The Effect of Soak-time on the Quality of Cod in Set Nets

Trials from Bridlington during July and September 1991

Seafish Report No. 415

February 1993

MAFF R&D Commission 1991/92

Sea Fish Industry Authority

Technology Division

SEAFISH

The Effect of Soak Time on The Quality of Cod in Set Nets

- Trials from Bridlington during July and September 1991

Seafish Report No. 415
MAFF R&D Commission 1991/92
Project Code FT5 IBN16

Philip Prout
February 1993

Sea Fish Industry Authority

Technology Division

Seafish Report No. 415

February 1993
P. Prout

The Effect of Soak Time on The Quality of Cod in Set Nets

- Trials from Bridlington during July and September 1991

Summary

This report summarises the findings of an investigation into the relationship between the quality of the cod catch and the immersion period (soak time) of set nets (or static nets) in the summer months off the East Coast of England .

Two phases of sea trials and related laboratory assessments were carried out during the summer of 1991 from Bridlington.

The soak times of commercial cod gill nets used were varied in steps from 3 to 48 hours. The related seawater temperatures during the trials were about 11°C. The cod catch was graded aboard boat for spoilage and net/predator damage. Samples of the graded fish were subject to expert sensory assessment during extended storage on ice at the Seafish Laboratory.

The results showed that the fish began to die within 9 hours soak time and this heralded the onset of rapid spoilage and progressive damage. After 24 hours in the water, cod had deteriorated to the point of market unacceptability. Approximately half of the cod from the 48 hour soak time were rejected due to deterioration. In addition, cod catch rates reduced with increasing soak time.

The laboratory assessment of cod samples against the basic at-sea grading scheme enabled demonstration of the pattern of deterioration with time in water. The at-sea grading schemes proved to be well based and are potentially applicable by fishermen.

Basic recommendations are given.

Contents

1. Introduction

It is recognised that the quality of individual fish caught in set (static) nets varies widely. Two main factors are held to be the cause - damage from being enmeshed in the gear for prolonged periods and spoilage in relatively warm water during that time.

Cod was chosen as an investigation species because it is relatively straightforward to assess for spoilage. Cod is also a target species in a large number of set net fisheries from the English Channel to Scotland.

The Yorkshire Coast was chosen for the trials because of its proximity to the Seafish Laboratory at Hull. The vessel chartered for the trials was a 9 metre, high speed vessel which commercially fishes for cod with gill nets. The vessel's fishing gear was that typically used along the Yorkshire Coast during the summer - i.e. 6-7 ins mesh mono and multi-mono gill nets.

The basis of the trials was to vary the immersion periods (soak times) of the nets in steps from 3 to 48 hours. In normal commercial conditions the gear is hauled and shot daily, i.e. an average 24 hour soak time. During the trials the net laying (shooting) times were staged to take advantage of slack tide periods. This was in order to catch fish early in the soak as well as potentially to maximise the catch.

Once aboard, each cod was logged and roughly graded for spoilage on a 4 point scale of A - D. The deteriorative effects of net and predator damage were similarly graded. Note of the fish and shellfish by-catch was also kept, although these were not the focus of investigation. Fish, sea water and air temperatures were also measured for technical reference. Directly after assessment, the catch was gutted, washed and iced. Two programmes of trials were undertaken during the summer period, firstly in late July and then the trials were repeated in mid September.

Cod samples, which were determined to be representative of the range of conditions found, were taken to the Laboratory and held on ice over their shelf life. The rest of the catch was sold commercially. The samples, which reflected the A - D grading of spoilage, were initially assessed at the Laboratory within 24 hours of grading aboard. The fish were then re-assessed after 6 and 12 days on ice.

The method used for this more rigorous assessment was the Torry Research Station (TRS) sensory scoring scheme. The fish were assessed according to the criteria of raw appearance, feel and gill odour, together with cooked odour and flavour. This was done on a numerical scoring basis by a panel of 3 - 5 experienced staff. This approach is accepted as being an effective and practical method of measurement of freshness quality.

This report describes the main findings of the trials and is not a detailed analysis. The sections which follow are a more detailed description of the trials' vessel and method, the reporting of the results, the discussion of the results and finally the conclusions/ recommendations.

Objectives

To quantify the effects on the quality of cod of soak time in set nets, in order to make recommendations to industry.

2. Fishing Vessel and Gear

F.V. "OSPREY"	SH.55
Construction	GRP planing hull with self draining decks
Dimensions	9 x 3 x 0.75 metres
Propulsion	2 x 250 hp engines
Net hauler	Sjovelar type multi drum hauler
Nets	50 fathom (90m) long nets of 6-7 ins (150-175mm) mesh multi or mono filament twine (set in by the half). The complement of gear was 6 fleets of 3 nets each.
Fish handling	1 x 350 L insulated container for ice together with insulated covers for fish iced into boxes.

3. Trials Method

3.1 Fishing Operations:

The vessel was fishing on wrecks in a band between 5 and 10 miles offshore along the Yorkshire Coast between Filey and Scarborough. In each case the trials started on the first day that the nets would normally have been put back to sea after spring tides.

All the soak times were started 1-2 hours before slack water. This window enabled more than one fleet of nets to be shot per slack water. The three shortest soak times, i.e. 3, 9 and 15 hours, spanned one, two and three slack waters respectively. The fleets of nets shot to these soak times were hauled between 1 and 2 hours after slack water when the 3, 9 or 15 hours soak time was up. The 24 and 48 hour soaks, although started at slack water, did not phase to slack water at the end of the soak. The 3 and 9 hour soaks were carried out during daytime.

3.2 Fish handling procedure:

The fish were removed from the nets as soon as possible by the crewmen. This was done in a commercial fashion but with added care. After examination and logging, the fish were carefully gutted, washed and packed in ice.

3.3 Temperature monitoring:

Sea water temperatures were measured periodically throughout the trials by lowering a recorder to the seabed. Sea surface temperatures were taken by hand held digital thermometers as were air (ambient) temperatures. The temperatures of large cod were also taken as soon as the fish came aboard. The core temperatures at their thickest part were measured in order to relate to seabed water temperatures.

3.4 Catch recording and assessment:

Some observations were made of the degree of entanglement of the fish in the netting before removal.

The cod were then graded by Seafish staff, A - D for spoilage and 0 - 3 for both net and predator damage. The cod were also measured by length and coded. Also the numbers of other fish and shellfish (mainly crabs) were recorded. Details of the grading system are given in the results section (pages 8-10).

3.5 Sampling procedure:

The sampling procedure for laboratory assessment was based on taking about 20 fish from each of the A, B, C and D spoilage grades, covering all the various soak times. Each sea phase of the trials was over 5 consecutive days and about 15 fish from each day's catch were taken to the Laboratory for assessment.

3.6 Laboratory sensory assessment procedure:

The sample fish were assessed by the panel without knowledge of the spoilage grade awarded at sea. Each assessor scored each fish individually according to the TRS sensory schemes for freshness shown in Appendix I. The main indications used for raw condition were the appearance of the eyes, gills and skin in conjunction with skin feel and gill odour. Small sections of flesh were removed from the samples and steamed for 20 minutes in order to sensory assess the cooked odour and flavour. All the samples were carefully stored in ice over the trial period. Assessments were carried out on the day of reception and then after 6 and 12 days.

3.7 Analysis of the data:

The at-sea grading data from each of the two separate phases of the trials in June and September was found to be similar and was therefore combined for each soak time. The at-sea grading data represents all the cod caught at both phases. The Laboratory assessment data was analysed to examine the differences between the at-sea spoilage grades A - D. All the assessments of fish in each grade were averaged for each soak time. Thus, average T.R.S. scores for both raw and cooked condition were obtained for each grade of fish for each soak time. The assessment results for each grade were found to be similar for each soak time and so all the results for each grade were combined and averaged.

4. Results

This section falls into 4 parts:

- Water, fish and air temperatures;
- The onboard grading of spoilage, net and predator damage compared to soak time;
- The laboratory freshness data compared to the onboard spoilage grading (A -D);
- Other catch data including catch rates of cod and other fin fish and shellfish by-catch.

4.1 Temperatures:

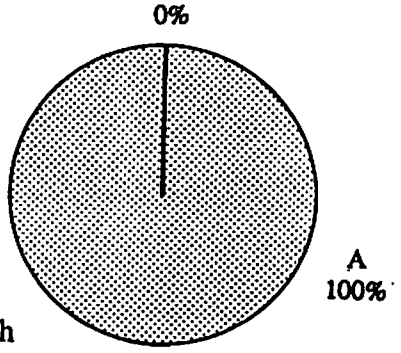
The sea water (seabed) temperatures during the two trial phases were broadly similar at 10-11°C during the 1st phase and 12-13°C in the 2nd phase. The core temperatures of large cod on boarding were found to be about 1-2°C higher than the seabed water temperatures. The sea surface temperatures were warmer at about 15-16°C in each phase. The air (ambient) temperatures ranged between 13°C and 21°C in phase 1 and between 14°C and 23°C in phase 2.

4.2 - AT SEA SPOILAGE GRADING

Percentage of Cod Catch in each spoilage grade for each soak time

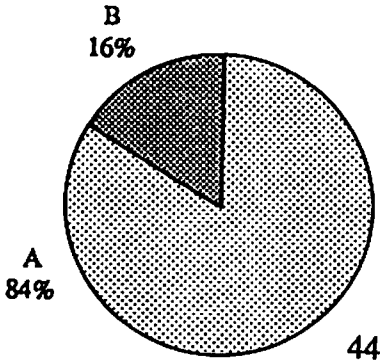
	Grade	Criteria
Spoilage	A	Alive
	B	Dead, but in appearance and odour the same as alive
	C	Dead, showing initial signs of spoilage
	D	Dead, showing obvious signs of deterioration of appearance and odour

3 Hours Soak-time



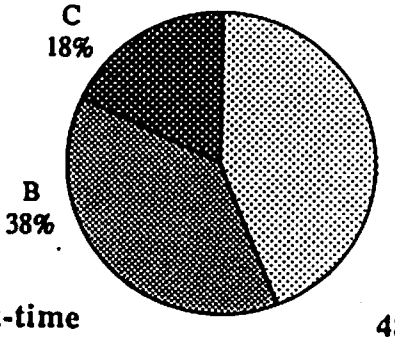
39 Fish

9 Hours Soak-time



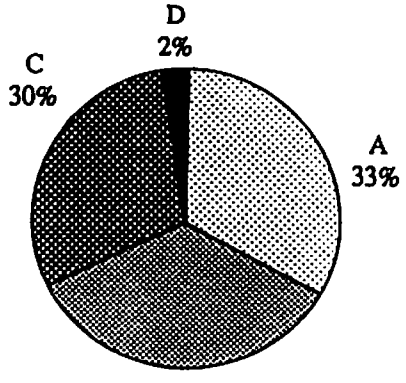
44 Fish

15 Hours Soak-time



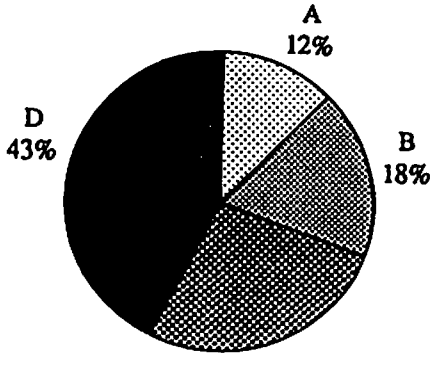
78 Fish

24 Hours Soak-time



110 Fish

48 Hours Soak-time

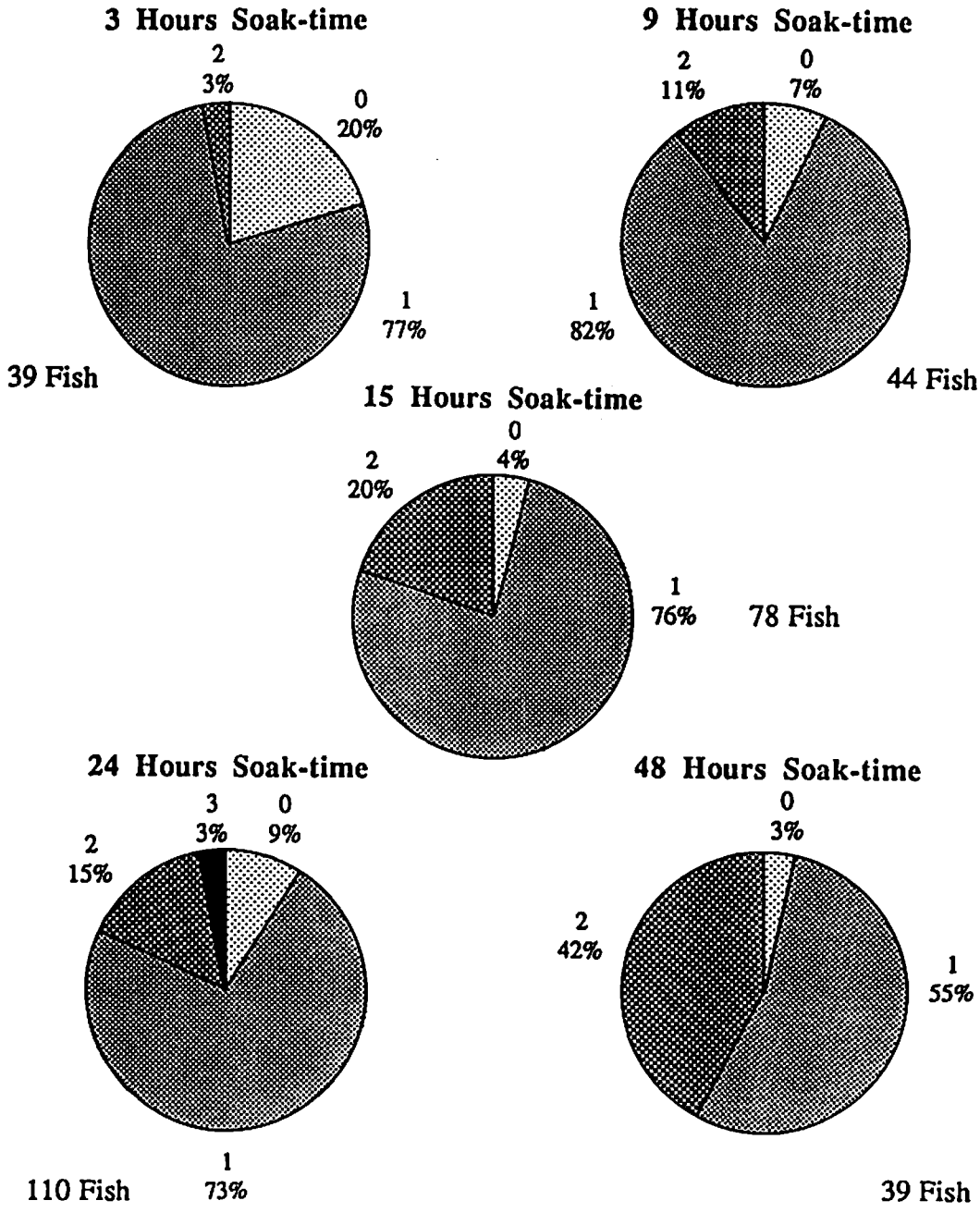


73 Fish

4.3 -AT SEA NET DAMAGE GRADING

Percentage of Cod Catch in each net damage grade for each soak time

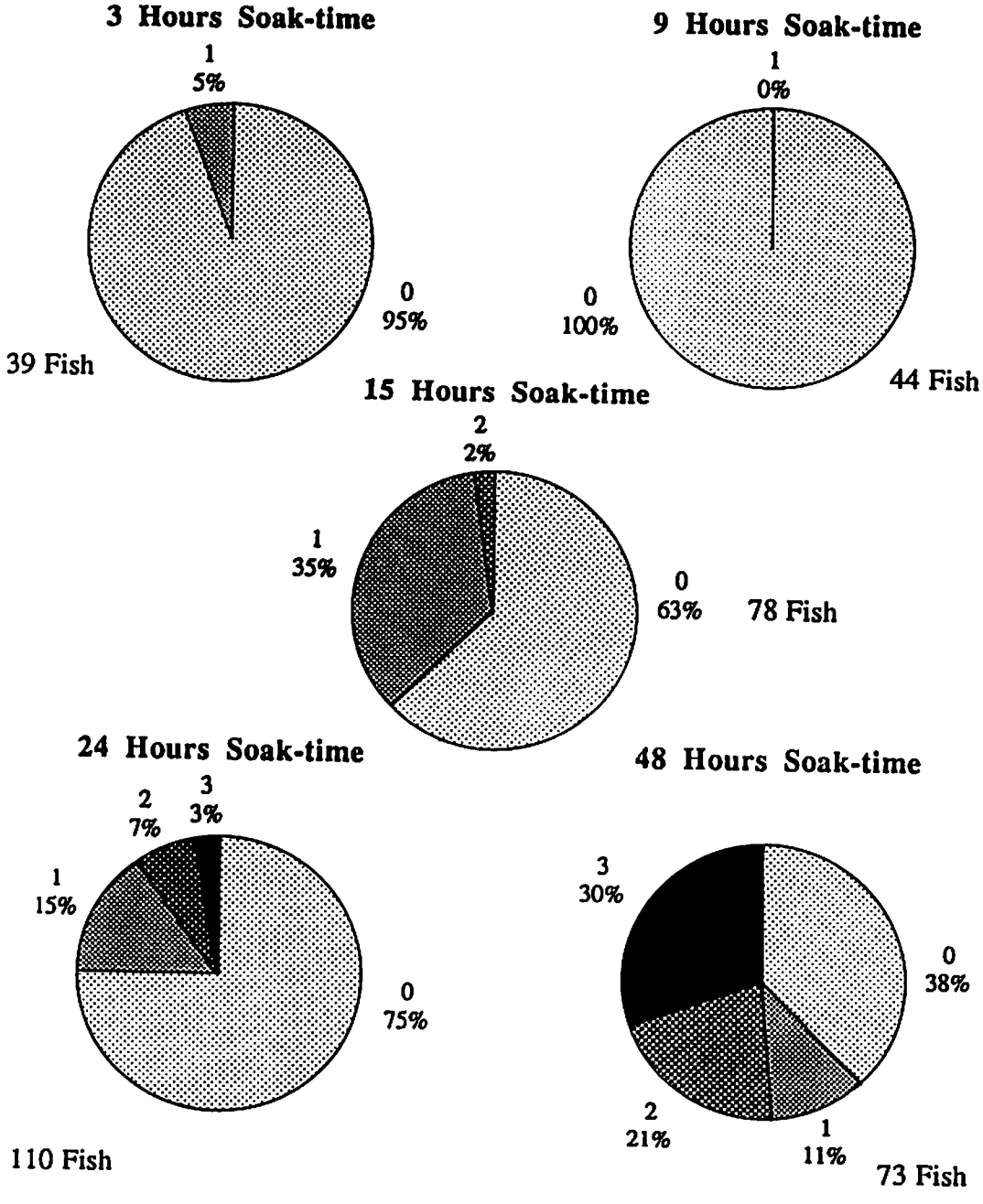
	Grade	Criteria
Net Damage	0	No marking
	1	Faint mesh marks to head
	2	Definite mesh marks to head and flesh with signs of softening
	3	Severe net marking and flesh softening to much of body and tail



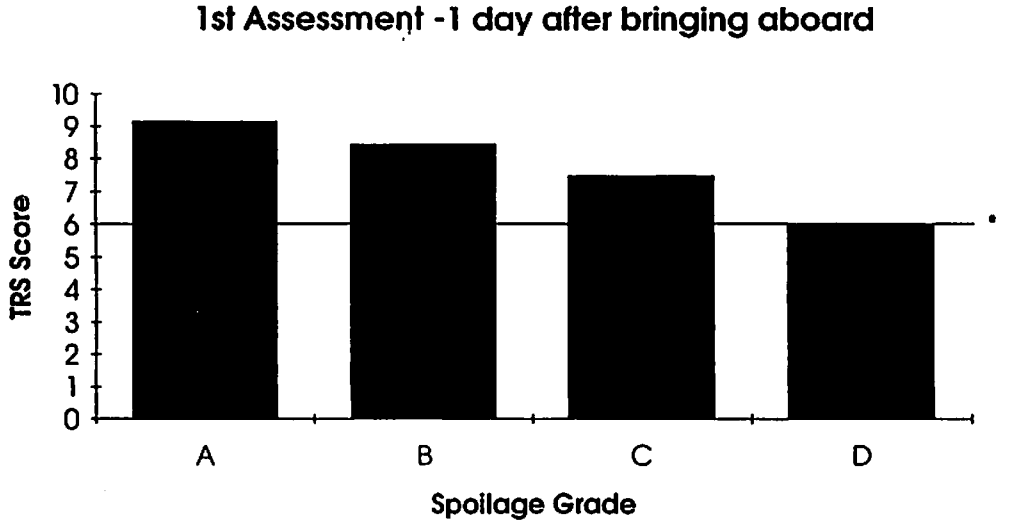
4.4 AT SEA PREDATOR DAMAGE GRADING

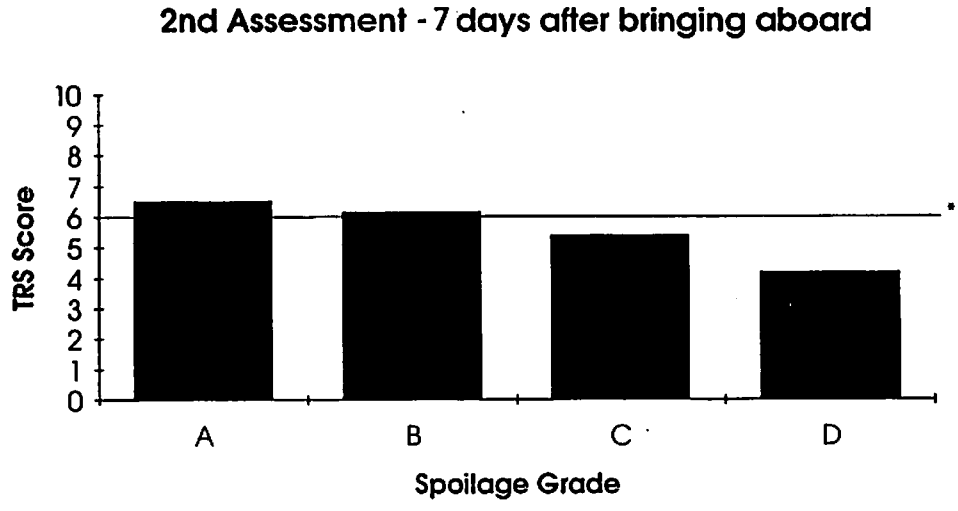
Percentage of Cod Catch in each predator damage grade for each soak time

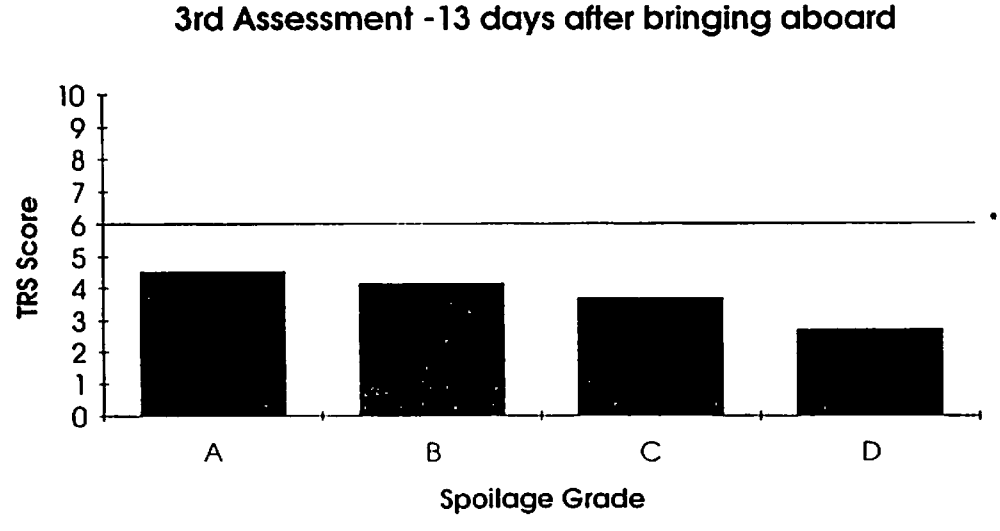
	Grade	Criteria
Predator Damage	0	No blemishes
	1	One or two slight blemishes
	2	More blemishes with indications of related softening
	3	Severe blemishing and softening - puncture of skin and flesh



4.5 - LABORATORY FRESHNESS ASSESSMENTS
(Raw Appearance and odour)
for each at-sea spoilage grade
(See Appendix 1 for details of assessment scheme)

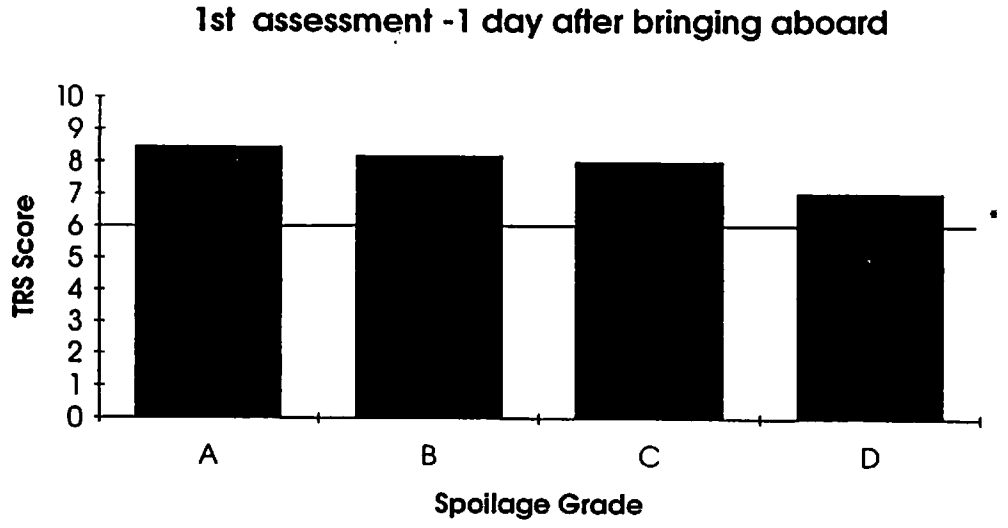


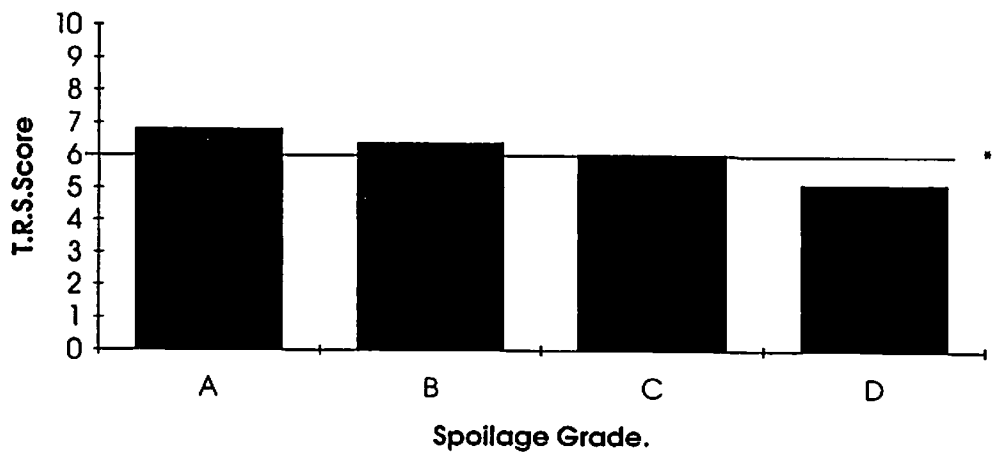


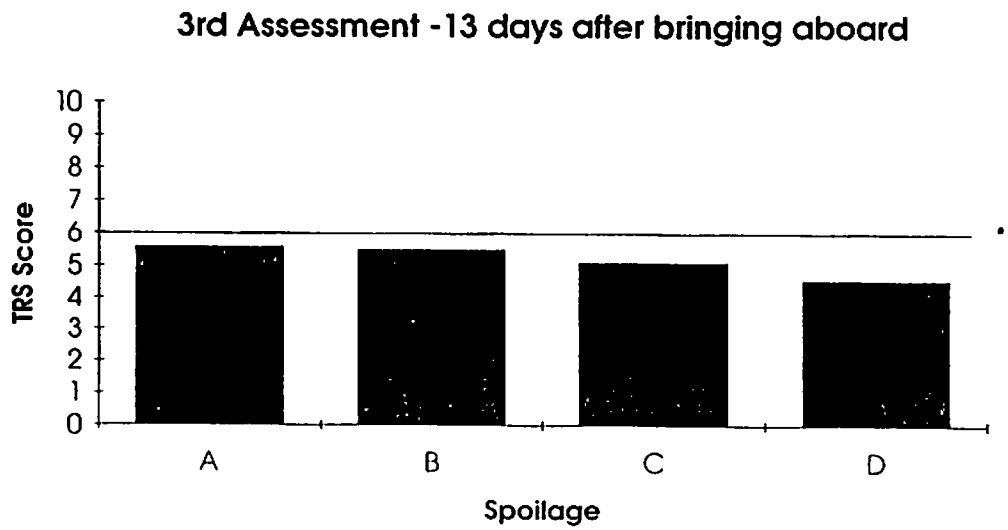


* Normal Limit of Commercial Acceptability

4.6 - LABORATORY FRESHNESS ASSESSMENTS
(Cooked Flavour)
for each at-sea spoilage grade
(See Appendix 1 for details of assessment scheme)







* Normal Limit of Commercial Acceptability

4.7 - CATCH RATES OF COD AND MAIN BY-CATCH SPECIES

Soak Time	No. Hauls	Average No. of Fish* Caught per Hour of Soak Time					Comments
		Cod	Whiting	Ling	Crab	Lobster	
3	9	1.43	0.63	0.07	0.27	0.03	Ling was the main saleable finfish by-catch. A few cat fish were also weighed in. Flat fish i.e. sole and plaice occasionally occurred. The crab catch rates were much higher in Phase 2.
9	8	0.61	0.37	-	0.03	0.04	
15	10	0.52	0.27	0.15	0.59	0.01	
24	13	0.35	0.16	0.04	0.48	0.09	
48	7	0.22	0.20	0.04	0.59	0.04	

* All sizes of fish/shellfish

Note: Due to the discards through spoilage the catch rate of **marketable** cod for the 48 hour soak would be much lower than the 0.22 fish per hour given above.

5. Discussion of Results

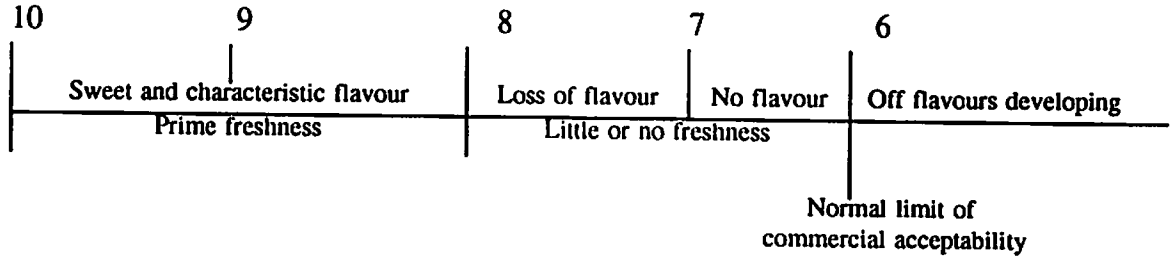
5.1 Temperature:

The temperatures about 10-12°C at the seabed would be expected to cause fish spoilage at about 4 times over that at 0°C. The air temperatures were typical of variable warm but not generally hot summer conditions.

5.2 Spoilage:

Although the assessment of both the raw condition and the cooked flavour are reported, the latter is normally considered to be the principal indicator of quality. The change in flavour over the shelf life of fish which have been properly handled is roughly as follows.

TRS Score (Points):



The difference between the 'A' and 'D' grade fish (about 8.5 ave. and 7.0 ave.) is large as the latter had lost nearly all its useful (and valuable shelf life). The C grade fish had lost its prime freshness whilst the B grade fish retained some. On assessment of flavour, the D grade fish had lost about 5 - 6 days of potential shelf life whilst in the water in comparison with A grade samples. This clearly reflects the warm water temperatures.

The Laboratory assessment of initial raw condition indicated greater loss of quality with soak time than cooked flavour. The "washing out" and other effects of prolonged sea water immersion found with the Cs and Ds, do not appear to match the TRS raw sensory assessment scheme well. However, raw appearance is the major factor which influences the marketability of the fish at the quayside.

The pie charts showing the incidence of A, B, C and D grades, with increasing soak time, show a clear pattern of freshness quality loss. At a point somewhere below 9 hours immersion, fish started to die. Given the relationship of A (live fish) with freshness, a soak time beyond 9 hours in the conditions experienced becomes undesirable. After a soak time of 24 hours, only about third of the fish brought aboard were still alive with another third (Cs and a few Ds) spoiling towards rejection. The state of the average catch from the 48 hour soak was such that the boat would have put less fish to market than from its 24 hour soak because of the degree of discard of spoiled fish.

5.3 Net Damage:

The pie charts relating net damage to soak time show that there is some effect whilst the fish are alive. However, the net damage up to grade 1 is superficial and not easily noticed. Net damage at grade 2 reflects the strong likelihood of some damage to the fillet. At grade 3 the flesh is very likely to be ruined by softness and/or bruising. Many buyers are wary of netted fish showing external damage because of reduced yields. As with spoilage, the turning point was some time before 9 hours in the net.

Although not matters of direct measurement, the nature of enmeshing of the fish and subsequent damage to the flesh were observed. An interesting indication is that the damage from enmeshment appeared to increase after death where grade C and D (spoilage) fish were generally well rolled/wrapped and entangled. Thus the fish not only suffered more damage in the rolled net but potentially incurred more during removal. The observations at the Laboratory indicated that otherwise prime fillets could be ruined by bruising in particular.

5.4 Predator Damage:

The onset of predator damage appeared to follow death and a period of about 15 hours was the turning point. Again, beyond a minor degree of about 1, the effects tend increase buyer's suspicion of the fish. The increase of spoiling fish with time coincided with increased predator damage. The main predators in this fishery appeared to be whelks, starfish and crabs although lice present problems in other fisheries.

5.5 Catch Rates:

During the 10 days of sea trials the catch rates were such that catches of reasonable commercial level occured only on a few days. A factor of the trial was the need to work wrecks which were close enough together. In commercial circumstances the likelihood is that the boat would have shifted grounds. Additionally the vessel would have been working the 24 hour soak time cycle which enables more nets to be hauled and shot as the time losses waiting for slack tides are minimised. However, the average catch rates during the trials showed some interesting variation with soak time. Overall catch rates of cod per hour of soak reduces with increasing time. The crab by-catch increased markedly overnight, i.e. the 15 or 24 hour soak time.

5.6 Commercial Quality:

The effect of spoilage and damage tend to coincide and reinforce as time increases. This means that the best quality relates all the more strongly to whether the fish are alive, i.e. grade A.

In general cod that had spoilt to category D or was damaged to category 3 would not have been considered fit for market.

The good fish handling principles followed in the set net trials are not necessarily applied in commercial conditions on small boats. A separate project during the summer of 1991at Scarborough showed that the commercial quality and value of fish from similar boats to the trials vessels could be improved. Up to 20% (average) higher prices for netted cod (24 hour soak) were obtained over the months June to August.

The fishermen achieved this by changing their handling standards and routines. The cod were carefully gutted, washed and iced **haul by haul.**

The fish were also re-iced on the market to maintain temperature control up to auction. The fishermen presented the fish which were broadly in the "C" bracket separately from the better fish. The fish broadly in "D" condition were discarded. The demand for the better handled and presented fish grew over a month or two when the buyers became confident of the reliability of new standards of quality.

The fish storage equipment used in the handling trials was vital as it enabled the effective icing of fish on deck. Ice was taken at landing in readiness for the next day. Insulated containers and fitted soft covers were used. These forms of portable equipment were used to protect iced boxes of fish which were stowed wherever convenient on deck.

6. Conclusions

Although these findings are based on limited trials off the Yorkshire Coast, they have implications to other fisheries:

Quality:

- Considerable degradation of the catch occurred over soak time.
- In warm seawater at about 11°C the cod spoils about 4 times as fast than if at 0°C (in ice)
- The spoilage grading of the catch at sea into the A - D categories was practical and effective.

  - D grade fish were unfit to market.
  - C grade fish had lost all their prime freshness and most of shelf life.
  - B grade fish had some prime freshness left.
  - A grade fish were of prime freshness and shelf life.

The at-sea grading of the catch by spoilage and damage showed the following findings:

- The spoilage and degradation through damage started as soon as the fish died in the nets.
- At some time within 9 hours the cod began to die.
- By 15 hours over half the fish had died and there was a significant onset of spoilage and net/predator damage.
- Within a maximum of 24 hours in the water (24 hour soak time) cod had spoiled to the point of rejection.
- Beyond the spoilage grade of B, the cod were increasingly degraded by net and predator damage.
- The 48 hour soak (double that of the typical 24 hour average day-boat soak time) degraded the catch to the degree that considerably less cod were marketable than from the 24 hour soaks.

Catch Rates:

- The by-catch of crab increased in line with prolonged soak and increased spoilage.
- The cod catch rates showed diminishing returns with time.

7. Recommendations

- Soak times should preferably be less than about 9 hours for cod in the summertime.

- The catch should be properly graded, handled and iced on board.

APPENDIX I

TRS Sensory Assessment Schemes
- Scoring System for Raw Cod

Score	Eyes	Skin	Texture and Effect of Rigor Mortis	Flesh and Belly Flaps	Kidney and Blood	Gill		Score
						Appearance	Odour	
10	Bulging, convex lens, black pupil, crystal-clear cornea	Bright well-different-iated colours, glossy, transparent slime	Flesh, firm and elastic. Body pre-rigor or 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, changing to less sharp seaweedy shellfish odours.	10
9	Convex lens, black pupil with slight loss of initial clarity		Flesh firm and elastic. Muscle blocks apparent. In or just passing through rigor.	White with bluish translucency, may be corrugated due to rigor mortis effect.	Bright red, blood does not flow.			9
8	Slight flattening or plane, loss of brilliance	Loss of brilliance of colour	Firm, elastic to the touch.	White flesh with some loss of bluish translucency. Slight yellowing of cut surface of belly flaps.	Slight loss of brightness of blood.	Loss of gloss and brightness, slight loss of colour.	Freshly cut grass. Seaweedy and shellfish odours just detectable.	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. Overal greyness. Opaque and somewhat milky slime.	Softening of the flesh, finger indentations retained, some grittiness near tail.	Waxy appearance of the flesh, reddening around the kidney region. Cut surfaces of the belly flaps brown and discoloured.	Loss of brightness, some browning.	Some discoloration of the gills and cloudiness of the mucus.	Bready, malty, beery, yeasty.	6
5							Lactic acid, sour milk or oily.	5
4	Sunken, milky white pupil, opaque cornea	Further loss of skin colour. Thick yellow knotted slime with bacterial discolouration. Wrinkling of skin on nose.	Softer flesh, definite grittiness.	Some opacity, reddening along backbone and brown discolouration of the belly flaps.	Brownish kidney blood.	Slight bleaching and brouw discolouration with some yellow bacterial mucus.	Lower fatty acid odours (eg acetic or butyric acids), composted grass, "old boots", slightly sweet, fruity or chloroform-like.	4
3							Stable cabbage water, stale turnips, "sour sink", wet matches.	3

TRS Sensory Assessment Schemes
- Scoring System for Cooked Fillet of Cod

Score	Odour	Flavour	Texture, Mouth Feel and Appearance	Score
10	Initially weak odour of sweet, boiled milk, starchy followed by strengthening or these odours.	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop.	Dry, crumbly with short tough fibres.	10
9	Shellfish, seaweed, boiled meat, raw green plant.	Sweet, meaty, creamy green plant, characteristic.	Succulent, fibrous. Initially firm going softer with storage. Appearance originally white and opaque going yellowish and waxy on storage.	9
8	Loss of odour, neutral odour.	Sweet and characteristic flavours but reduced in intensity.		8
7	Wood shavings, woodsap, vanillin.	Neutral.		7
6	Condensed milk, caramel toffee-like.	Insipid.		6
5	Milk jug odours, boiled potato, boiled clothes-like.	Slight sourness, trace of "off" flavours.		5
4	Lactic acid, sour milk "byre-like".	Slight bitterness, sour, "off" flavours.		4
3	Lower fatty acids (eg acetic or butyric acids), composted grass, soapy, turnipy, tallowy.	Strong bitter, rubber, slight sulphide.		3