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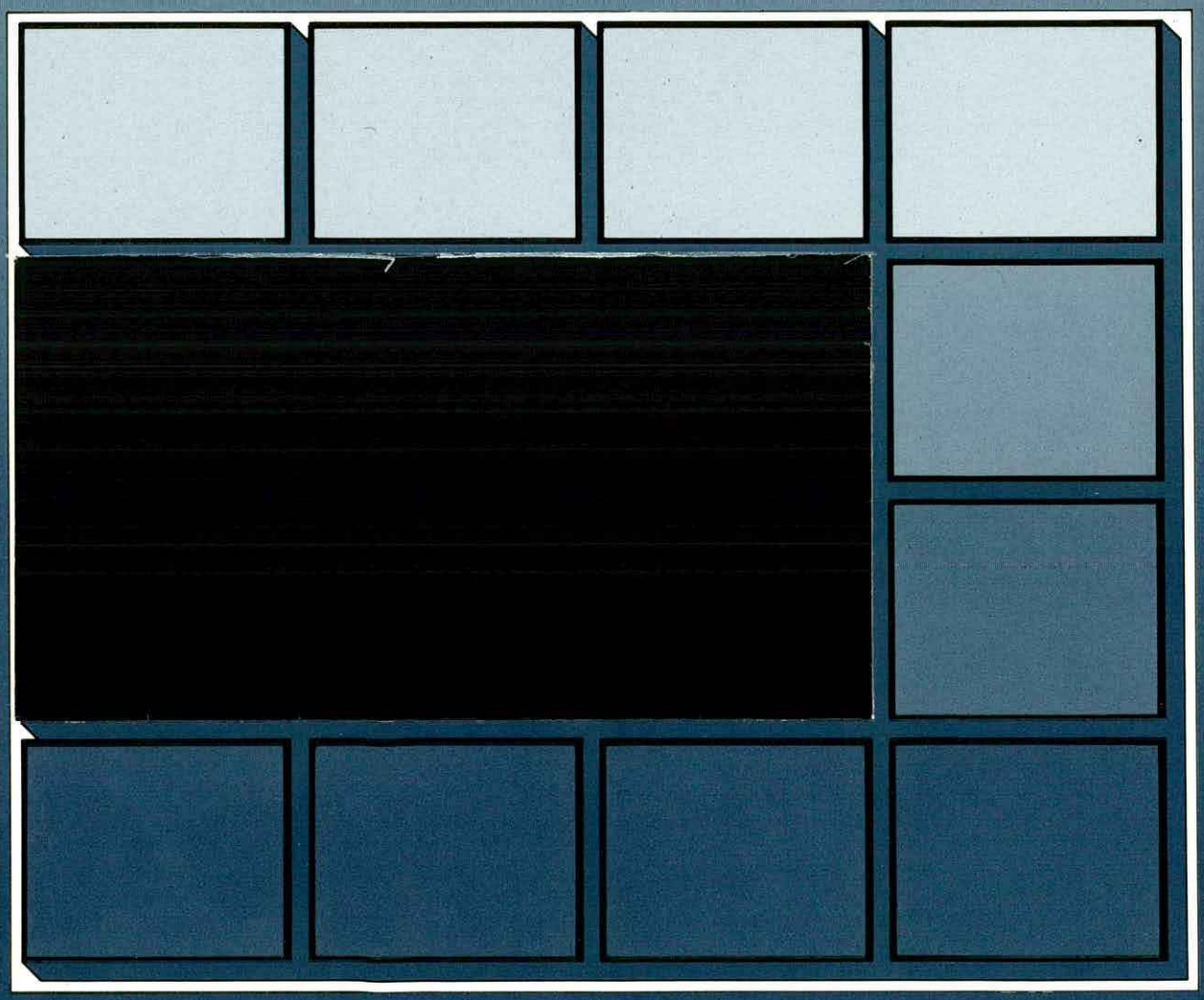

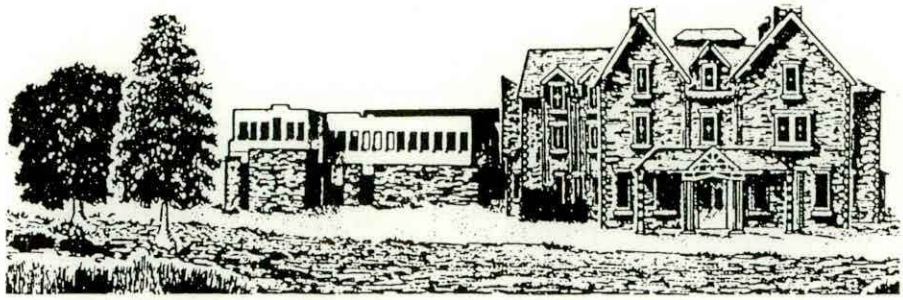

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The FBA's primary source of funding is the Natural Environment Research Council but, in addition, the Association receives substantial support from the Department of the Environment and the Ministry of Agriculture, Fisheries and Food who commission research projects relevant to their interests and responsibilities. It also carries out contracts for consulting engineers, water authorities, private industry, conservation bodies, local government and international agencies.

The staff includes scientists who are acknowledged experts in all the major disciplines. They regularly attend international meetings and visit laboratories in other countries to extend their experience and keep up to date with new developments. Their own knowledge is backed by a library housing an unrivalled collection of books and periodicals on freshwater science and with access to computerized information retrieval services. A range of experimental facilities is available to carry out trials under controlled conditions. These resources can be made available to help solve many types of practical problems. Moreover, as a member of the Terrestrial and Freshwater Sciences Directorate of the Natural Environment Research Council, the FBA is able to link up with other institutes to provide a wider range of environmental expertise as the occasion demands. Thus, the FBA is in a unique position to bring relevant expertise together for problems involving several disciplines.

Recent contracts have involved a wide variety of topics including biological monitoring, environmental impact assessment, fisheries problems, salmon counting, ecological effects of reservoirs and other engineering works, control of water weeds, control of insect pests and effects of chemicals on plants and animals.

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Dispersal of salmon (*Salmo salar* L.) fry from the point of stocking - experiment in Bollihope Burn, Co. Durham during 1988.

FRESHWATER BIOLOGICAL ASSOCIATION

TFS PROJECT T O 4009 - 5

Report to : Ministry of Agriculture, Fisheries and Food,
Northumbrian Water Authority,
Natural Environmental Research Council.

Date: 10 November, 1988

Dispersal of salmon (Salmo salar L.) fry from the point of stocking - experiment in in Bollihope Burn, Co. Durham during 1988.

D. T. Crisp

CONTENTS

SUMMARY

1. A batch of 1188 salmon fry were released at a point in Bollihope Burn, Co. Durham on 30 June, 1988 following an electrofishing census of indigenous brown trout and stone loach on 22 June, 1988.

2. On 5 September, 1988 a double electrofishing was performed at each of six marked stations within the stream. The results showed that:

(a) Some salmon fry had moved upstream for up to 50 m, despite the presence of a minor obstacle.

(b) Fry had moved downstream for at least 450 m.

(c) In September the dispersed fry were as large as, or larger than, those which remained close to the point of release.

(d) For downstream dispersing salmon, population density in September (y fish m^{-2}) could be related to distance downstream of the point of release (x m) by the equation $y = -0.0597 \ln x + 0.3773$.

3. A repeat of this experiment in 1989, using improved procedures, is suggested.

INTRODUCTION

There is debate over the extent to which young salmon disperse from the sites of redds after swim-up. Some workers consider that dispersal at this time is limited and that most supernumerary fry perish. This seems unlikely as appreciable dispersal should lead to higher survival rates and fuller exploitation of available habitat. The upper reaches of Bollihope Burn were used in a simple investigation of dispersal of young salmon following "point stocking".

THE STREAM

Bollihope Burn is a moorland tributary of the River Wear. A waterfall at Harewood Quarry some 650 m from the confluence with the R. Wear is impassable to adult salmon (Salmo salar L.) and sea trout (S. trutta L.). Upstream of the fall there are c. 10.5 km of potential spawning and nursery streams which contain indigenous populations of brown trout (S. trutta L.) and stone loach (Noemacheilus barbatulus L.).

SAMPLING STATIONS

The salmon fry were introduced immediately downstream of the road bridge at Nat. Grid Ref. NY/985352 and the 14 m length of stream immediately downstream of the bridge was designated "Station 2". The positions of five other stations, relative to Station 2, are shown on Figure 1. The dimensions and areas of the stations are given in Table 1. Between Stations 1 and 2, just upstream of the roadbridge, the stream flows over a smooth concrete ramp with a height of 0.6 m and a slope of 14°.

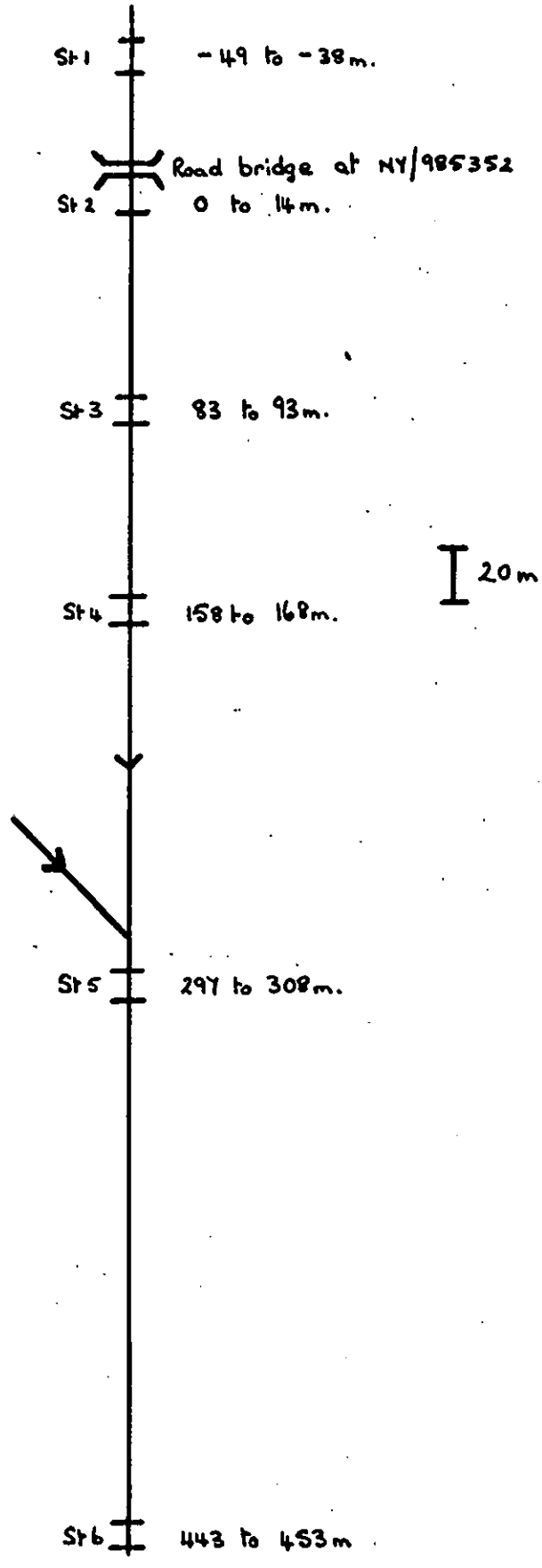

FIG. 1 Linear map of Bollihope Burn to show positions of sampling stations. The distances of the upper and lower ends of each station downstream from the downstream side of the road bridge are shown.

TABLE 1. Dimensions of Stations 1 to 6 in Bollihope Burn, based on measurements in dry weather on 14 June, 1988.

STATION NO.	Length (m)	Mean width (m)	Area (m^2)
1.	10.36	7.11	73.7
2.	14.02	6.10	25.5
3.	10.06	3.71	37.3
4.	10.06	3.76	37.8
5.	11.28	5.38	60.7
6.	10.06	4.17	41.9

The stations were selected, by eye, to all contain similar areas of shallow riffle, which is assumed to be good salmon habitat.

PREVIOUS STOCKING

In August 1986 22,000 underyearling salmon were stocked in Bollihope Burn by Mr J. Cave, on behalf of the Northumbrian Water Authority, at a site 800 m long downstream of Bollihope Bottoms Bridge (2.14 -2.94 km downstream of Station 1) after removal of about 70% of the indigenous brown trout population by electrofishing.

PROCEDURE & METHODS

Each station was given a double electrofishing on 22 June 1988 and estimates of the indigenous populations of trout and stone loach were obtained by the method of Seber & Le Cren (1967).

The salmon fry were fed fry from Kielder (NWA) hatchery. A subsample of 30 were killed, weighed and measured and 1188 fry were released at Station 2 on 30 June 1988.

On 5 September and 3 November each station was double fished and population estimates were obtained by the Seber & Le Cren method. There was some doubt about the continuity of operation of the electronic equipment on 3 November, so this account refers mainly to the results of 5 September.

Approximate estimates of biomass were obtained by use of the length:weight relationships given in Table 2. The relationships for trout were applied to both salmon and trout.

TABLE 2. Values of the constants a and b in the equation $w = a\ l^b$, where w = fish weight (g) and l = fish length (cm). Values of the correlation coefficient (r) and the probability (P) for the $\log_{10}$ transformed data are also shown. The data for trout refer to the Trout Beck system in the northern Pennines (Crisp et al. 1975). The relationship for stone loach is approximate and is based on mean lengths and weights given by Mann (1971) for two streams in southern England.

TROUT

Age group	Month	a	b	r	P
0	July/August	0.00621	3.4952	0.9772	<0.001
0	October	0.01313	2.9058	0.9704	<0.001
0/I	May	0.01313	2.9157	0.9339	<0.001
II and older	May	0.02516	2.6738	0.9876	<0.001
I and older	July/August	0.01540	2.8903	0.9935	<0.001
I and older	October	0.01076	3.0133	0.9877	<0.001

STONE LOACH

	All months	0.0065	3.166	-	-

RESULTS

1. Population densities and biomasses of trout and stone loach.

In June 0 group trout were found in Stations 1, 2 & 3 only, at population densities of 0.1 m^{-2} or less and biomasses of less than 0.075 g m^{-2} (Table 3). However, this probably reflects the small size and consequent difficulty of capture of these fish in June. In September they were recorded in all but one of the stations at rather higher densities than were estimated in June. Older trout were found at all stations at population densities of 0.1 to 0.5 fish m^{-2} and biomasses of 1 - 8 g m^{-2}. Stone loach were found at Stations 2 and 5 at low population densities and biomasses of 0.4 - 1.0 g m^{-2}.

2. Population densities and biomasses of salmon in September.

0 group salmon were found at all stations (Table 4), but in relatively low numbers and this is the main reason why it was not possible to attach 95% C.L. to the estimates. Population densities and biomasses were broadly similar to those observed for indigenous 0 group trout (Table 3).

3. Dispersal of 0 group salmon between June and September.

The data (Table 4) clearly show that between 30 June and 5 September the 0 group salmon dispersed from Station 2 to all other stations and gave population densities and biomasses in those other stations similar to those of 0 group trout (Table 3). The presence of salmon in Station 1 is clear evidence of upstream movement, which includes scaling the concrete ramp. Downstream dispersal covered a distance of at least 450 m.

TABLE 3. Estimated population densities and biomasses of 0 group trout, older trout and stone loach in June and September 1988. Electrofishing efficiences varied from 44 to 100% but were generally over 60% in June and 55% in September. 95% C. L. are given where appropriate.

		22 June 1988			5 September 1988		
	Station	0 Group trout	Older trout	Stone loach	0 Group trout	Older trout	Stone loach
Population density	1	0.014	0.145 ± 0.038	-	0.014	0.122	-
(no. m^{-2})	2	0.012	0.180 ± 0.019	0.059	0.158 ± 0.039	0.115 ± 0.002	0.047 ± 0.081
± 95% C.L.	3	0.107	0.447 ± 0.223	-	0.121 ± 0.080	0.322	-
	4	-	0.318	-	-	0.238	-
	5	-	0.211 ± 0.105	0.066	0.017	0.191 ± 0.040	0.017
	6	-	0.263	-	0.024	0.215 ± 0.101	-
Biomass	1	0.007	2.595	-	0.034	2.846	-
(g m^{-2})	2	0.004	1.668	0.530	0.442	2.012	1.012
	3	0.072	6.712	-	0.435	8.191	-
	4	-	7.177	-	-	6.306	-
	5	-	3.463	1.075	0.042	3.949	0.420
	6	-	4.462	-	0.069	2.967	-

TABLE 4. Estimated minimum population density and biomass of 0 group salmon at each station on 5 September, 1988. Mean weight of salmon and number captured (in parenthesis). are also shown.

STATION	Minimum Population density (No. m^{-2})	Minimum Biomass (g m^{-2})	Mean weight $fish^{-1}$ (g)
1.	0.027	0.100	3.70 (2)
2.	0.269	0.481	1.79 (23)
3.	0.107	0.186	1.74 (4)
4.	0.053	0.118	2.23 (2)
5.	0.016	0.052	3.16 (1)
6.	0.048	0.129	2.71 (2)

The estimated mean weights of fry at stations other than Station 2 (Table 4) are based on too few fish to be conclusive. However, they do suggest that the fish which dispersed from the area of release either were above average size when they dispersed or had grown more rapidly after dispersal than had those fish which did not disperse.

The population density at each downstream station in September (y fish m^{-2}) can be related to distance downstream of the point of release (x, m) by the equation:

$y = -0.0597 \ln x + 0.3773$ ($n = 5$, $r = -0.9739$ and $P < 0.001$.)

Predictions based on this equation are a good fit (Chi-squared = 0.49, $P > 0.99$) to the observed population densities.

4. Growth of 0 group trout and salmon.

The growth of 0 group trout and salmon between June and November is summarized in Table 5. The initial and final weights of the trout were higher than those of the salmon. However, the instantaneous growth rates of the salmon were rather higher than those of the trout.

5. Upstream movement of salmon from the 1986 stocking.

During electrofishing on 3 November 1988 a salmon of 13.0 cm (24 g) was taken at Station 6 and another of 13.8 cm (29 g) was taken at a site c.100 m upstream of Bollihope Bottom Bridge (NY/004350). These two fish were almost certainly residual fish from the stocking in 1986 and had moved at least 1685 and 100 m, respectively, upstream of the area where they were originally released.

TABLE 5. Mean weight and mean instantaneous growth rate day^{-1} for 0 group trout and salmon in Bollihope Burn.

Mean Instantaneous growth rate day^{-1} = $\bar{G}_w = \dfrac{\ln w_t - \ln w_o}{t}$

Where w_o is weight at start, w_t is weight after time t and t is time in days.

Date	Trout	Salmon
	Mean weight (g) ± 95% C.L.	
22 June	0.694 ± 0.251	
30 June		0.504 ± 0.068
5 September	2.945 ± 0.352	2.173 ± 0.244
3 November	2.974 ± 0.530	2.446 ± 0.283
	Instantaneous growth rate day^{-1}	
June - September	0.0193	0.0218
June - November	0.0109	0.0125

DISCUSSION

The present data have several deficiencies. The main problems arose from the relatively small number of salmon stocked. This led to lack of precision in the population estimates. Nevertheless the results clearly showed that upstream dispersal of up to 50 m can occur, despite the presence of obstacles, and that downstream dispersal occurs to distances of at least 450 m.

The stocked fish were "fed fry", though not far past the swim-up stage. It is doubtful whether the use of "fed fry" rather than "unfed fry" affected the results obtained.

It is arguable that it would have been valuable to obtain census data on several occasions between the time of stocking and 5 September. This temptation was deliberately avoided in order not to disturb the population until it had had time to disperse and until individual fish were large enough to be efficiently and harmlessly sampled by electrofishing.

It would be useful to repeat this experiment in 1989 and, in the light of experience gained in 1988, the following modifications in procedure are suggested:

(i) Use larger numbers of salmon. At least 2000 should be used, preferably more. However, this will depend upon availability.

(ii) Add at least one new station c.1000 m downstream of the Station 2, and, if necessary, eliminate one or more of the 1988 stations to compensate.

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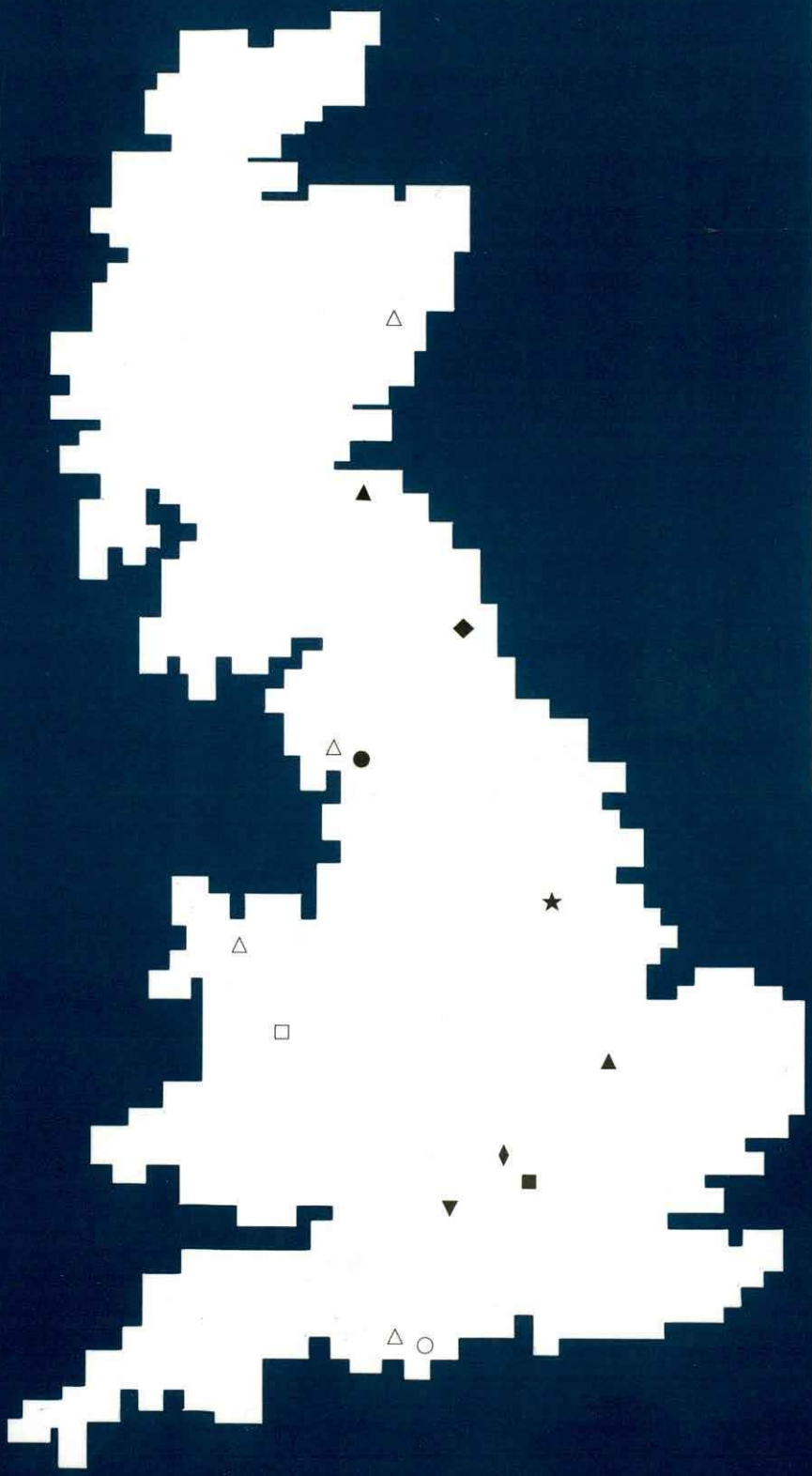

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