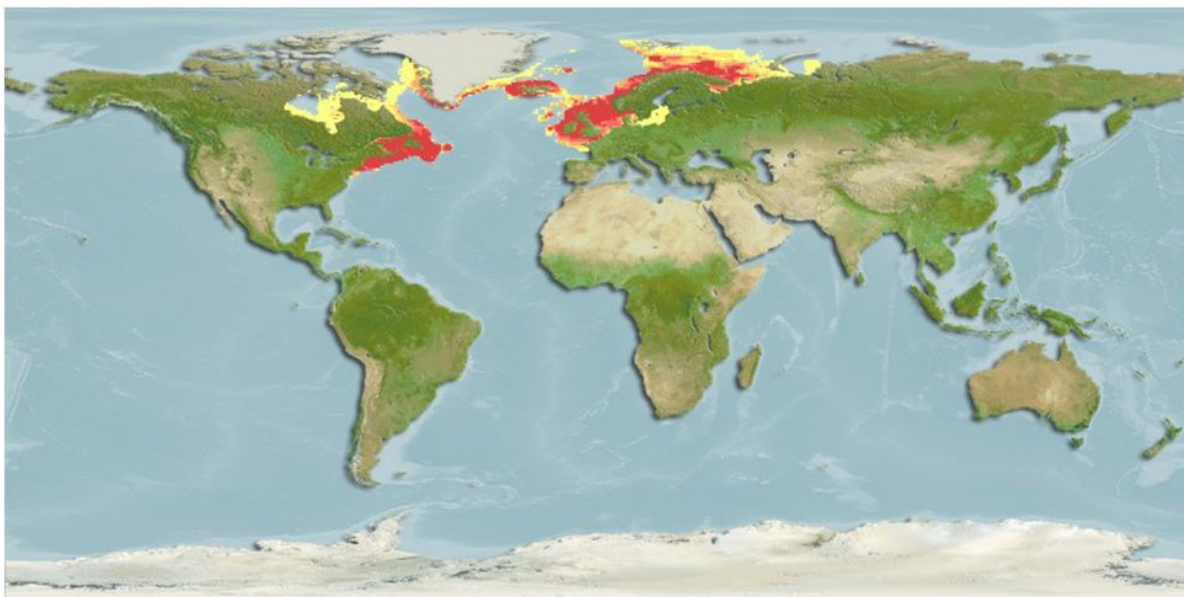


Image taken from (Cohen et al. 1990)

Introduction

Cod (*Gadus morhua*) is generally considered a demersal fish although its habitat may become pelagic under certain hydrographic conditions, when feeding or spawning. It is widely distributed throughout the north Atlantic and Arctic regions in a variety of habitats from shoreline to continental shelf, in depths to 600m (Cohen et al. 1990). The Irish Sea stock spawns at two main sites in the western and eastern Irish Sea during February to April (Armstrong et al. 2011). Historically the stock has been commercially important, however in the last decade a decline in SSB and reduced productivity of the stock have led to reduce landings.



Reviewed distribution map for *Gadus morhua* (Atlantic cod), with modelled year 2100 native range map based on IPCC A2 emissions scenario. www.aquamaps.org, version of Aug. 2013. Web. Accessed 28 Jan. 2011

Life history overview

Adults are usually found in deeper, colder waters. During the day they form schools and swim about 30-80 m above the bottom, dispersing at night to feed (Cohen et al. 1990; ICES 2005). They are omnivorous; feeding at dawn or dusk on invertebrates and fish, including their own young (Cohen et al. 1990). Adults migrate between spawning, feeding and overwintering areas, mostly within the boundaries of the respective stocks. Large migrations are rare occurrences, although there is evidence for limited seasonal migrations into neighbouring regions, most Irish Sea fish will stay within their management area (ICES 2012).



Historical tagging studies indicated spawning site fidelity but with varying degrees of mixing of cod between the Irish Sea, Celtic Sea and west of Scotland/north of Ireland (ICES 2015). The adult fish may form spawning aggregations in the water column when bottom temperatures are unsuitable (Cohen et al. 1990), while different spawning areas may be used in subsequent years (ICES 2005). In the Irish Sea spawning lasts between February and April. Spawning sites are in offshore waters, at or near the bottom, in 50-200 m depth and 0-12 °C (preferred range 0-6°C) ((Cohen et al. 1990), (ICES 2005)). Recent egg surveys in 2006 and 2008, using DNA probes to distinguish early stage eggs of cod from other gadoids, confirm the location of distinct cod spawning grounds in the western and eastern Irish Sea (Goodsir et al. 2008). Egg and larval development rate is temperature dependent with the larval phase lasting about 3 months (at 8°C). The number of eggs (fecundity) spawned by females ranges from 2.5 million eggs in a 5 kg female to a record of 9 million eggs in a 34 kg female. Classified as a determinate multiple spawner (McEvoy and McEvoy 1992). The larvae remain pelagic before settling on the bottom at around 85mm (Cohen et al. 1990; Bastrikin et al. 2014).

Juveniles prefer shallow (less than 10-30 m depth) sublittoral waters with complex habitats, such as seagrass beds, areas with gravel, rocks or boulder, which provide protection from predators (Gotceitas et al. 1997; Gregory et al. 1997) .

Settled juveniles, or codlings, may disperse over a wide area as demonstrated by fish tagging studies.

Summary of life history and habitat parameters

Species: <i>Gadus morhua</i> (Cod)				
Life Stage	Size and Growth	Habitat	Substrate	Temperature
Eggs	Cod eggs 1.1-1.75mm ¹	Early stage eggs are buoyant and found near the surface ² . Depths 20-50m ¹ .	Pelagic zone	Optimal 6-7 °C ¹
Larvae	3-15mm	Distributed in upper 30m of water column, peak concentration 10-20m. Frontal zones between water masses with freshwater influence and shelf water masses (haline fronts) ⁵	Pelagic	Larval growth in lab positive at 4-14°C Lethal high 15.5-18°C ² Field growth max 7°C ³
Juveniles	Remain semi-pelagic until 85mm ⁴ Evidence suggests that juvenile cod settle initially close to the shore in shallow waters and move deeper as size increases. ⁴	Pelagic until settlement on mixed strata. Shallower coastal and estuarine sites important ⁶ . Mostly in shoal waters, coastal or offshore banks, during summer. Deeper water in winter. ⁷ The highest abundance of early juvenile cod coincided with the areas of highest zooplankton biomass. Associated with seasonal gyre in Western Irish Sea. ⁹	Demersal. Prefer complex bottom types (cobbles, macrophytes)	6-13°C in Irish Sea commonly encountered ¹ More tolerant of extremes than adults.
Adults (feeding)	Asymptotic length 104cm ¹ steep age profile indicates a continued very high total mortality rate. ⁸	Demersal to depths of 154m in Irish Sea ¹ Demersal with regular vertical migrations. Later in the year in quarters 3 and 4 the cod have a very restricted distribution, confined to deeper waters in the northern and southern channels. ⁸ The Vlla commercial fishery for cod extends into the North Channel ⁸	Demersal with pelagic migrations. Opportunistic feeder of crustacea and fish sp.	6-13°C in Irish Sea commonly encountered ¹ Temperature preferences differ winter-summer. ⁷

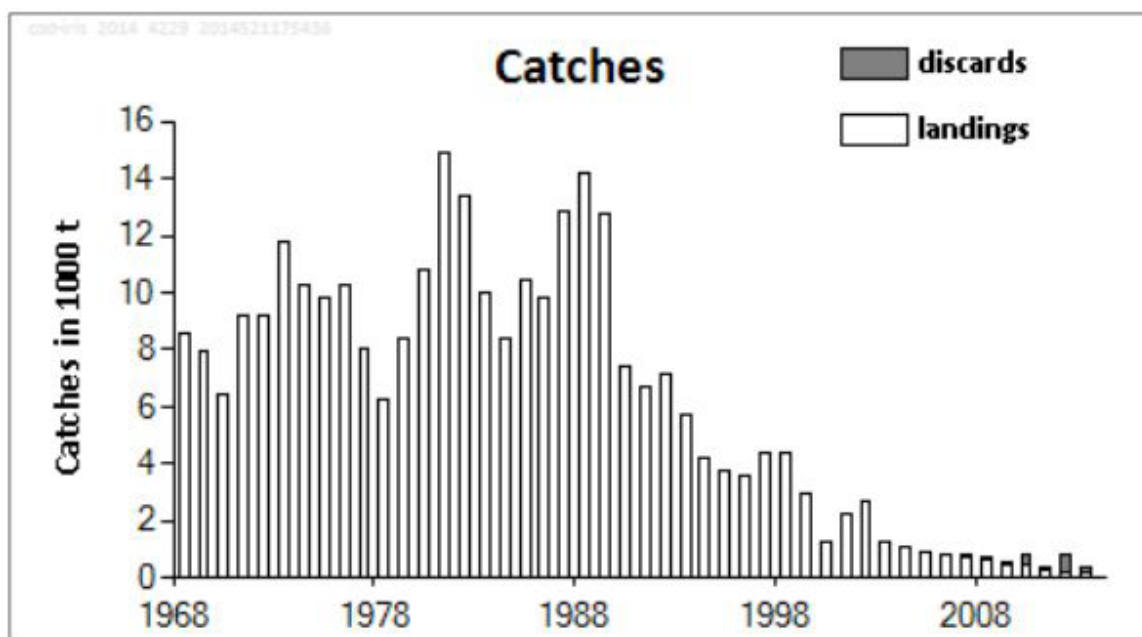
Species: *Gadus morhua* (Cod)

Adults (Spawning)	Asymptotic length 104cm ¹ survey data indicate that the proportion mature at age 2 increased between 1995 to around 2003 from levels close to that of the WG historic estimate of 38% to 65% and has subsequently remained stable at that proportion. ⁸	Spawning occurs in western coastal bights and more widespread in eastern Irish Sea.	Pelagic, Although there is evidence for limited seasonal migrations into neighbouring regions, most fish will stay within their management area. ⁸	Generally < 10°C, varies seasonally. ⁷ 6-7 °C ¹
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(ICES 2005)¹; (Otterlei et al. 1999)²; (Buckley et al. 2004)³; (Bastrikin et al. 2014)⁴; (Munk et al. 2002)⁵ (Rogers et al. 1998)⁶; (Fahay et al. 1999)⁷; (ICES 2014)⁸; (Dickey-Collas et al. 1997)⁹

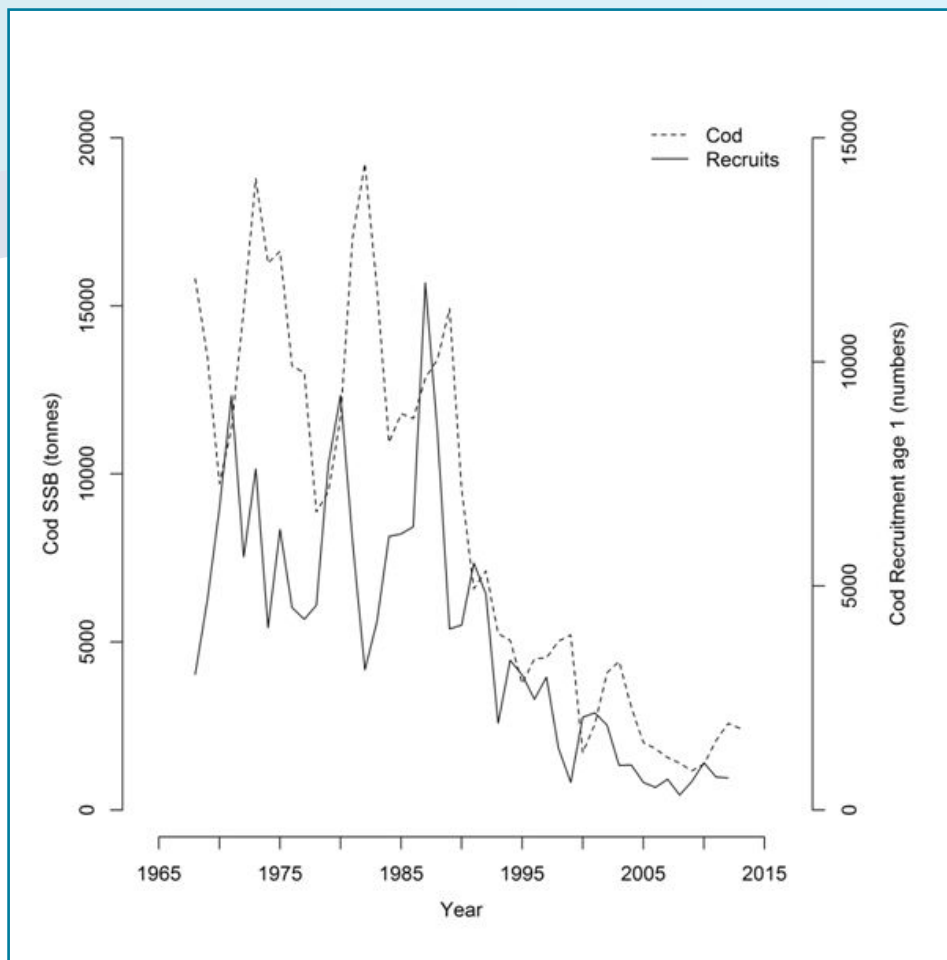
Fishery

Irish Sea fisheries for cod have changed considerably since the 1960s when UK and Irish trawlers targeted spawning cod in spring in the eastern and western Irish Sea. Fisheries for young cod (codling) also took place in autumn and winter. Effort increased until the 1990s when the cod stock and landings declined sharply (Armstrong 2002). TAC reductions and cod recovery measures were introduced in the 1990s and with continued slow recovery of the stock there is no longer a directed commercial fishery in the Irish Sea (ICES 2014)



Cod in Division VIIa (Irish Sea). Summary of stock assessment (weights in tonnes). Catches reported to ICES. (ICES 2014)

Stock Status



Irish Sea Cod SSB and recruitment indices.

ICES advice applicable to 2015

"Given the low SSB and low recruitment it is not possible to identify any non-zero catch which would be compatible with the MSY transition scheme. This implies no targeted fishing should take place on cod in Division VIIa. Bycatches including discards of cod in all fisheries in Division VIIa should be reduced to the lowest possible level and uptake of further technical measure to reduce discards." (ICES 2015)

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