INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA

C.M. 1975/ F: 28
Demersal Fish (N) Committee
Ref. Statistics Committee

ON DISCARDING IN THE SOLE FISHERY AND PRELIMINAR OBSERVATIONS ON SURVIVAL RATES OF DISCARDED PLAICE AND SOLE IN 1975

by

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1. Introduction

At the last Council Meeting a resolution of the Statistics Committee urged member countries to initiate or continue research into the collection of data on discards, especially of species under quota regulation, and of survival of discarded fish.
In the Netherlands research on discarding in the beam trawl fishery for sole has been carried out in 1968 and 1970 (de Veen and Rodenburg, 1971). In the first half of 1975 this study has been repeated. In addition to the collection of data on board of commercial ships necessary to estimate the total annual number of discards of the whole fleet, research has been started into the survival of discarded plaice and sole. In this paper the results of these studies will be discussed and compared with the earlier discard studies of 1968 and 1970.

2. Methods

Data on discards were collected on board of a number of flatfish beamtrawlers with engine power ranging from 240 - 1350 b.h.p. and fishing on different grounds during 12 trips (see figure 1). During each cruise the length distribution of discarded and landed fish has been estimated by sampling a limited number of hauls. By raising these data to the total amount of discards and kept fish during the whole cruise (estimated by the skipper in baskets of known weight) the total length distribution of all discards for the whole cruise could be assessed.
Species studied are plaice, sole, dab, lemon sole, turbot, brill, cod and whiting. Although the number of ships sampled is rather limited we think that the results represent more or less the whole Dutch sole fleet in the first half of 1975.
For survival studies we used tanks on board of the R.V. "Tridens" during cruises. In these tanks a large number of flat basins, each with own continuous sea water supply, can be inserted, making it possible to study some 1000 flatfish for a number of days (under conditions approaching nature as much as possible as temperature of sea water is concerned).

Survival of discarded fish depends largely on the amount of damage or injuries inflicted to the fish during their stay in the net during the fishing operation and in addition to effects of being handled on deck before being thrown overboard. For survival studies we graded the fish according to apparent damage to the body of the fish into 6 categories from completely healthy and undamaged to dead fish. In the survival studies we put fishes belonging to the various damage categories in separate tanks and followed their survival during four days.
In order to apply the results of these survival studies to the data from the commercial ships, we used the same grading into damage categories in assessing the damage of the fish caught by the sole cutters.

3. Results

3.1 Total number and length distribution of discarded fish by species and per unit of effort

The total number of discarded fish by species per 100 hours fishing, based on all data collected, is as follows.

Plaice	13.026	Dab	32.249
Sole	1.229	Cod	2.777
Turbot	93	Whiting	2.276
Brill	13		

The length distributions of the discarded plaice and sole per 100 hours fishing are given below for the coastal area (0 - 12 miles from the coast) and the open sea (>12 miles)

length	Plaice			length	Sole		
cm	coastal area	open sea	Total	cm	coastal area	open sea	Total
7	7		2	7			
8	22		6	8			
9	27		7	9		21	9
10	39		11	10		21	9
11	40	1	12	11			
12	138		38	12			
13	180	3	52	13			
14	275	3	79	14	3		2
15	694	10	200	15		13	10
16	824	22	245	16	14	35	30
17	463	28	150	17	14	53	45
18	930	39	289	18	40	36	38
19	1277	111	426	19	55	174	152
20	2142	113	683	20	116	282	255
21	3056	221	1010	21	233	296	290
22	4637	302	1519	22	305	221	244
23	4341	452	1548	23	357	101	167
24	4715	732	1855	24	52	28	29
25	3564	944	1717	25	29	71	10
26	3117	989	1629	26	7	2	3
27	811	705	774	27			
28	81	315	269	28			
29	37	150	116	29			
30		31	24	30			
31		4	3	31			

For calculating the length distribution of the discard of the total fleet we had to count the data of the open sea category twice.

For other species only the length - distribution of discards of the total North Sea per 100 hours fishing is given.

	Dab	Turbot	Brill	Lemon Sole	Cod	Whiting
length						
5	9					
6	5					
7	20					
8	33					1
9	63					11
10	60					13
11	253					15
12	260					73
13	820				4	69
14	1310				14	103
15	2217				11	134
16	3234				7	111
17	4555				15	113
18	3642				15	106
19	3050	7		1	48	80
20	2501			4	72	92
21	1589	1		2	104	126
22	1170	14		2	123	112
23	769	15		2	152	126
24	430	21		1	199	165
25	213	20	4	2	234	157
26	141	16			257	213
27	24	10	5		280	195
28	3	16	4	1	266	131
29	19	14	1		261	138
30	2		5		107	84
31					59	20
32				1	23	10
33					2	2
34						1

3.2 Retention ogives of sole and plaice

In figure 2 the retention ogives derived from the present study for sole and plaice are given as solid lines. For comparison those given for the two species in 1970 (de Veen and Rodenburg, 1971), are also given, in broken lines.
In the sole there is hardly any change since 1970. As in that year the 50% retention length is about 22 cm, 2 cm below the legal minimum size of 24 cm, thus resulting in a fair amount of undersized soles not discarded. One should expect more or less a knife-edge selection in sole, where on board each sole is measured precisely before landing.
In practise, fishermen keep soles from 20 - 24 cm on board and select the fish to be landed later.
In the plaice we see a distinct change in the retention ogive, it is now much steeper (even steeper than the present sole-ogive) The selection of plaice to be kept carried out by hand is much better now, but still a fairly large number of plaice of above 25 cm (international legal size) is discarded. The 50% retention length is now more or less identical to the Dutch minimum landing size of 27 cm.

3.3 The number of fish by species discarded annually by the total Dutch sole fleet

The total number of fish discarded in the first half of 1975 has been estimated by raising the numbers per 100 hours fishing to the total number of fishing hours of the fleet.
To arrive at an annual figure we have doubled the resulting figures.

Annual number of discards in the Dutch sole fisheries, 1975

Plaice	110, 800, 000	Dab	274, 200, 000
Sole	10, 400, 000	Cod	23, 300, 000
Turbot	790, 000	Whiting	19, 300, 000
Brill	109, 000		

For plaice and sole we can compare the present figures with those given for 1967 and 1970.

	Plaice	Sole
1967	48, 600, 000 ')	2, 700, 000 ')
1970	116, 500, 000 ')	57, 300, 000 ')
1975	110, 800, 000	10, 400, 000

') recalculated from the initial values given by de Veen and Rodenburg.

The number of discards is a function of the strength of the relevant yearclass. This strength can be estimated by means of virtual population analysis. This type of analysis, however, fails to give reliable data for the most recent recruiting yearclasses.

3.4 Degree of damage of discarded fish

In order to be able to use the survival rate of discarded fish derived from tank experiments (to be described later) in estimating overall survival of discards in the commercial fleet we have assessed the degree of damage to plaice and sole in the catches of the commercial cutters.
The following qualitative scale has been used:

damage category	Description of damage	
A	fish lively,	slime layer intact, no visible damage to skin.
B	fish lively,	slime layer not more intact, slight scratches on skin.
C	fish not so lively,	slime layer partly removed, loss of scales near tail.
D	fish sluggish,	slime layer mostly removed, many scales missing.
E	fish sluggish,	slime layer lost, most scales missing.
F	fish dead.	

The relative frequency per damage stage for the total Dutch fleet is:

	A	B	C	D	E	F	
Plaice	13.6	26.5	25.9	16.1	15.9	7.0	%
Sole	6.5	24.9	24.7	17.1	22.0	6.5	%

For plaice the average damage for increasing length of discards was:

length	A	B	C	D	E	F	
< 21 cm	14.9	24.4	28.7	20.4	16.8	0.8	%
22-26 cm	13.4	27.4	25.0	17.1	15.5	1.6	%
> 26 cm	21.7	23.7	29.0	9.6	14.4	1.6	%

/‾ speeds (6 knots) as compared with the smaller

There is a slight decrease in the average amount of damage with increasing length.

Sole cutters with a large engine power are able to drag heavier beamtrawls with more chains over the bottoms and moreover fish with higher /‾ cutters (3 - 4.5 knots). Therefore we may expect more damage to fish in the nets of the large cutters than in those of the less powerful boats.
The following tables give the average damage stage per ships - category for plaice and sole.

Plaice

ships category	A	B	C	D	E	F	
0 - 500 b.h.p.	13.9	23.3	23.7	27.1	11.8	0.3	%
500 -1000 b.h.p.	19.2	26.9	22.1	11.6	19.9	0.3	%
> 1000 b.h.p.	4.0	18.2	31.1	18.2	24.5	3.9	%

Sole

ships category	A	B	C	D	E	F	
0 - 500 b.h.p.	14.6	44.7	26.0	14.8	7.3	0	%
500 -1000 b.h.p.	0	16.7	31.2	29.4	23.0	0	%
> -1000 b.h.p.	4.6	17.8	23.6	16.5	28.6	8.2	%

The influence of the stronger engine on the degree of damage to the discards is clearly visible for plaice in the ship's category > 1000 b.h.p. and for sole in the categories 500 - 1000 b.h.p. and > 1000 b.h.p.
However, the results are not completely comparable between ship's categories, because ships with different engine power may fish on different fishing grounds.
For the other discard species such as cod and whiting no degree of damage has been estimated because these species have hardly any chance of surviving when discarded.

3.5 Survival studies on plaice and sole in tanks on board "Tridens"

3.5.1 Mortality caused in the net

On board of "Tridens" the mortality inflicted on fish in the net during fishing has been studied in November 1972, April - May 1973 and January - February 1975.
During these preliminar experiments the influence of the duration of the haul of an ottertrawl with beamtrawlnet and 5 chains on the damage of the fish and the net-mortality was estimated.
In plaice it was apparent that the degree of damage increased with increasing duration of the haul.
Plaice, graded by stage of damage and duration of haul were then put in separate tanks and examined twice a day. Mortality increased with increasing degree of damage and per degree of damage mortality more or less stopped after three days. The situation on the third day was then taken for constructing survival curves (figure 3) in order to relate the mortality of the plaice

to the time trawled, thereby using the information on damage collected in each of the hauls during the cruises of "Tridens". Thus in November 1972 in the North Sea with windforces 5 - 8 40% of the plaice from hauls of 20 minutes would have died later if they had been discarded immediately and the values for one and two hour hauls are 60% and 74% (figure 4).
In this particular case bad weather conditions may have had an ill effect.
In April 1973 a survival curve for sole could be constructed for the same ship, same net and the same amount of chains in the Irish Sea with better weather conditions (2 - 5) and is given in figure 5.
The data of the "Tridens" cannot be applied directly to the data of the commercial ships, for the reason that "Tridens" used a relatively light - weight net with only 5 chains.
However, the ill-effects of increasing duration of hauls on the amount of damage to the fish and a corresponding decreasing survival rate of discards shown in the "Tridens" experiments, undoubtedly will be operating in the commercial fleet with heaver beamtrawls.
In the first half of 1975 the relative frequency of the duration of hauls by Dutch beamtrawlers was as follows:

Duration of haul	1	1 1/2	2	2 1/2	3	3 1/2	4	hours
	11.0	20.4	56.3	10.3	1.3	0.4	0.2	%

This shows that in practise we have to take account of an average duration of a haul of 2 hours.

3.5.2 Mortality caused by exposure on deck

In February 1975 survival studies were initiated on total mortality of net and of exposure on deck together.
The duration of the hauls of "Tridens" with the same net as before but with 2 chains was 20 minutes. Plaice and sole graded to damage were left in batches on deck for 20 and for 40 minutes, thereafter placed in the separate tanks and examined twice a day for three days.
Survival in this experiment at the end of the third day was as follows:

	Plaice		Sole	
	20 min.	40 min. exposure	20 min	40 min exposure
A	100%	100%	14%	0%
B	89	57	11	0
C	52	7	0	0
D	10	0	0	0
E	0	0	0	0

This shows that in winter plaice of damage - category A (undamaged) do not show any extra mortality for exposure on deck but that an increase in time on deck leads to an increased mortality in damaged plaice. In the case of sole survival is very low in the case of 20 minutes exposure and all soles died after an exposure of 40 minutes on deck.
The duration of the periods in which discards were lying on deck on board of commercial cutters was during 193 hauls in the 12 cruises concerned:

Exposure period	0-5	5-10	10-15	15-20	20-25	25-40 minutes
	0	2.6	18.3	53.5	20.9	5.7 %

Thus on average discards were exposed on deck for 15-20 minutes. In the above mentioned experiments no plaice and sole were put in tanks immediately, without exposure on deck. It is therefore not possible to split the total mortality into net- and exposure mortality. Net mortality per damage stage increased with increasing duration of the haul as is shown in figure 3.
Thus net-mortality in 2 hours hauls as usual in commercial ship will be higher than in the 20 minutes haul of the above experiment. It is our plan to repeat these exposure experiments if possible on board of commercial ships.

Reference

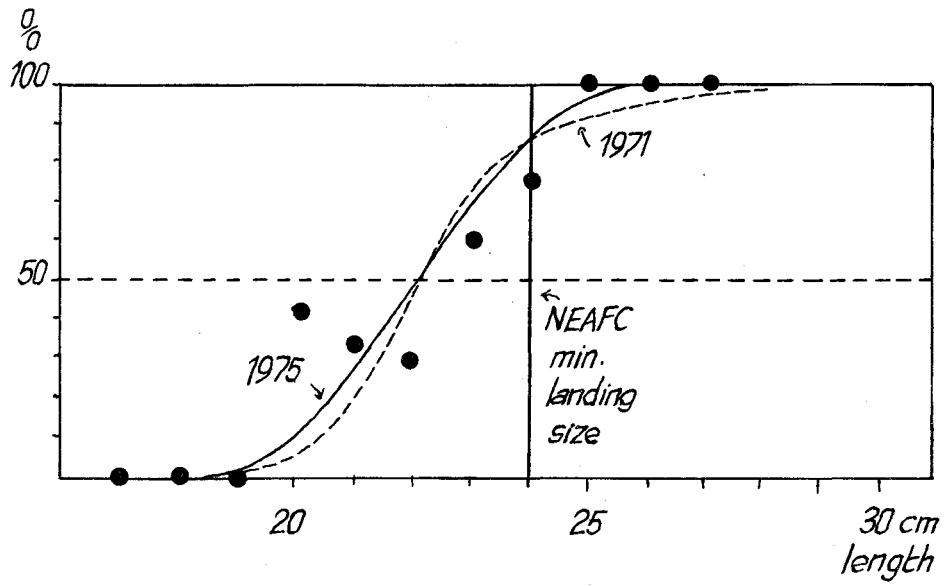
de Veen, J.F., and Rodenburg, W.F., 1971. - Discarding in the Dutch sole fisheries in 1969 and 1970 ICES CM 1971/B:11, mimeo, 2 pp.

/wm

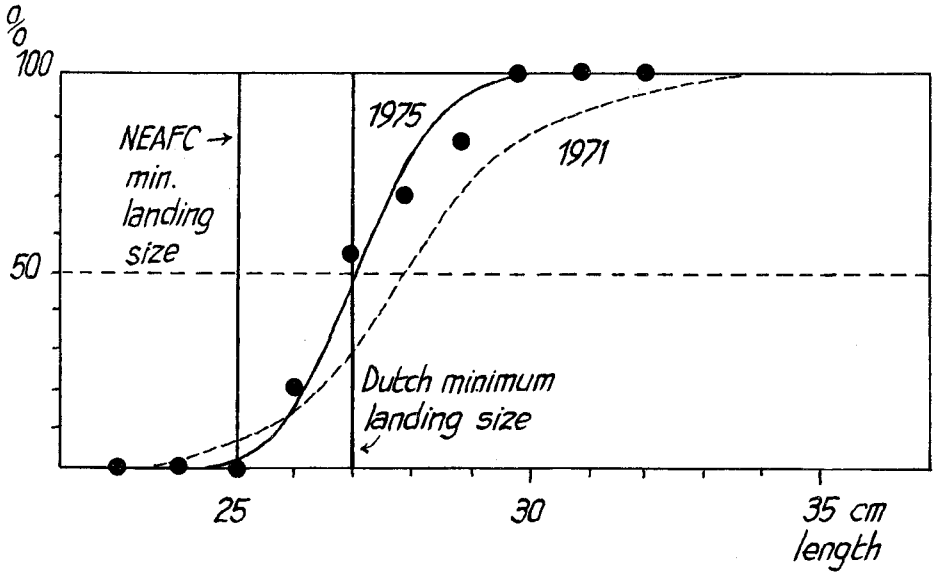
Fig. 1

positions visited during 11 cruises of commercial vessels in the 1st half of 1975

Fig. 2 retention_ogives for sole and plaice for 1971 and 1975



Sole



Plaice

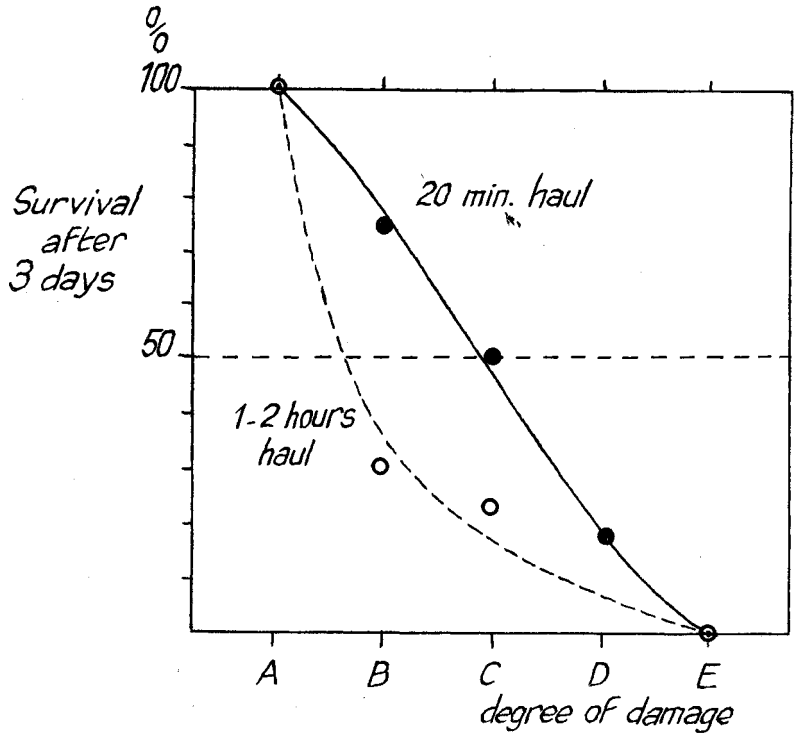


Fig. 3

Survival of North Sea Plaice per degree of damage as a function of the duration of the haul

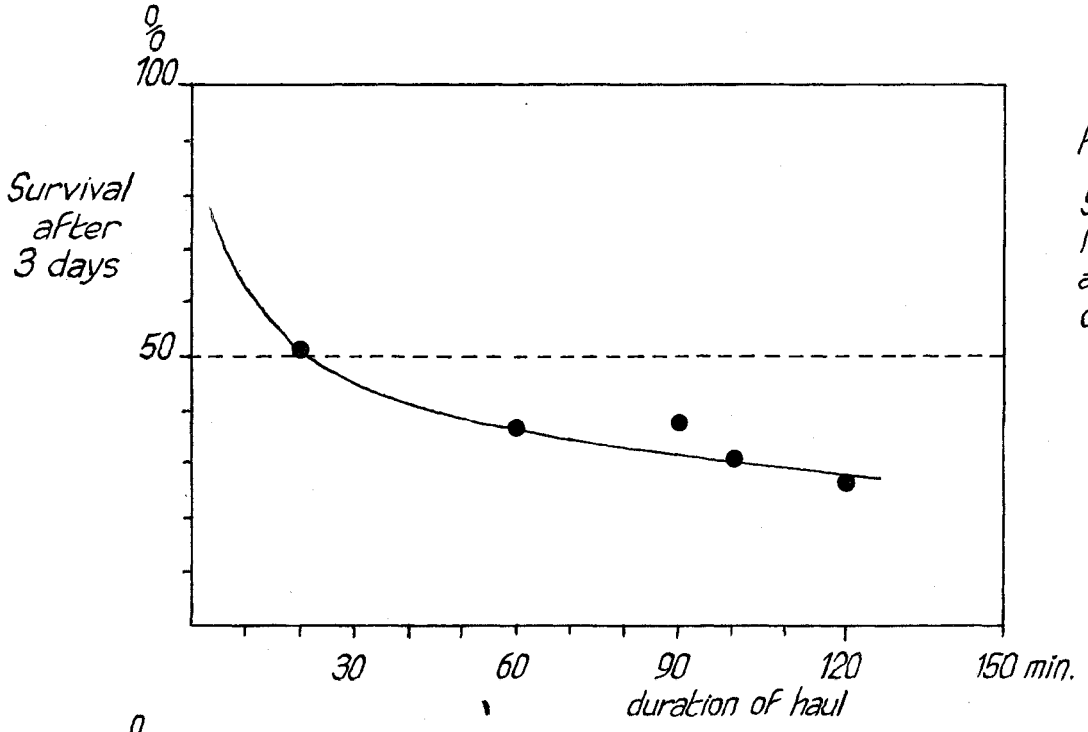


Fig. 4

Survival of discarded North Sea Plaice as a function of the duration of the haul

Tridens nov. 72

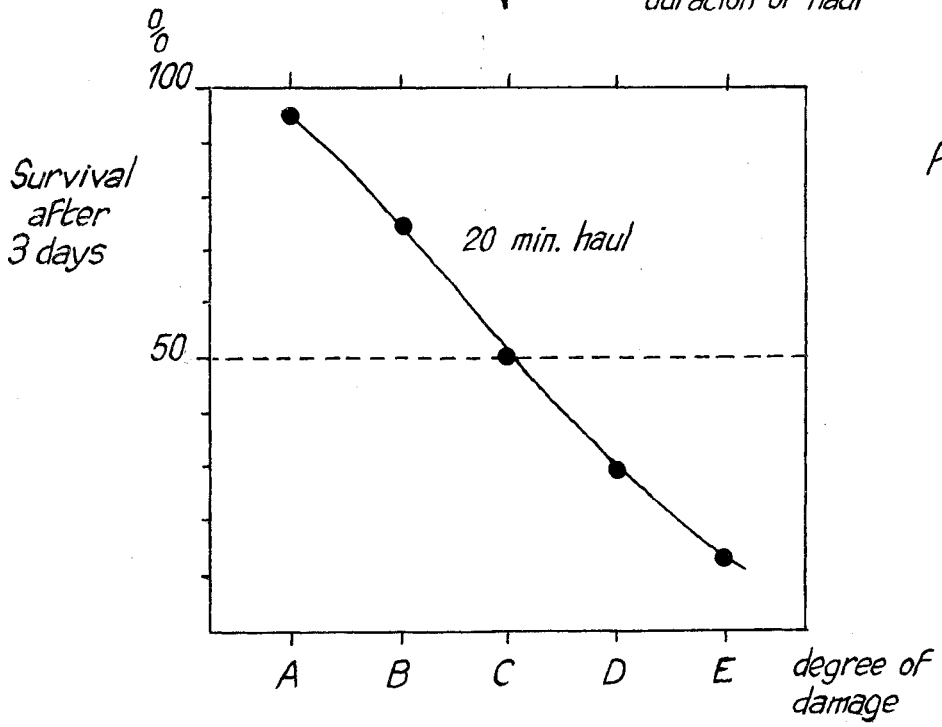


Fig. 5

Survival per degree of damage in Irish Sea Sole

Tridens april '73