NATIONAL INSTITUTE OF OCEANOGRAPHY
WORMLEY, GODALMING, SURREY

The Drift Envelope Experiment in the North-East Atlantic Ocean, 1954

by

A. L. LAWFORD

N. I. O. Internal Report No. A 19

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C O N T E N T S

INTRODUCTION

The drift envelope experiment of 1954 was carried out by the National Institute of Oceanography on behalf of the Ministry of Transport and Civil Aviation, in connection with international action which was then about to be taken to prevent or minimise the pollution of the sea by oil. This report is concerned only with the drift and recovery of the envelopes themselves.

It was decided to drop, at different seasons of the year, a number of plastic envelopes, each containing a postcard returnable to the National Institute of Oceanography. The dropping tracks were arranged to zigzag across the approximate northern and southern boundaries of the North-East Atlantic Drift and also to traverse the main body of the Drift. To encourage finders of the envelopes to complete and return the short questionnaire printed on the postcard, a reward was offered of half-a-crown or its equivalent in foreign currency. The nature and contents of the envelopes are described in the Appendix.

To ensure that all cards were dropped within the same short space of time, Royal Air Force Coastal Command agreed to release them during periodical training flights from Ballykelly and Pembroke.

METHOD

The dropping tracks were planned to zigzag across the approximate northern boundary of the Drift between about 10° and 20°W, and the approximate southern boundary between about 5° and 15°W. The traverse joined the western ends of the zigzags. The tracks were varied to suit the seasonal movement of the Drift boundaries. (Figure 1)

As aircraft speeds were too high to permit the envelopes to be dropped at the desired spacing of one per mile, the envelopes were bundled in tens, secured with gummed paper strip. The bundles were released at 10 mile intervals. The strip soaked off after a few minutes immersion, allowing each envelope to drift free.

The aircraft flew at heights of between 1000 and 2500 feet, depending on weather conditions. The prescribed tracks were faithfully followed except for occasional divergences due to bad weather. Gaps were sometimes left in the tracks because the aircraft had run short of envelopes through flying a greater mileage in adverse weather conditions.

NARRATIVES

(a) Unsuccessful Drop - January 20th and 23rd, 1954 - 2178 envelopes.

For this drop the postcards were encased in single plastic envelopes. Evidently the material used was not robust enough to stand up to battering by the waves, either afloat or when cast ashore, as only 4 cards were returned in a recognisable condition, (i.e. with the serial number, from which the dropping position could be ascertained, legible) though a few others were recovered completely mangled.

The dropping track was identical with that used for the Third Drop. The four cards recovered were released within 300 miles of the south-eastern end of the track and at the ends of the zigzags nearest to the coast. They were recovered from the River Gironde entrance, near Santander, and at Capes Villero and Corrubedo. The unidentifiable cards were picked up on the west coast of Ireland.

As this drop was completely abortive, no further reference will be made to it in this report. The four cards are not included in any of the quantities tabled or shown on the diagrams.

(b) First (Successful) Drop - May 5th and 7th, 1954 - 2239 envelopes.

As soon as it was realised that the envelopes were not strong enough, arrangements were made for those earmarked for the next drop to be encased in a second and thicker plastic envelope. As a result, the next drop, planned for late April, had to be postponed until early May.

The additional envelope proved successful, and envelopes from this drop were recovered from June, 1954 onwards. The order of their first appearance on coasts was as follows:-

June - Iceland, Ireland, France
July - Spain, Scotland, England
August - Portugal
September - Netherlands
October - Färoes, Norway
October (1955) - Denmark

(c) Second Drop - August 31st and September 1st, 1954 - 2146 cards.

A further three weeks delay had to be accepted while waiting to see whether the additional envelope proved satisfactory, before treating the remainder of the stock. Due to the presence of strong westerly winds soon after the dropping date, envelopes were recovered more quickly than from the previous drop.

The order of their first appearance on coasts was as follows:-

September - France, Ireland, Färoes
October - Scotland, England, Wales
November - Netherlands, Norway
December - Denmark
April - Belgium
September (1955) - U.S.S.R.

(d) Third Drop - December 17th and 19th, 1954 - 2010 envelopes.

This drop was made less than three months after the last, in order to make up a little lost time. Although envelopes began to be found very soon after the drop, recoveries have always remained at a lower level than from either of the preceding drops, presumably due to the wind sequence in the first few months after dropping. On the other hand, envelopes from some parts of the dropping track stranded on coasts never before reached by envelopes from those areas.

The order of their first appearance on coasts was as follows:-

December - Färoes [M]
January - Scotland, England, France
February - Iceland
March - Norway
May - Denmark, Sweden
July - Spain
August - Wales, Germany, Netherlands

[M] One envelope only; no others were received from these islands until August.

(e) Total Recoveries

From 6395 envelopes released during the three successful drops, a total of 2643 identifiable cards have been returned. On 26 more the serial number was illegible, making a grand total of 2669 cards, or 41•7% of the number dropped.

Envelopes have continued to be recovered in ever-decreasing quantities until the time of writing, but in the past two years less than a dozen have been returned.

The envelopes picked up came from over 90% of the total length of the dropping tracks.

(f) Envelopes dropped from Ocean Weather Ships

Arrangements were made for one envelope to be dropped at noon each day of 1954 from the two Ocean Weather Ships when at Stations "India" and "Kilo". Unfortunately, all the envelopes supplied were of the single type, and none was recovered.

QUANTITATIVE RESULTS

(a) Total Recoveries from each Drop

The numbers and percentages of envelopes released and recovered in each drop are shown in the tables below.

	Drop I	Drop II	Drop III	Total
Envelopes released	2239	2146	2010	6395
Cards returned	983	980	680	2643
Unidentified cards				26
Total recoveries				2669

% recoveries	43•9	45•7	33•8	41•3
% unidentified cards				0•4
Total % recoveries				41•7

(b) Recoveries from Different Parts of the Coastline

Figures 2 and 3 show diagramatically the positions and numbers of cards recovered along the coastline of North-West Europe and the off-lying islands.

To simplify the work of preparation and presentation, the true coastal lengths are not used. Instead, an artificial coastline has been built up by joining prominent geographical features, as shown in pecked line in Figure 2. The black squares in Figure 3 indicate the numbers and positions of cards from each drop recovered per 12 miles (approximate) of this artificial coastline. The names of the geographical features which form the "turning points" of the artificial coastline are written in on the left, so that the positions of the recoveries may be readily identified. National frontiers are also shown.

Recoveries from the island groups are shown either for the group as a whole, or for different parts of the group. The positions of the black squares therefore have no significance in these cases.

(c) Discussion

Drop I - The greatest number of cards were recovered on the coasts of France, especially on the west coast; the main impact fell on the stretch between the Gironde and the Spanish frontier, where the density of recovery was more than one card per mile.

Many cards stranded among the Scottish island groups and on the south-west coast of Scotland, but England received an insignificant quantity. In Ireland the greatest effect was felt between the Bloody Foreland and Slyne Head.

From this drop only cards were picked up on the southern coasts of Iceland, and the Färoes returned their maximum number, as also did Spain. In the south cards penetrated as far as Portugal.

Recoveries were fairly evenly spread along the Norwegian coast from Utsira to Vardø, the bulk lying between Frøya and Andenes.

Two cards reaching the Netherlands passed up the Channel, but two reaching Denmark later on went round the north of Scotland.

Drop II - Well over half the total of recoveries came from the coasts of the United Kingdom, and of these half were recovered among the Scottish island groups and on the south-west coast of Scotland. Most of the remainder stranded on the south coast of England after strong winter gales; between Portland and Dungeness recoveries averaged nearly one card per mile. Significant quantities were received from North Cornwall and South Wales, and cards penetrated northwards along the eastern shores of the Irish Sea as far as Solway.

In Ireland the main impact shifted southwards to the length of coast between Galway Bay and Mizen Head, and a few cards were found on the south coast, some as far east as Carnsore Point.

Färoe returned almost as many cards as from the first drop. The situation on the Norwegian coasts was also very similar to that which obtained previously, both in scale and position. It was from this drop that a card was found on the Rybachi Peninsula, on the Russian Barents Sea coast - the most easterly point attained.

Although comparatively few cards stranded in France, recoveries were almost entirely concentrated between Ouessant and Les Sables d'Olonne; in the neighbourhood of the latter the density averaged more than one card per mile of coastline. No cards were recovered south of the Gironde.

A number of cards reached the Netherlands and Denmark via the Channel.

Drop III - As in Drop II, more than half the cards recovered were found on the coasts of the United Kingdom. Four-fifths of these stranded among the Scottish island groups and on the north coast between Cape Wrath and Duncansby Head after winter gales; here the density of recoveries averaged one card per mile of coastline. From this drop also, cards were recovered on the shores of the Moray Firth and as far down the east coast of Scotland as Fife Ness. In England a handful of cards was picked up on the coasts of Cornwall and Scilly.

Ireland returned many less cards than previously, mostly from the west coast, the highest density being in the extreme south-west.

Only three cards stranded in the Färoes, although the first card to be picked up came from there. Scandinavian recoveries, though second only to those from the United Kingdom, were less than previously. The cards were more or less evenly spread along the

coastline from Göteberg in Sweden to Nordkapp in Northern Norway, with a rather higher density in the neighbourhood of Vega.

On the Netherlands, German and Danish coasts recoveries, though small in comparison with those for other countries, were at a maximum and their spacing was regular. All these cards reached their destinations by passing round the north of Scotland; no card moved up-Channel further than the Isle of Wight.

French recoveries dropped once more, the main impact falling on the Breton Peninsula; between Pointe du Chateau and Point de Raz the average recovery density was one card for every four miles of coastline. To the southward a scatter of cards was picked up round the Biscayan coast from Quibéron as far as Cape Ortegal.

Two points are remarkable about this drop:-

(i) Cards from the south-western parts of the dropping area in 50°N travelled as far as the north-eastern coast of Norway.

(ii) The chronological sequence of first recoveries on the eastern shores of the North Sea was South Norway and North Denmark, Sweden, Netherlands and Germany. Since, from the destinations of other cards from the same bundles, it can safely be assumed that these cards entered the North Sea from the north, it would appear possible that the normal anticlockwise circulation in the North Sea was disrupted or considerably modified; this seems likely from a study of the recorded winds at the time, which would also explain why cards did not pass through the Channel on this occasion.

(d) Distances Travelled

As the dropping area lay between 200 and 400 miles from the nearest land, most of the distances between dropping and recovery points ranged from 500 to 1000 miles; but cards recovered on the north coast of Norway, even if released over the most northerly part of the dropping area, had to travel at least 1000 miles to reach the nearest part of this coast, and in a few cases the distance exceeded 1500 miles. The longest distance travelled was about 1700 miles from approximately 50°N, 18°W to 71°N, 25°E, near Hammerfest, by a card from the third drop.

(e) Protected Coasts

Very few cards stranded on coasts which face to the east and are therefore protected from the North-East Atlantic Drift and its offshoots. A small number rounded the north of Scotland under the influence of the North Sea inflow, but the east coast of the United Kingdom was clear of cards from Fife Ness to the North Foreland. No recoveries were made on the east coasts of Ireland and Denmark, and only one on the south-east facing Norwegian coast.

(f) Cards recovered at Sea

Although quite a number of cards appear to have been recovered while still afloat, most of them were found so close inshore that it was not possible to tell for how long they had been under the influence of the coastal tidal streams; they could not therefore be used to determine approximate current velocities. Only two cards, both in the Bay of Biscay, were found in the true open sea. Unfortunately, both were picked up very soon after dropping and had only travelled short distances.

QUALITATIVE RESULTS

(a) General

The qualitative results can best be assessed by comparing:-

(i) The total length of coastline to which cards were delivered, from

different parts of the dropping area, per unit length of dropping track; this has been designated the "Comparative Delivery Factor".

(ii) The total lengths of dropping track from which cards were recovered, on different parts of the coast, per unit length of coastline; this has been designated the "Comparative Recovery Factor".

(b) Definitions

To obtain both comparative factors it is necessary to disregard the total numbers of cards recovered or delivered, and to consider only the total length of coast on which cards from different bundles were recovered or the total length of track from which they were delivered.

(i) Comparative Delivery Factor

The coastal regions of N.W. Europe were gridded in rectangles measuring $\frac{1}{2}$ degree of latitude by 1 degree of longitude. The dropping area was divided into sixteen sub-areas, in each of which 400 cards had been dropped during the course of the experiment. A sub-area delivering a card to a rectangle was credited with a "delivery" value of 30 miles of coastline (the average of the coastal length in all rectangles) but no addition to this was made for subsequent cards arriving from the same sub-area. As each sub-area contained a different length of dropping track for each drop, the total coastal length associated with each sub-area was divided by the numbers of bundles of ten cards dropped on the sub-area and by ten (miles between each bundle), i.e. -

$$\text{Comparative Delivery Factor} = \frac{\text{Rectangles receiving cards} \times 30}{\text{Bundles in sub-area} \times 10}$$

The resulting figure gives the number of miles of coastline to which each mile of dropping track delivered cards, and can be used as a basis for comparison of one sub-area with another.

(ii) Comparative Recovery Factor

As the bundles were dropped, on average, at 10 mile intervals, each bundle in the central portion of the track (the North-South traverse) was assigned that value as its track length; along the northern and southern zigzags, which cross the mid-lines of the tracks at about 60°, a track length of only 5 miles was assigned to each bundle. For each stretch of coast an artificial coastal length was estimated by measuring the general line of the coast and neglecting minor indentations and small islands lying close inshore. The track length from which cards were received upon a coast was divided by the length of the coast, i.e. -

$$\text{Comparative Recovery Factor} = \frac{\text{Bundles} \times 10 \text{ (or 5)}}{\text{Coastal length}}$$

The resulting figure gives the number of miles of track from which each mile of coastline received cards, and can be used as a basis for comparison of one length of coastline with another.

(c) Discussion

Figure 2 shows the sub-division of the dropping area formed from the envelope of the dropping tracks; the selected coastal lengths (pecked line) are separated by heavy black lines across the coastline.

Comparative Delivery Factors for each sub-area and each drop, together with averages for the whole experiment, are given in Table 1. Comparative Recovery Factors are given in Table 2.

Table 3 links Tables 1 and 2 by showing which coastlines received cards from which sub-areas.

(i) Comparative Delivery Factor (C.D.F.)

The average C.D.F.s for the northern, central and southern parts of the track are roughly in proportion of $8\frac{1}{2} : 6 : 4$ respectively. This falling-off is at least partially attributable to the fact that the more southerly a sub-area lies, the shorter is the "future" of its cards - that is, they have shorter distances in which to disperse before stranding.

Sub-area F has the greatest C.D.F., both for an individual drop (9·4) and on average (7·2). Sub-area X, the "opposite number" to F in the south, has the lowest C.D.F.; in Drops I and III most or all of its cards never reached the shore.

Sub-areas M and L delivered cards to 24 and 23 respectively of the 38 coastal lengths and island groups which received cards. This is partially due to their position in the centre of the traverse across the North-Eastern Atlantic Drift; under some circumstances their cards passed to the north of the British Isles, under others to the south. Sub-area Z delivered cards to only 7 coastallengths; it is one of the nearest to the coast.

(ii) Comparative Recovery Factor (C.R.F.)

The highest C.R.F.s, both for individual drops and on average, are found in the Scottish island groups (Orkney, Drop III - 2·2, and Shetland, average - 1·5). High C.R.F.s of the same order are found in Scilly. It is presumed that these island groups tend to "comb" the tidal streams and retain cards more readily than the continental coasts, to which the streams run parallel.

Comparable C.R.F.s only occur on the west coast of France in Drop I, when the C.R.F. for the southern half was 1·5, and on the eastern part of the south coast of England (Drop II - 1·1) and north-west Scotland (Drop III - 1·0). Both these last were due to the coincidence of onshore gales with the arrival of the cards off the coasts. The more distant coasts, such as the U.S.S.R., northern Norway and Portugal, and those which are sheltered from the direct flow of the Drift, such as the whole stretch of the continental coast from Cherbourg to 60°N., the east coast of Scotland and the north west coast of England and Wales, have very low average C.R.F.s.

Some part or other of the United Kingdom received cards from all 16 sub-areas during one or another of the drops. Cards from the 10 northern sub-areas reached the Orkney Islands and the south-western coast of Norway, and on several other lengths of coasts cards from 9 sub-areas were found.

ACKNOWLEDGEMENTS

The thanks of the National Institute of Oceanography are due to Coastal Command of the Royal Air Force for their co-operation in dropping the cards, and to the RAF personnel taking part in the flights for their share in the work.

PAPERS RELATING TO THE EXPERIMENT

HERDMAN, H.F.P. "Operation Post Card", Trident, April, 1954.

LAWFORD, A.L. "The Effect of Wind upon the Surface Drift in the North-Eastern Atlantic and North Sea", Weather, XI, 5, May 1956.

LAWFORD, A.L. "Postscript to Operation Post Card", Trident, September 1956.

HUGHES, P. "A Determination of the Relation between Wind and Sea-surface Drift", Q.J. Roy. Met Soc, 82, 354, October, 1956.

APPENDIX

DESCRIPTION OF DRIFT ENVELOPE AND CONTENTS

Inner Envelope

(1) This was made from 300 gauge polythene, cut from a tube and heat-sealed at the cut edges. The material was found to be insufficiently robust for the purpose; it is possible that weakness developed along the folded edges due to the material having been previously rolled and stored flat.

Outer Envelope

(2) An outer envelope made from polyvinylchloride, cut from sheet and heat-sealed along all four edges, was added later. This proved sufficiently robust; although a significant number of envelopes were recovered in a water-logged condition, in only 1% of all recoveries were the postcards rendered unidentifiable (i.e. with the serial number illegible).

Postcard

(3) This was of ordinary pasteboard and of the usual postcard size. A Business Reply Card licence was taken out from the General Post Office to save the finder expense if the card was posted in the United Kingdom. On one side of the card was a simple questionnaire, printed in English, French, Spanish, Portuguese, Dutch, German, Danish and Norwegian, against which the finder was asked to insert his name and address and the place and date of the card's recovery. The serial number was printed in the top right corner*, and a broad red diagonal stripe ran across the face of the card to render it more conspicuous. It was found that this stripe faded with time, presumably due to exposure to sunlight, through pink to yellow and finally pale grey, though a few were returned on which it was deep red-brown. The other side of the card bore the address of the National Institute of Oceanography.

Instruction Sheet

(4) The sheet of instructions, in the same eight languages, was printed on thin, bright yellow paper and packed on the opposite side of the card to the red stripe. It contained a brief description of the purpose for which the cards were dropped and advised the finder that a reward of half-a-crown (or its equivalent) would be paid for every postcard returned with the questionnaire filled in. The colouring faded with time to white.

Cork Floats

(5) Two floats of natural cork sheet, each measuring about 4in. x 3in. x 1/25in., were enclosed to provide buoyancy should the envelopes be pierced and become waterlogged. These undoubtedly prevented many cards from being lost.

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* If similar postcards are used in future, it is strongly recommended that the serial number be printed at or near the centre, since the corners were the first parts of the card to disintegrate when envelopes became waterlogged.

TABLE 1 - COMPARATIVE DELIVERY FACTORS

(Miles of coastline on which cards were recovered per mile of dropping track from which they were delivered)

AREA	DROP I	DROP II	DROP III	AVERAGE
A	4•8	5•0	7•1	5•6
B	7•1	6•4	4•5	6•0
C	7•3	6•0	5•0	6•1
D	7•1	5•5	7•5	6•7
E	7•8	4•2	4•5	5•5
F	9•0	3•1	9•4	7•2
K	4•6	3•0	6•0	4•5
L	8•4	3•5	6•2	6•0
M	5•0	2•6	7•1	4•9
N	3•6	2•4	3•0	3•0
U	4•9	2•2	2•1	3•1
V	3•2	4•1	2•1	3•1
W	2•5	-	4•0	3•2
X	1•0	3•0	Nil	1•3
Y	3•0	2•0	1•5	2•2
Z	2•6	1•2	3•0	2•3

Note:- No cards fell in Area W during Drop II.

TABLE 2 - COMPARATIVE RECOVERY FACTORS

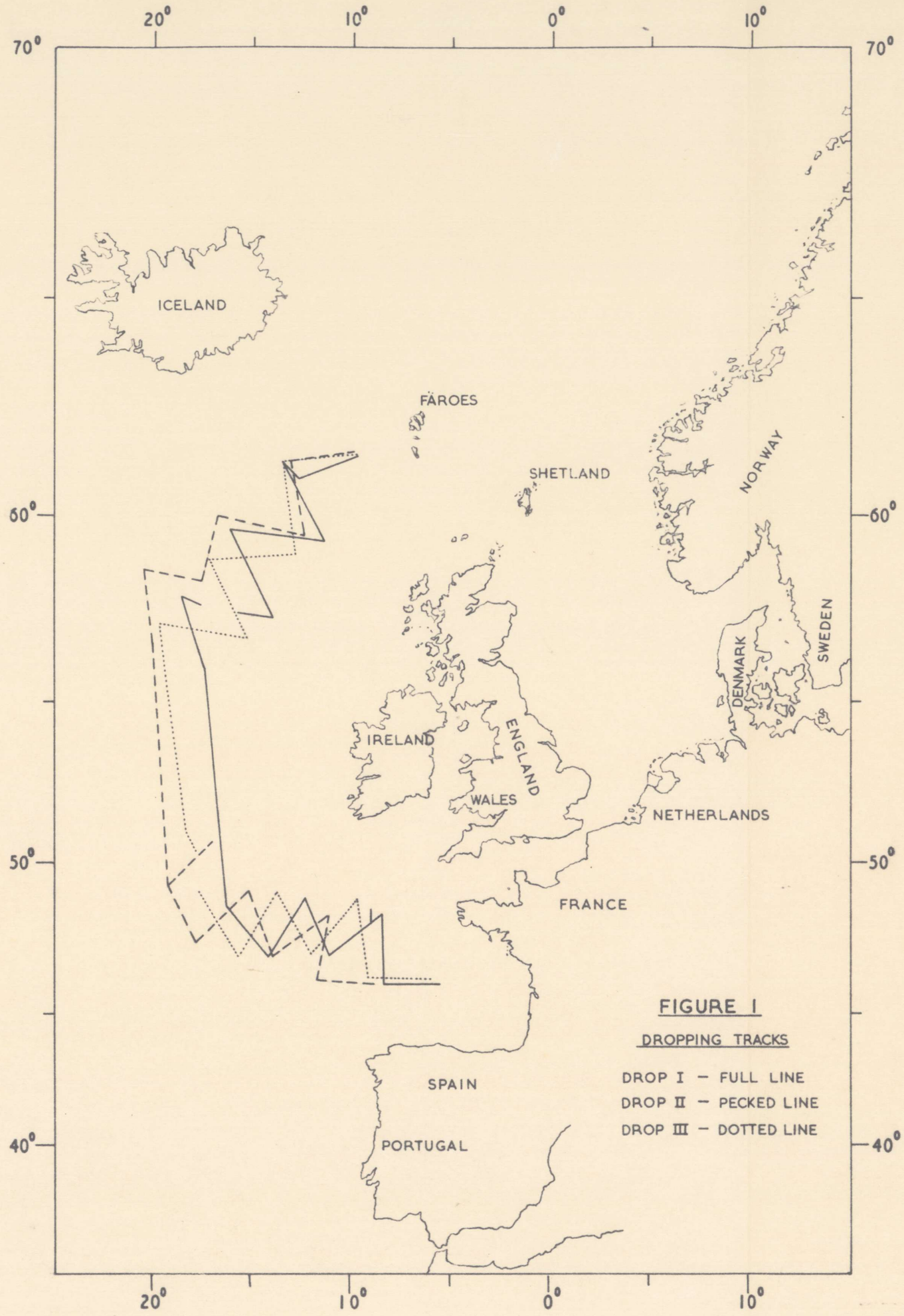
(Miles of dropping track from which cards were delivered per mile of coastline on which they were recovered)

COUNTRY	COAST	DROP I	DROP II	DROP III	AVERAGE
ICELAND	South-West	0·3	–	–	0·1
"	South-East	0·7	–	–	0·2
FÆROES	–	0·9	0·7	0·2	0·6
SCOTLAND	East	–	–	0·2	0·1
"	North-East	0·1	–	0·9	0·3
"	North-West	0·3	0·9	1·0	0·7
"	South West	0·7	0·6	0·1	0·4
ENGLAND & WALES	North-West	–	0·2	0·0	0·1
ENGLAND	South-West	–	0·4	0·1	0·2
"	South (West)	0·1	0·6	0·3	0·3
"	" (East)	0·1	1·1	0·0	0·4
SCOTLAND	Shetland	1·4	1·1	1·8	1·5
"	Orkney	1·0	0·5	2·2	1·3
"	Outer Hebrides (North)	0·7	0·4	1·5	0·9
	Outer Hebrides (South)	0·9	1·2	1·1	1·1
ENGLAND	Isle of Man	–	0·1	–	0·0
"	Scilly	0·5	1·3	1·5	1·1
"	Channel Is.	0·5	0·7	–	0·4
IRELAND	North	0·8	0·4	0·3	0·5
"	West	0·7	0·7	0·7	0·7
"	South	–	0·5	0·1	0·2
U.S.S.R.	North (West)	–	0·0	–	0·0
NORWAY	North-East	0·1	0·1	0·1	0·1
"	North-West	0·7	0·5	0·3	0·5
"	West (Central)	0·9	0·8	0·8	0·8
"	South-West	0·3	0·2	0·5	0·3
"	South	0·1	0·0	0·2	0·1
SWEDEN	South-West	–	–	0·2	0·1
DENMARK	North and West	0·0	0·1	0·3	0·1
GERMANY	North-West	–	–	0·2	0·1
NETHERLANDS & BELGIUM		0·1	0·1	0·1	0·1
FRANCE	North (East)	0·2	0·0	–	0·1
"	" (West)	0·5	0·3	0·3	0·4
"	West (North)	1·0	0·7	0·2	0·7
"	" (South)	1·5	0·2	0·1	0·6
SPAIN	North (East)	0·9	–	0·2	0·4
"	" (West)	0·4	–	0·1	0·2
PORTUGAL	West (North)	0·0	–	–	0·0

Note:- "0·0" indicates less than 0·05.

TABLE 3 - TABLE LINKING DROPPING SUB-AREAS WITH COASTS UPON WHICH CARDS FROM THEM WERE RECOVERED

COUNTRY	COAST	AREAS														
		A	B	C	D	E	F	K	L	M	N	U	V	W	X	Y	Z
ICELAND	South-West	x	x		x	x											
"	South-East	x	x		x	x											
FÆROES	-	x	x		x	x	x		x								
SCOTLAND	East			x		x	x										
"	North-East			x			x	x									
"	North-West	x	x	x		x	x	x	x	x		x					
"	South-West		x	x	x		x	x	x	x		x					
ENGLAND & WALES	North-West									x				x			
	South-West									x	x						
ENGLAND	South (West)								x	x	x	x	x	x			x
"	" (East)								x		x	x	x	x	x	x	
SCOTLAND	Shetland	x	x	x	x	x	x	x	x	x							
"	Orkney	x	x	x	x	x	x	x	x	x	x						
"	Outer Hebrides (North)		x	x	x	x	x	x	x	x							
	Outer Hebrides (South)		x	x		x	x	x	x	x	x		x				
ENGLAND	Isle of Man									x							
"	Scilly								x	x	x	x	x				
"	Channel Is.								x	x	x		x		x	x	
IRELAND	North			x			x	x	x	x							
"	West			x				x	x	x	x	x	x			x	
"	South									x	x	x	x				
U.S.S.R.	North (West)				x												
NORWAY	North-East	x	x	x	x	x			x	x							
"	North-West	x	x	x	x	x	x	x	x	x							
"	West (Central)	x	x	x	x	x	x	x	x	x							
"	South-West	x	x	x	x	x	x	x	x	x	x						
"	South		x		x	x	x			x							
SWEDEN	South-West		x		x				x								
DENMARK	North and West	x	x	x	x	x						x	x	x	x		
GERMANY	North-West			x	x			x									
NETHERLANDS & BELGIUM		x	x	x					x		x		x				
FRANCE	North (East)								x	x	x						
"	" (West)								x	x	x	x	x	x	x	x	x
"	West (North)								x	x	x	x	x	x	x	x	x
"	" (South)								x	x	x	x	x	x	x	x	x
SPAIN	North (East)												x	x	x	x	x
"	" (West)											x		x	x	x	x
PORTUGAL	West (North)													x			x



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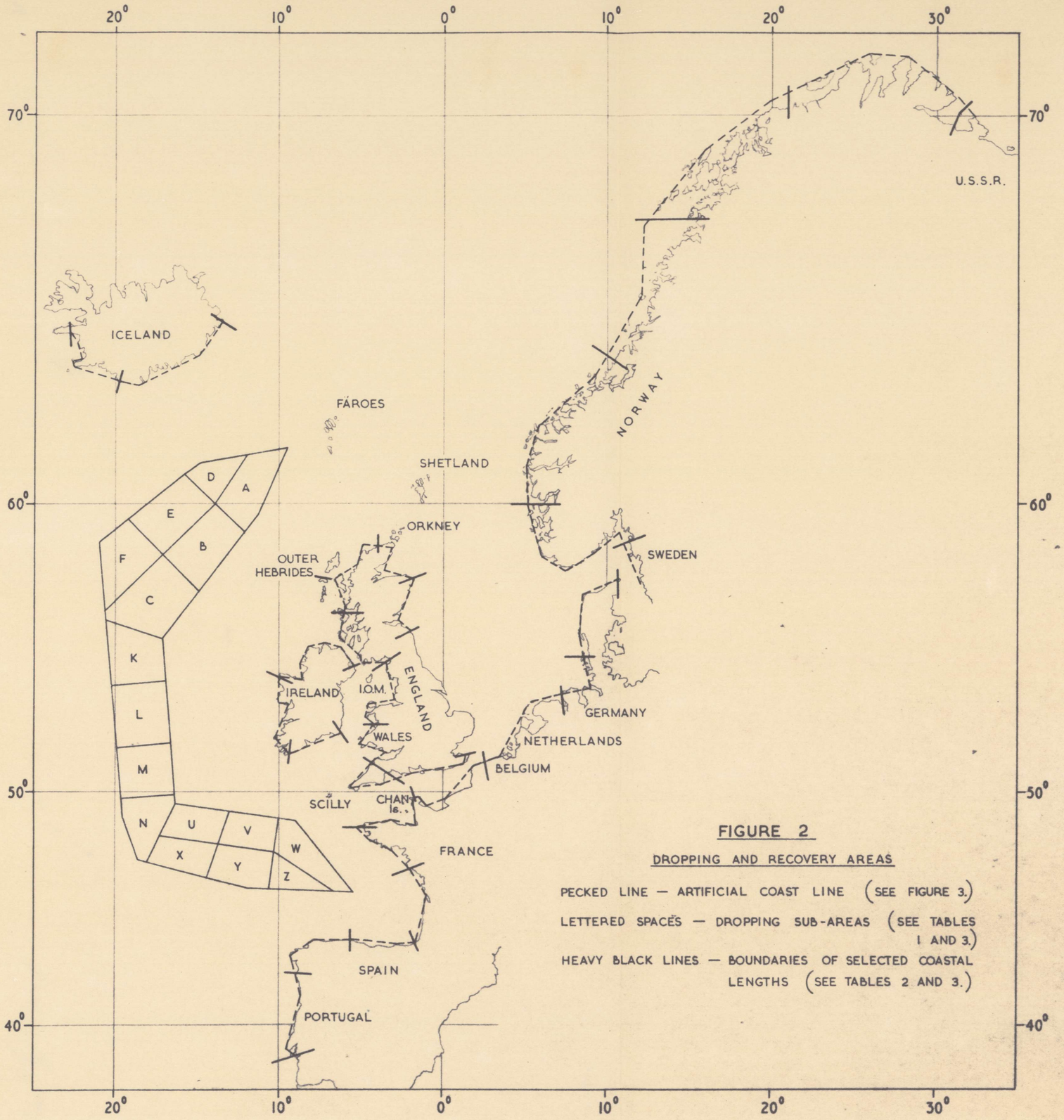


FIGURE 2

DROPPING AND RECOVERY AREAS

PECKED LINE — ARTIFICIAL COAST LINE (SEE FIGURE 3.)

LETTERED SPACES — DROPPING SUB-AREAS (SEE TABLES 1 AND 3.)

HEAVY BLACK LINES — BOUNDARIES OF SELECTED COASTAL LENGTHS (SEE TABLES 2 AND 3.)

NATIONAL INSTITUTE OF OCEANOGRAPHY. WORMLEY, SURREY.

FIGURE 3(a)

RECOVERIES FROM EACH DROP

Each small shaded square represents the recovery of a card approximately where indicated on the coastline.

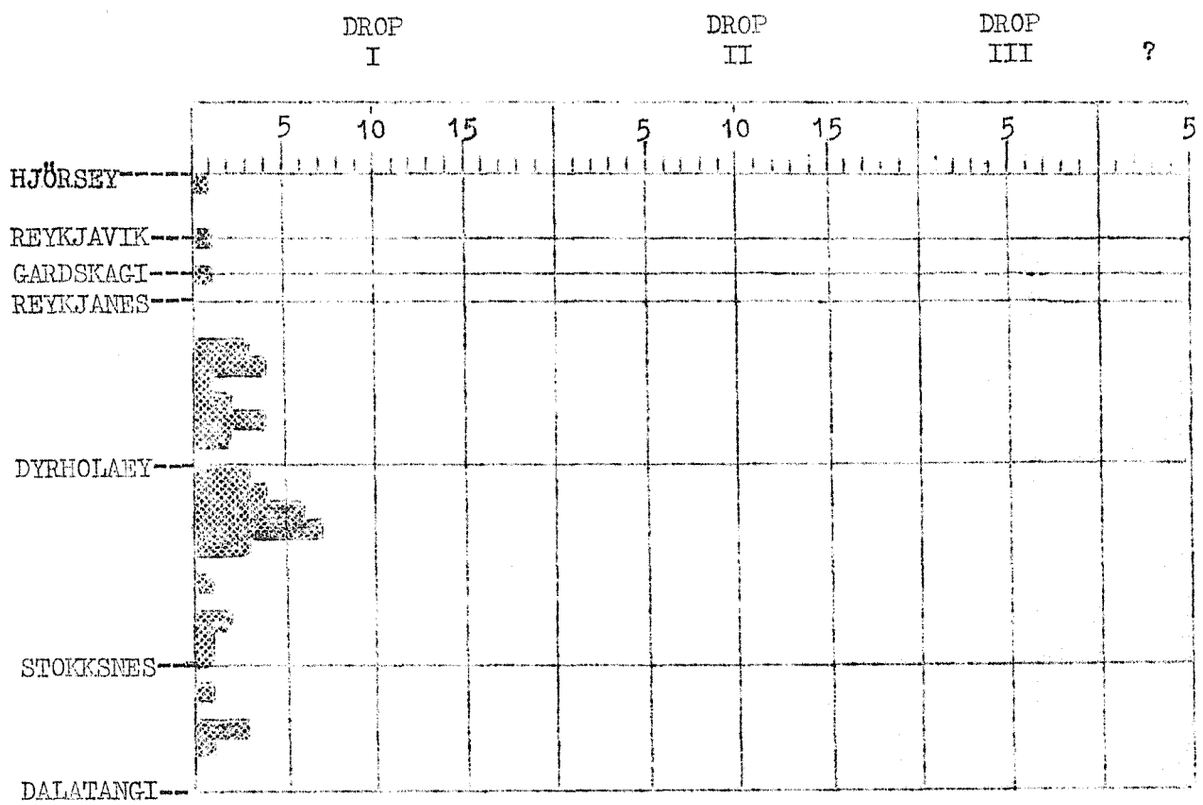
The coastline itself is built up from lines joining prominent points, as shown in Figure 2. The side of each square represents approximately 12 miles of this false coastline.

Island groups marked * are either taken as a whole or divided into two or four more or less equal parts. The vertical positions of the shaded squares have no meaning as regards position of recovery, and the statement above does not therefore apply.

White dotted squares in part (e) of this Table represent recoveries from the Channel Islands, which are also shown separately part (c).

The column headed ? shows the positions of unidentifiable cards recovered.

ICELAND



FÄROES

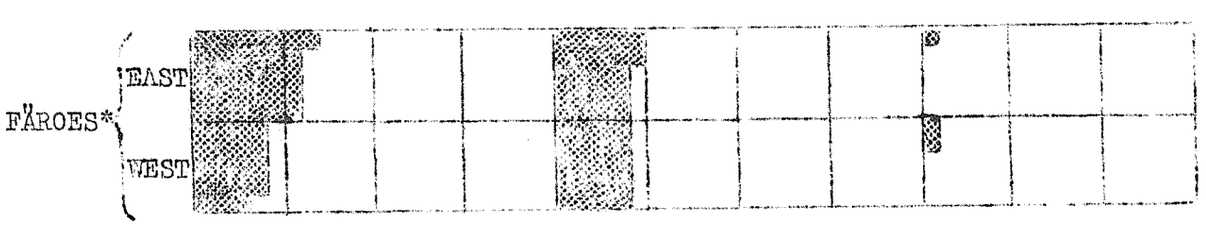


FIGURE 3(b)

RECOVERIES FROM EACH DROP

UNITED KINGDOM

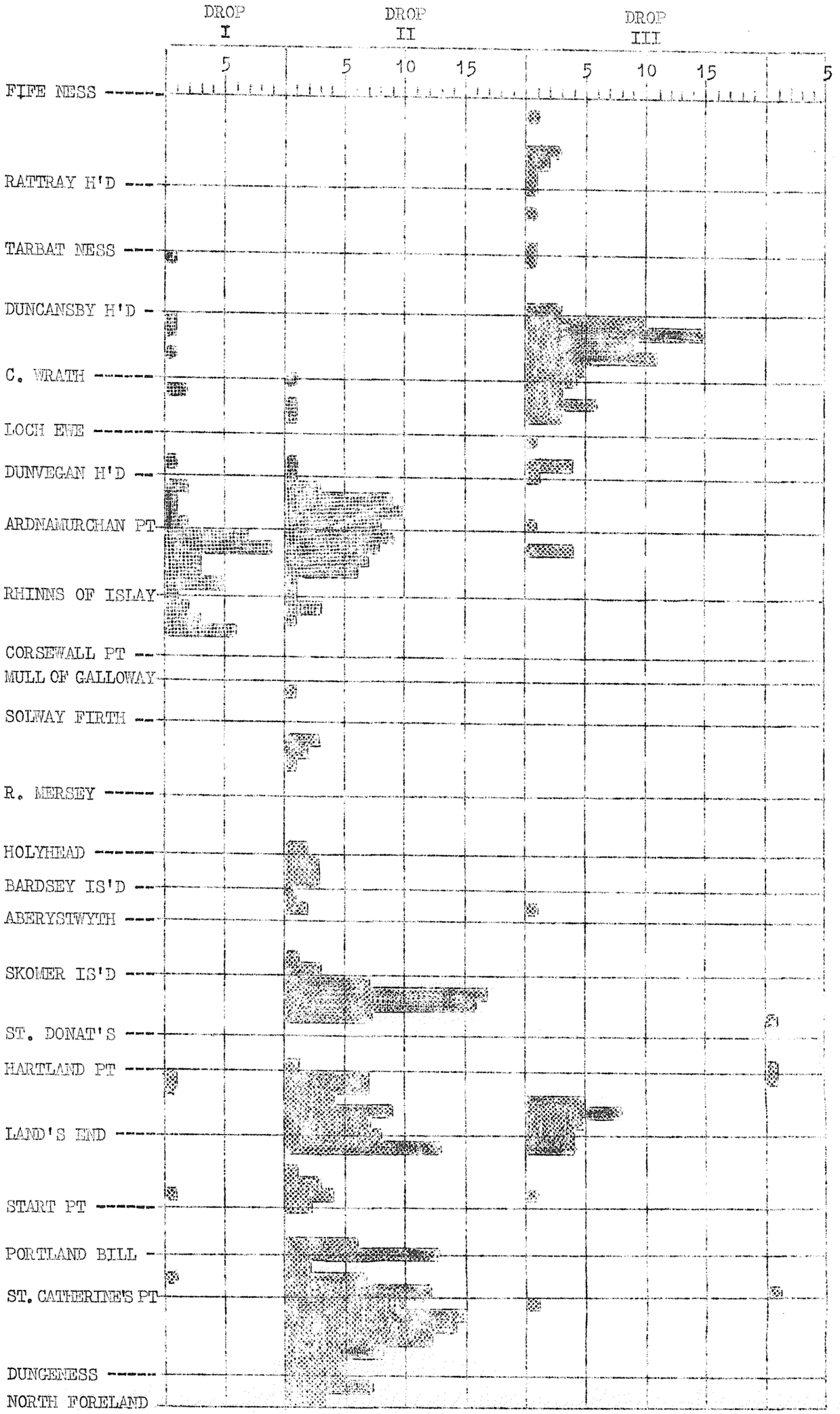
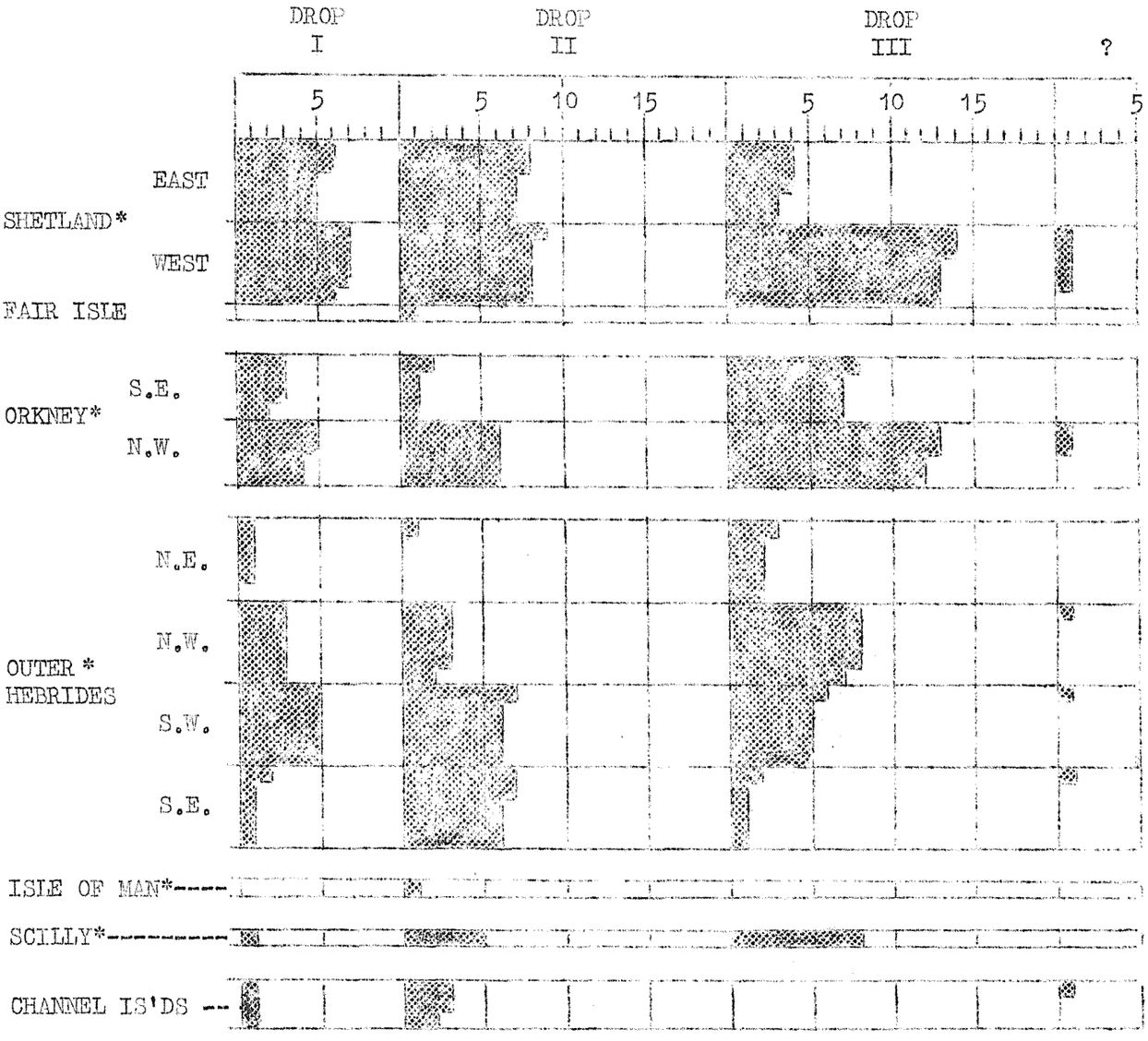


FIGURE 3(c)

RECOVERIES FROM EACH DROP

UNITED KINGDOM - OFFSHORE ISLANDS



IRELAND

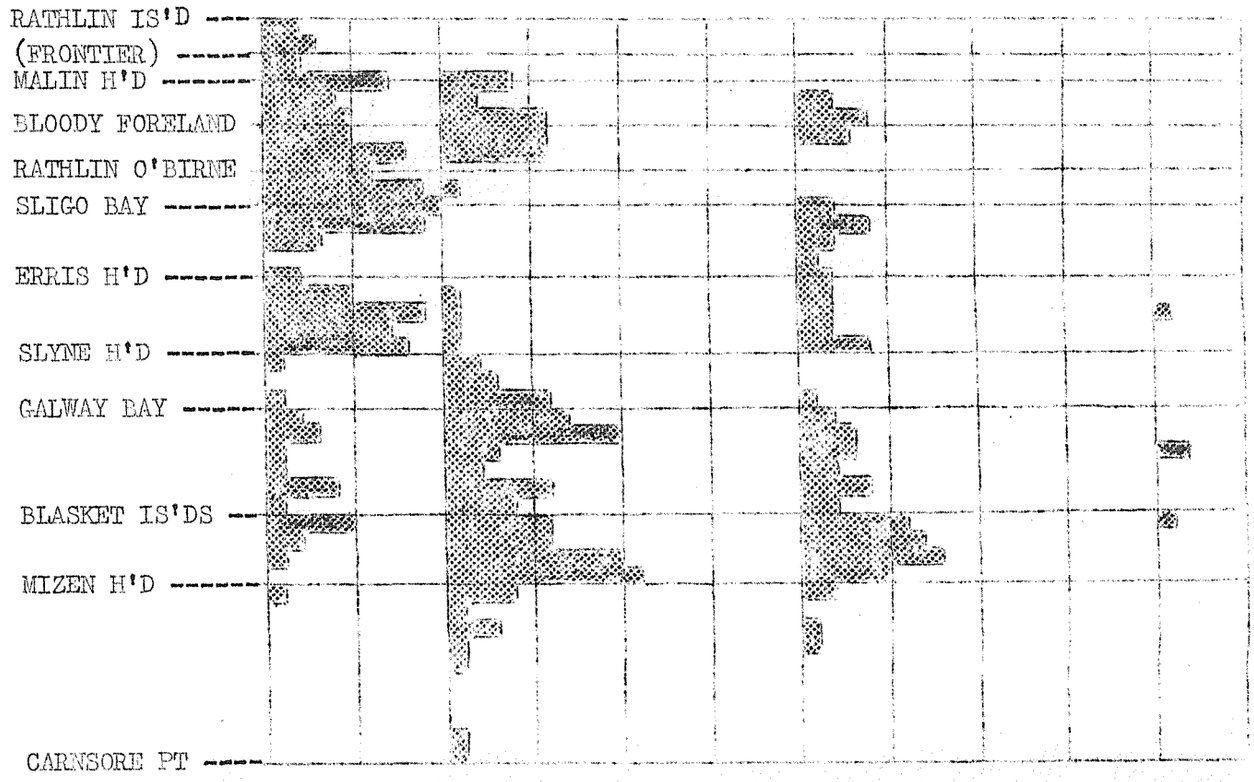


FIGURE 3(d)

RECOVERIES FROM EACH DROP

U.S.S.R. TO SOUTH NORWAY

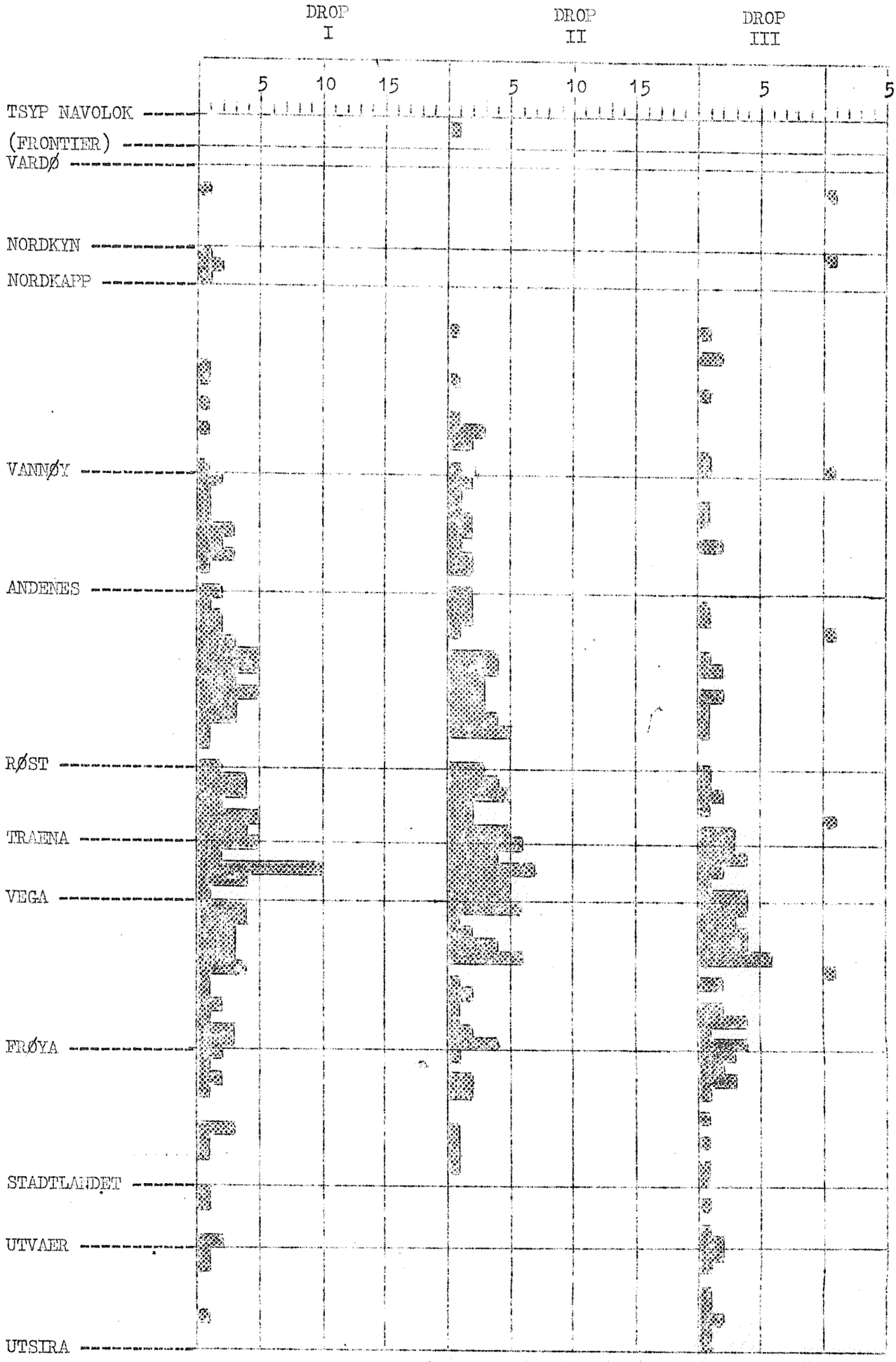


FIGURE 3(e)

RECOVERIES FROM EACH DROP

SOUTH NORWAY TO NORTH-WEST FRANCE

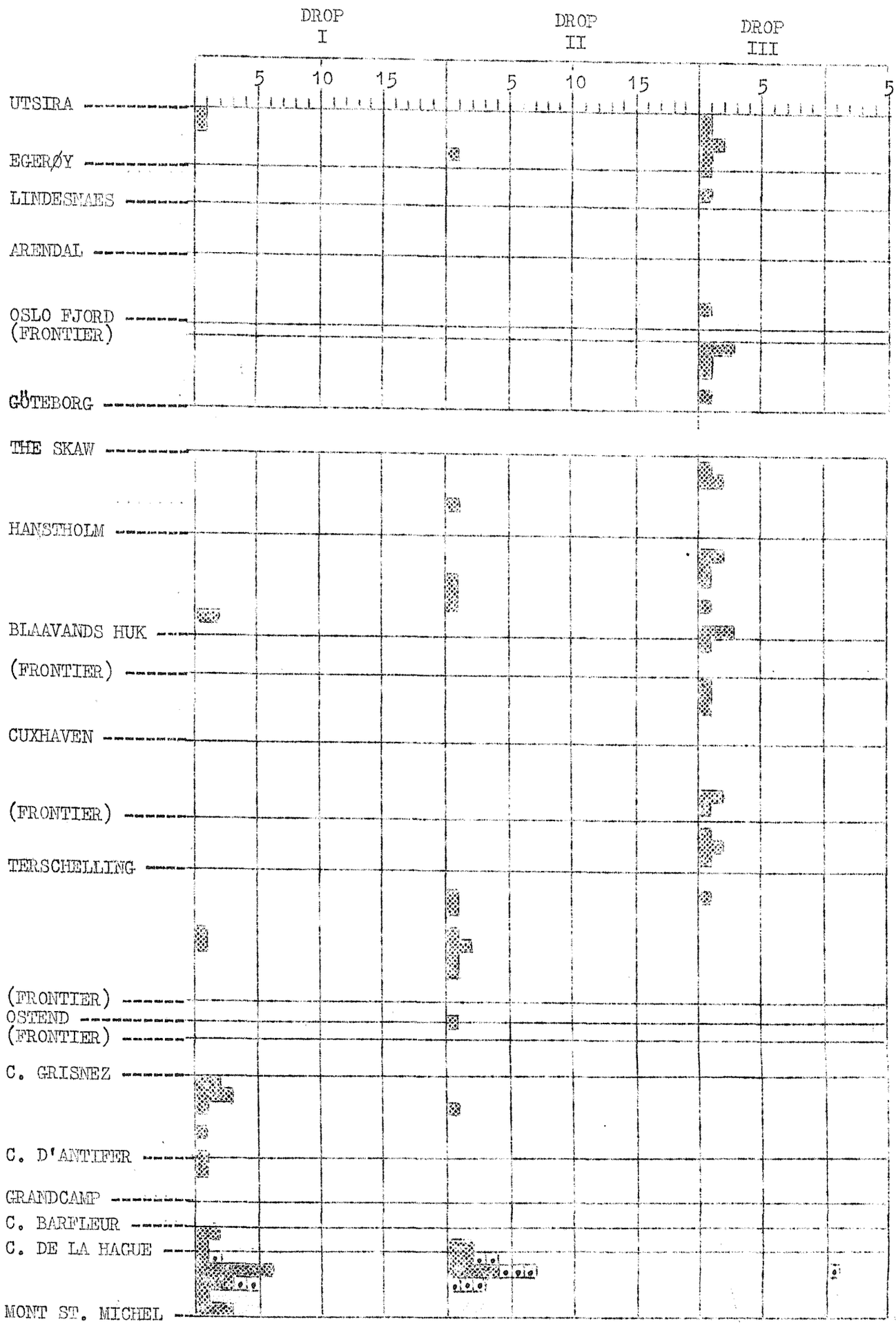


FIGURE 3(f)

RECOVERIES FROM EACH DROP

NORTH-WEST FRANCE TO PORTUGAL