**Cluster analysis:  
What cluster analysis is doing is setting an initial cluster (numbers defined by numbers of reference locations we have) and measuring that distance of rest of points of reference location and assign each points to the nearest cluster. (hence become ellipse graph but no overlaps in between, since all the data gets assigned to the nearest cluster)**

**The table below shows within those clusters, how many points belongs to each reference location after clustering are done.**

Barents Sea Celtic Sea Icelandic Sea Irish Sea North Sea Norwegian Sea

1 0 7 100 3 4 0

2 0 2 0 0 43 99

3 0 6 0 0 78 0

4 50 7 0 8 0 0

5 0 41 0 6 51 0

6 0 0 0 0 61 0

**We can see that in cluster 1, majority falls to Icelandic sea, therefore that cluster are dominated by Icelandic sea data points. Cluster 2 has both North Sea and Norwegian Sea, suggesting those locations share a similar chemical composition. Cluster 3 suggests Majority lies in North Sea and very few in Celtic sea. Cluster 4 suggests majority of the data points around that area are assigned to Barents Sea, suggesting it being distinct to the other seas. Cluster 5 shows data points can be assigned to both Celtic and North Sea, suggesting Celtic and North Sea share very similar chemical composition. And finally, cluster 6 shows the data points all belong to North Sea. Therefore, any data points around that C:N is definitely from North Sea.**

The 6 different clusters created through the cluster analysis showed high distinctiveness of the data from the Barents and Icelandic Seas. However, large overlap in chemical composition is seen between the North Sea, Irish Sea and Celtic Sea.

As can be seen in figure X, whilst there is relatively low variance within the non-UK fisheries compared to the UK fisheries. On the other hand, there is significant overlap between these and the UK fisheries; in the case of the Norwegian Sea in fact the entire variance was contained within the larger North Sea spread.

However, these analyses show overall that whilst there is significant overlap in many areas between UK offshore Seas and the Icelandic, Barents and Norwegian Seas, the data do show observably different variance according to geographic origin. Accordingly, for some areas, ascertainment of geographic origin of samples through comparison of stable isotope composition with these reference data would be possible.

A close up of a map

Description automatically generated

A screenshot of a computer

Description automatically generated

A screenshot of a cell phone

Description automatically generated

Linear Discriminant analysis

% if same value was inputted and returning it to original data.

barents sea celtic sea icelandic sea irish sea north sea norwegian sea

1.0000000 0.5396825 1.0000000 0.0000000 0.7848101 1.0000000

Sum of

[1] 0.8286219

[1] north sea north sea north sea north sea

[5] north sea north sea north sea celtic sea

[9] north sea north sea north sea north sea

[13] north sea north sea north sea north sea

[17] north sea north sea north sea north sea

[21] north sea north sea north sea north sea

[25] north sea north sea north sea north sea

[29] north sea celtic sea celtic sea barents sea

[33] celtic sea

6 Levels: barents sea celtic sea ... norwegian sea

[1] Atlantic Atlantic Atlantic Atlantic

[5] Atlantic Atlantic Atlantic Atlantic

[9] Atlantic Atlantic Atlantic Atlantic

[13] Atlantic Atlantic Atlantic Atlantic

[17] NE Atlantic NE Atlantic NE Atlantic North Sea

[21] North Sea North Sea North Sea North Sea

[25] North Sea North Sea North Sea North Sea

[29] Scotland Scotland Scotland Scotland

[33] Scotland

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Location stated on product label | | | |
| Statistically probable origin of sample | Atlantic | NE Atlantic | North Sea | Scotland |
| North Sea | 15 | 3 | 9 | 1 |
| Celtic Sea | 1 | 0 | 0 | 3 |
| Barents Sea | 0 | 0 | 0 | 1 |
| Irish Sea | 0 | 0 | 0 | 0 |
| Norwegian Sea | 0 | 0 | 0 | 0 |
| Icelandic Sea | 0 | 0 | 0 | 0 |