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North West Water

FISH SURVEYS ON THE LEVEN AND KENT ESTUARIES; 1980 – 81

K.W. Wilson & J.B. Leeming

Head Office
Planning
May 1982

MEMORANDUM

North West Water

From	Principal Scientist (Biology)	To	Divisional Manager, Rivers Division
		fao	Regional Fisheries Officer
Our ref	506/01/JBL/IK	cc	D. Cragg-Hine and C. Harpley
Your ref		Date	20 July 1982

River Leven Migratory Fisheries

In 1980 and 1981, Head Office (Biology) staff were responsible for the initiation, organisation and implementation of special faunistic surveys of the Leven and Kent estuaries. The surveys were carried out jointly with the Lancashire and Western Sea Fisheries Joint Committee to investigate in particular the distribution of estuarine fish and were intended to provide objective information towards suggestions that estuarine water quality might be a factor in the decline, or alleged decline, in the migratory fish stocks of the River Leven.

The subject of declining fish stocks in the Leven has been previously considered in some detail by Rivers Division and in reports to the Area Fisheries Advisory Committee and various recommendations have been implemented as a result. In writing up the estuarine fish surveys in the attached report compiled by Dr. K. Wilson it has therefore been felt valuable to attempt to set them in the context of the overall issues using existing reports and papers and to try to draw some inferences as to the nature and reality to the alleged problems. In doing so, no special discussions have taken place with Rivers Division Fisheries staff and it is readily appreciated that this "desk study" approach might well have overlooked some important consideration and therefore be wide open to critical comment. Nevertheless, it is intended that this unbiased document might provide some food for thought and stimulate further discussion. Comment is invited!

J.B. Leeming

J.B. LEEMING,
Principal Scientist
(Biology).

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FISH SURVEYS ON THE LEVEN AND KENT ESTUARIES, 1980/81

K. W. Wilson and J. B. Leeming
(Directorate of Planning)

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SUMMARY

In recent years there has been increasing concern expressed about alleged declines in the fish stocks of the River Leven and Leven estuary. In this report data from a variety of sources have been examined to determine if there is any objective foundation for the allegations and for the assertion that poor fish catches were related to discharges of industrial effluent to the estuary. Catches of salmon and sea trout from the Leven do not appear to have suffered any long term declines and year to year fluctuations do not appear to be any more extreme than in other north west rivers. Fish surveys did not show any marked differences in the diversity or distribution of fish between the Kent and Leven estuaries but catches of flounders were consistently lower from the Leven estuary. Analysis of fisheries statistics of landings of fish and shellfish from Morecambe Bay did not show any evidence of localised declines in catches from the Leven estuary. Results of laboratory experiments suggest that populations of bivalve molluscs might be more at risk from the effects of discharges to the Leven estuary than resident or migratory fish.

FISH SURVEYS ON THE LEVEN AND KENT ESTUARIES, 1980/81

K. W. Wilson and J. B. Leeming
(Directorate of Planning)

1. INTRODUCTION

In recent years there has been increasing concern expressed about a possible decline in the fish stocks in the River Leven and, in particular, about the disappointing standard of rod catches of migratory fish, especially salmonids. Such was the depth of concern that in 1977 a special sub-committee of the Lune, Wyre and Furness Fisheries Advisory Committee was set up to discuss the apparent decline of fish stocks in the River Leven and to make recommendations on possible remedial actions.

The sub-committee used as its starting point a paper prepared by Fell (1977) which began with the premise that there was "now... a very small... run of migratory fish" in the River Leven. The paper drew attention to the feelings amongst fishermen that, in addition to the decline in fish numbers the average size of migratory salmonids entering the Leven was diminishing, that there was a trend to later runs and that the numbers of resident brown trout also appeared to be on the decline. No evidence was introduced to support these feelings but several factors were introduced that were considered as potential causes, individually or collectively, for the "disappointing" state of affairs. These included:

(a) The effect of ulcerative dermal necrosis (UDN) from the mid 1960's. There is little doubt that UDN did severely reduce the numbers of spawning salmon from about 1966 onwards and though this occurred throughout the UK it was claimed that the River Leven had fared worse than its neighbours.

(b) Low flows in the river during the summer months, due to unusually dry summers (1975, 1976), the installation of an impervious weir at Newby Bridge (1966) or abstraction of water from Windermere for potable supply. It was felt that the effect of the low flows could have been to limit the numbers of salmon entering the river through for example loss of holding pools consequent on increased siltation of the estuary channels. The lower flows might also have led to increased plant nutrients thereby to excessive plant growths and their attendant problems on water quality, flow, interference with angling etc. By way of example it was claimed that unprecedented weed growth was occurring immediately downstream of the discharge from the new Haverthwaite sewage works. Finally the paper claimed that decreased flows in the Leven would lead to increased predation of fish by mergansers, herons and (sub) humans. The possible increased predation of smolts by pike and trout following the collapse of the perch population in Windermere in 1976 was not raised apparently.

(c) The absence of very large floods down the river since the installation of the new weir and flood release gates at Newby Bridge, with some of the consequences set out for (b) above.

(d) Possible pollution of the estuary by industrial effluent (there was no suggestion of pollution in the river catchment being a serious concern)

(e) Increased netting activity in the estuary, Morecambe Bay and further afield, and

(f) Increased poaching.

Many of these points were examined further in a written response to Fell's paper by officers of the Authority (NWWA, 1977) and indeed many were effectively discounted by the officers' report. Perhaps their most significant comment is in the opening sentence of the report... "It is, perhaps, arguable whether the Leven has, in fact, fared worse than neighbouring rivers in recent years, so far as runs of migratory fish are concerned".

If arguable it was, the argument appears not to have been joined or was lost, for a recommendation by the sub-committee that the River Leven should receive special attention through a "policy of rearing pre-parr salmon onto the smolt stage, in cages sited in secure suitable waters within the Leven catchment area be adopted in principle as a five-year project" was carried (Lune, Wyre and Furness Advisory Committee, 16th January 1978, minute 16(i)). Apparently it was concluded that the problem on the River Leven was due to poor recruitment in some way and cage rearing of juvenile salmon was started in 1978 with the aim of introducing annually some 10,000 smolts "in an attempt to restore the seriously reduced runs of salmon" in the Leven. [NB Fell's comments relating to sea trout and brown trout appear to have been largely overlooked].

Complaints on the disappointing rod catches of migratory salmonids continued throughout 1978, to be supported in 1979 by complaints from the estuary fishermen that net catches, particularly of salmon but also of flounders and eels, had declined severely in the Leven, compared to catches in the adjacent and superficially similar estuary of the River Kent. Furthermore there were an increasing number of adherents to the claim that poor catches were due to the effects of effluent discharges to the Leven estuary.

In response to the rising tide of complaints and allegations we initiated in 1980 in conjunction with the Lancashire and Western Sea Fisheries Joint Committee a limited programme of work in an attempt to cut across the largely subjective element of the reports. In addition to examining historic fisheries data and statistics it was planned that the principal thrust of the investigation would be surveys of the distribution, abundance and size of fish and epibenthos in the estuaries of the River Leven and the neighbouring River Kent. The object of the surveys was to provide a basis of comparison, to determine if there were measurable differences in the fish populations of the two estuaries, to see if there were particular regions of the Leven estuary deficient in fish and, if so, to attempt to explain these in terms of effluent discharges, water quality or other environmental influences. The surveys were supported by toxicity studies of the major industrial effluent discharging to the Leven estuary, and by on-going water quality surveys.

2. HISTORIC DATA

Rod catches will be doubtless deemed "disappointing" if they do not reach expectations derived from contemporary catches on other rivers or from recollections of previous catches on the same river. It is extremely difficult to quantify expectations based on such comparisons but one possibly useful statistic is the mean number of fish caught per unit length of river.*

On this basis salmon (Fig. 1) though not sea-trout (Fig. 2) catches in the Leven would appear to be consistently lower than in the Crake, Kent and most other north west rivers. However, a proportionately greater length of the Leven is taken up with less suitable waters e.g. Lakes Windermere, Rydal etc., and if allowance is made for this (and salmon fishing is confined largely to downstream of Windermere, a distance of ca 6 km) then catch per unit length of the River Leven lies well within the values for other rivers.

An alternative approach is to examine catch statistics for the same river over a long period to see if a decline has occurred, and/or if catches have behaved differently to those in other rivers. Thus if one examines the total reported catches (i.e. rod and line plus net) of migratory fish from NW rivers over the past twenty years it appears that, although fluctuations occur from year to year or perhaps over 2-3 year cycles, there has been no persistent trend over that period, with the possible exception of the River Duddon (Fig. 3). A more detailed examination of the data, by species and by method of capture confirms the view that there has been no overall trend either downwards or upwards in catches of salmon or sea trout whether by rod and line or by netting (Figs. 4-7). Reported catches of sea trout in both the River Leven and River Kent are predominantly by rod and line with catches fluctuating markedly from year to year in both rivers. There is perhaps some slight indication in the data that whereas prior to the early 1970's catches in the two rivers behaved in a generally consistent manner moving up and down in unison, this has been much less marked since about 1973. Fluctuations in the catches of salmon in the two rivers are, on the other hand, dominated largely by net catches. The marked decrease seen in both estuaries around 1970 was due to the effects of UDN prevalent in the rivers a few years earlier. Again it is noticeable that from about 1972 onwards fluctuations in catches in the two estuaries have been less in unison than previously.

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* It should be noted that a more useful statistic would involve catch per unit effort but data on fishing effort, for example man-hours expended, is practically unavailable for angling and net fishing. It should also be remembered that most fisheries statistics suffer from considerable drawbacks. This is particularly so for rod catches where statistics are based on 'returns' which may represent only a small proportion of fish actually taken. Any conclusions drawn on the basis of these types of data are therefore to be considered in the light of the uncertainties surrounding the base-data.

Net catches in the River Leven have fluctuated markedly during the late 1970's and whilst they are generally below the levels seen during the 1960's there is no indication of a downward trend during the last ten years, especially when comparison is made with the River Kent where catches have plummeted during the past three years.

Catches of rod-caught salmon in the River Leven have fluctuated about a mean of ca 50 fish/annum since the late 1960's. The fluctuations do not appear to match in extent or periodicity the more marked fluctuations in sea trout catches from the river, or indeed those of either salmon or sea trout catches in the River Kent, which tend to vary together.

Consideration of the figures for the Eels Dam (Haverthwaite) fish counter on the River Leven is not particularly helpful since the counts produced are suspect for a variety of reasons. Similarly analysis of data on the numbers of spawning redds has not been very actively pursued since many of the counts have been unreliable usually due to spate conditions under which some of the surveys were made.

Interpretation of data on commercial landings of fish and shellfish at ports around Morecambe Bay is fraught with even more difficulties than encountered with rod and line returns. The same criticisms relating to fishing effort and degree of reporting still hold but in addition are the problems of market forces and location of fishing effort. Often estuary fishermen will land their catch at a port where they can expect to receive the highest price for their catch, rather than at the port immediately adjacent to the fishing area, and this economic factor might influence the reported landings at each port to a much greater extent than the performance or effort on individual fishing grounds adjacent to each port. This is particularly likely where there are a number of ports within a short distance of each other, as in Morecambe Bay (Fig. 8).

However, with these provisos there is no indication that there has been a major decline in landings of either flounder or shrimp, the principal commercial fish species, at any particular port during the last decade (Figs. 9 and 10).

3. TOXICITY STUDIES

A frequent allegation was that the Glaxo effluent discharged tidally from Hammerside Point was either toxic to fish or caused fish to avoid the River Leven. We considered that laboratory experiments could provide useful evidence to support or confound these ideas. Accordingly a sample of the 'Hammerside Point' effluent was taken and promptly despatched to the Water Research Centre, Stevenage which agreed to undertake a preliminary evaluation of the potential effects of the effluent on fish.

A standard acute toxicity test was carried out using rainbow trout in a relatively hard dilution water (ca 260 mg l^{-1} $CaCO_3$). The experiment was performed with static solutions using five fish at each dilution of the effluent. The time to death of individual fish was noted and the median period of survival of the test population in each dilution of the effluent was interpolated from the data in Figure 11.

A second experiment was carried out to examine the ability of fish to detect and avoid the effluent. A simple linear choice chamber was fitted with electrodes capable of monitoring the activity of an individual fish as well as its position in relation to the effluent stream in the chamber. The results of the experiment are shown in Fig. 12. Rainbow trout avoided concentrations of the effluent equal to or greater than 3.5% (in hard water) within one hour but though they showed an increase in activity to 2% effluent they showed no avoidance behaviour during exposures lasting over 1000 minutes. Avoidance behaviour was shown at concentrations an order of magnitude less than those causing mortality but rainbow trout showed no avoidance at concentrations more than an order of magnitude greater than those likely to be found in the estuary under discharge conditions. On the basis of this it was decided not to pursue at this stage more detailed (and expensive) laboratory studies.

4. FISH SURVEYS

Three surveys of the Kent and Leven estuaries were carried out: 20th-22nd May 1980; 4th-6th August 1980 when local industry was closed down for annual holidays and effluent discharges were minimal; and 7th-9th July 1981. The procedure was the same on each occasion with seine-netting for fish and push-netting for fish carried out at suitable sites at low water by a team of staff from NWWA and LWSFJC. The team worked in two groups. The first group of three (occasionally four) set out from the upstream point in a boat and established fishing sites when topography and water depth suggested suitable holding pools for fish. At each site a single sweep was made with a standard flat beach seine. All fish and invertebrates were identified, counted and measured by the second group (2 scientists) following behind the first in another boat. The second group also carried out push-netting at suitable locations using a standard 2 metre Riley push net over 25-50 metres in water of about 50 cm depth. The team progressed downstream in this manner until the flooding tide prevented further fishing when the team returned to base.

In the case of the River Leven, netting commenced above the Plumpton viaduct in May and from just above the River Crake confluence in August and July and was carried out to a point some 2.5 km downstream of Carter Pool. In the Kent estuary, the surveys ranged in each case from above the viaduct at Arnside to points below Blackstone Point; downstream of the confluence with the River Winster. It was not possible in all cases to re-sample at the same points because of the extensive changes in the topography of the low water channels that occurred between the survey dates. During the three surveys a total of 54 seine hauls and 39 push nettings were carried out. Their locations are shown in Figs. 13-18.

The catches of the individual hauls are given in Tables I - VI and summarised in Table VII. Fluke (= flounder, Platichthys flesus) was the most abundant and widely distributed species in both estuaries.

They ranged in size from recently metamorphosed larvae (taken in the push nets as "postage stamp" fish), through 0+ groups which dominated the seine catches to considerable numbers of commercially valuable fish in excess of 30 cm total body length. The data suggested that there were no marked differences in the size composition of the Kent and Leven populations (Fig. 19). The incidence of lymphocystis and other epidermal lesions or abnormalities was very low in both estuaries.

Eel (Anguilla anguilla), smelt (Osmerus) and whitebait (principally immature sprat, with some herring) were the only other species to occur in large numbers in the seine net. A decision was taken early in the programme not to use gear which would optimise catches of salmonids because of its potentially destructive nature so it was not anticipated that large numbers of adult salmonids (or other very mobile mid water species such as mullet) would be taken in either estuary during the course of the surveys. Nonetheless, a substantial number of sizeable migratory salmonids, both salmon and sea trout were caught; in all cases it was possible to return these fish still in a healthy condition.

The push-net catches were dominated by brown shrimp, Crangon crangon, but large numbers of ghost shrimps (Neomysis), sea gooseberries (Pleurobrachia), gobies (probably P. minutus) and small flatfish were variously abundant. The very small ("postage-stamp") flatfish were largely a mixture of plaice and flounder though in July 1981 numbers of small turbot were caught in the Kent.

The limited diversity of fish and shellfish species taken in both estuaries is typical of the middle reaches of shallow sandy estuaries, and is not indicative of stress from poor water quality. In qualitative terms there was no difference in the fish faunas of the two estuaries and it is not sensible to regard the catches as quantitative in the generally accepted sense of the term. The numbers of fish taken during any one haul depend upon amongst other factors length of warp set, angle of warp, depth of water, speed of hauling (some of which can be more or less standardised), the extent to which the foot rope of the net bites or buries into the bottom, clarity of water, current velocity (over which there is little control), in addition to the fundamental aspect of numbers of fish available for capture. In shallow estuaries like the Leven and Kent, fish will be distributed in a very heterogeneous pattern at low water, being almost entirely confined to deep pools which form around rocky projections, sand bars etc., and this was found to be the case. A subjective assessment was that the number of fish caught was related to the volume of the holding pool, with the largest catches being made in the deep pools around the railway viaducts of both estuaries, and this dominated the pattern of fish distributions within the estuaries. The mean catch per haul of flounders remained constant over the three surveys for the Kent estuary but there was more survey to survey variation for the Leven catches and only in August 1980 did they match the levels found in the Kent (Fig. 20). Mean catches for eels, the only other species for which there is a reasonably complete data matrix, were similar for the two estuaries and all surveys, though Leven catches again tended to be somewhat higher for August 1980.

5. DISCUSSION

On the basis of the limited studies carried out as outlined above we can find no evidence to support the view that there has been a long term decline in the catches (i.e. numbers) of salmon and sea trout in the catchment of the River Leven or its estuary, nor is there any strong reason to believe, given the relatively short stretch of river which is fished for salmon, that rod catches should be substantially greater than they are at present. The relationships between numbers caught, fishing effort, fishing conditions and fish available for capture are exceedingly complex and it is largely unknown how these contribute to the year to year fluctuations in reported catches. However, in the case of the Leven catchment these fluctuations appear to be no greater or of a different pattern to those in adjacent rivers. From the more limited data available (1976 to present) it appears that rod catches have, on average, been maintained in both the River Crake and the River Leven, that is, the catchment has responded as a whole rather than a decline in one part (e.g. the River Leven) having been compensated for over the long term by an increase in another, in this case the River Crake. There is no reliable evidence to hand which demonstrates a long term decline in the numbers of migratory salmonids running up these rivers since the counts for the Eels Dam counter have been shown to be unreliable at least for 1980 and 1981. A superficial examination of the relationship between redd counts and fish counts suggests that problems may have existed with the counter since at least 1977. In the years 1971-76 redd counts (when made) varied between 16 and 32% of fish counts; since 1976 they have varied from 50% (in 1978 when there was a good salmon count of 243) to 188%!

It appears then that if there are water quality or other problems in the Leven estuary or catchment they are not sufficiently grave to affect the stocks of salmon and sea-trout in the rivers.

The complaints of a long term decline in the numbers of net-caught salmonids in the estuary cannot be substantiated either. There was an undeniable reduction in the numbers of salmon caught during 1979 when complaints were most vociferous but this was apparently part of the normal fluctuations. Successful lave netting is very much dependent on the topography of the estuary as has been recognised for some time. Thus the Ninth Annual Report of the Lancashire River Board (1960) reports that "the Duddon and Leven estuaries produced a lesser number of fish than in 1958/59 due, probably, to the lack of channel formulation in these estuaries". It is not possible to say with any certainty in what way the movement of the low water and flood channels affect the numbers of fish entering the estuary or their catchability, especially when major changes to topography can occur, as they do in the Leven, over a period of only a few days. In 1980 one of the striking features in the Leven was the shallow and restricted area of the channel at low water, and the virtual absence of suitable holding pools for salmonid and other fish. The only large and persistent holding pool of any note in the Leven estuary was situated immediately adjacent to Plumpton Viaduct, with another substantial pool at Greenodd, on the confluence with the River Crake. Any Migratory salmonids entering the Leven from Morecambe Bay would, after locating the flood channel, have to run for considerable distances on the rising tide before reaching a suitable holding area. Any that did not do so presumably fell back with the ebb to the general area of the Bay, though fish are not infrequently left stranded on the banks. Similarly frequent changes in channel type and location occur in the Kent estuary and indeed this may be part of the explanation for the poor net catches reported there over the last three years.

Fisheries statistics on commercial landings at different ports are less useful in determining if very localised changes in fishing patterns are occurring. All that can be said at this stage is that there does not appear to have been any marked declines over the past ten years in the weights of flounder and brown shrimps landed from the Kent and Leven estuaries.

The fishing surveys were planned to provide a more detailed local picture of fish distributions in the two estuaries and a number of tentative points have emerged. By and large there have been no marked differences in fish faunas; diversity was relatively low in both estuaries. Sizeable fish appeared to be located, at low water, in the deeper pools of the low water channel. In May 1980 and July 1981 catches of flounder (the only species for which there is sufficient data) in the Leven were statistically smaller than catches for the Kent, whereas in August 1980 this was not true. It is not sensible to ascribe too much weight to these few observations but it is noteworthy that the increased catches in the Leven followed a two week period when there had been no discharges from Hammerside Point.

Limited experimental work by WRC suggested that fish could detect and avoid dilutions of the effluent down to 3% under laboratory conditions. However, this figure should be compared with a dilution of over a thousand (<0.1%) that occurs within one quarter of a mile of the discharge point from Hammerside Point, suggesting that detection and avoidance of the Hammerside Point effluent by flounders, generally regarded as a pollution-tolerant species, is unlikely. In the laboratory acutely lethal effects of the effluent to fish were not observed at dilutions less than 20% effluent. Forster (1979) on the other hand recorded lethal effects on Crassostrea larvae down to 0.1% effluent and concluded that "the discharge operates with a small margin of safety". Importantly he also recorded toxic effects of the Carter Pool discharge at the same concentration, and it may be that this latter discharge is producing a greater environmental impact because it discharges continuously and has, at low water, much less dilution available to it. There was no evidence from the push netting that the discharge from Carter Pool was affecting the distribution of mobile epibenthic species, such as shrimps but its impact on the more sessile fauna, particularly bivalve molluscs, could be more marked.

A survey of the distribution of the major bivalve species (Mytilus, Macoma, Cerastoderma, Mya, Scrobicularia) would elucidate this.

The estuarine fish surveys reported in this paper have, in our opinion, satisfied the limited objectives for which they were designed, and need not be repeated unless allegations of poor catches continue to be made and there is objective evidence that such allegations are well founded.

The preparation of this paper has clearly illustrated that existing fisheries data from the Rivers Leven and Kent are extremely frail when attempts are made to answer specific questions about salmonid stocks. In particular, it highlights the desirability of collecting and assessing data from a variety of sources (catches, fish counters, redd counts, surveys of juvenile fish populations etc) rather than placing undue reliance on a single source - usually (rod) catch statistics, which are known to contain inherent uncertainties but which nevertheless form the main basis for complaint. This is particularly important when fishery policies are being formulated, and when relatively short term management practices involving a large commitment of resources are contemplated (e.g. smolt rearing projects).

6. ACKNOWLEDGEMENTS

The fish surveys were carried out jointly with the Lancashire and Western Sea Fisheries Joint Committee. It is a pleasure to record our appreciation for the help and co-operation of the Committee staff, particularly Gren Harrison and David Evans, and of Rivers Division staff in carrying out the surveys. Mr. Mike Nicholson (Head Office) offered statistical advice on the data and his help is acknowledged.

7. REFERENCES

Fell, J. H. (1977). River Leven - notes on possible reasons for the apparent depletion of fish stock. Lune, Wyre and Furness Advisory Committee, NWWA, 24th October 1977, Item 5, Appendix 1.

Forster, R. (1979). The environmental effects of antibiotics wastes in the Leven estuary, Morecambe Bay. Ph. D. Thesis, Lancaster University.

NWWA (1977). Officers comments on paper by Mr. J. H. Fell on possible reasons for depletion of fish stocks in the River Leven; Lune, Wyre and Furness Advisory Committee, NWWA, 24th October 1977, Item 5, Appendix 2.

NB: Salmon and sea trout statistics were derived from:

Annual Reports of Lancashire River Board, 1952-1964

Annual Reports of Lancashire River Authority, 1964-1974

North West Water Summary of Fisheries Statistics, 1974-1981

Additional information was obtained from:

NWWA (1979). River Leven and River Crake - Catchment Study Report. Lune, Wyre and Furness Advisory Committee, 9th April, 1979.

TABLE 1

SUMMARY OF CATCHES ON LEVEN ESTUARY

20TH MAY, 1980

(a) Beach Seine

Site	Fluke	Eels	Smelt	Trout (S)	
1. u/s Viaduct	102	26	0	0	
2. d/s Viaduct	28	0	0	1	
3. Canal Foot	14	1	0	0	
4. Scar	25	1	0	0	
5. Shallow reach d/s Scar	8	0	0	0	

(b) Riley Push Net

Site	Pleurobrachia	Crangon	Flounder	
1. u/s Viaduct *	7	1205	3	
2. d/s Viaduct - 200 m. *	-	287	1	
3. ½ m. u/s Canal Ft. *	-	52	0	Live Macoma, Corophium
4. 150 m. d/s Discharge *	2	330	0	Live Macoma present
5. 250 m. d/s	12	138	0	1 Carcinus
6. 800 m. d/s Slag	10	212	0	2 Mysids
7. d/s Carter Pool	9	112	0	7 Mysids
8. 800 m. d/s Carter Pool	7	89	0	
9. 1,500 m. d/s C.P.	19	71	0	
10. 2,500m.d/s C.P.	27	74	0	1 Syngnathus sp; 1 Idotea linearis

* 22nd May, 1980

TABLE 1 (CONT'D)

SUMMARY OF CATCHES ON LEVEN ESTUARY

22ND MAY, 1980

(c) Beach Seine

Site	Fluke	Eels	Smelt	Trout (S)	
1. u/s Viaduct RHB	108	14	12	(3)	1 Carcinus, Crangon, Pleurobrachia
2. u/s Viaduct LHB	68	5	-	-	Fastener, Crangon
3. d/s Viaduct RHB	112	0	1	(1)	
4. 200 m. d/s Viaduct	41	86	1	ST. 1 T. 1 (3)	Pleurobrachia
5. 220 m. d/s Viaduct	34	9	0	1	1 Goby Pleurobrachia Macoma
6. Glaxo Discharge	75	0	0	0	Prawn
7. 200 m. d/s Glaxo Discharge	99	0	1	(1)	

TABLE II

SUMMARY OF CATCHES OF THE KENT ESTUARY

21ST MAY, 1980

(a) Beach Seine

	Fluke	Eels	Smell	Trout	
1. u/s Viaduct Mid.	473	46	2	3 + (1)	
2. u/s Viaduct LHB	194	0	21	1 (1)	
3. d/s Viaduct	100	0	0	0	Fastener, Crangon Trachinus
4. ½ mi. d/s Viaduct	118	7	6	0	1 Mullet 1? ST escaped
5. 1 mi. d/s Viaduct	18	0	0	0	Shrimps and Mysids
6. u/s R. Winster	58	0	0	(2)	Fastener
7. opp. Winster	86	40	2	2	1 Sygnathus
8. d/s Winster	78	8	0	5 (Smelt)	

(b) Push Netting

	Pleurobrachia	Crangon	Flounder	
1. u/s Viaduct	84	98	1	Several hundred mysids
2. ½ mi. d/s Viaduct RHB	250	174	0	Mysids, Gobius minutus
3. 1 mi. d/s Viaduct RHB	68	459	2	40 mysids
4. Mid-channel across estuary	48	80	4	1 Goby
5. Main channel u/s R. Winster	5	643	3	2 Carcinus

TABLE III

SUMMARY OF CATCHES ON LEVEN ESTUARY

AUGUST 1980

(a) Beach Seine

Monday, 4th August, 1980

	Fluke	Eels	Smelt	Trout	Whitebait	
1. u/s Plumpton Viaduct	121	4	1	O	11	
2. d/s Plumpton Viaduct	6	1	O	O	O	Site apparently fished by commercial men beforehand.
3. 100 m. d/s Glaxo discharge	58	9	O	O	85	
4. 1200 m. below Carter Pool	293	33	O	O	18	Macoma, Arenicola Cerastoderma
5. Rocky Scar ½ mi. d/s Chapel Is.	824	1	1	O	ca.200	1 Goby, 45 Carcinus

Wednesday, 6th August, 1980

	Fluke	Eels	Smelt	Trout	Whitebait	
6. Greenod, 100 m. u/s Crake, LHB	12	O	O	6 (S)	O	2 Salmon
7. Greenod, 20 m. d/s Crake, LHB	O	O	1	8 (S)	O	1 Salmon 1 Mullet
8. 150 m. d/s Crake, LHB	4	O	O	O	O	FASTENER!
9. 50 m. below Greenod Viaduct	12	O	O	14 (S)	O	1 Goby
10. 50 m. u/s Plumpton Viaduct	67	Many (¾cwt)	O	2 (S)	O	
11. Immediately u/s Plumpton Viaduct	28	O	O	1 (S)	O	

TABLE III - CONT'D

(b) Push Netting

	Fluke	Crangon	Goby	Whitebait	
1. 50 m. u/s Plumpton Viaduct	7	1350	67	0	1 Stickleback
2. 150 m. d/s Glaxo discharge	0	440	1	1	
3. 1200 m. below Carter Pool	10	350	8	0	
4. u/s Plumpton Viaduct	0	200	200	0	

TABLE IV

SUMMARY OF CATCHES ON KENT ESTUARY

AUGUST 1980

(a) Beach Seine

Tuesday, 5th August, 1980

	Fluke	Eels	Smelt	Trout	Whitebait	
1. u/s Viaduct 50 m.	85	0	6	0	200 +	
2. 150 m. u/s Viaduct	274	70	3	2 (S)	0	1 Mullet
3. 800 m. d/s Viaduct Opp. Car Park	71	20	1	2 (S)	0	
4. 1700 m. d/s Viaduct RHB	76	16	1	0	0	
5. u/s Blackstone Point	171	0	13	0	100	
6. 300 m. d/s Blackstone Point	74	0	5	3 (S)	0	

(S) = Sea Trout

(b) Push Netting

	Fluke	Crangon	Goby	Others
1. 50 m. u/s Arnside Viaduct	101	27	325	1 Stickleback _Corophium_ abundant
2. 150 m. u/s Viaduct	20	25	340	
3. 300 m. d/s Viaduct	1	60	10	3 Stickleback
4. 1700 m. d/s Viaduct	0	30	15	
5. 300 m. d/s Blackstone Point	0	100	50	
6. d/s Jenny Browns Point	0	10	1	

TABLE V

SUMMARY OF CATCHES ON LEVEN ESTUARY

JULY 1981

(a) Beach Seine

No.	Site	Flounder	Eel	Sprat/ Herring	Salmonids	Plaice	Others
1	u/s Plumpton Viaduct	19	1	212	1 *		Carcinus
	u/s Plumpton Viaduct	296	11	1300	2 *		
3	u/s Plumpton Viaduct	10	0	1000	1 *		
	d/s Plumpton Viaduct	15	3	92	0	13	
	Canal Foot	11	82	7	1 *	11	2 Pomatoschistus sp.
6	Carter Pool	1	0	9	2 *	10	Carcinus
	500 m. d/s Carter Pool	8	0	500	0	9	
	Greenod - Centre Pool				1 - 1 *		
	u/s R. Crake	Ca20			1 *		
10	500 m. u/s R. Crake	Ca20			2 *		
	d/s Viaduct RHB	Some			7 *		1 Mullet, Crangon
	d/s Viaduct LHB	65			3 - 10 *		1 Smelt

- Adult * Smolt

(b) Push Netting

No.	Site	Crangon	Plaice	Flounder	Carcinus	Mysids	Others
1	u/s Plumpton Viaduct	200	1	3	1	1000s	Pleurobrachia
2	u/s Plumpton Viaduct	100	6			600	Pleurobrachia
3	d/s Plumpton Viaduct	300	2			50	Numerous Macoma
4	Canal Foot	600	5			100	Pomatoschistus sp.
5	Carter Pool	200				40	
6	50 m. d/s Carter Pool	200				45	Herring (?) larvae Sygnathus sp.
7	500 m. d/s Carter Pool	500				50	15 m. push only Soft sands.
8	600 m. d/s Carter Pool	1100	2			100	Pleurobrachia

TABLE VI

SUMMARY OF CATCHES ON KENT ESTUARY

JULY 1981

(a) Beach Seine

No.	Site	Flounder	Eel	Sprat/ Herring	Salmonids	Plaice	Others
1.	u/s Viaduct	558	6	1	2	9	Crangon, Carcinus
2	d/s Viaduct off car park	42	3	4			Smelt, Carcinus, Crangon, Cerastoderma
3	Opp. tanks	171	12	1		Some O-group	Carcinus
4	u/s Blackstone Pt.	28	3				Crangon, Carcinus
5	off Blackstone Pt.	49	2	3			Carcinus

(b) Push Netting (25 m. haul)

No.	Site	Pleurobrachia	Plaice	Crangon	Carcinus	Mysids	Others
1	u/s Viaduct	100s	1	50	2		
2	u/s Viaduct		1	200		100	Sea trout, goby, turbot
3	Opposite car park	Abandoned due to dangerously soft sand					
4	Off tanks	3	2	500			1 turbot
5	u/s Blackstone Pt.		2	300	1		1 goby
6	off Blackstone Pt.	100s	2	458		30	2 gobies

TABLE VII

SUMMARY OF CATCHES FROM BEACH SEINE

SURVEYS ON THE KENT AND LEVEN ESTUARIES, 1980/81

		No. of hauls	No. of fish	Fish/haul
May 1980	Kent	8	1276	160
	Leven *	12	883	74
Aug. 1980	Kent	6	894	149
	Leven	7	1666	238
July 1981	Kent	5	886	177
	Leven	7	509	73

* from Plumpton viaduct seawards only

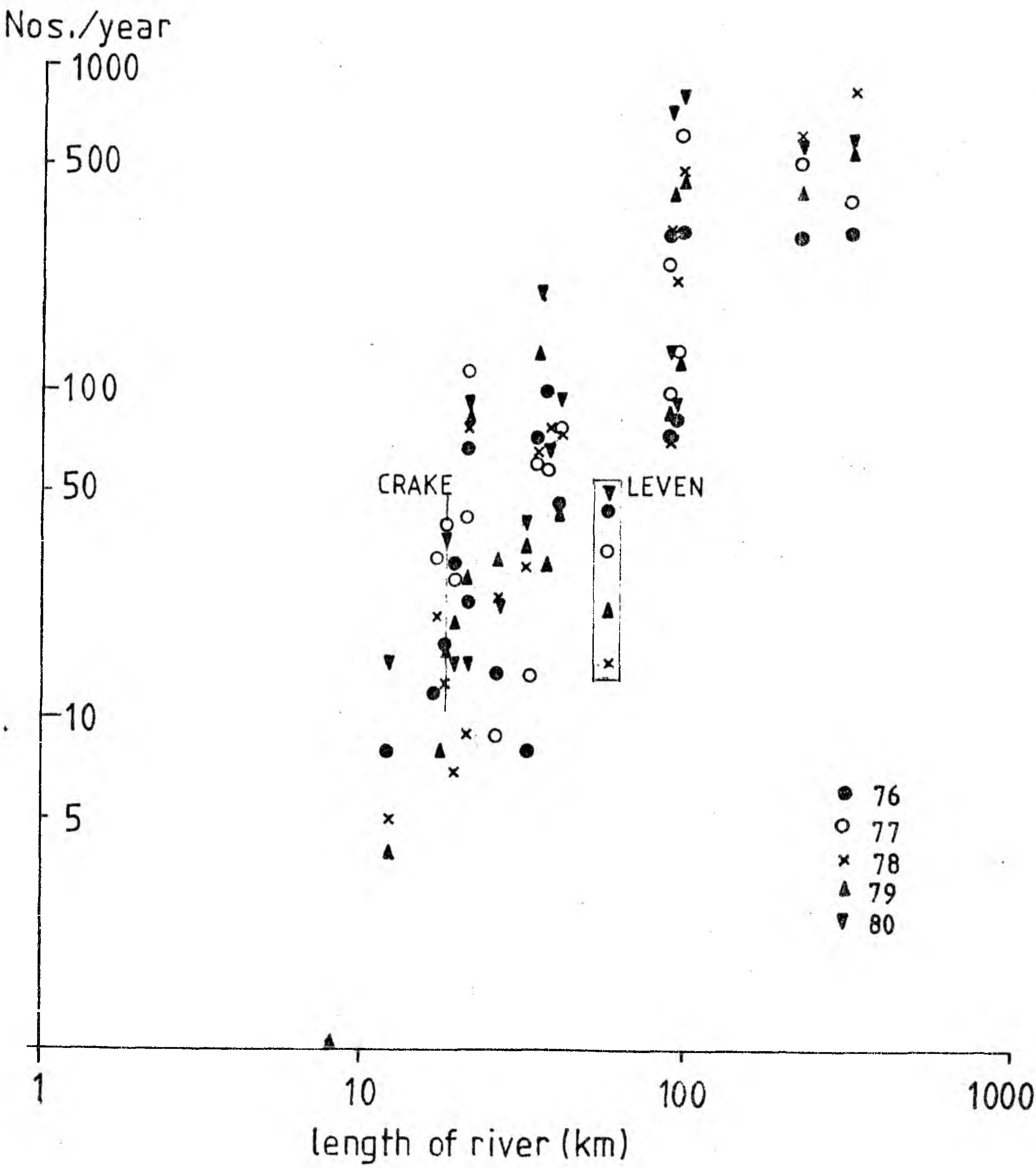


FIGURE 1: ROD CATCHES OF SALMON (1976-80) IN RELATION TO THE LENGTH OF MAIN RIVER AND MAJOR TRIBUTARIES FOR NW RIVERS

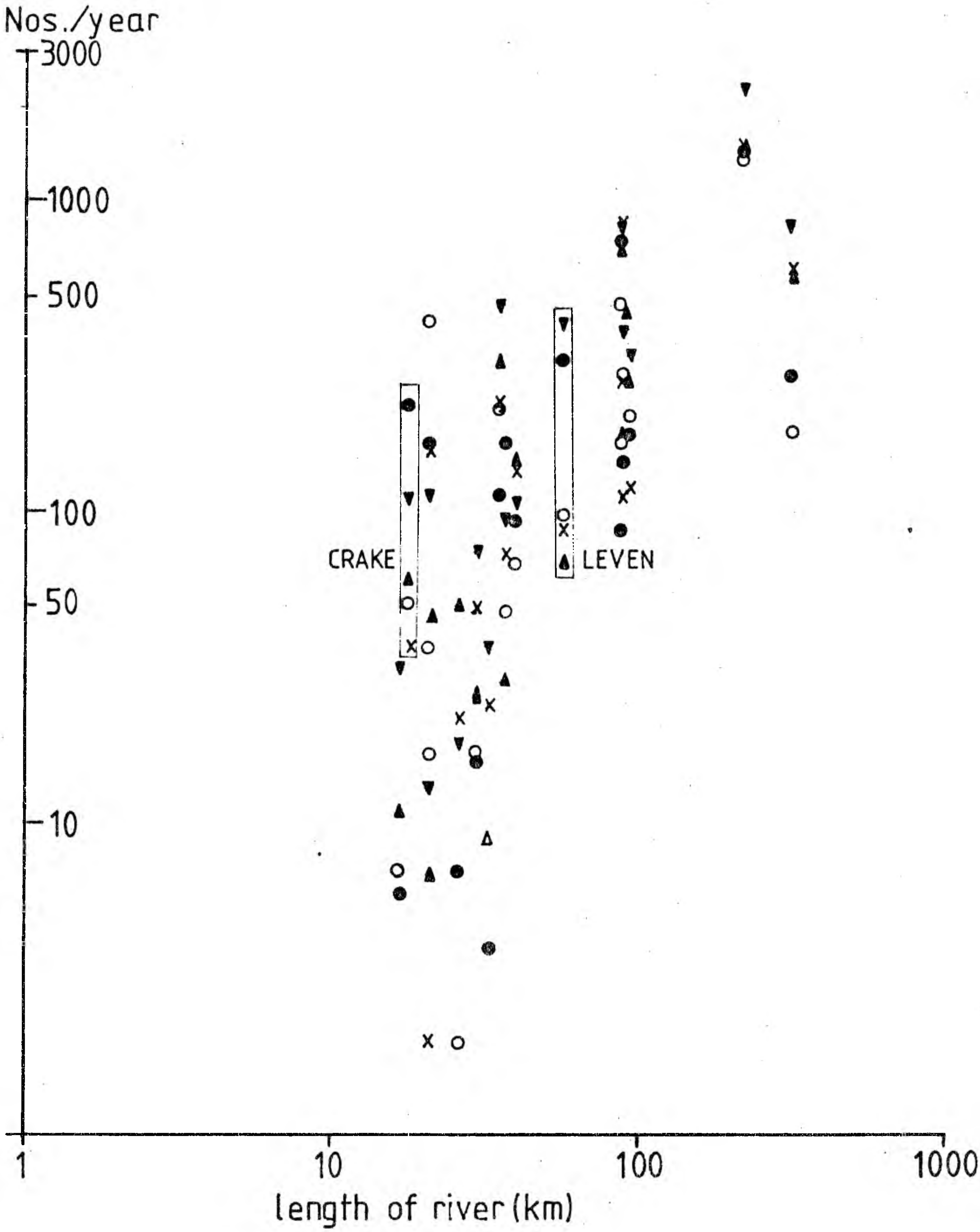


FIGURE 2: ROD CATCHES OF MIGRATORY TROUT (1976-80) IN RELATION TO THE LENGTH OF MAIN RIVER AND MAJOR TRIBUTARIES FOR NW RIVERS

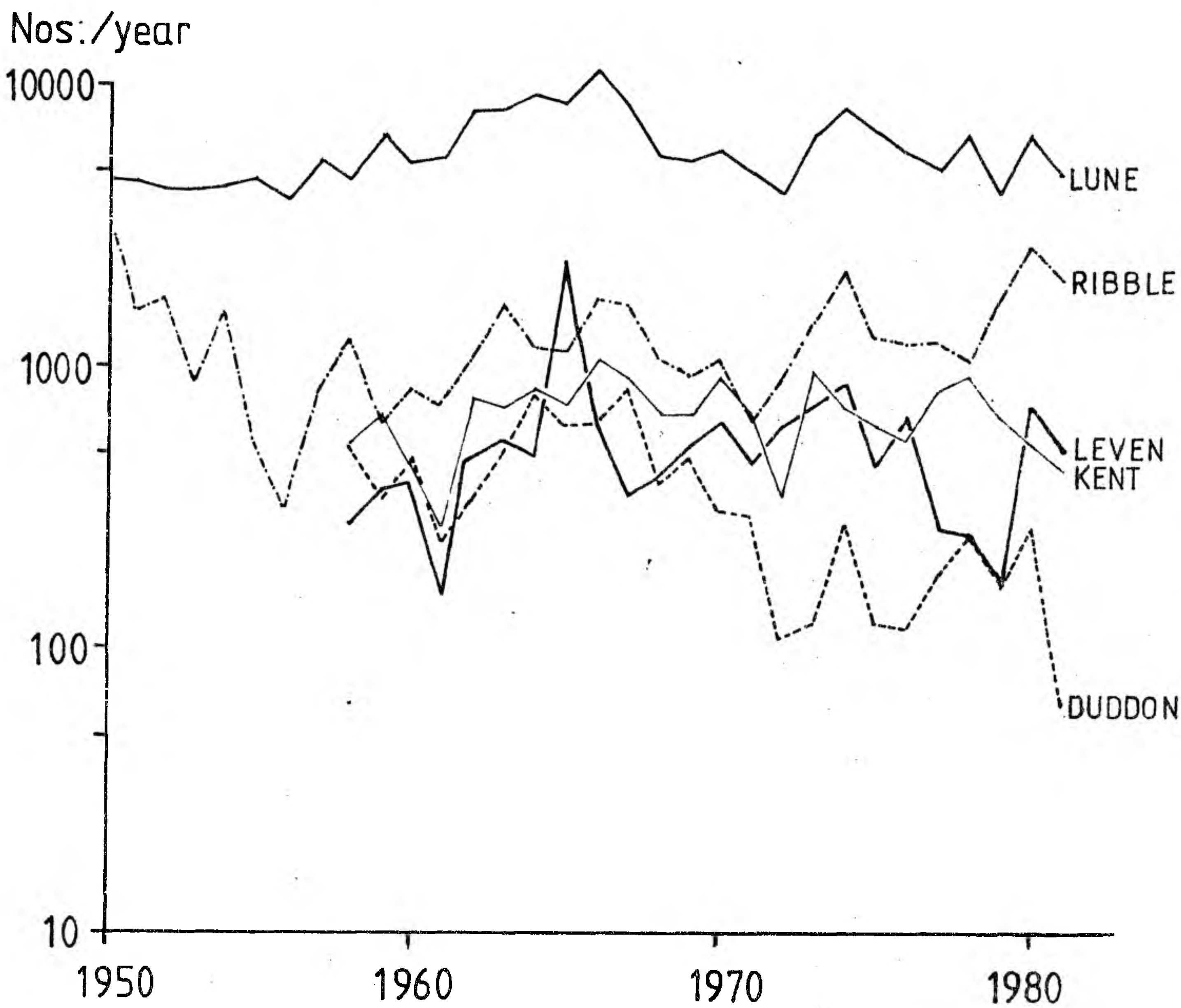


FIGURE 3: TOTAL CATCHES OF MIGRATORY SALMONIDS IN SELECTED NW RIVERS OVER THE PAST 30 YEARS

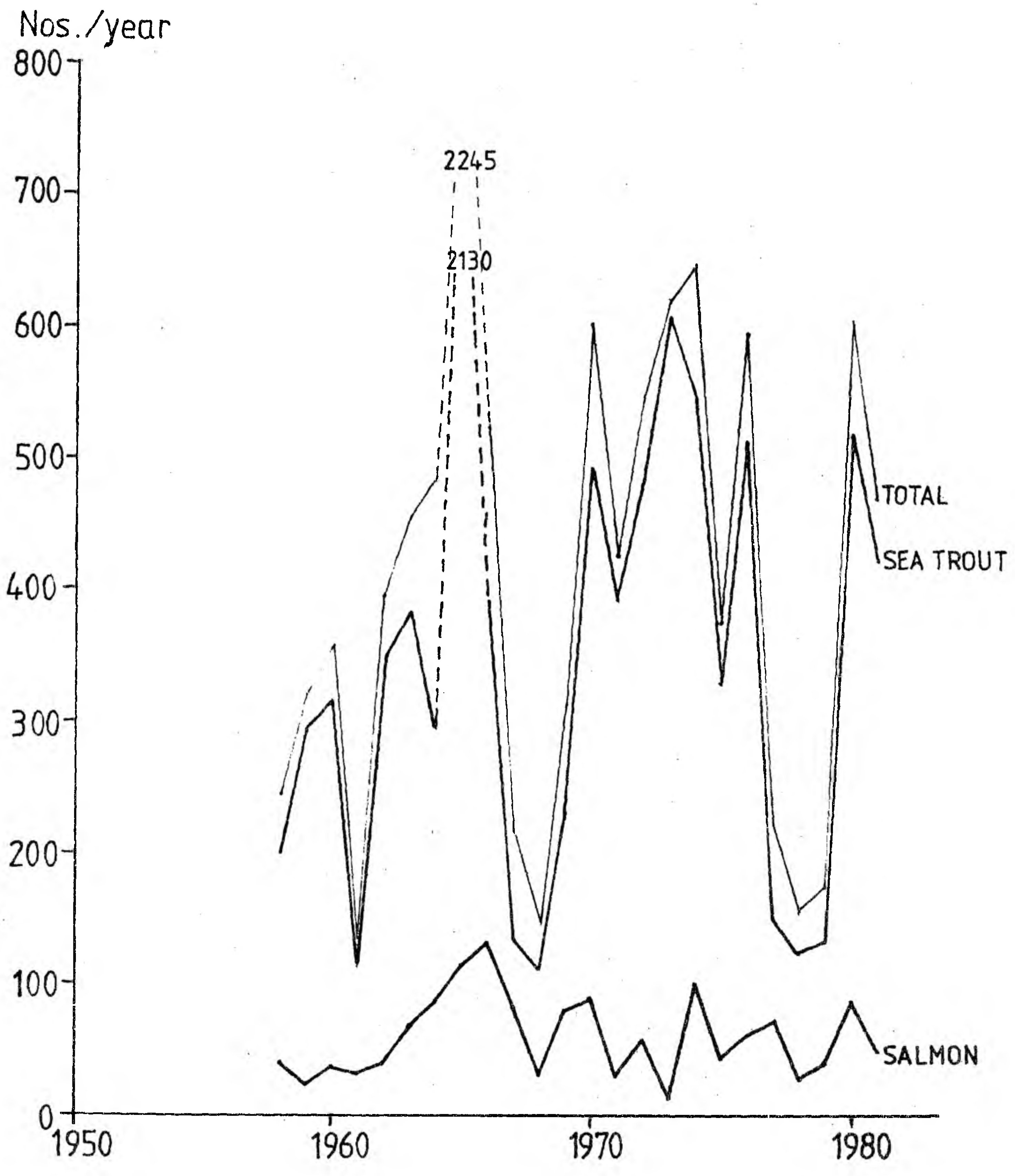


FIGURE 4: FLUCTUATIONS IN THE NUMBERS OF ROD-CAUGHT MIGRATORY SALMONIDS FROM THE RIVER LEVEN

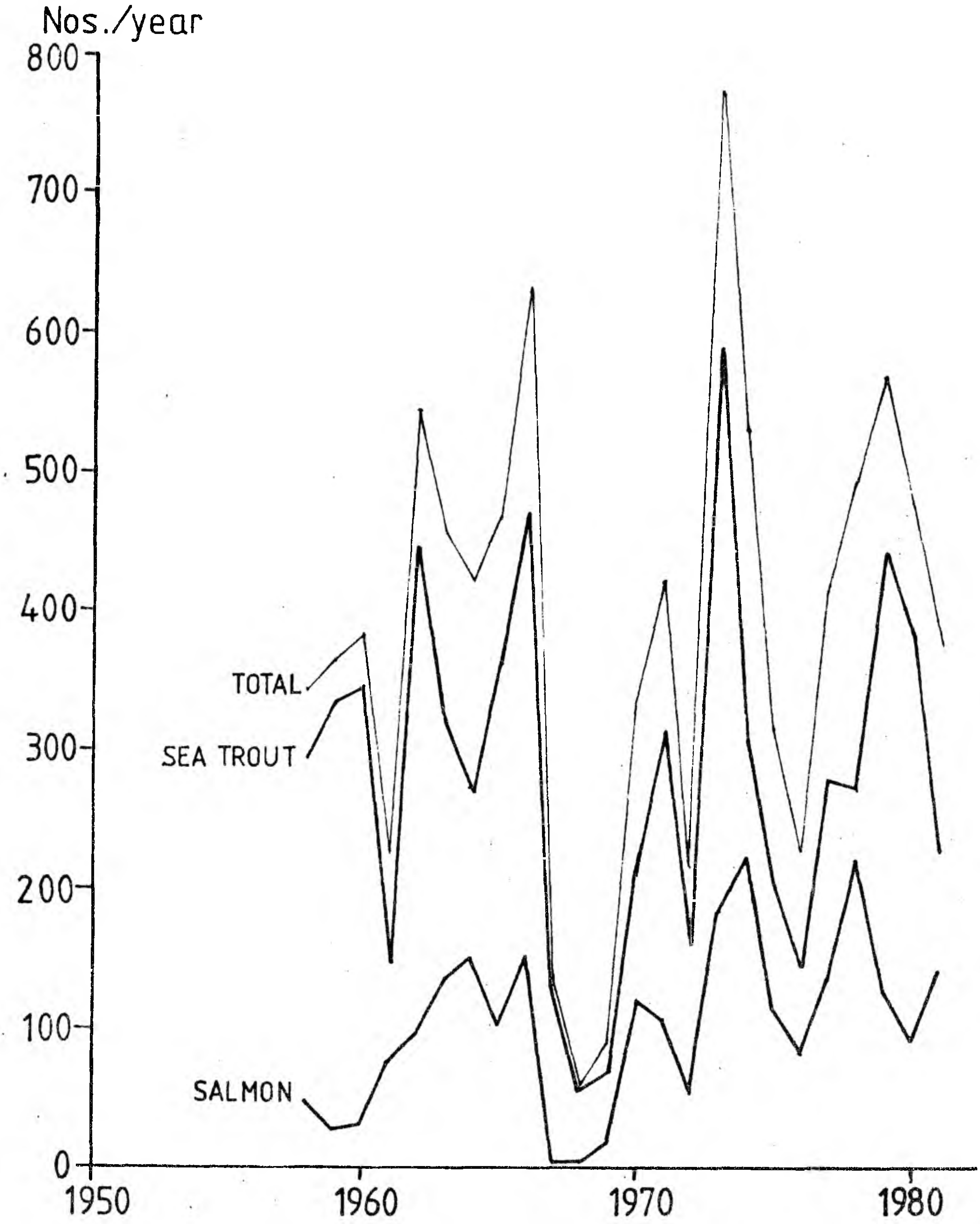


FIGURE 5: FLUCTUATIONS IN THE NUMBERS OF ROD-CAUGHT MIGRATORY SALMONIDS FROM THE RIVER KENT

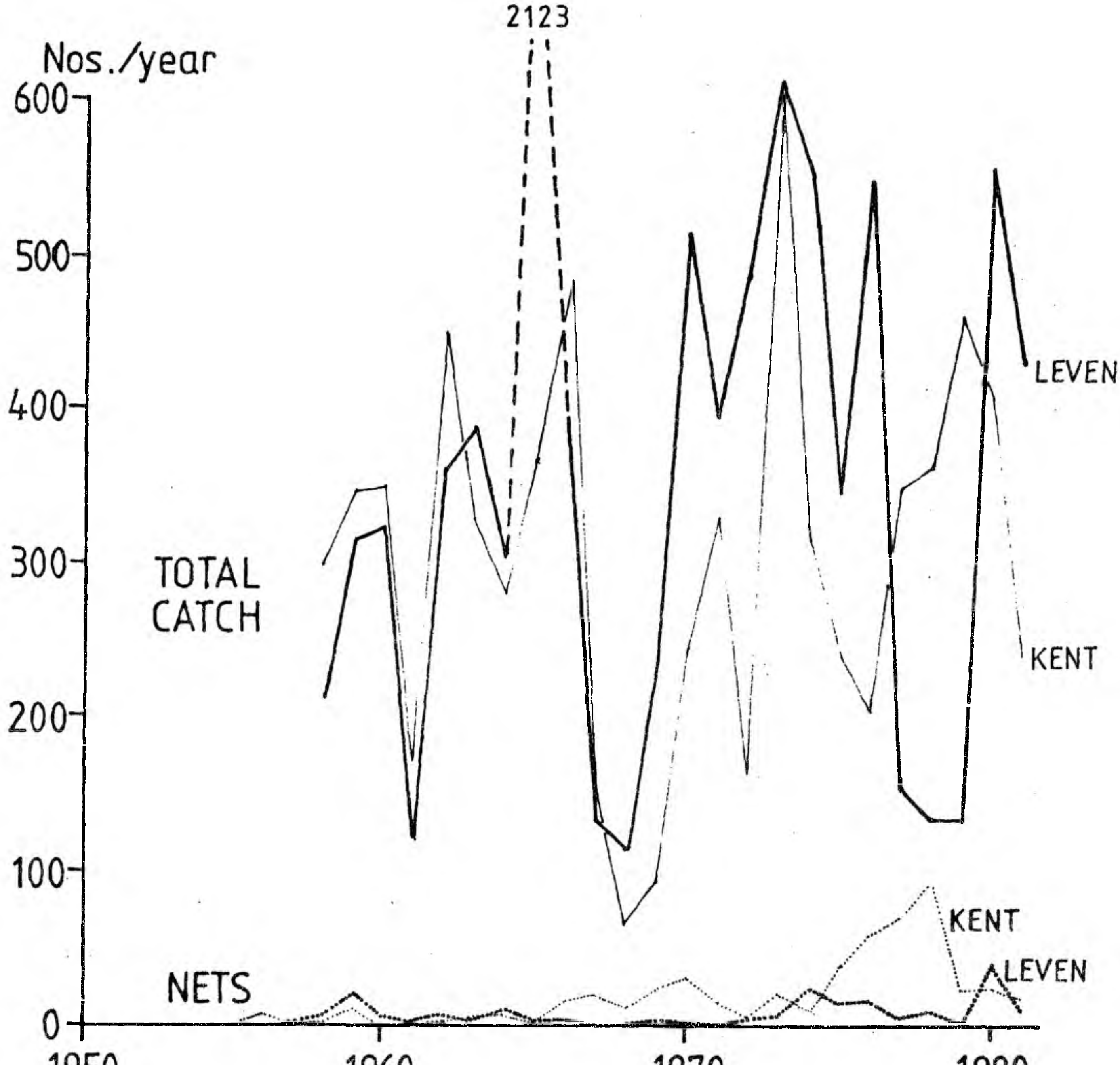


FIGURE 6: REPORTED CATCHES OF SEA TROUT FROM THE KENT AND LEVEN

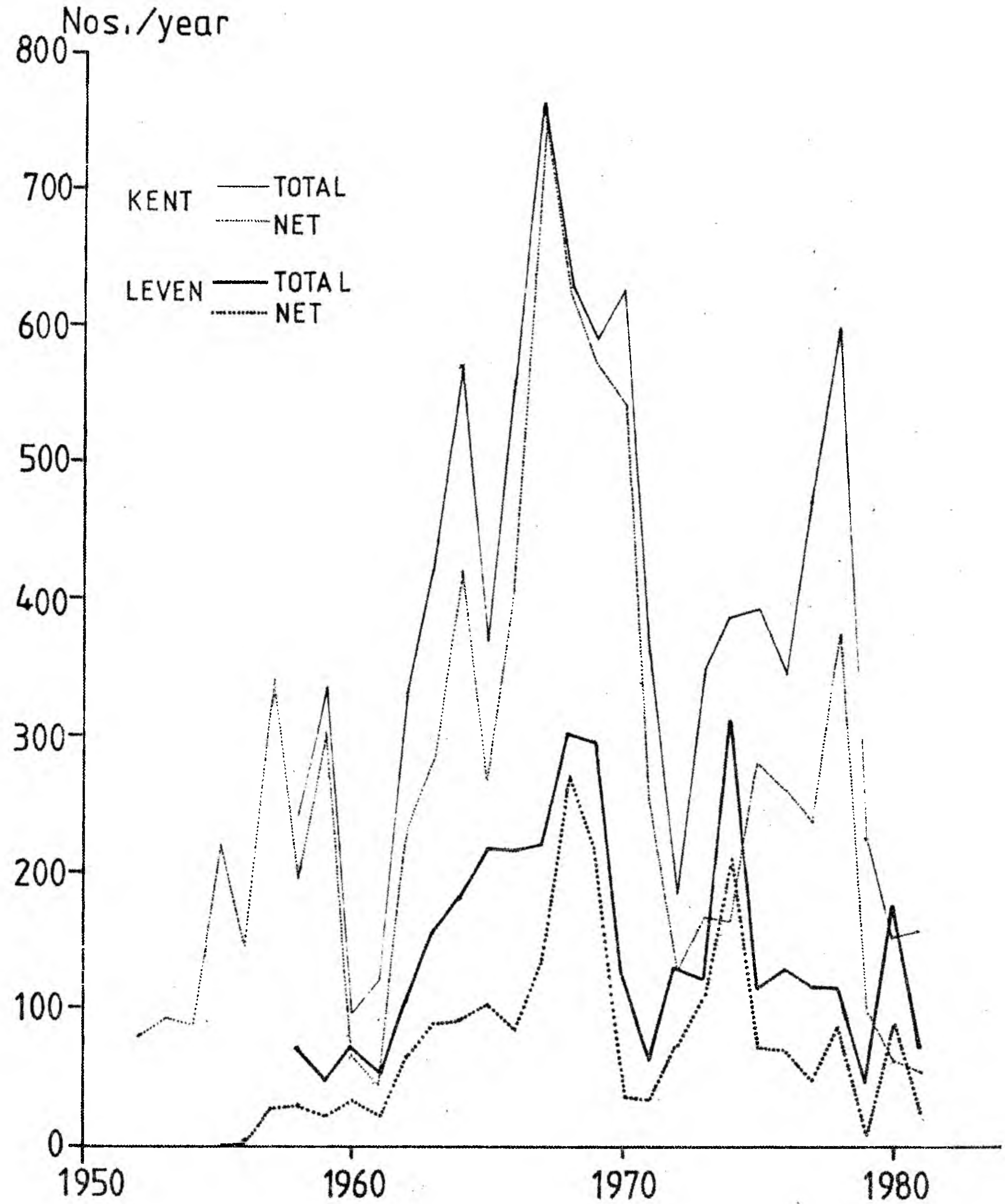


FIGURE 7: REPORTED CATCHES OF SALMON FROM THE KENT AND LEVEN

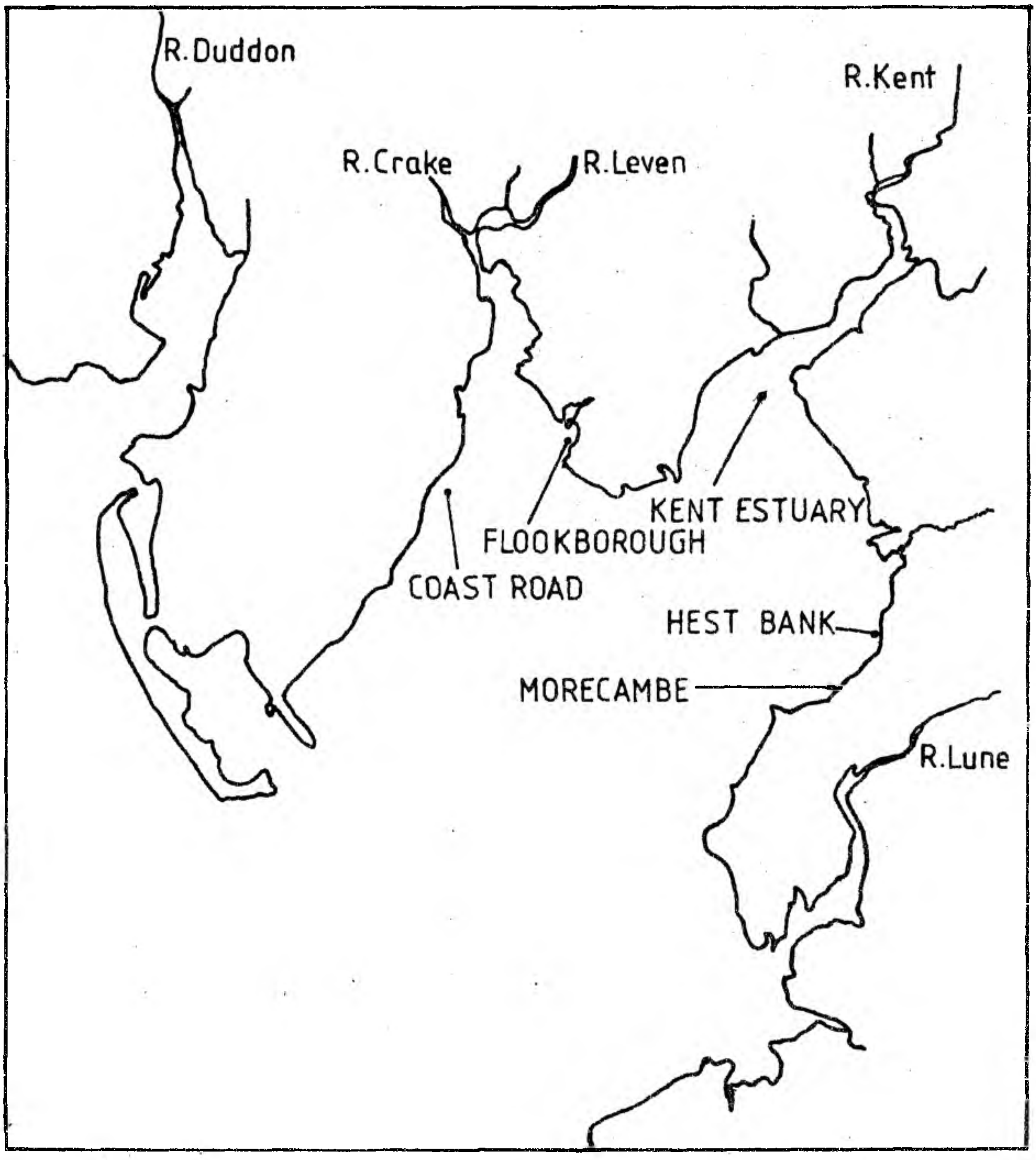


FIGURE 8: MAJOR AREAS FOR COASTAL LANDINGS OF FISH AND SHELLFISH AROUND MORECAMBE BAY, AS REPORTED TO LWSFJC

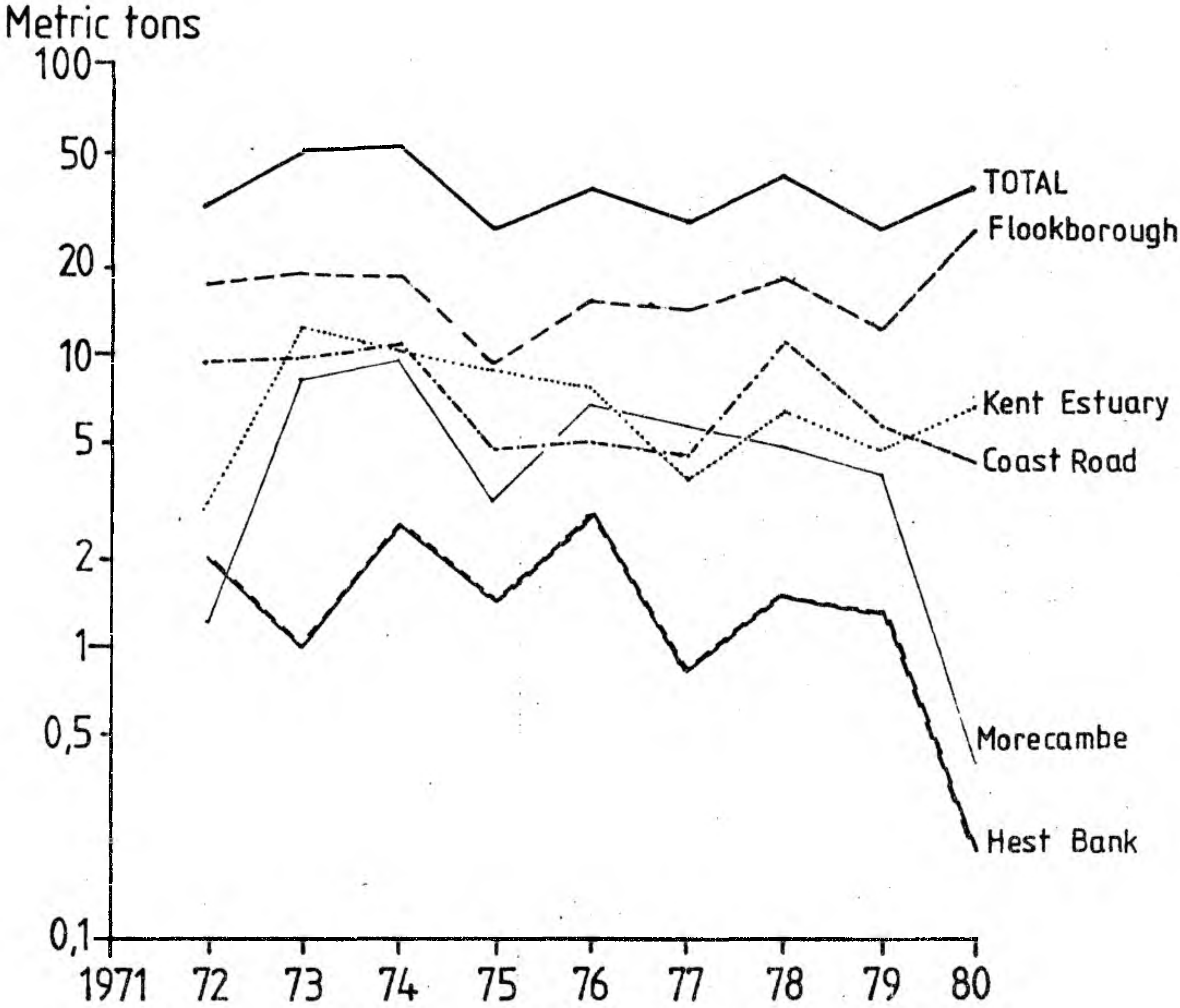


FIGURE 9: LANDINGS OF FLOUNDERS FROM MORECAMBE BAY, 1972-1980.
DATA FROM LWSFJC

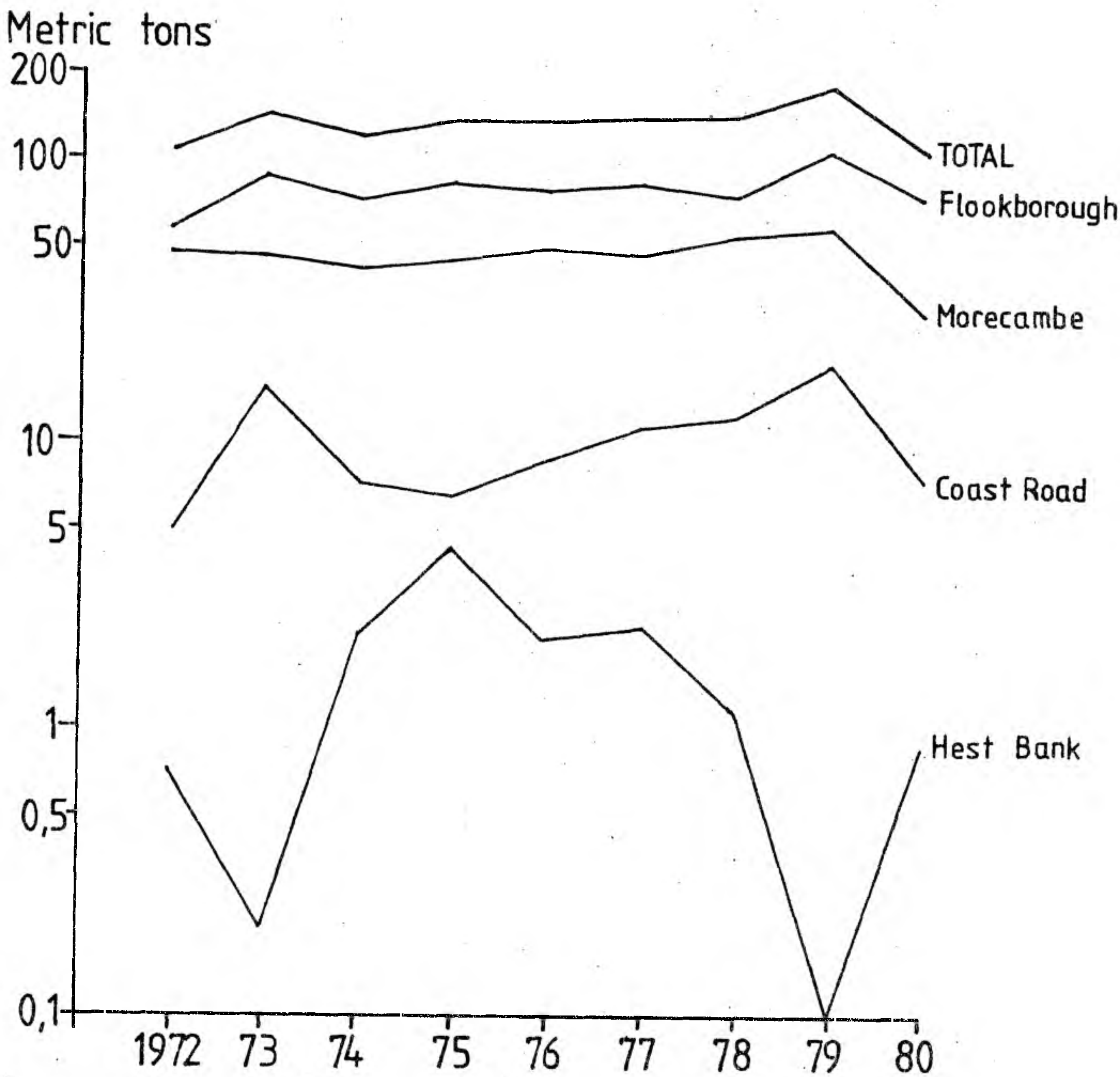


FIGURE 10: LANDINGS OF SHRIMPS FROM MORECAMEBE BAY, 1972-1980.
DATA FROM LWSFJC

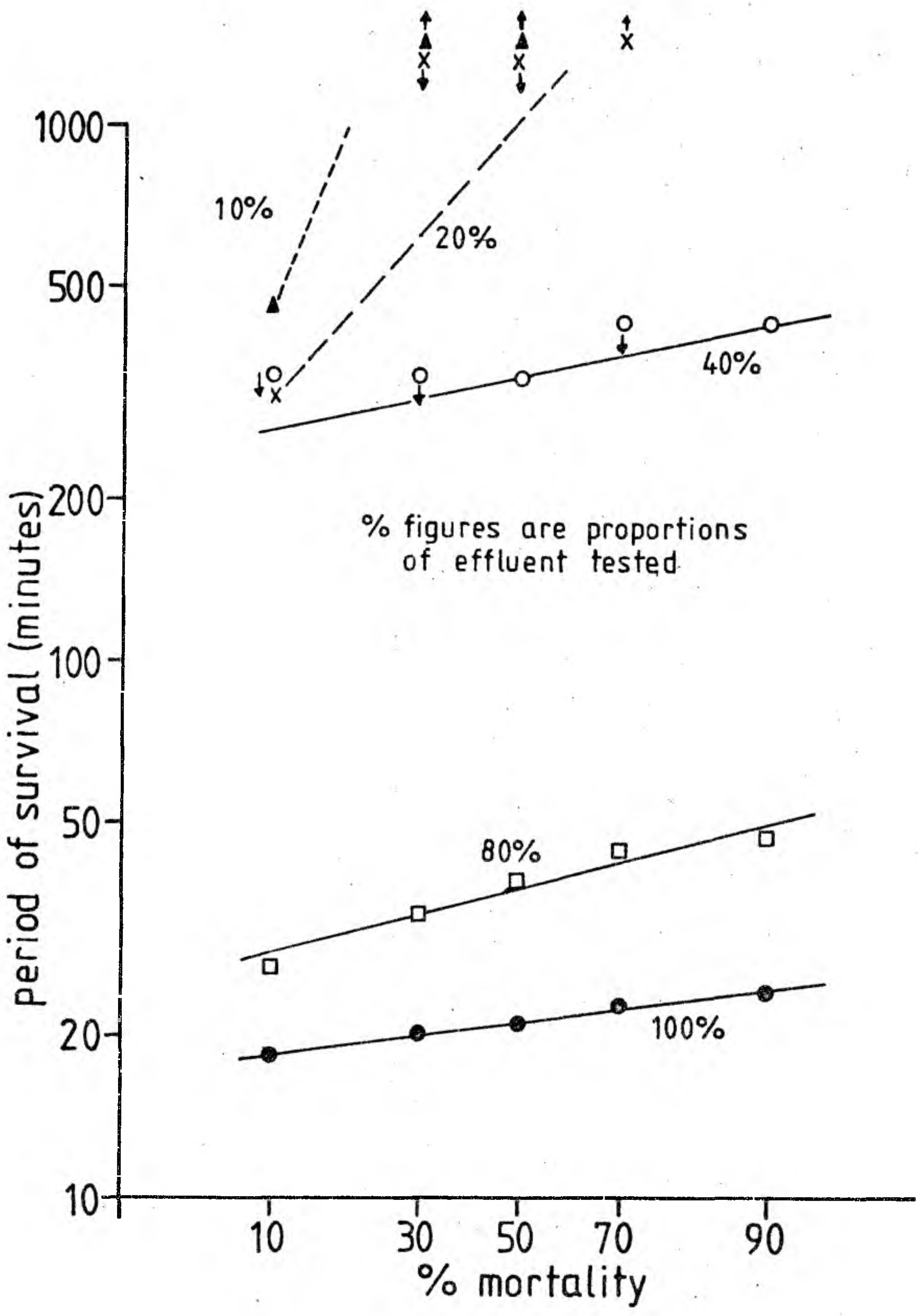


FIGURE 11: ACUTE LETHAL TOXICITY OF GLAXO EFFLUENT TO RAINBOW TROUT
(DATE FROM WRC, STEVENAGE)

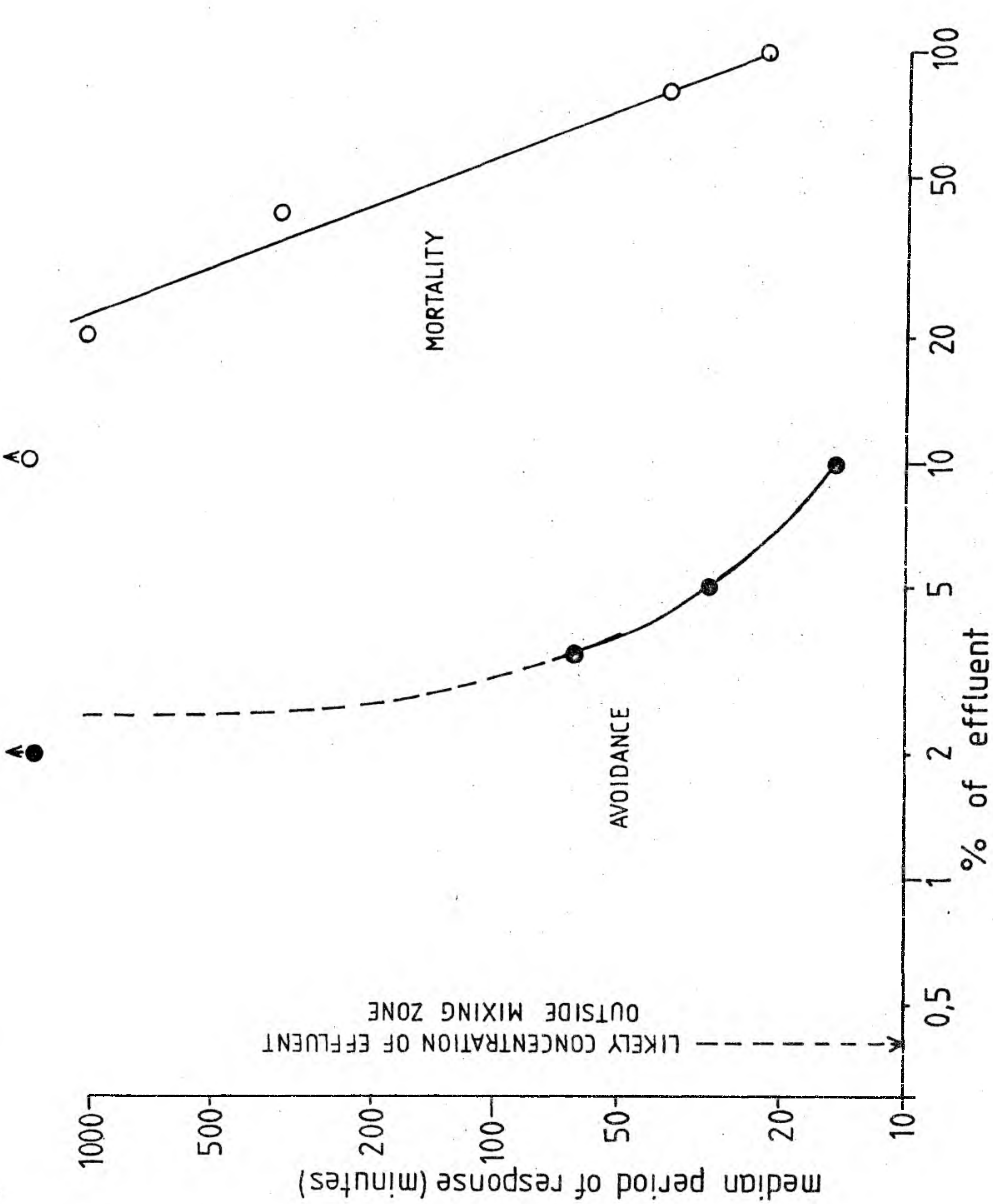


FIGURE 12: AVOIDANCE AND MORTALITY RESPONSES OF RAINBOW TROUT TO GLAXO EFFLUENT. (DATA FROM WRC, STEVENAGE)

FIGURE 13: FISHING SITES FOR THE BEACH SEINE SURVEY OF THE KENT AND LEVEN ESTUARIES, MAY 1980

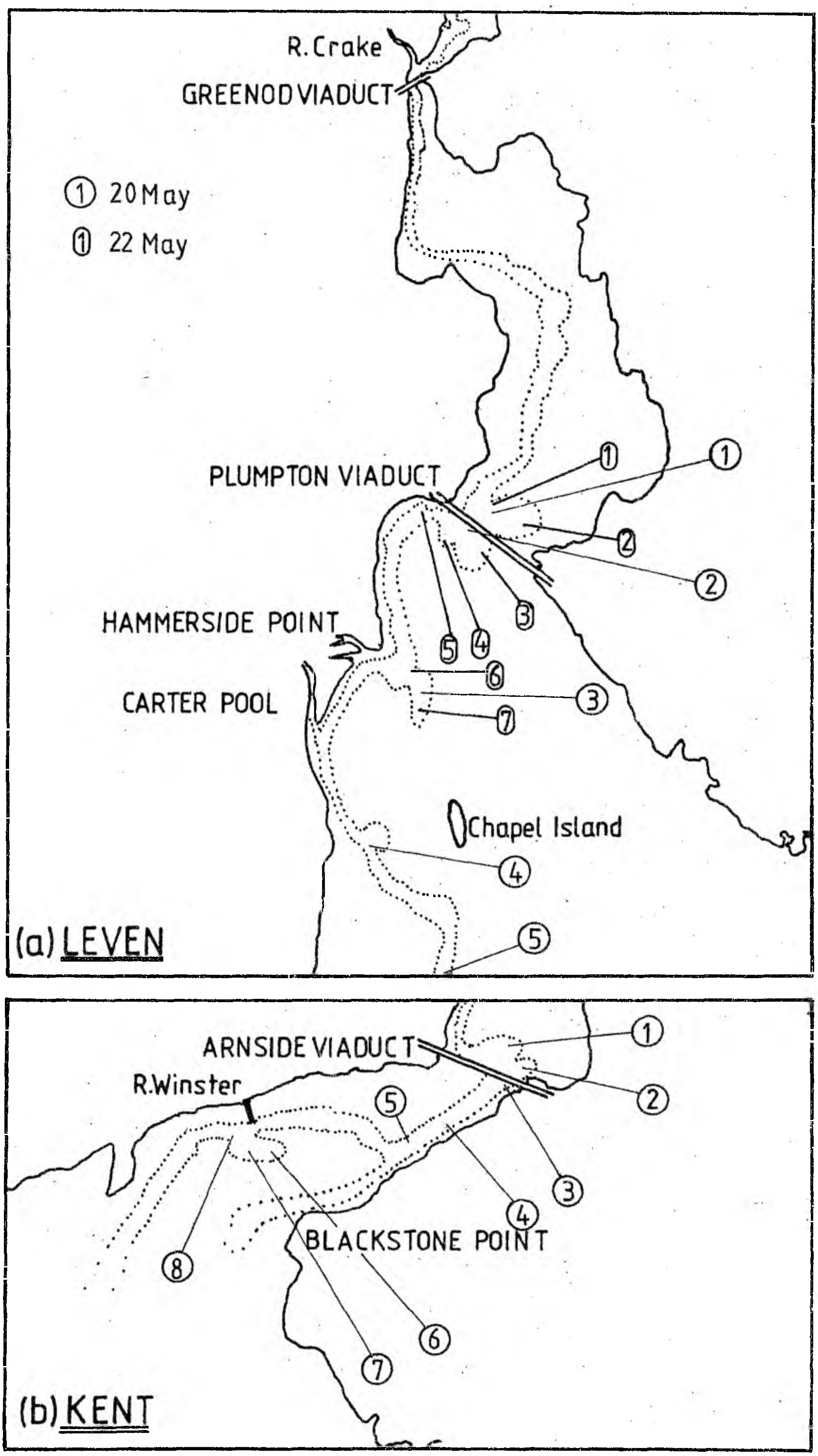


FIGURE 14: FISHING SITES FOR THE PUSH-NET SURVEY OF THE KENT AND LEVEN ESTUARIES, MAY 1980

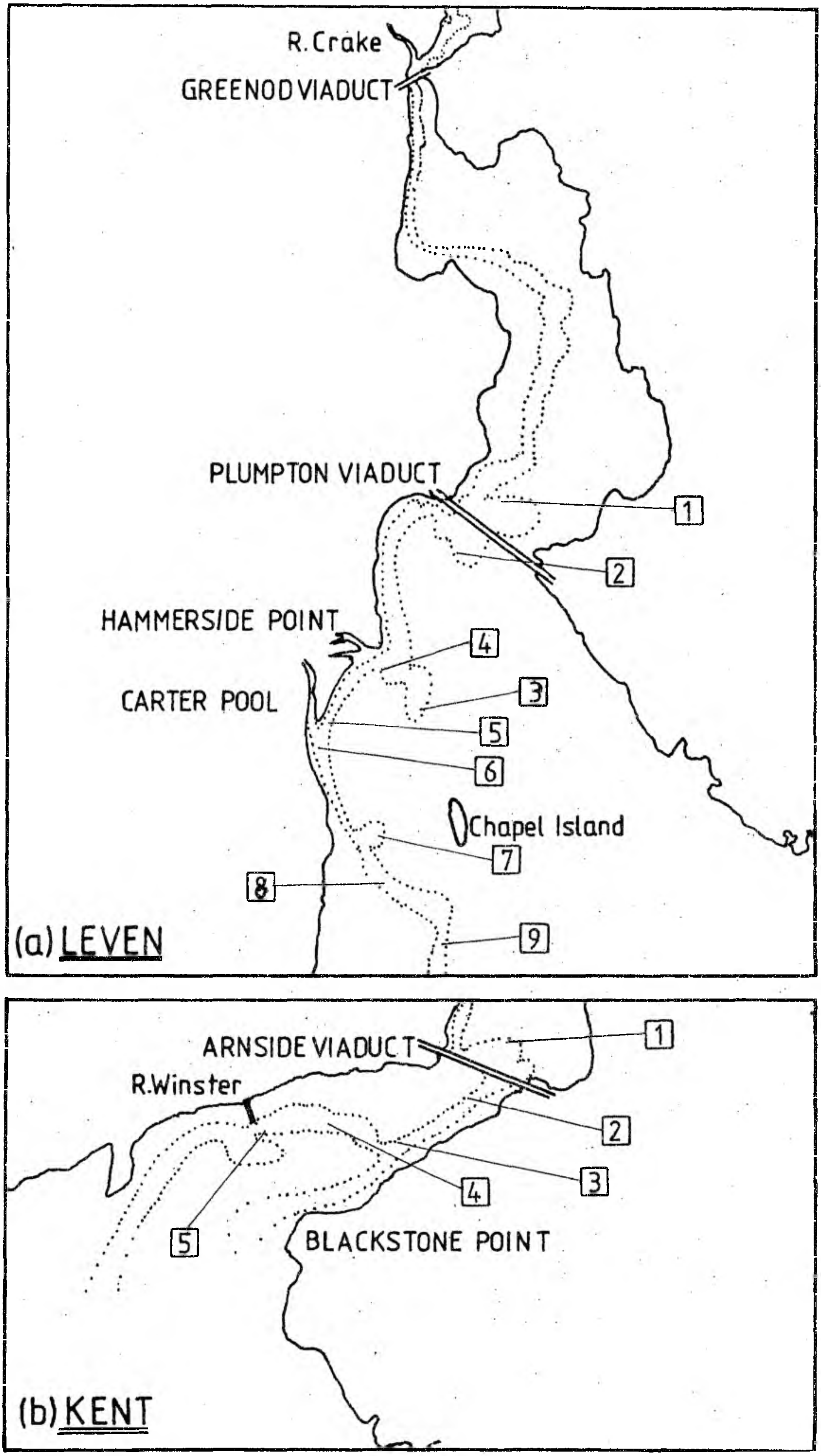
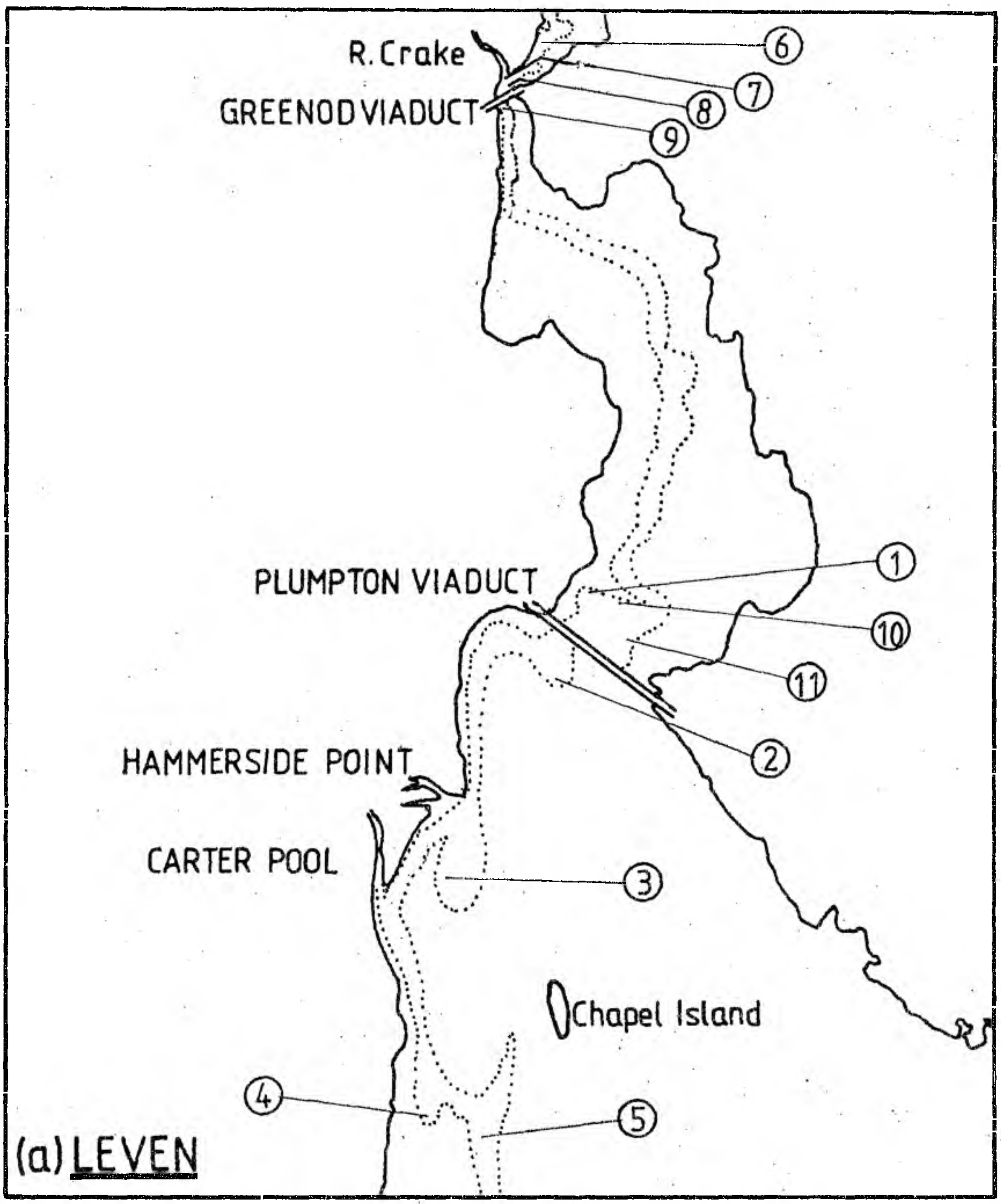


FIGURE 15: FISHING SITES FOR THE BEACH SEINE SURVEY OF THE KENT AND LEVEN ESTUARIES, AUGUST 1980



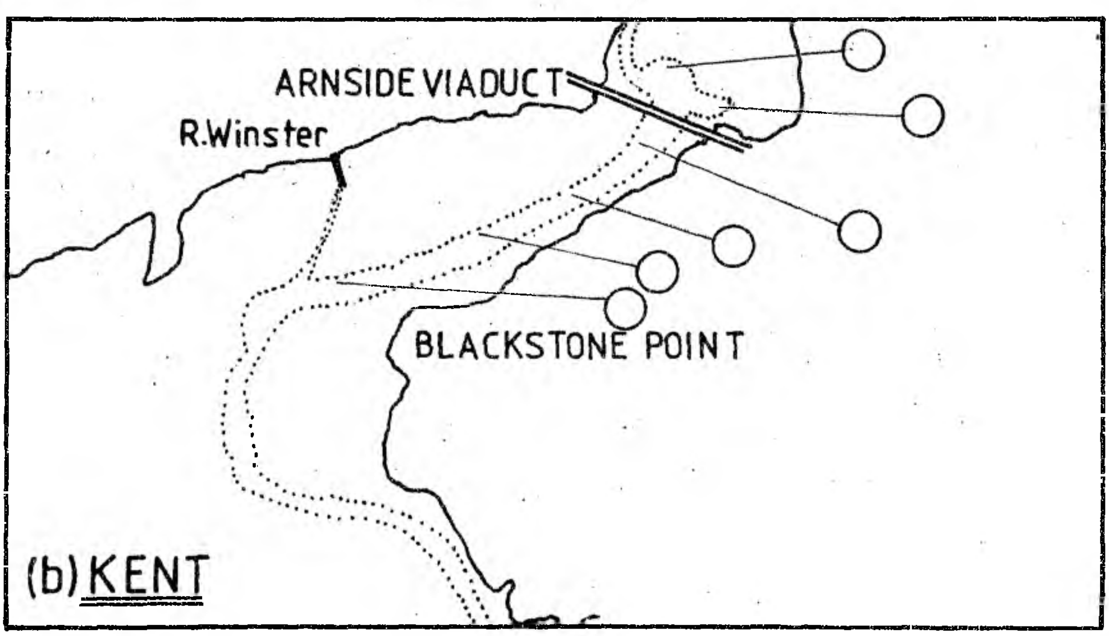
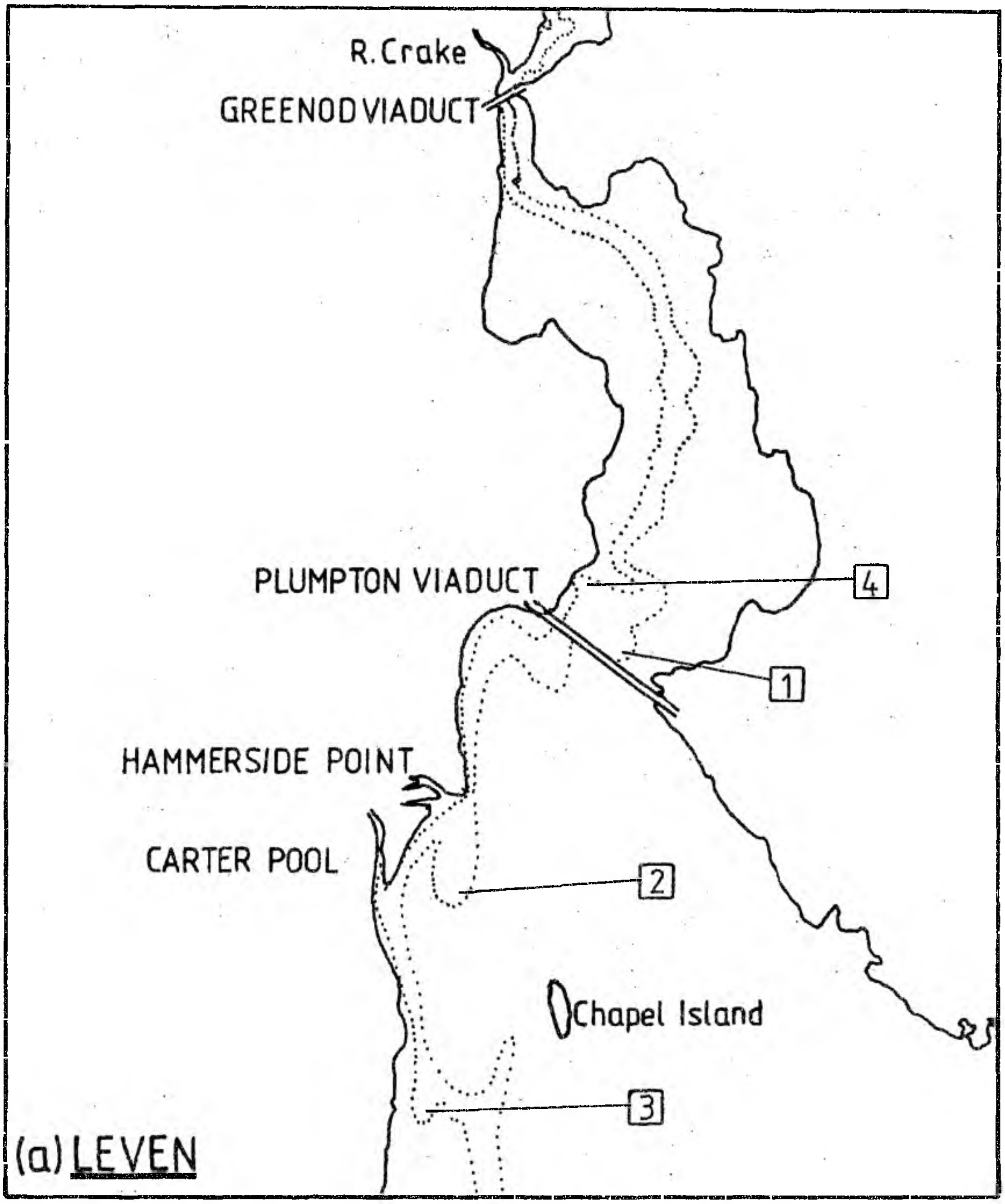


FIGURE 16: FISHING SITES FOR THE PUSH NET SURVEY OF THE KENT AND LEVEN ESTUARIES, AUGUST 1980



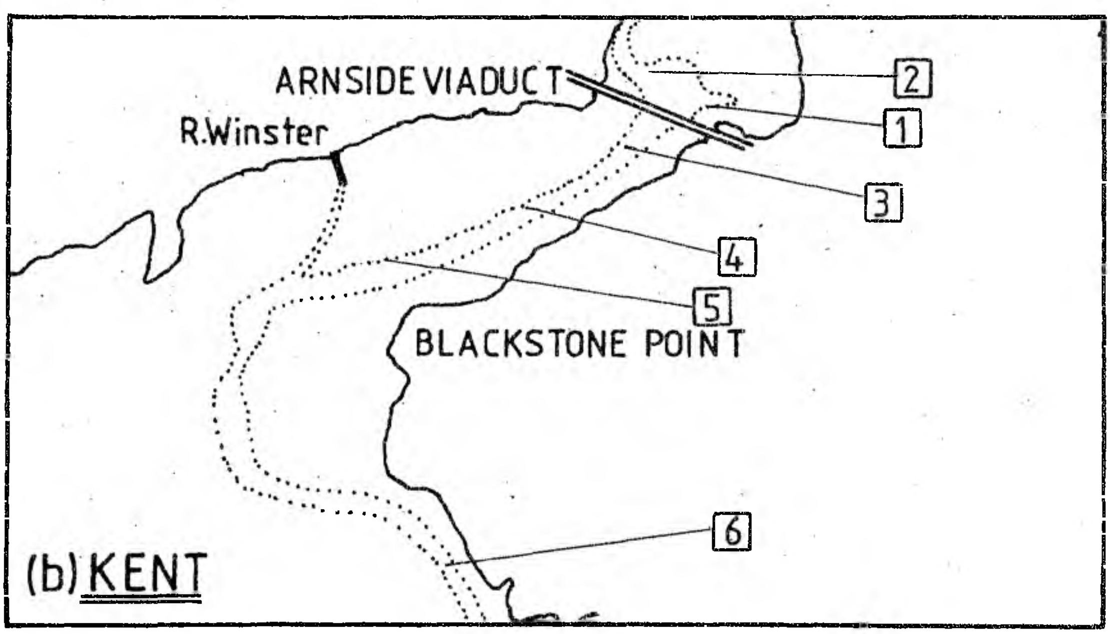


FIGURE 17: FISHING SITES FOR THE BEACH SEINE SURVEY OF THE KENT AND LEVEN ESTUARIES, JULY 1981

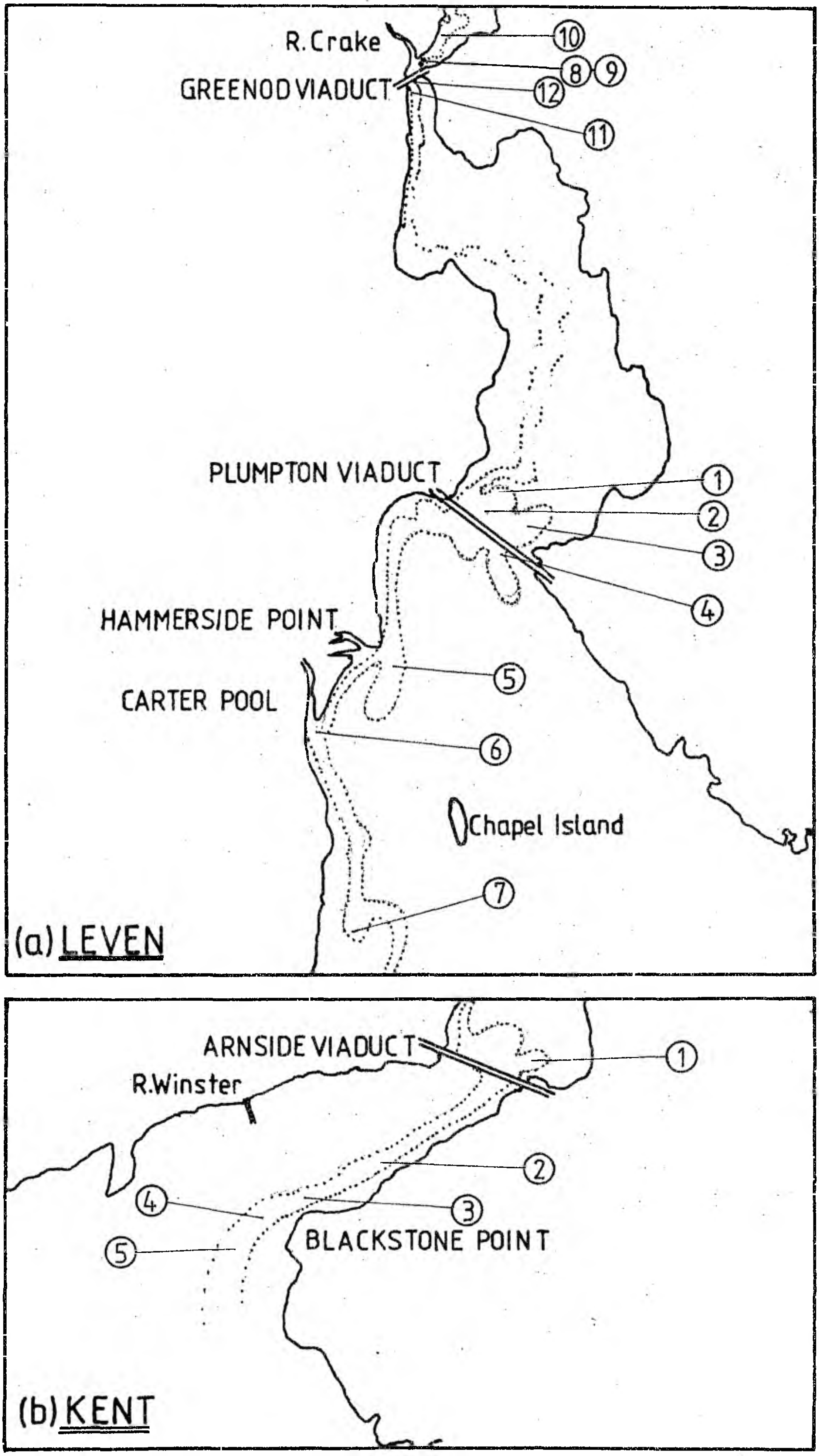


FIGURE 18: FISHING SITES FOR THE PUSH-NET SURVEY OF THE KENT AND LEVEN ESTUARIES, JULY 1981

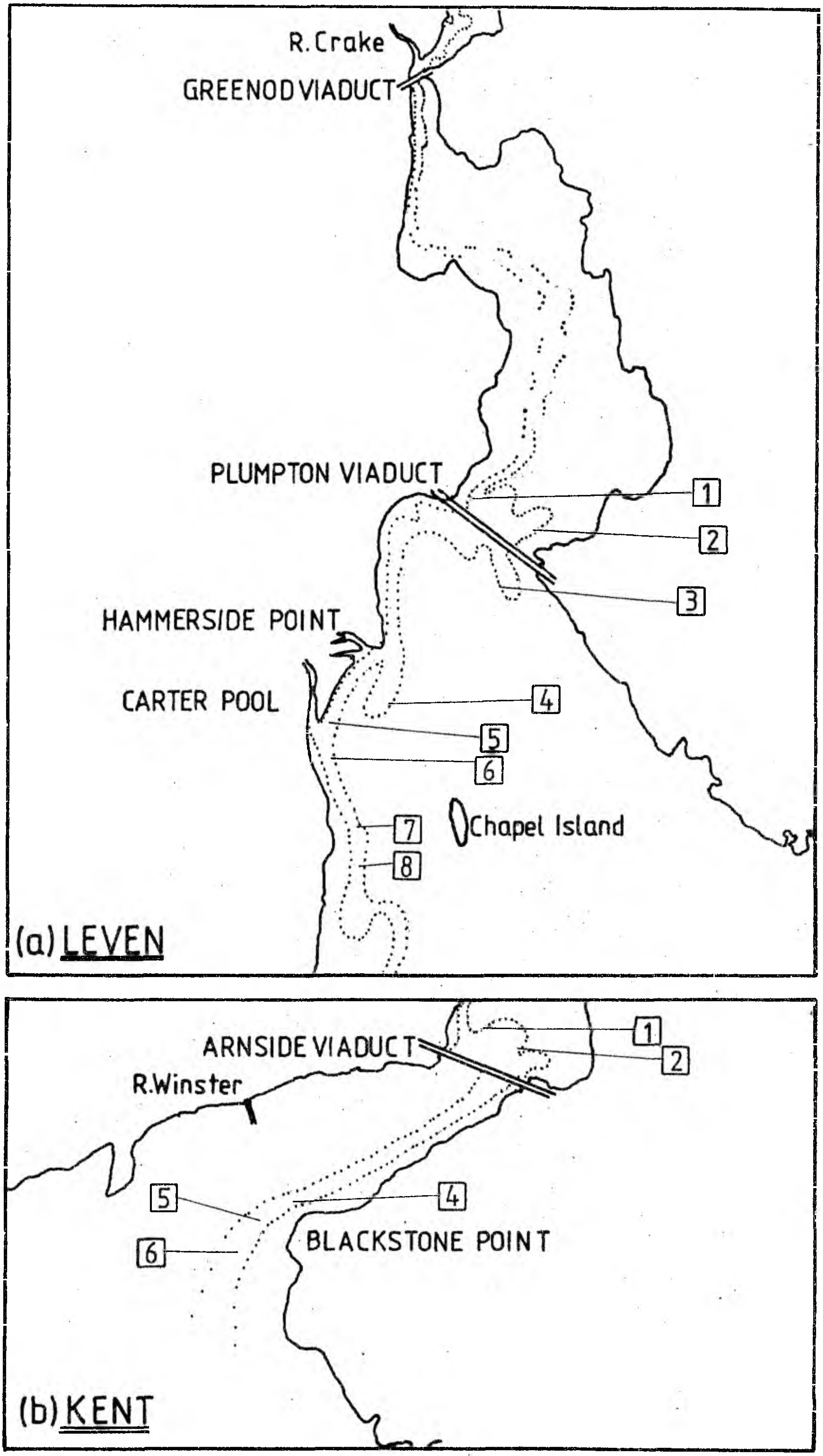
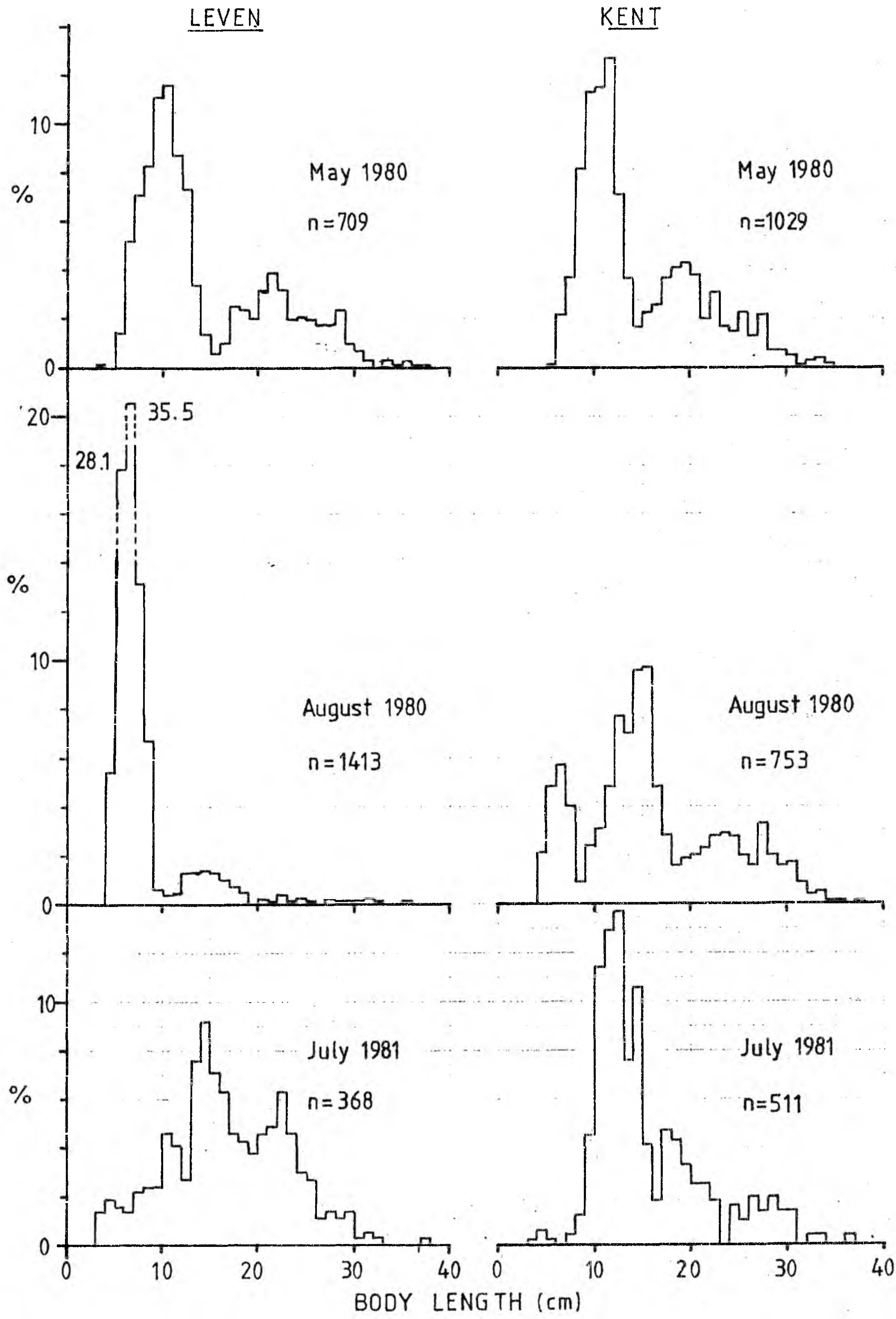


FIGURE 19: SIZE DISTRIBUTION OF FLOUNDERS FROM FISHING SURVEYS



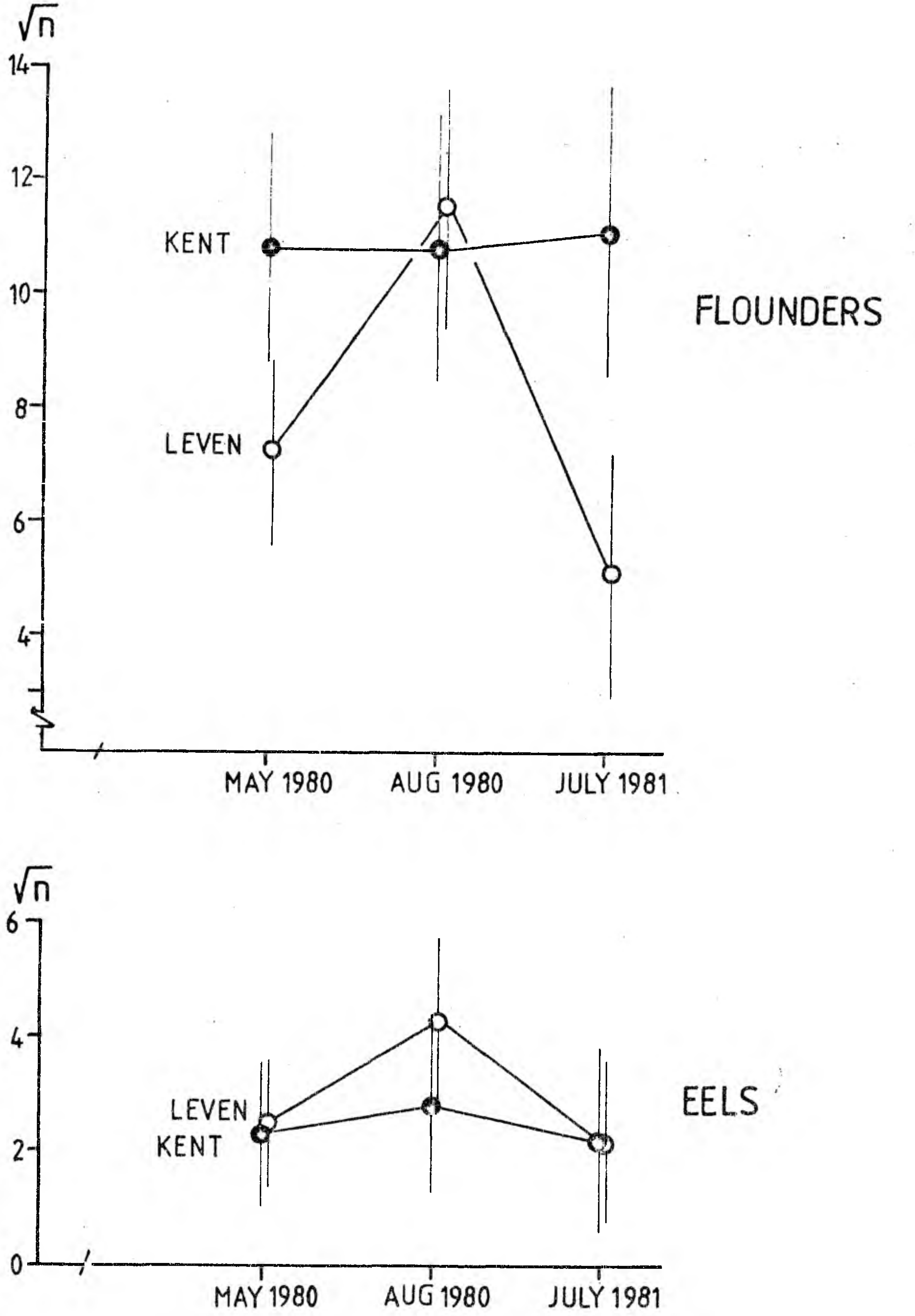


FIGURE 20: THE NUMBER OF FLOUNDERS AND EELS CAUGHT IN THE BEACH SEINE SURVEYS. EACH POINT IS THE MEAN SQUARE ROOT OF THE NUMBERS OF FISH PER HAUL FOR EACH SURVEY (± 1 SE)