solubles from the liquid phase and gently dried. The resulting product is then milled into meal and treated with an antioxidant to help the meal maintain its protein and residual oil qualities during storage and shipment.

The oil and water released during the pressing stage is pumped to decanters to remove any suspended solids. This semi-clarified liquor is then separated by centrifuge and the oil pumped to storage tanks. The water fraction is returned to be dried with the meal to retain the protein rich dissolved and suspended solids.

### Food safety/traceability

Fishmeal plants must possess a working license from the Ministry of Production and a health certification from ITP (Instituto Tecnico Pesquero). Plants must also have HACCP

systems in place and many are working towards implementing quality control systems such as FEMAS, and some have sought and gained ISO certification.

### Output statistics

#### Estimated Peruvian meal & oil production

|      | Fishmeal (metric tons) | Fish oil (metric tons) |
|------|------------------------|------------------------|
| 2000 | 2,208,996              | 593,300                |
| 2001 | 1,844,079              | 332,509                |
| 2002 | 1,941,447              | 221,458                |
| 2003 | 1,250,793              | 206,817                |
| 2004 | 1,982,652              | 351,631                |
| 2005 | 2,019,858              | 286,990                |
| 2006 | 1,377,536              | 285,407                |
| 2007 | 1,407,000              | 337,000                |
| 2008 | 1,396,000              | 276,000                |

## PRODUCTS AND MARKETS

**Product** – the main products of the anchovy fishmeal and fish oil industry are:

| Fishmeal         |  | Fish oil                         |         |
|------------------|--|----------------------------------|---------|
| <b>Protein</b>   | 64–68% Minimum   | <b>Free Fatty Acid</b>           | <4%     |
| <b>Fat</b>       | 12% maximum  | <b>Unsaponifiable Matter</b>     | <2%     |
| <b>Ash</b>       | 12–18%   | <b>Moisture &amp; Impurities</b> | <0.8%   |
| <b>Moisture</b>  | 6–10%  | <b>Iodine Value</b>              | 160–180 |
| <b>Salt/Sand</b> | 1–5%   | <b>Totox</b>                     | 20–35%  |
| <b>Histamine</b> | Varies according to quality<br>– <500ppm, <1000, or<br>not specified | <b>EPA omega-3</b>               | 15–17%  |
|                  |  | <b>DHA omega-3</b>               | 7–9%    |

The specifications above are typical for fishmeal and oil supplied from Peru. Suppliers in fact offer FAQ Fishmeal (direct dried), Steam Dried Fishmeal (indirect dried) and Fish Oil products, each to a range of more detailed specifications to meet the needs of the market.

### Fishmeal amino acid profile

|                      | % of sample |
|----------------------|-------------|
| <b>Threonine</b>     | 2.8         |
| <b>Cystine</b>       | 0.6         |
| <b>Valine</b>        | 3.5         |
| <b>Methionine</b>    | 2.0         |
| <b>Iso-Leucine</b>   | 3.2         |
| <b>Leucine</b>       | 5.0         |
| <b>Tyrosine</b>      | 2.2         |
| <b>Phenylalanine</b> | 2.8         |
| <b>Histidine</b>     | 1.6         |
| <b>Lysine</b>        | 5.0         |
| <b>Arginine</b>      | 3.8         |
| <b>Tryptophane</b>   | 0.7         |

**Main markets** – the primary markets for anchovy fishmeal are the manufacturers of feeds for aquaculture, young pigs and specialist chicken diets. The principal geographical markets are in China and Europe.

Anchovy fish oil is sold principally for the aquaculture feed market in Europe and Chile. Its richness in EPA and DHA long chain omega-3 fatty acids also makes it attractive for direct human consumption in the rapidly expanding markets for supplements and functional foods.

## HUMAN CONSUMPTION

The vital role of fish and particularly oily fish such as anchovy in the human diet, has led both government and industry to develop the human consumption market for anchovy in Peru. In recent years there has been considerable investment in processing and distributing anchovy throughout the country and particularly into the poorer areas in the mountains. This market and indeed the export market for anchovy for direct human consumption is expected to grow. However, in relative terms, the volumes are likely to remain small and will not significantly effect the output of fishmeal and fish oil.

The growing awareness worldwide of the importance of the omega-3 fatty acids EPA and DHA, in the human diet for a wide range of critical functions, including in the cardiovascular and immune systems as well as in brain functions, is resulting in increased demand for fish oil for direct human consumption. Fish oil is the richest available source of the long-chain highly unsaturated fatty acids EPA and DHA and Peruvian anchovy oil has one of the highest contents of these fatty acids of all fish oils. This means that the oil is increasingly sought after for its inclusion not only into capsules for direct consumption but also into functional foods. However, despite this growing market, the majority of the anchovy oil goes for inclusion into aquaculture diets thereby ensuring the health of the fish and imparting valuable health promoting properties into the final products.

## ACRONYMS

|        |  |
|--------|--|
| UN FAO | United Nations Food and Agriculture Organisation                 |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| ICES   | International Council for the Exploration of the Sea             |
| CIAT   | Centro Internacional de Agricultura Tropical                     |

## CONTACT DETAILS

IFFO Ltd  
2 College Yard  
Lower Dagnall Street  
St Albans  
Hertfordshire  
AL3 4PL  
United Kingdom

Telephone: (44) 1727 842844  
Fax: (44) 1727 842866  
e-mail: [secretariat@iffo.net](mailto:secretariat@iffo.net)  
website: [www.iffo.net](http://www.iffo.net)

Last updated May 2009