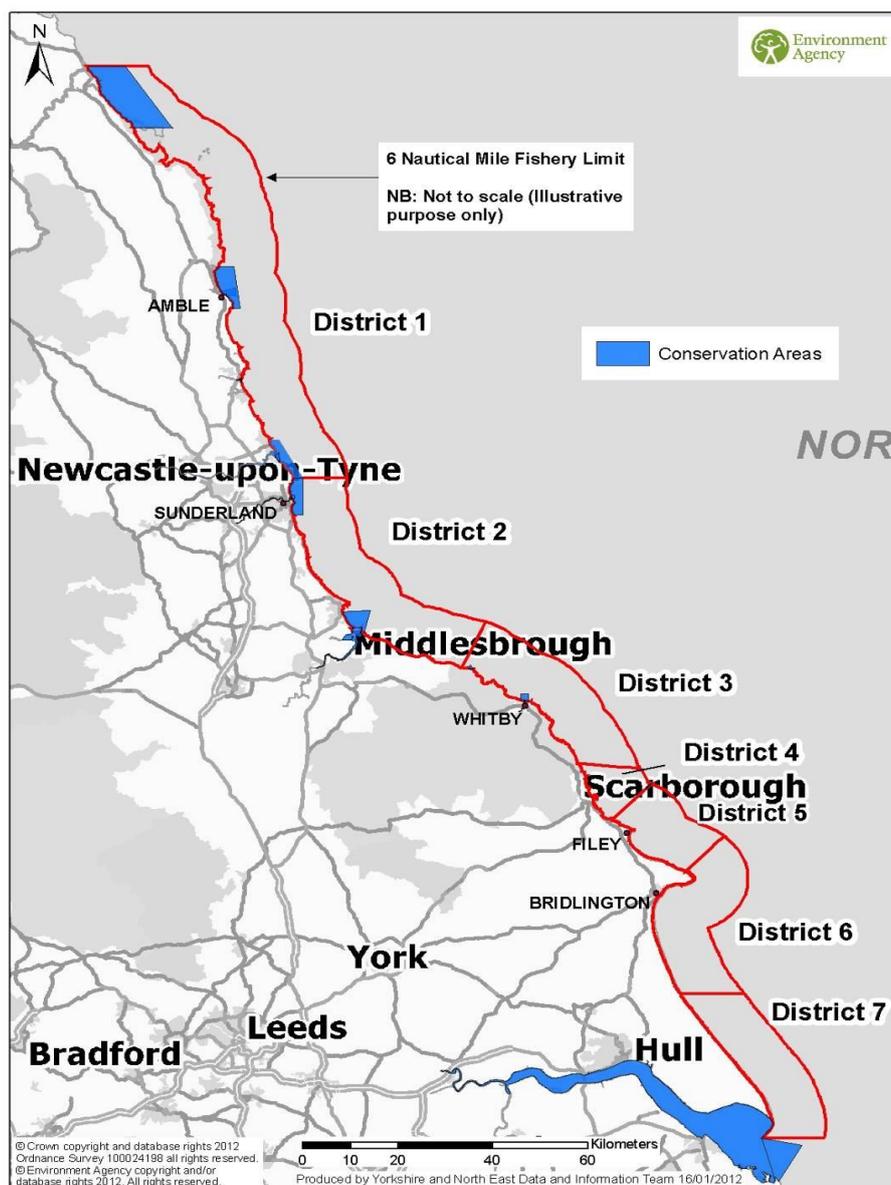


## Appendix 4: Evidence for the Mixed Stock Fishery status of the North East Coast Net Fishery

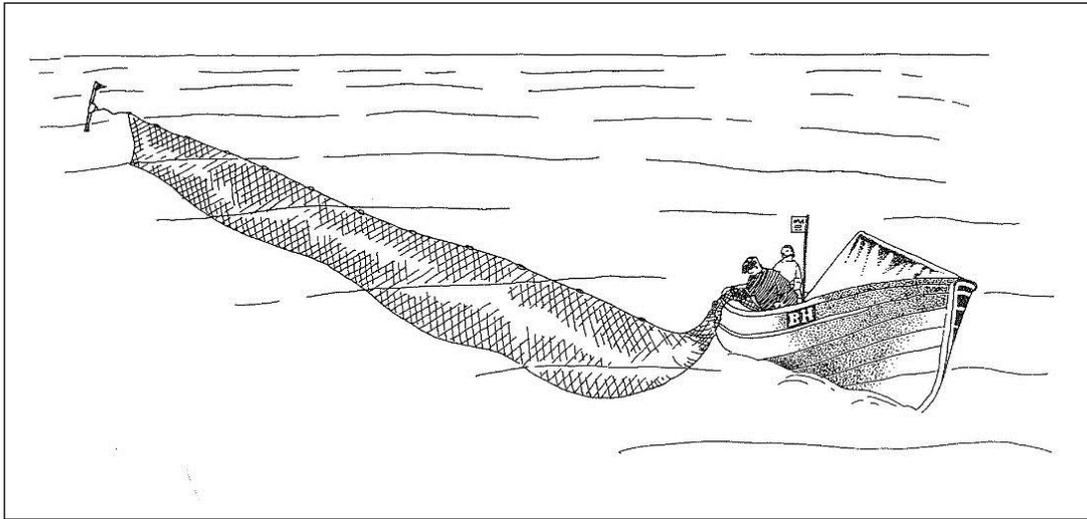
### Introduction

The North East Coast Net Fishery is the largest remaining coastal salmon and sea trout net fishery in England and Wales. The fishery is divided into 7 districts, extending from the Scottish border to Spurn Point on the Humber estuary. Fishing is from small boats using drift nets operated up to six miles offshore and with 'T' and 'J' nets ('fixed engines') anchored to the seabed close to the shoreline.

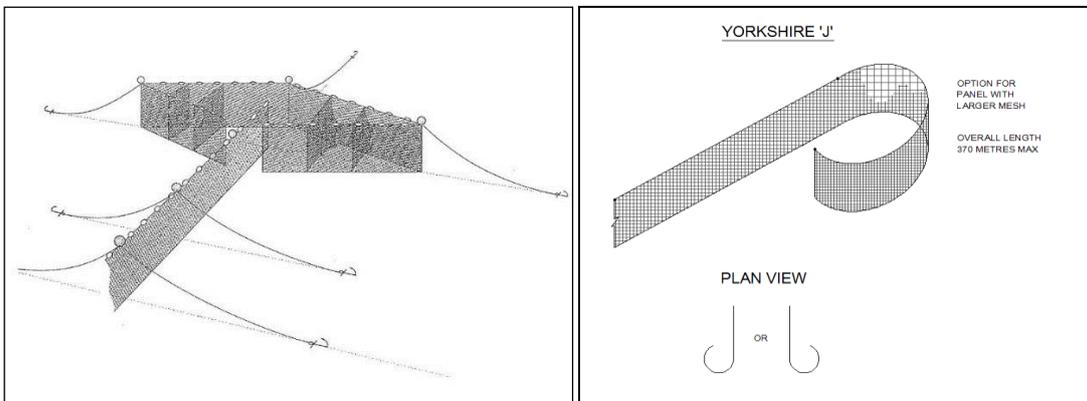
The North East Coast Net Fishery operates as a coastal mixed stock fishery, in that both drift nets and beach (T and J) nets exploit a large number of salmon from a number of different rivers in eastern Britain. A map of the fishery and diagrams of the types of nets used are shown below:



Map showing the extent of the Yorkshire and North East coastal net fishery

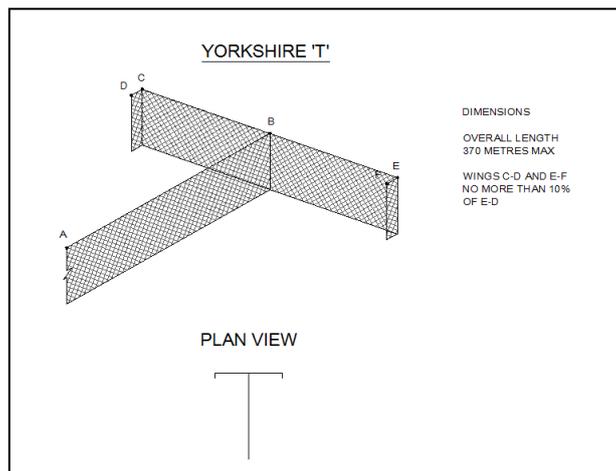


Drift net – mostly operating in district 1



Northumbrian T net – operating in district 1

J net – operating in districts 3-5



Yorkshire T net, operating in districts 6&7

## Mixed Stock Fishery Status

There are multiple lines of evidence confirming the mixed stock fishery status of the North East Coast Net Fishery, which are summarised below.

### Adult tagging studies

- Early adult tagging studies in the late 1970's were undertaken by the Ministry of Agriculture, Fisheries and Food (MAFF) to determine the origin of salmon captured in the North East Coast Net Fishery. In 1977, a total of 670 adult salmon were captured in drift and T nets, and externally tagged before being released.
- Subsequent recaptures of these tagged fish in other fisheries indicated that they returned to all the major east coast British salmon rivers, from the river Wear in the south to the Aberdeenshire Dee in the north. This study also showed drift nets exploited fish from a wider range and larger number of rivers than T nets.

### Juvenile tagging studies

- In 1983, in response to ICES North Atlantic Salmon Working Group recommendations, a programme of microtagging was initiated in the north east of England by MAFF and the National Rivers Authority. Microtags are very small pieces of coded wire inserted under anaesthetic into the cartilage in the nose of juvenile salmon and sea trout that can subsequently be detected and read by scanners.
- The programme enabled an assessment of the patterns of exploitation of salmon and sea trout from the Yorkshire and North East region's rivers in the North East Coast Net Fishery, as well as contributing to estimates of exploitation on national stocks in various interception fisheries.
- Between 1983 and 1994, over 670,000 salmon, and a small number of sea trout reared at Kielder Salmon Centre were microtagged before release to all the region's principal salmon rivers as one year old parr. Over 70,000 wild salmon and over 40,000 wild sea trout from the rivers Wear, Yorkshire Esk and Coquet were also captured as smolts and microtagged during this period.
- Microtagged fish had their adipose fin removed as an identifying feature, and the net fishery was scanned for recaptures through a targeted programme of checking the landed catch. While most of the tags recovered during screening originated from the fish tagged in north-east rivers, the scanning programme also resulted in the recovery of some fish tagged in Scotland, as well as smaller numbers tagged in other areas.
- The majority of salmon from all rivers of origin were recovered in the northern part of the fishery, where fishing effort was greatest. This pattern was particularly pronounced for the more northern rivers, reflecting the abundance of fish returning to their native rivers. The majority of these recoveries were from drift nets.
- The observed patterns of recoveries reflect both the migration routes of returning adult fish and levels of fishing effort across the fishery.
- The districts in the Yorkshire area of the fishery, where fishing effort is lower, and at a greater distance from the principal salmon rivers, take fewer salmon. Salmon from the River Yorkshire Esk showed a higher relative exploitation in areas which are closest to the river, but half of all Yorkshire Esk salmon recoveries were from the northern part of the fishery.
- The pattern of exploitation for sea trout showed a greater degree of local exploitation. This presumably reflects a higher exploitation rate for sea trout in the T and J nets than in drift nets, in part at least reflecting differential gear selectivity.
- Sea trout were predominantly taken in the district containing the home river, although sea trout from all three rivers Yorkshire Esk, Wear and Coquet where tagging had taken place were captured in nets across the whole fishery.

## Genetic studies

Both Atlantic salmon and sea trout exhibit strong homing behaviour and return to spawn in their native rivers and streams. This results in relatively distinct groups of interbreeding individuals which have a degree of reproductive isolation. Therefore, distinct genetic groups can develop between rivers. Such genetic structuring can be exploited to investigate the composition of fish catches by river of origin. Two differing genetic techniques have been employed to analyse catches.

### Salmon genetics - Microsatellite Analysis

- In 2011, a Mixed Stock Analysis (MSA) was undertaken by Marine Scotland Science (MSS) which developed a baseline of genetic microsatellites to describe genetic variation across the geographic range from which the salmon contributing to the net fishery may have originated.
- The analysis compared genetic samples from fish sampled from the net fishery to the reference genetic baseline of juvenile salmon sampled from those rivers which were likely to have contributed fish to support the fishery. This was used to assign captured fish to their likely geographic area or river of origin, based upon statistical probability.
- The baseline was comprised of genetic samples from 65 rivers. This baseline was developed using all stocks likely to contribute to the North East Coast Net Fishery, and stretched from northern Scotland, through England into France and northern Spain.
- Genetic samples were taken from almost 2,000 salmon from the North East Coast net fishery in 2011. These samples were then compared to the reference baseline. Whilst it was not possible to assign salmon to their river of origin by this method, it was possible to determine the proportion of the net catch that originated from north east English and Scottish rivers, as regional groups.
- Analyses demonstrated that all parts of the North East Coast Net Fishery exploited mixed stocks, taking salmon from both the English and Scottish groups of rivers.
- The estimated proportion of Scottish origin fish was 70-75 per cent in the Northumbrian drift nets, 30-50 per cent in the Northumbrian T nets, 60-70 per cent in the Yorkshire drift nets and around 50 per cent in the Yorkshire J nets.
- These figures reflect the composition of the sample taken, and it is recognised that these levels are likely to vary across years. However, this estimate shows close agreement with recent Cefas estimates, based on earlier tagging and changes in stock status, of 63-65 per cent Scottish salmon in the north-east net catch.

### Salmon - Single Nucleotide Polymorphic analysis

- In 2013, MSS applied an alternative genetic technique to determine the origin and proportions of different stock components captured in the North East Coast Net Fishery. The samples collected from the fishery in 2011 were also used in this study.
- The genetic baseline used consisted of genetic samples from 27 salmon rivers in Scotland and north-east England, screened to develop a panel of Single Nucleotide Polymorphic (SNP) markers.
- A total of 1,000 fishery samples were screened at the SNP markers and proportions of fish in the different fisheries estimated using genetic Mixed Stock Analysis (MSA) techniques.
- This analysis confirmed again that all parts of the North East Coast Net Fishery exploits mixed stocks of both Scottish (c.47%) and English (c.53%) origin salmon.

### Sea Trout - Single Nucleotide Polymorphic analysis

- In 2011 a panel of Single Nucleotide Polymorphic markers was developed by the Danish Technical University (DTU) from samples taken from 40 sea trout rivers across the North Sea region, to investigate the origin of sea trout contributing to the North East Coast Net Fishery.

- Samples of genetic material were collected from 917 sea trout, during the 2011 netting season from a number of locations across the fishery, and screened using the panel to determine their river of origin.
- This analysis confirmed that sea trout from a large number of catchments were exploited by the fishery. The majority of sea trout originated from rivers in Yorkshire and the north-east, and from the Tweed, with a smaller number from other Scottish rivers including the Spey and Deveron. Smaller numbers of sea trout from the Adur in Sussex and the west coast of Denmark were also recorded in the sample.

## Summary

- The results of the earlier tagging studies of both adult and juvenile salmon are consistent with the later genetic analyses, all of which indicate both the drift nets and the T and J nets of the beach fishery operate as mixed stock fisheries for salmon, and take fish from a large number of rivers of the east coast of England and Scotland.
- These findings match expectations of catch compositions based on knowledge of the salmon's life history and migratory behaviours at sea.
- The proportion of salmon from each exploited population contributing to the net fishery will likely differ from year to year, and in different parts of the fishery in each year. The variable contribution to the net fishery from each of the individual salmon populations makes an assessment of the impact of the net fishery on individual contributing stocks very difficult.
- As a result of annual variations in catch composition, setting a catch limit such that protection could be given to the weakest of the contributing stocks would prove extremely difficult, since the impact of any catch limit on the weakest of the contributing stocks would not be known with confidence.
- Tagging and genetic studies also confirm that the net fishery for sea trout in both the drift nets and beach nets operates as a mixed stock fishery, taking fish from a large number of catchments.

## References

Gilbey J, Cauwelier E, Coulson MW, Stradmeyer L, Sampayo JN, Armstrong A, Verspoor E, Corrigan L, Shelley J, Middlemiss S. (2016) Accuracy of Assignment of Atlantic Salmon (*Salmo salar* L.) to Rivers and Regions in Scotland and Northeast England Based on Single Nucleotide Polymorphism (SNP) Markers. PLoS ONE 11(10)

Gilbey J, Stradmeyer L, Cauwelier E, Sampayo JN, Middlemas S, Shelley J, Corrigan L (2014) Assignment of Atlantic Salmon to origin in Scotland and North East England using Single Nucleotide Polymorphic genetic markers. Marine Scotland Science. ISSN: 2043-7722

Gilbey J, Stradmeyer L, Cauwelier E, Middlemas S, Shelley J, Rippon P. (2012) Genetic Investigation of the North East English Drift Net Fisheries. Marine Scotland Science Report Vol. 4 No 12.

Jowitt A & Russell IC (1994) Analysis of North East Salmonid Microtagging Data. MAFF

North East Coast Net Fishery Review (1991) Salmon Net Fisheries: Report of a review of fishing in the areas of Yorkshire and Northumbria regions of the National Rivers Authority and the salmon fishery districts from the River Tweed to the River Ugie. MAFF & SOAFD

Potter, ECE & Swain A (1982) Fisheries Technical Report No. 67. Effects of the North East coast English salmon fisheries on Scottish salmon catches. MAFF. ISBN 0308-5589

Rippon P & Kirkland D An analyses of the origin, exploitation and migration of Sea Trout in the North Sea (2013) Environment Agency

Shelley J (1996) A Review of Microtagging and Stocking of Hatchery Salmon in the North East Region 1984 – 1994. Environment Agency

Solomon, DJ (1993) Analysis of catches in the North East Coast Fishery and recommendations for future work. R&D Report 443/3/W. National Rivers Authority