

Implications of fisheries during the spawning season for the sustainable management and recovery of depleted fish stocks: life history characteristics of several North Sea species

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Introduction

Fish traders and NGOs have put the idea forward that in order to not disturb the spawning process and hence improve the reproductive success of a fish population one should stop fishing during the spawning period. This idea has resulted in the project “Vis & Seizoen”. Within this project a theoretical framework is being developed to examine the possible effect of fishing during the spawning season. This is the first report within the project. It presents a summary of the life history characteristics that are related to the reproduction of nine important commercial fish species (Table 1).

The following life history characteristics are discussed:

- Number of breeding opportunities: semelparous¹ or iteroparous²
- Fertilization: internal or external
- Fecundity type: determinate³ or indeterminate⁴
- Spawning pattern: batch⁵ or total⁶ spawner
- Reproductive output
- Egg size
- Larval size
- Specific spawning ground⁷
- Fecundity
- Time of hatching
- Parental care⁸

Table 1: Overview of the nine commercial fish species that are discussed in this report with corresponding TAC

Species	Latin name	TAC 2009 (tonnes) ¹
Herring	<i>Clupea harengus</i>	2 211 051
Cod	<i>Gadus morhua</i>	581 656
Mackerel	<i>Scomber scombrus</i>	547 116
Horse mackerel	<i>Trachurus trachurus</i>	272 819
Plaice	<i>Pleuronectes platessa</i>	78 311
Norway lobster	<i>Nephrops norvegicus</i>	78 138
Sole	<i>Solea vulgaris</i>	28 496
Dab	<i>Limanda limanda</i>	18 810
Turbot	<i>Psetta maxima</i>	5 263

¹ As agreed by Council Regulations (EC) No 1139/2008 of 10 November 2008, No 1322/2008 of 28 November 2008, No 1359/2008 of 28 November 2008 and No 43/2009 of 16 January 2009.

¹ Species devote all their energy to a single spawning event and then die

² Species reproduce repeatedly during their lives

³ Fecundity is fixed prior to spawning

⁴ Fecundity is not fixed prior to spawning

⁵ The offspring is released in batches over an extended period during each breeding season

⁶ The offspring is released in a single episode during each breeding season

⁷ An area where fish come together to reproduce

⁸ An association between parent and offspring that will enhance the survival of the offspring

Herring

Herring – <i>Clupea harengus</i>	TAC (2009): 2 211 051 tonnes
Number of breeding opportunities	Iteroparous ¹
Fertilization	External
Fecundity type	Determinate ¹
Spawning pattern	Total spawner ¹
Reproductive output	Demersal eggs ²
Egg size	0.9-1.5 mm in diameter ²
Larval size	5.5-9.0 mm long ²
Specific spawning grounds	Yes – Figure 1 ³
Spawning season	Downs population: November – January ⁴ Banks population: August – October ⁴ Buchan population: August – September ⁴ Shetland population: August – September ⁴
Fecundity	Number of eggs per gram body weight may vary ⁵
Time of hatching	After 1-3 weeks, depending on water temperature ²
Parental care	No

¹ Murua and Saborido-Rey, 2003; ² Russell, 1976; ³ Dickey-Collas *et al.*, in prep.; ⁴ summarized by Knijn *et al.*, 1993; ⁵ Jennings and Beverton, 1991

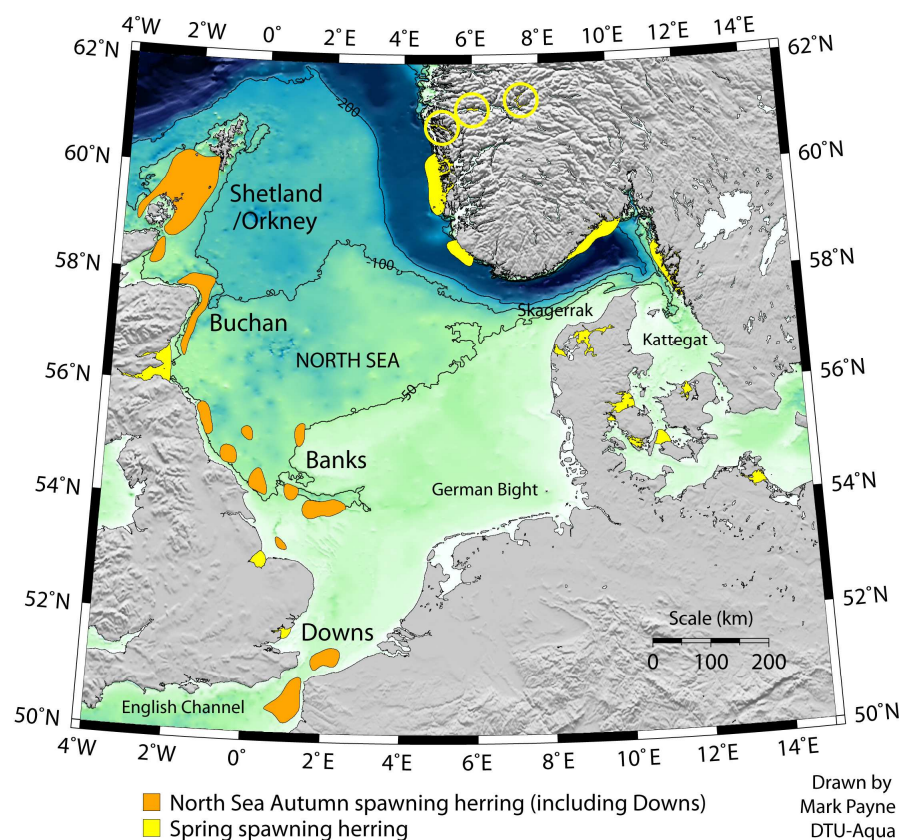


Figure 1: Spawning grounds North Sea autumn spawning (including Downs) and Spring spawning herring (Dickey-Collas *et al.*, in prep.)

Cod

Cod – <i>Gadus morhua</i>	TAC (2009): 581 656 tonnes
Number of breeding opportunities	Iteroparous ¹
Fertilization	External
Fecundity type	Determinate ¹
Spawning pattern	Batch spawner ¹
Reproductive output	Pelagic eggs ²
Egg size	1.16-1.89 mm in diameter ²
Larval size	About 4.0 mm long ²
Specific spawning grounds	Yes – Figure 2 ³
Spawning season	February, March, April and May ⁴ Sometimes a second spawning later in the year ⁴
Fecundity	500 eggs per gram body weight ^{5,6}
Time of hatching	After 11-12 days (at 8°C). It depends on the water temperature ⁷
Parental care	No

¹ Murua and Saborido-Rey, 2003; ² Russell, 1976; ³ Fox *et al.*, 2008; ⁴ summarized by Harden Jones, 1968; ⁵ Rijnsdorp *et al.*, 1991; ⁶ summarized by Knijn *et al.*, 1993; ⁷ Buckley *et al.*, 2000

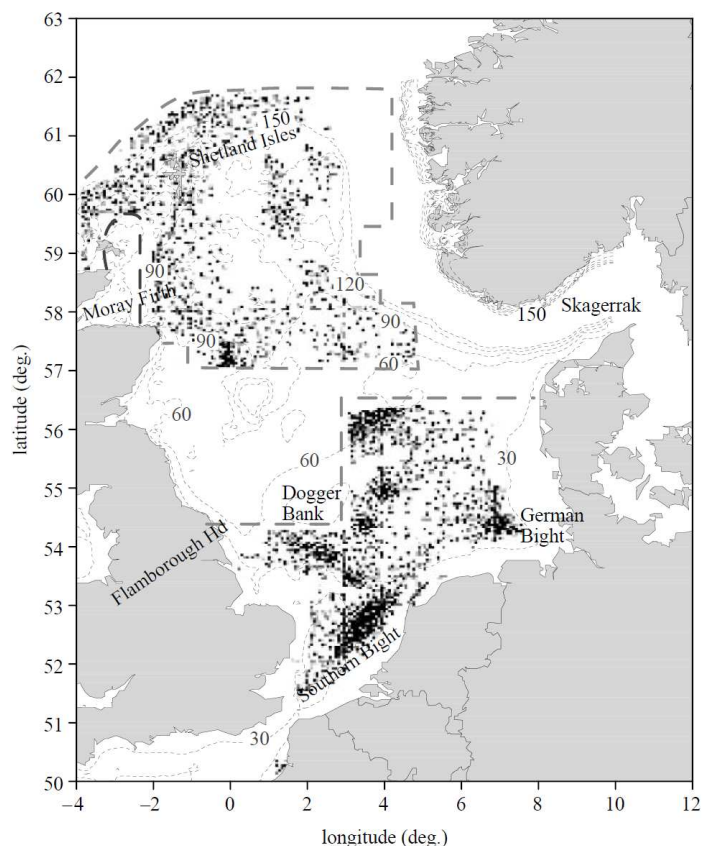


Figure 2: Spatial distribution of cod eggs (Fox *et al.*, 2008)

Mackerel

Mackerel – <i>Scomber scombrus</i>	TAC (2009): 547 116 tonnes
Number of breeding opportunities	Iteroparous ¹
Fertilization	External
Fecundity type	Determinate ¹
Spawning pattern	Batch spawner ¹
Reproductive output	Pelagic eggs ²
Egg size	1.0-1.38 mm in diameter ²
Larval size	About 3.3-3.9 mm long ²
Specific spawning grounds	Yes – Figure 3 ³
Spawning season	May – July ^{3,4}
Fecundity	1359 eggs per gram body weight ⁵
Time of hatching	After 6 days (at 14°C). It depends on the water temperature ²
Parental care	No

¹ Murua and Saborido-Rey, 2003; ² Russell, 1976; ³ Dawson, 1991; ⁴ Eltink, 1987; ⁵ Krüger-Johnsen, 2006

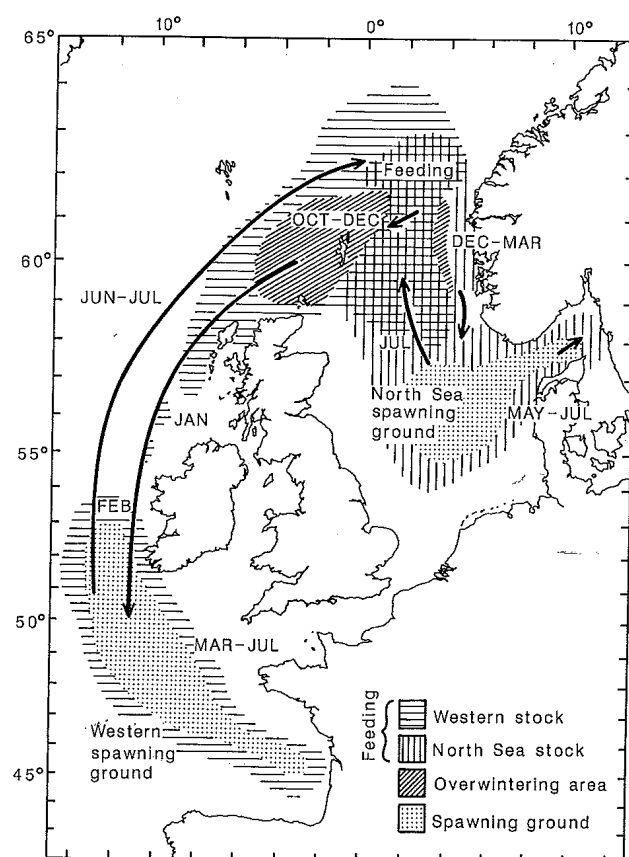


Figure 3: Migration patterns of North Sea and Western mackerel from feeding to overwintering to spawning ground (Dawson, 1991)

Horse mackerel

Horse mackerel – <i>Trachurus trachurus</i>	TAC (2009): 272 819 tonnes
Number of breeding opportunities	Iteroparous ¹
Fertilization	External
Fecundity type	Indeterminate ¹
Spawning pattern	Batch spawner ¹
Reproductive output	Pelagic eggs ²
Egg size	1.0-1.38 mm in diameter ²
Larval size	About 3.3-3.9 mm long ²
Specific spawning grounds	Yes – Figure 4 ³
Spawning season	May-July (Peak: June) ⁴
Fecundity	1557 eggs per gram body weight ³
Time of hatching	After 2-3 days (at surface temperature North Sea) ⁵
Parental care	No

¹ Murua and Saborido-Rey, 2003; ² Russell, 1976; ³ summarized by www.homsir.com; ⁴ Macer, 1974;

⁵ Pipe and Walker, 1987

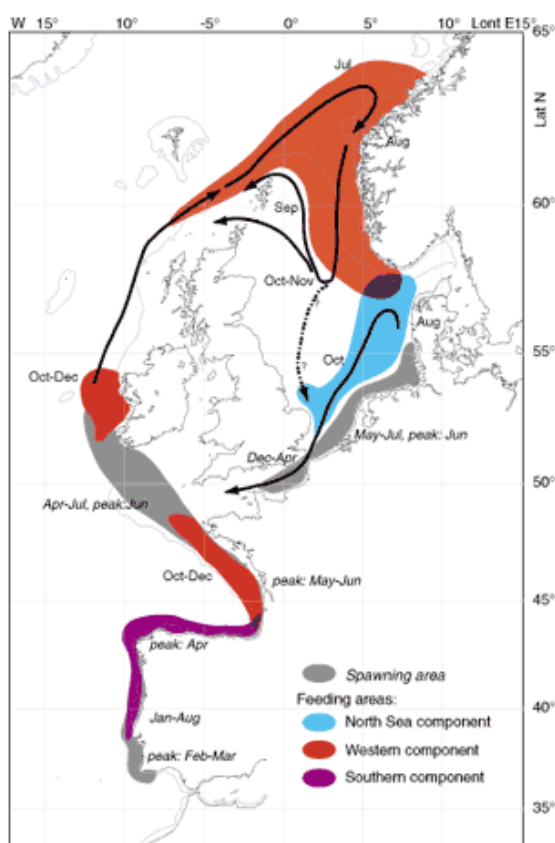


Figure 4: Migration patterns of the three horse mackerel stocks from feeding to spawning ground (www.homsir.com)

Plaice

Plaice – <i>Pleuronectes platessa</i>	TAC (2009): 78 311 tonnes
Number of breeding opportunities	Iteroparous ¹
Fertilization	External
Fecundity type	Determinate ²
Spawning pattern	Batch spawner ²
Reproductive output	Pelagic eggs ³
Egg size	1.66-2.17 mm in diameter ³
Larval size	6.0-7.5 mm long ³
Specific spawning grounds	Yes – Figure 5 ⁴
Spawning season	December until March ⁴
Fecundity	262 eggs per gram body weight ^{5,6}
Time of hatching	After 6-20 days, depending on the water temperature ⁷
Parental care	No

¹ Murua and Saborido-Rey, 2003; ² Urban, 1991; ³ Russell, 1976; ⁴ Cushing, 1990; ⁵ Rijnsdorp *et al.*, 1991;

⁶ Rijnsdorp, 1991; ⁷ Harden Jones, 1968

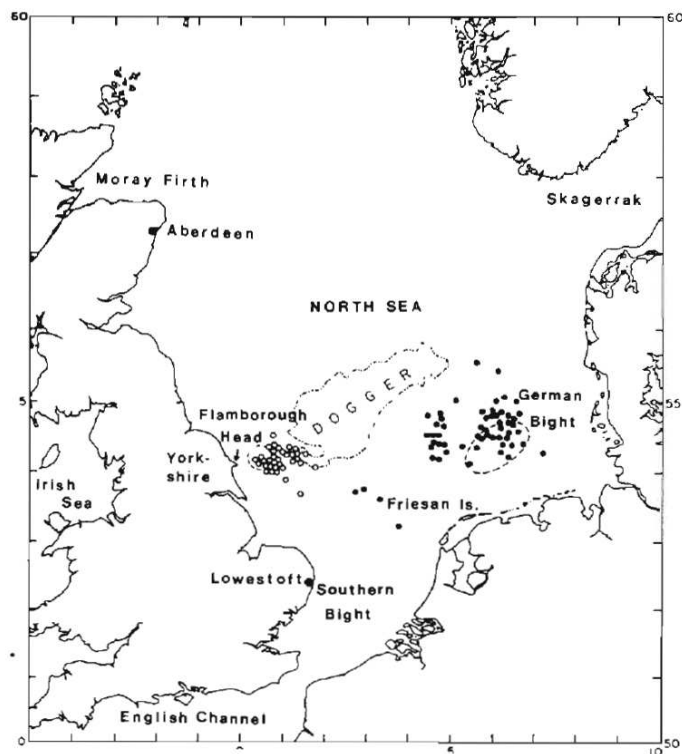


Figure 5: Locations of plaice spawning grounds (Cushing, 1990)

Norway lobster

Norway lobster – <i>Nephrops norvegicus</i>	TAC (2009): 78 138 tonnes
Number of breeding opportunities	Iteroparous
Fertilization	External (insemination internal) ¹
Fecundity type	-
Spawning pattern	Total spawner
Reproductive output	Eggs
Egg size	1.5-1.87 mm ¹
Larval size	-
Specific spawning grounds	-
Spawning season	August – September ²
Fecundity	450-4400 eggs (Moray Firth) ²
Time of hatching	After ~ 8-9 months ²
Parental care	Yes – Eggs are kept under the abdomen of the female ²

¹ Aiken and Waddy, 1980; ² Chapman, 1980

Sole

Sole – <i>Solea vulgaris</i>	TAC (2009): 28 496 tonnes
Number of breeding opportunities	Iteroparous ¹
Fertilization	External
Fecundity type	Determinate ¹
Spawning pattern	Batch spawner ¹
Reproductive output	Pelagic eggs ²
Egg size	1.0-1.6 mm in diameter ²
Larval size	2.5-3.75 mm long ²
Specific spawning grounds	Yes – Figure 6 ³
Spawning season	Spring (peak: April – May) ⁴
Fecundity	790 eggs per gram body weight ⁵
Time of hatching	After 7 days (at 10°C) ⁶
Parental care	No

¹ Murua and Saborido-Rey, 2003; ² Russell, 1976; ³ Rijnsdorp *et al.*, 1992; ⁴ Van der Land, 1991; ⁵ summarized by Rijnsdorp *et al.*, 1992; ⁶ Fonds, 1979

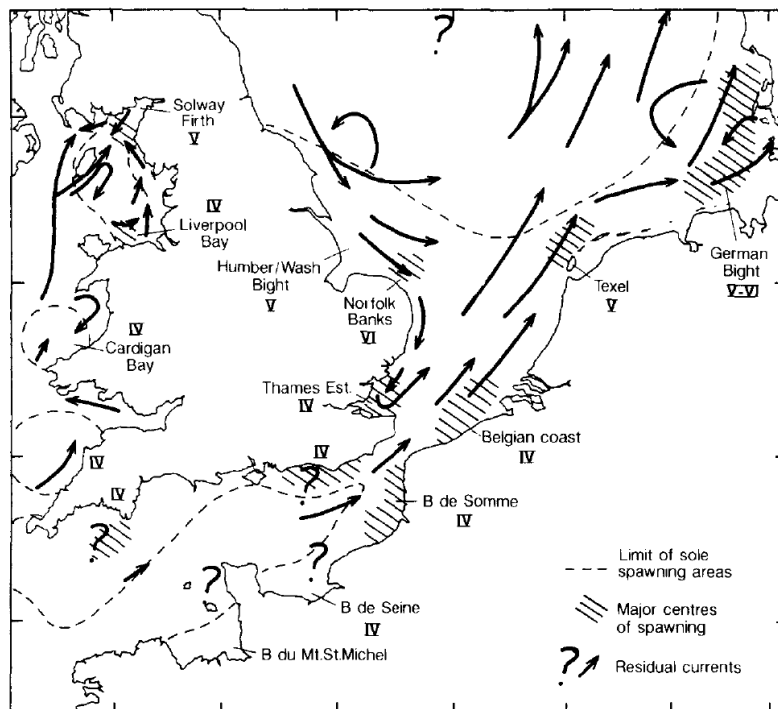


Figure 6: Summary of major centres of spawning of sole in the North Sea (Rijnsdorp *et al.*, 1992)

Dab

Dab – <i>Limanda limanda</i>	TAC (2009): 18 810 tonnes
Number of breeding opportunities	Iteroparous ¹
Fertilization	External
Fecundity type	Determinate ¹
Spawning pattern	Batch spawner ¹
Reproductive output	Pelagic eggs ²
Egg size	0.66-1.20 mm in diameter ²
Larval size	2.7 mm long ²
Specific spawning grounds	Yes – Figure 7 ^{3,4}
Spawning season	January-May (peak: February-April) ³
Fecundity	3300 eggs per gram body weight ⁵
Time of hatching	After 3-12 days ⁶
Parental care	No

¹ Murua and Saborido-Rey, 2003; ² Russell, 1976; ³ Van der Land, 1991; ⁴ Rijnsdorp *et al.*, 1992; ⁵ summarized by Knijn *et al.*, 1993; ⁶ summarized by Russell, 1976

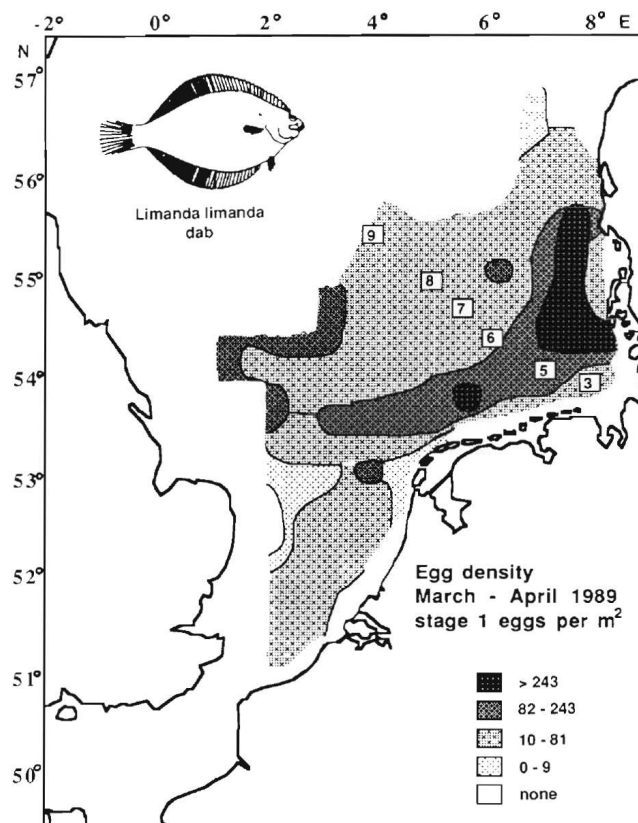


Figure 7: Distribution dab eggs March-April 1989 (Van der Land, 1991; Rijnsdorp *et al.*, 1992)

Turbot

Turbot – <i>Psetta maxima</i>	TAC (2009): 5 263 tonnes
Number of breeding opportunities	Iteroparous ¹
Fertilization	External
Fecundity type	Determinate ¹
Spawning pattern	Batch spawner ¹
Reproductive output	Pelagic eggs ²
Egg size	0.91-1.20 mm in diameter ²
Larval size	2.14-2.8 mm long ²
Specific spawning grounds	Aberdeen Bank (43E8) and Turbot bank (43E9) ³ – Figure 8
Spawning season	May – August ³
Fecundity	1100 eggs per gram body weight ³
Time of hatching	After 6-7 days ²
Parental care	No

¹ Murua and Saborido-Rey, 2003; ² Russell, 1976; ³ summarized by Knijn *et al.*, 1993

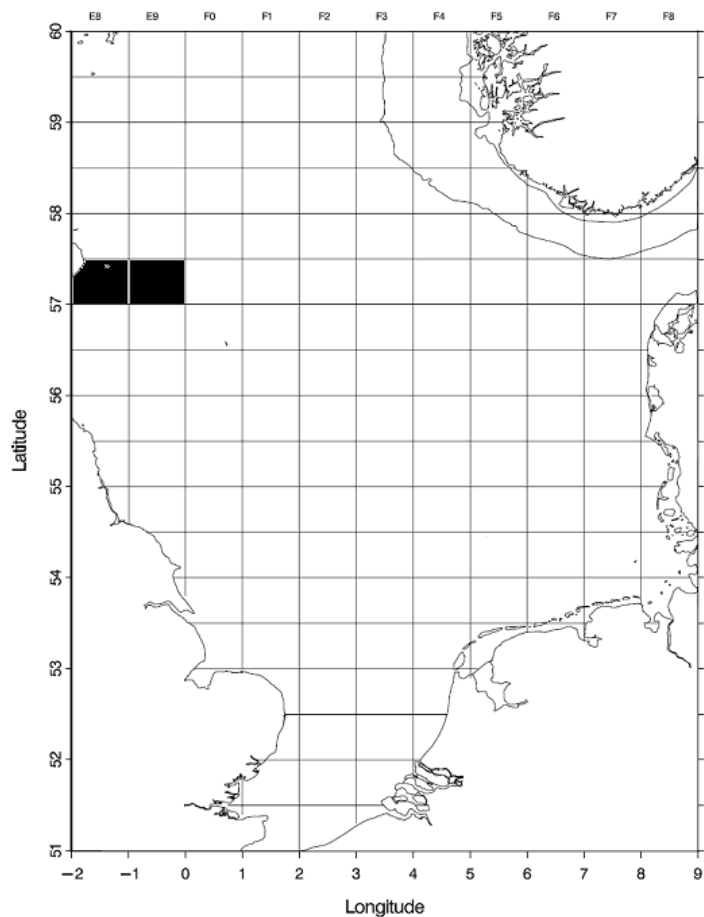


Figure 8: Relatively important spawning grounds of turbot: Aberdeen bank and Turbot bank

Quality Assurance

IMARES utilises an ISO 9001:2000 certified quality management system (certificate number: 08602-2004-AQ-ROT-RvA). This certificate is valid until 15 December 2009. The organisation has been certified since 27 February 2001. The certification was issued by DNV Certification B.V. Furthermore, the chemical laboratory of the Environmental Division has NEN-AND-ISO/IEC 17025:2005 accreditation for test laboratories with number L097. This accreditation is valid until 27 March 2013 and was first issued on 27 March 1997. Accreditation was granted by the Council for Accreditation.

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Justification

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