FRESHNESS SEMINAR PRESENTATION

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Preamble

This document is a slightly edited and expanded version of a presentation made at an Interwise seminar held on the 20th of April 2010. The topic of the seminar was the sensory evaluation of the freshness of fish as applied in quality control and quality assurance in commerce, the grading of fish for regulatory purposes, and in studies of properties of fish and the handling and processing of fish, i.e. in the R & D field.

Let me start with a quotation from a paper published in 1937 by Beatty and Gibbons, researchers at the Canadian Halifax laboratory which was a pioneer in the field of fish technology at that time.

> "Tests dependent primarily on the senses of smell, taste, sight or touch are the only ones that have been applied generally in commercial practice. They are useful in that they can be applied, rapidly, and in that they provide some information as to the quality of the fish. They are faulty in that they are at best only qualitative and indicate very roughly the degree of spoilage that may have taken place. They are dependent on the sharpness of the senses of the observer, and not only are the results of different examiners at variance, but the same examiner may differ from day to day and from sample to sample."

It is a very pessimistic view of the utility of sensory evaluation in fish technology and sensory analysts would not accept such a view nowadays. Sensory evaluation of freshness as I wish to discuss here is an analytical procedure and the sentiments of the last sentence can be applied to any analytical procedure; replace 'sharpness of the senses' by 'sensitivity', and 'observer; and 'examiner' by 'instrument' to see the correspondence. The views shown here were commonplace in the food industry generally at that time. Systematic studies of the sensory properties of foods and their measurements did not really get started until the 1950s, and the first recognized textbook of the subject, Principles of the Sensory Evaluation of Food, by Amerine, Pangborn & Roessler was not published until 1965.

60 years later, 1997, sentiments had changed as shown by this quotation from the recommendations of an EU sponsored project on the evaluation of the freshness of fish.

"Sensory evaluation is the most important method for freshness evaluation in the fish sector. The trend is to standardise sensory evaluation by improving methodologies and training of panels and to make sensory evaluation an objective measurement"

The quotation acknowledges the importance of sensory evaluation in measuring freshness, though I was disappointed to find in the published proceedings of the conference from which this quotation was taken that only three of the 45 papers appearing in it were concerned with the methodology of sensory evaluation of freshness. The quotation refers to a trend to standardise sensory evaluation and to improve methodologies and training of assessors, but in my opinion the trends referred to had already been operating for decades.

I assume you all have some knowledge of, and experience in, the sensory evaluation of fish and all I will do at the moment is to recap some basic principles.

Freshness in the contexts I referred to earlier must be evaluated by objective methods, that is, by methods that avoid value judgements such as god/bad like/dislike; those are used in the realms of product development and market research. (Fig. 1.) A large number of sensory procedures are described in text books, but here we require one that involves scaling, that is the allocation of a product to a position on a scale of freshness. Grading, that is allocating a sample to one of an ordered set of classes of freshness, even if this is just two classes, above and below a criterion, is a scaling method. Scoring is the allocation of a number to the position of perceived position of the attribute on the psychological continuum. Two forms of scales are popularly used in scoring attributes of foods: the line scale, and the numeric scale. In the former a line, typically 10 cm long, is drawn on the score sheet with the endpoints anchored with terms like 'completely fresh' and 'completely spoiled' and the assessor puts a mark on the line indicating their judgement of the freshness of the sample. The distance of this mark from the origin is taken as the score for freshness. The other type of scale is the numeric scale with each, or most, of the score points 'anchored' by descriptions of the attribute at each score point. Numeric scales are the type most frequently used in sensory evaluation of freshness of fish. When constructing such a scale it is important that the intervals on it are equal spaced in the perceived attribute being measured, that is, on the psychological continuum for that attribute or concept. This is a requirement for the use of arithmetic procedures on the data and is usually assumed rather that demonstrated.

Can freshness be measured?

Before we go on to discuss procedures and applications we should consider what we mean by 'freshness'. For me the usual definition in dictionaries - 'newly harvested or prepared' - is quite adequate. Though there is a considerable literature on freshness of fish and its measurement, this literature is not always consistent about what freshness is even to the opinion that it can not be measured. Allan Bremner has questioned whether freshness can be measured at all:

> "Freshness is a concept and it is not an entity, yet much of the terminology that has grown up around it treats it as though it were an entity. It cannot be treated as if it were a measurable quantity, but in scientific and technical writings that is how it is (incorrectly) often used. That is really not good enough. Since it is nonspecific, its use allows the writer to avoid the issue and be vague instead of particular. It is better not to use the term at all in scientific and technical writing."

This is certainly not my view and I believe Bremner is wrong in his assertion that freshness can not be measured. If he is right a lot of people have been wasting a lot of time. I agree with him that freshness is a concept and not an entity, but freshness being a concept is the key to the measurability of freshness. I must here make a brief excursion into psychophysics to argue the case.

Psychophysics is the branch of psychology that studies the quantitative relationships between stimuli and the resultant sensations. Textbooks of sensory evaluation of foods often have a brief introduction to psychophysics, but they are usually descriptions of what is sometimes termed classical psychophysics. The model in psychophysics proposes that events and conditions in the external world that have magnitude are perceived by the sense organs and after processing in the brain are mapped to a corresponding psychological continuum of magnitude in the mind of the assessor. The object of the psychophysics is to study the relationship, especially the quantitative relationship, between the magnitude of a stimulus in the perceived object and its magnitude on the psychological continuum. In classical psychophysics the stimuli are chemical or physical properties whose intensities can be measured, e.g., the weight of a fish, concentration of salt in a cured product, and the response is the perceived intensity of the stimuli. The relationship between the real and the perceived intensities leads to the Fechner's and Weber's laws described in textbooks, Fig. 2.

However, freshness does not sit easily in this psychophysics because there is no physical representation of the property of freshness; you can not prepare a fish that has x units of freshness. Current psychophysics offers a broader treatment of

psychological judgements that does not require the response continuum to have a physical or chemical correlate. This model was developed by Thurstone who proposed that it is not necessary to limit psychophysical analysis to stimuli that have intensity or magnitude of physical or chemical properties. The psychological objects may be any objects or ideas about which the subject can make comparative judgements in the form "A is x'er than B" where x is any designated attribute. All that is required is that a person can discriminate between a pair of objects on some concept of interest. Thus, if a person can compare two fish and declare that one is fresher, or staler, than the other then the concept of freshness can be measured.

Freshness scales

The earliest published score sheet that I am aware of for assessment of freshness is that from the Halifax laboratory in Canada published in 1949 for assessment of cooked cod fillets. It had four scales - odour, flavour, texture, appearance, though the authors considered that measurements of the last two were of little value. Fig. 3 shows the scales for odour and flavour. They are numeric scales anchored at each point by objective terms. (I don't like to see the term 'fishy', qualified or not, on score sheets; if you are smelling or tasting fish then of course it will smell or taste fishy). In 1953 Torry Research Station in Scotland published a set of scales, Fig 4, for evaluating freshness of raw and of cooked cod, often referred to as Shewan scales after the name of the senior author of the paper. In this system there are four scales for attributes of raw fish, and three for attributes of cooked fish The scale for gill odour is shown in Fig. 5 as an example. Again it is a fully anchored scale, that is, the character of the odour at each scale point is described by objective terms. The authors describe in the paper how the terms were selected and formed into a scale so that the intervals on the scale represented equal changes in perceived freshness. They also discuss reasons for having separate scales the primary one being that they reflected the use of different senses: vision, odour, flavour, and the more complicated sense that evaluates texture by touch or in the mouth. They also thought that different handling and storage procedures might affect the attributes measured on the scale in different ways and this was a subject for further study. The authors did not approve of adding scores on the different scales to give a spoilage index - it is not clear what is measured by summing, say, a score for a visual attribute and a score for an odorous attribute. Over the years extensive experience of using the scales at Torry showed that for normal storage in melting ice there was a very high correlation between scores on the different scales and scores on any one scale gave good estimates of the freshness of the fish.

The separate scales were then combined into a single scale covering all of the attributes for each of the raw and for cooked forms, Figs 6 & 7. Another impetus for combining scales was that they were being used in commercial quality control and

quality assurance by processors and distributors and they wanted the convenience of a single scale rather than considering results on different scales. Though the columns on this score sheet show attributes to be assessed I would like to emphasise that the assessors were trained to allocate the freshness of a fish to a position on the scale, not to try to score individual attributes, though they could use any clues provided by the individual attributes to aid them in allocating a score. When evaluating raw fish an assessor would assess the attributes from left to right on the score sheet. An experienced assessor would be able to estimate the freshness of the fish quite accurately from the appearance, and probably accurately enough for grading purposes, but any doubt about the score or grade would be resolved by examining the appearance and odour of the gills, attributes that are particularly discriminating for freshness. If you compare the terms in the original Shewan scale for odour shown in Fig. 5 you will note that those relating to chemicals have been taken out of this one. Similar score sheets were developed for other classes of fish, for example herring, mackerel, flat fish, salmonids and for crustacean shellfish.

The Shewan et al. 1953 paper has a statistical appendix describing how errors of the procedure, including biases of individual assessors, can be determined. This important appendix is well worth reading even now, because errors in the determination of the freshness are rarely described in papers on measurement of freshness by sensory methods. At Torry we routinely monitored the performance of assessors, individually and as panels, using the procedures described in this annexe.

The Torry scales were developed for use in research, but were soon taken up by the processing industry in the UK for inspection and quality control. Originally just the scales for general appearance and gill odour were used in QC of raw material, and scales for cooked odour and flavour for QC of fillets, but, as related above, the combined scales were later used. Levels of freshness defined on the Torry scales were used to specify freshness levels in contracts between suppliers and retailers when prepacked products became important in retail sales of fish in supermarkets, and between suppliers and large-scale users of fish such as local authorities and hospitals.

There is now a very large literature on the spoilage of fish and on its measurement by both sensory and non-sensory methods. A quick scan through my own bibliography reveals 100 or so papers in the research literature describing sensory scoring procedures for measuring freshness, and I am sure there are many more. Most papers describe objective, numeric, scaling systems of the sort I have been describing, but many describe subjective scales, such as for acceptability, liking, quality.

Other types of scoring systems and various systems for grading fish by freshness have been described. Though Shewan and his colleagues did not countenance summing of scores on the Torry scales other laboratories did. In the 1950's inspectors at port markets in France had a grading scheme based on a freshness index developed at the French fish technology laboratory in Nantes in conjunction with the fish inspection service. Fig 8. Thirteen attributes were each scored on a scale of 0-6 and the mean value was calculated and used as the spoilage index. The full table shown here includes examination of the odour and flavour of cooked fish, but these attributes were omitted in examination of fish at port markets and the mean was based on 11 scores. This scoring scheme was important then because a modified version of it was used as the basis of grading fish for freshness at port markets that was adopted by the EEC (Belgium, Luxembourg, the Netherlands, France, Italy, and West Germany at that time) in Regulation 2445/70. The scoring system specified in the Regulation was essentially the same as the French one just described, but with the scale simplified by deleting categories 0, 5 and 6 and the numbering reversed to scale from 3, fresh, to 0, spoiled. Again the mean value of the scores for the attributes was calculated and used to allocate grades of freshness: >2.7, Grade Extra; <2.7 and >2.0, Grade A; <2.0 and >1.0, Grade B; <1.0 Unfit.

The UK was not a member of the EEC when the Regulation came into force in the EEC, but when it joined in 1973 Torry was involved in the implementation of grading at UK ports and in training the inspectors. We had two major reservations about the process of allocating grades as specified in the Regulation, one theoretical, one practical: we were averse in principle to summing scores over attributes; and in practice we could not envisage inspectors at port markets scoring and recording 11 attributes and calculating the mean value. WEFTA, the West European Fish Technologists Association, was formed in 1970 and its first working party was set up to examine the procedures for the sensory evaluation of freshness with a view to comparing methods and scales, and perhaps produce a single one for the EEC countries. The working group was able to align the scoring systems used in the various WEFTA laboratories and with the grading scheme of the EEC regulation, though the goal of standard scale over the laboratories did not get very far. During visits to the collaborating laboratories and from visiting fishing ports around that time it was clear that inspectors in practice allocated fish directly to grades and did not use the scoring system described in the EEC regulation . Using the correspondence between scoring systems established at the WEFTA working group and the scale in the regulation Torry drew up guidelines for allocating fish directly into grades which was used for implementing the grading regulation at UK fishing ports, Fig. 9. The grading regulations were later amended to incorporate this Guide in place of the scoring system. The guides have been translated into the languages of the EU and Fig 10 is the Spanish version as an example.

In the last decade or so the index approach developed in France and referred to earlier has been revived as the Quality Index Method (QIM). It has some following in Scandinavian and European fish technology laboratories, but I do not know to what extent it has been taken up in commercial QC. I have no practical experience of using QIM, but judging from what has been published I have some serious reservations about it, both in principle and in practice. Fig. 11 is an example of a QIM score sheet for raw cod. Ten attributes are each scored on scales from 0-2 or 0-3 and the sum of the scores is the index. The writings on the method describes these scores as demerit points. Freshly harvested fish are considered as the standard and loss of this initial perfect quality is considered a loss of quality and the loss quantified as demerit points. This conflated quality with freshness, and it is not clear in the literature of QIM whether the score is to be interpreted as a freshness score or a quality score. When a QIM score sheet is being developed the descriptions are obtained from examination of spoiling fish and scores on the developed score sheet are related to storage time in ice and are used to as freshness scores, for example to predict remaining shelf life. I do not agree with this equating of freshness with quality because quality of a fishery product is more than freshness, though freshness might be an important, and perhaps overriding, quality factor. I do not like in principle the summing of various attributes based on different sense modalities as I have discussed above. The scales are very short for precise scoring. For example scores for gill odour have a range of 0 to 3, that is, 3 intervals. The description for score 3 corresponds to about 18 days in ice for cod so each interval spans 6 days in ice. Assessors can discriminate freshness better than that. Having to assign 10 scores to a sample and adding them seems to me adding unnecessary complications, especially in the context of assessment at port markets, over just allocating a single score for freshness.

Summary

There is a large literature on the evaluation on the sensory evaluation of freshness of fish using numeric scales and it would be a large task to try to review them here, but let me summarise what are think as some principles based on my experience at Torry Research Station, on working with the fish processing industry in Britain, and on projects concerned with quality control and inspection in various countries in the world.

People involved in the handling and marketing of fish, whatever their backgrounds and cultures, have a concept of freshness, and recognise that freshness exists on a continuum from fresh to spoiled. With a little demonstration and instruction people can accept that freshness is measurable and that fish can be allocated at least to grades of freshness if not to position on a scale.

People can be trained to allocate items to grades or to positions on scales without too much difficulty, though it takes some time to for experience to build up in order to achieve consistent and precise results. Over a long period of monitoring the performance of freshness panels at Torry Research Station the intrinsic error of the procedure for measuring freshness of cod was calculated at 0.4 scale units, equivalent to the change in freshness occurring during 0.8 days of storage in ice. (95% confidence limits twice that). That is the error of using one assessor; the error of a panel mean of 4 assessors would be half that.

Measurement of freshness on anchored, objective scales are portable, that is they can be used successfully outside of the establishments that developed them. The scales can be used directly for specifications in QA and QC within and between companies and they can be adapted for commercial or regulatory grading.

Within a language group, for example, within Europe, the descriptive terms can be translated effectively across languages, but it is useful to do this in collaboration with native speakers to catch nuances of meanings. Translations across very different culture groups and language structures, and across climate zones can present some difficulties because some terms are not relevant in that culture or can not be translated directly, but the principles for developing score sheets are the same and score sheets with objective terms relevant to the local conditions can be developed in the local language and calibrated against score sheets in other languages.

A well-constructed freshness scale using objective terms is robust in the sense that it can be used effectively with precision in various situations, such as landing sites and port markets, reception areas in processing plants, QC testing rooms, on processing lines, as well as in research laboratories. The freshness of fish can be evaluated effectively and precisely in without needing the facilities of sophisticated sensory laboratories.

As a postscript to this presentation, here is a picture of myself, on the left, in my younger days evaluating fish at Aberdeen Fish market. I can estimate from the appearance of the fish in the picture that they are around score 8 on the Torry freshness scale, about 5 days in ice, or Grade A on the EU grading scheme.

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Figure 1.

Selecting a sensory method

Do you want to know about the attributes of the product, or the response of the person to the attributes?

If the first , select an objective method, if the second, select a subjective method.

Characteristics of the methods

type	alternative labels	characteristics
Subjective	Affective Hedonic	Any method in which personal opinions are taken in consideration (ISO) Measures responses such as: like/dislike, good/bad, acceptable/not acceptable Assessors are sampled at random from a defined test population Assessors might be instructed, but not trained Used in product development and in marketing
Objective	Cognitive Analytical Descriptive	Any method in which the effects of personal opinions are minimized (ISO) Measures organoleptic properties such as: saltiness, toughness, ammoniacal odour Assessors are selected for the task Assessors trained to evaluate the attribute Used in quality control, inspection, and in R & D

Affective: Concerned with or arousing feelings or emotions

Cognitive: Concerned with the mental process of knowing, including aspects such as awareness, perception, reasoning, and judgment

Figure 2.

Psychophysics: the branch of psychology concerned with quantitative relations between physical stimuli and their psychological effects.

Classical psychophysics

Fechner's and Weber's Laws $R = a \log S + c$

R is the magnitude of the perceived response;
S is the magnitude of the stimulus; a and c are coefficients

Contemporary psychophysics

Theory of Signal Detection (TSD)

Thurstones's Law of Comparative Judgement

Figure 3

SCORE SHEET FOR COOKED COD FILLETS
Dyer, F.E. & Dyer, W.J. 1949

Score	Odour
0	fresh fish odour
1	no odour
2	sweet (volatile acid) sour
3	fishy (trimethylamine)
4	stale (enough trimethylamine to be objectionable)
5	rancid, putrid

Score	Flavour
0	sea-fresh tang
1	more or less tasteless
2	sweet sour
3	slightly fishy (trimethylamine)
4	stale (enough trimethylamine to be objectionable)
5	rancid, putrid

Figure 4.
Shewan scales for freshness for round, white fish

Raw fish   Cooked fish

Attribute	Scale length	Attribute	Scale length
General appearance	5 - 0	Odour	10 - 0
Appearance of flesh	5 - 0	Flavour	10 - 0
Gill odour	10 - 0	Texture	5 - 0
Texture	5 - 0		

Figure 5.
Freshness scale for iced cod: Gill Odour

Fresh 'seaweedy' odours	10
Loss of 'fresh seaweediness', shellfish odours	9
No odours, neutral odours	8
Slight musty, acetamide, milky or caprylic acid-like odours	7
'Bready', 'malty', 'yeasty' odours.	6
Lactic acid, 'sour milk', or oily odours.	5
Some lower fatty acid odours (e.g. acetic or butyric acids), 'grassy', slightly sweet, fruity odours.	4
Stale, sour, 'cabbage water', 'turnipy', phosphine-like odours.	3
Ammoniacal (trimethylamine and other lower amines) with strong o-toluidine-like odours.	2
Hydrogen sulphide, other sulphide odours and strong ammoniacal odours.	1
Nauseating, putrid, faecal odours; indole, ammonia, etc.	0

Figure 6

FRESHNESS SCORE SHEET FOR ICED COD AND ROUND WHITE FISH - RAW FISH

| SCORE | EYES | SKIN | TEXTURE AND EFFECTS OF RIGOR MORTIS | FLESH AND BELLY FLAPS | BLOOD AND COLOUR OF KIDNEY | GILLS | | SCORE |
						APPEARANCE	ODOUR	
10	Bulging, convex lens, black pupil, crystal-clear cornea	Bright, well-differentiated, colours. Glossy, transparent slime	Flesh firm and elastic. Body pre-rigor or just in rigor.	Cut surface stained with blood. Bluish translucency around backbone. Fillet may have rough appearance due to rigor mortis contraction.	Bright red, blood flows readily.	Glossy, bright red or pink, clear mucus.	Initially very little odour increasing to sharp, iodine, starchy, metallic odours, then to less sharp, seaweedy odours.	10
9	Convex lens, black pupil with loss of initial clarity.		Flesh firm and elastic. Muscle blocks apparent. In, or passing out of, rigor.	White with bluish translucency. May be corrugated due to rigor mortis shrinkage.	Bright red, blood does not flow.			9
8	Slight flattening or plane, loss of brilliance.	Loss of brilliance of colours.	Firm, elastic to the touch.	White flesh with some loss of translucency. Slight yellowing of cut surfaces of belly flaps	Slight loss of brightness of blood.	Loss of gloss and brightness, slight loss of colour.	Freshly cut grass. Just detectable seaweedy, and shellfish odours.	8
7							Slight mousy, musty, milky, or caprylic.	7
6	Slightly sunken, slightly grey pupil, slight opalescence of cornea.	Loss of differentiation, and general fading, of colours; overall greyness. Opaque and somewhat milky slime.	Softening of the flesh, finger indentations retained. Some grittiness near the tail.	Waxy appearance of the flesh, reddening around the kidney region of the backbone. Cut surfaces of the belly flaps brown and discoloured.	Loss of brightness, some browning.	Some discolouration of the gills and cloudiness of the mucus.	Bready, malty, beery, yeasty.	6
5							Lactic acid, sour milk, oily.	5
4	Sunken, milky white pupil.	Further loss of skin colour. Thick yellow knotted slime with bacterial discolouration. Wrinkling of skin on the nose.	Softer flesh, definite grittiness of the skin.	Some opacity . Reddening along the backbone and brown discolouration of the belly flaps.	Brownish blood.	Bleaching or brown discolouration of the gills, yellow bacterial mucus.	Lower fatty acids odours (acetic and butyric acids), composted grass, slightly sweet, fruity or chloroform like odours.	4
3							Stale cabbage water, stale turnips, 'sour sink', wet matches.	3

NOTES:

The relationship between the characteristics in the columns of this table apply to fish well iced in boxes and stowed at an ambient temperature just above $0^{\circ}C$, that is with some slight melting of the ice. The relationships might not hold for other forms of storage. In particular, appearance will be affected by the degree of melting of the ice: low melting rate or no melting will result in maintenance of appearance of eyes and skin, high melting rate will result in more rapid progression through the rows for eyes and skin. The rigor mortis effects can be affected by method of capture and by condition of the fish. Fish in poor condition might have soft texture even when very fresh. If characteristics are not consistent across a row, put most weighting on the gill appearance and odour when assigning a score.

Appearance of the flesh and blood staining around the backbone are assessed after removing a fillet.

Figure 7

FRESHNESS SCORE SHEET FOR ICED COD - COOKED FISH

score	odour	flavour	texture, mouthfeel and appearance
10	Initially weak sweet, boiled milk, starchy odours followed by strengthening of these odours	Watery, metallic, starchy. Initially no sweetness, but meaty flavours with slight sweetness may develop	Dry, crumbly with short tough fibres
9	Shellfish, seaweed, boiled meat, raw green plants	Sweet, meaty, creamy, green plants, characteristic	Succulent, fibrous. Initially firm going softer with storage.

Appearance originally white and opaque going yellowish and waxy on storage |
8	Loss of odour, neutral and order	Sweet and characteristic flavours but reduced in intensity	
7	Wood shavings, wood sap, vanillin	Neutral	
6	Condensed milk, caramel, toffee-like	Insipid	
5	Milk jug odours, boiled potato, boiled closed-like	Slight sourness, trace of off flavours	
4	Lactic acid, sour milk, byre-like	Slight bitterness, sour, off flavours	
3	Lower fatty acids (acetic, butyric acids), compost the grass, soapy, turnipy, tallowy	Strong bitter, rubber, slight sulphide	

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The relationship between the characteristics in the columns of this table apply to fish well iced in boxes and stowed at an ambient temperature just above 0°C, that is with some slight melting of the ice. The relationships might not hold for other forms of storage.

Figure 8

DESCRIPTIVE SCALE FOR DETERMINING THE SPOILAGE INDEX
Soudan, F., Bazin, J., Chapel, G., Seynave, E., Daknoff, A 1960.

Attribute		0	1	2	3	4	5	6
External examination								
skin	pigmentation	iridescent	iridescent	bright colours	dull colours	dull	discoloured	greyish
	mucus		transparent	milky	opaque	clotted	yellowish, thick	
eyes	colour		bright black pupil	duller pupil transparent cornea	opalescent cornea	pupil grey, milky cornea	whitish	
	shape		convex	a little sunken	flat	sunken	very sunken	
gills	colour		bright	less coloured	slight discolouration	yellowish	greyish	
	smell	marine, seaweedy	neutral	sweetish	slightly rancid	spoiled	putrid	offensive
texture	flesh	pre rigor	firm	elastic	supple	soft	flabby	
	abdominal wall		intact		soft	fragile	perforated	
Internal examination								
peritoneum		intact	adherent	not adherent	torn	deteriorated	dissolved	
vertebral column	colour				pink	red	brown	
	adherence of flesh		breaks off	adherent		not adhering	easily detached	
Examination after cooking								
odour		seaweedy	neutral	weak, not old	sour, lactic acid	lower fatty acids	ammoniacal	putrid

Figure 9

GUIDE TO EEC FRESHNESS GRADES

In order to be placed in grade E, A, B, or Unfit(C) the fish should possess the following characteristics. The descriptive terms are meant to be guides and not all the characteristics described will necessarily occur together in every fish. Gill odours are particularly discriminatory.

WHITE FISH: cod, saithe, haddock, whiting, plaice, redfish, ling, hake

		E	A	B	C
Skin		bright; shining; iridescent, (not redfish), or opalescent: no bleaching	waxy; slight loss of bloom; very slight bleaching	dull; some bleaching	dull; gritty; marked bleaching and shrinkage
Outer slime		transparent; water white	milky	yellowish-grey; some clotting	yellow-brown; very clotted and thick
Eyes		convex; black pupil; translucent cornea	plane; slightly opaque pupil; slightly opalescent	slightly concave; grey pupil; opaque cornea	completely sunken; grey pupil; opaque discoloured cornea
Gills		dark red or bright red; mucus translucent	red or pink; mucus slightly opaque	brown/grey and bleached; mucus opaque and thick	brown or bleached; mucus yellowish grey and clotted
Peritoneum (in gutted fish)		glossy; brilliant; difficult to tear from flesh	slightly dull; difficult to tear from flesh	gritty; fairly easy to tear from flesh	gritty; easily torn from flesh
Gills and internal odours	all except plaice	fresh; seaweedy; shellfishy	no odour; neutral odour; trace musty, mousy, milky, caprylic, garlic or peppery	definite musty, mousy, milky, caprylic, garlic or peppery; bready; malty; beery; lactic; slightly sour	acetic; butyric; fruity; turnipy; amines; sulphide; faecal
	plaice	fresh oil; metallic; freshly cut grass; earthy; peppery	oily; seaweedy; aromatic; trace musty, mousy or citric	oily; definite musty, mousy or citric; bready; malty; beery; slightly rancid; painty	muddy; grassy; fruity; turnipy; amines; sulphide; faecal

Figure 10

GUIA DE LA COMUNIDAD ECONOMICA EUROPEA PARA LA CLASIFICACION POR FRESCURA DEL PESCADO

Estas especies deberán poseer las siguientes características de cara a su clasificación en los grados E, A, B o no apto (C). Los términos descriptivos pretenden ser guías y no necesariamente todas las características descritas deben de ocurrir simultáneamente en cada pescado. Los olores de las branquias son particularmente discriminantes.

PESCADOS BLANCOS: Bacalao, faneca plateada, eglefino, merlanes, sollas, gallinetas nórdicas, maruca y escolano azul, merluza

		E	A	B	No apto (C)
Piel		luminosa; brillante; tornasolada (no para gallinetas nórdicas) u opalescente; sin decoloraciones	cérea; ligera pérdida de iridiscencia; muy ligeras decoloraciones	mate; algo de decoloración	mate; arenosa; decoloración marcada y contracción
Limo superficial		transparente; acuoso	lechoso	gris-amarilento; algo de coagulación	amarillo-marrón; muy coagulado y grueso
Ojos		convexos; pupila negra córnea translúcida	planos; pupila ligeramente opaca; córnea ligeramente opalescente	pupila gris ligeramente cóncava; córnea opaca	completamente hundidos; pupila gris; córnea opaca y decolorada
Branquias		rojas oscuras o rojas brillantes; mucosidad translúcida	rojas o rosas; mucosidad ligeramente opaca	marrón/grises y decoloraciones; mucosidad gruesa y opaca	marrón/grises y decoloraciones; mucosidad gruesa y opaca
Peritoneo (en pescado eviscerado)		lustroso; brillante; difícil de separar de la carne	ligeramente mate; difícil de separar la carne	arenoso; relativamente fácil de separar de la carne	arenoso; fácil de separar de la carne
Olores internos y de las branquias	Todos excepto sollas	a fresco; a algas; a marisco	sin olor; olores neutros; indicios de olor a moho, a ratones, a leche, a caprílico, a ajo o a pimienta	claramente a moho, a ratones, a leche, a caprílico, a ajo o a pimienta; a pan; a malta; a cerveza; a ácido láctico; ligeramente agrio	a acético; a butirico; frutal; a nabo; a aminas; sulfurosos; fecales
	Sollas	a aceite fresco; metálico; a hierba recién cortada; a tierra; a pimienta	a aceite, a algas, aromático, indicios de olor a moho, a ratones o a cítrico	a aceite; claramente a moho, a ratones o a cítrico; a pan; a malta; a cerveza; ligeramente a rancio; a pintura	a lodo; a hierba; frutal; a vinagre; a acido butírico; a rancio; a aminas; sulfurosos; fecales

(Howgate, P., Johnston, A., Whittle, K.J. 1992. Multilingual Guide to EC Freshness Grades for Fishery Products.

Fig 11

QIM SCHEME FOR COD
Luten, J.B. & Martinsdottir, E., 1997

Quality parameter		Description	Score
Appearance	Skin	Bright, iridescent pigmentation	0
		Rather dull, becoming discoloured	1
		Dull	2
	Stiffness	In rigor	0
		Firm, elastic	1
		Soft,	2
		Very soft	3
Eyes	Cornea	Clear	0
		Opalescent	1
		Milky	2
	Form	Convex	0
		Flat, slightly sunken	1
		Sunken, concave	2
	Colour of pupil	Black	0
		Opaque	1
		Grey	2
Gills	Colour	Bright	0
		Less coloured, becoming discoloured	1
		Discoloured, brown spots	2
		Brown, discoloured	3
	Smell	Fresh. seaweedy, metallic	0
		Neutral, grassy, musty	1
		Yeast, bread, beer, sour milk	2
		Acetic acid, suiphuric, very sour	3
	Mucus	Clear	0
		Milky	1
		Milky, dark, opaque	2
Fillets	Colour	Translucent, bluish	0
		Waxy, milky	1
		Opaque, yellow, brown spots	2
Blood	Colour	Red	0
		Dark red	1
		Brown	2