

**Research into herring population structure**

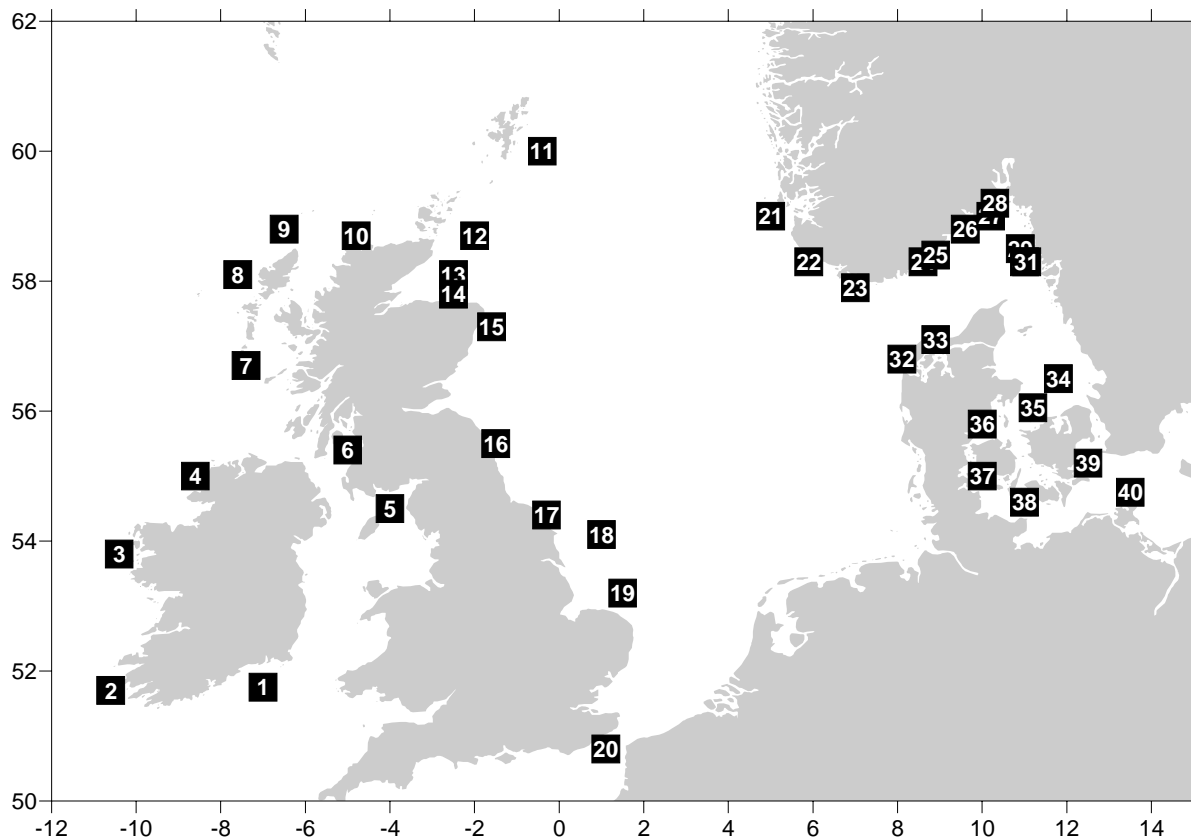
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In Northern Europe the distribution of herring extends from the Celtic Sea, up the western shelf, into the Barents Sea, through the North Sea and into the Baltic. Herring have existed for millions of years and stocks have lived in the seas around Northern Europe at least since the last ice age. They are well suited to their environment. They have survived through periods when the climate was much colder and much warmer than it is now. But at those times there were no major fisheries. Today the stocks have found a number of different strategies to be successful. They overlap with one another at different times of year, spawning in either autumn, winter or spring, in distinct areas. All of these stocks are fished commercially. If these stocks mix together and interbreed freely then there are no specific genetic issues to concern us about which fish are caught where. However, if the different stocks do not interbreed and they are genetically different then it's important to ensure that each one survives. Generally, for any fish species that is made up of different stock components, it's more dangerous for the population if we fish out one or more components, and this can easily happen even when fisheries are tightly regulated and controlled. Heavy fishing on one component can make the population more sensitive to changes in the environment. If one component is lost we may have accidentally removed the one that is best suited to the new situation! Therefore protecting all the stock components is the best safeguard for the future, especially if the environment is changing.

FRS Marine Laboratory, Aberdeen is currently involved in two EU funded projects to investigate the stock structure of herring in the North Sea and to the west of Scotland. These two projects are known as HERGEN and WESTHER and also involve scientists from Denmark, Germany, Ireland, the Netherlands, Norway and other UK laboratories, covering the stocks in their areas. The projects aim to investigate differences in the composition of these herring stocks. The reason for these two projects is that we are uncertain about just how separate the herring populations are to the east and west of the British Isles, in the north and south of the North Sea and in the entrance to the Baltic. Currently North Sea herring in ICES Divisions IV & VIIId are assessed as a single stock. Management also tends to reflect this rather uniform treatment. However, the Downs herring from the southern North Sea spawns at a different time and in a different location and grows at a different rate from the northern North Sea herring. Within the North Sea fishery the mixing of herring with adjacent stocks from the west of Scotland and the Western Baltic complicates the estimates of stock size and the management situation. Conversely, to the west of the British Isles herring are distributed over a wide area, with several discrete fisheries in existence, all assessed and managed separately (west of Scotland, north and west of Ireland, Irish Sea, Celtic Sea and the Clyde). In the assessment of these stocks there is uncertainty about the current level of fishing and this is compounded by a lack of knowledge on the correct identity of distinct stocks. While the fisheries are managed in distinct units, the herring themselves may not observe similar boundaries, and therefore current management areas may contain more than a single discrete stock.

**Spawning areas and spawning time for herring with map reference number**

Map Number	Location	Spawning time	Map Number	Location	Spawning time
1	Celtic Sea	Winter/Spring	21	Karmøy	Spring
2	SW Ireland	Winter/Spring	22	Siragrunnen	Spring
3	Rosamhil	Winter	23	Lindesnes	Spring
4	Donegal	Winter/Spring	24	Risørfjorden	Spring
5	Irish Sea	Autumn	25	Kragerø	Spring
6	Clyde	Spring	26	Langesundsbukta	Spring
7	Barra Head	Autumn	27	Stavern	Spring
8	Western Hebrides	Spring	28	Tjøme	Spring
9	Butt of Lewis	Autumn	29	Hamburgsund	Spring
10	Cape Wrath	Spring & Autumn	30	Ftatbotten	Spring
11	Shetland	Autumn	31	Maaseskaer	Spring
12	Orkney	Autumn	32	Limfjord	Spring
13	Moray Firth	Autumn	33	Limfjord	Autumn
14	Buchan	Autumn	34	Middelgrund	Winter
15	Aberdeen	Autumn	35	N of Sjaelland	Spring & Autumn
16	Longstone	Autumn	36	Lillebaelt North	Spring & Autumn
17	Flamborough	Autumn	37	Fåborg	Winter
18	Dogger	Autumn	38	Fehmarn	Autumn
19	East Anglia	Autumn	39	East of Møen	Autumn
20	Downs	Winter	40	Rügen	Spring



**Spawning areas for herring from the Celtic Sea to the Norwegian Coast and the Baltic**

In order to find out if the population of herring around the British Isles is made up of different stocks, we want to determine if there are genetic differences between the various spawning components of herring in the North Sea (Orkney/Shetland, Banks, Buchan & Downs), Skagerrak, Kattegat, Western Baltic, west of Scotland, north, west and south of Ireland and in the Irish Sea. To do this we are collecting samples of spawning ('ripe-and-running') fish to ensure that these fish are caught on their spawning grounds so we may know the identity of the herring we have sampled. The Figure and Table show the approximate locations of spawning areas and when the fish spawn. These data will allow us to detect even small genetic differences. Other studies have detected population structure in cod and mackerel. FRS Marine Laboratory is responsible for collecting the samples from the west of Scotland, Orkney/Shetland, Buchan/Aberdeen and Banks areas.

In the HERGEN project we will use a number of genetic markers for the study of stock structure. Two of these are microsatellite DNA and allozymes. The analysis of microsatellite DNA is now believed to be the most powerful technique to detect even very small differences between individuals. Allozyme analysis uses enzymes (proteins) to detect genetic diversity. This method is a less powerful technique than DNA techniques but it will provide HERGEN with the chance of a temporal comparison with data available from previous studies in the 1980s and 1990s. The sampling procedures require that we sample fresh fish

that has not been frozen (if it's fresh enough to eat it's fresh enough for a sample). We are taking two different types of tissue samples – fin-clips, from which the DNA will be extracted for microsatellite analysis, and eye, liver and muscle tissue, from which enzymatic proteins will be obtained for allozyme analysis. Fin-clip samples will be taken from all areas shown above. Allozyme samples are only required from the Aberdeen/Buchan and Banks areas as these areas, along with some in the Kattegat, were sampled some years ago.

In WESTHER we will extend the observations to include sampling for juveniles particularly to the west of Scotland, around Ireland, and in the Moray Firth. From this information we hope to understand more about the nursery grounds for the young for each stock. In addition to the genetic information to separate spawning components, the herring will also be sampled for the parasites that they pick up early in life. Different parasites are acquired in different places and these will provide a form of natural tagging to allow a better understanding of the migrations of herring at different stages of their lives. Several other non-genetic techniques will also be used to try to determine stock differentiation.

The results of both projects aim to provide information on how best to protect the herring stocks around the UK for the future. The studies will also allow us to find out which data must be collected to monitor the populations, taking into account genetic diversity and practical management issues.