Marine Strategy Framework Directive Consultation: UK Initial Assessment and proposals for Good Environmental Status

Impact Assessment Annex D

Irish Sea cod

Stock and recruitment

Figure 1 presents the cod time series of recruitment at age 0 used by the ICES WGCSE working group. Irish Sea cod recruitment and spawning stock biomass are positively related; recruitment to the cod stock is characterised by two features:

a) Strong autocorrelation in the time series, such that the level of recruitment in any given year is very likely to be similar to that in the previous year
b) A strong reduction in recruitment in recent years with a corresponding reduction in spawning stock biomass.

Figure 2 presents the fit of two alternative models for the future response of recruitment to increased spawning biomass; both models assume a constant level of recruitment after spawning biomass exceeds a set threshold. An "optimistic" model represents recovery of recruitment abundance to the historic levels recorded in the 1980's. A pessimistic model assumes that recruitment does not recover at high biomass abundance under the assumption that the environment is less favourable for cod and the historic dynamics cannot be recaptured.

Fishing mortality scenarios

Fishing mortality for Irish Sea cod (F = 0.61) currently exceeds F_{MSY} (0.4) by a factor of more than 1.5. Consequently, fishing mortality for Irish Sea cod will be decreased in future years to achieve the F_{MSY} target. Two alternative fishing mortality scenarios are explored in conjunction with the potential for low and high recruitment events (Figure 3):

1) No change in the cod exploitation level – status quo fishing morality at the current level under low and high recruitment (the black line)
2) A 25% reduction in fishing mortality per annum (the current EU management plan rate of change) until the F_{MSY} target mortality of F = 0.4 is achieved under low and high recruitment (the green line).

Discarding scenarios

Estimates of discarding are available in the ICES reports but are not included in the assessment. ICES has concluded that currently the rates of discarding are low and do not affect the dynamics of the stock significantly at the current time. No projections of discarding are presented for this stock.

Output

Percentiles of fishing mortality, spawning biomass, recruitment and landings for a run of the model for 30 years are included for the options:

a. Status quo fishing mortality in the future under low and high recruitment
b. A 25% annual reduction in fishing mortality until cod achieves the F_{MSY} framework target mortality of F = 0.4 under low and high recruitment

Figures 3 – 5 present the realised fishing mortality, spawning stock biomass and landings outcomes for each scenario.

Discussion

The future trajectory of Irish Sea cod productivity depends on the level of incoming recruitment, as illustrated by the spawning stock biomass and landings outcomes for the two alternative fishing mortality scenarios (Figures 4 and 5). Historically, the stock was more productive with relatively higher stock biomass, recruitment and landings. Spawning stock biomass has decreased ten-fold since the late 1980's coinciding with a reduction in reproductive capacity and below average recruitment since 1990's. These temporal trends indicate that the productivity can no longer support the high levels of mortality to which this stock is subjected and there is significant potential for the stock to rebuild to high levels if fishing mortality is reduced to follow the F_{MSY} framework and the environment supports a return to more favourable recruitment levels.
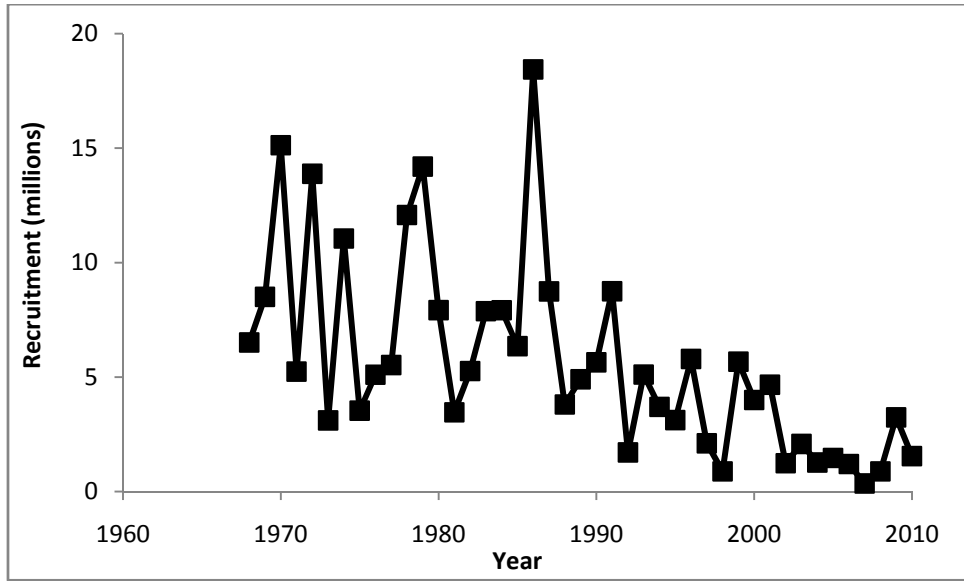
Figure 1. The time series of Irish Sea cod recruitment at age 0, illustrating below average recruitment since the 1990's, except for the 2009 year class.
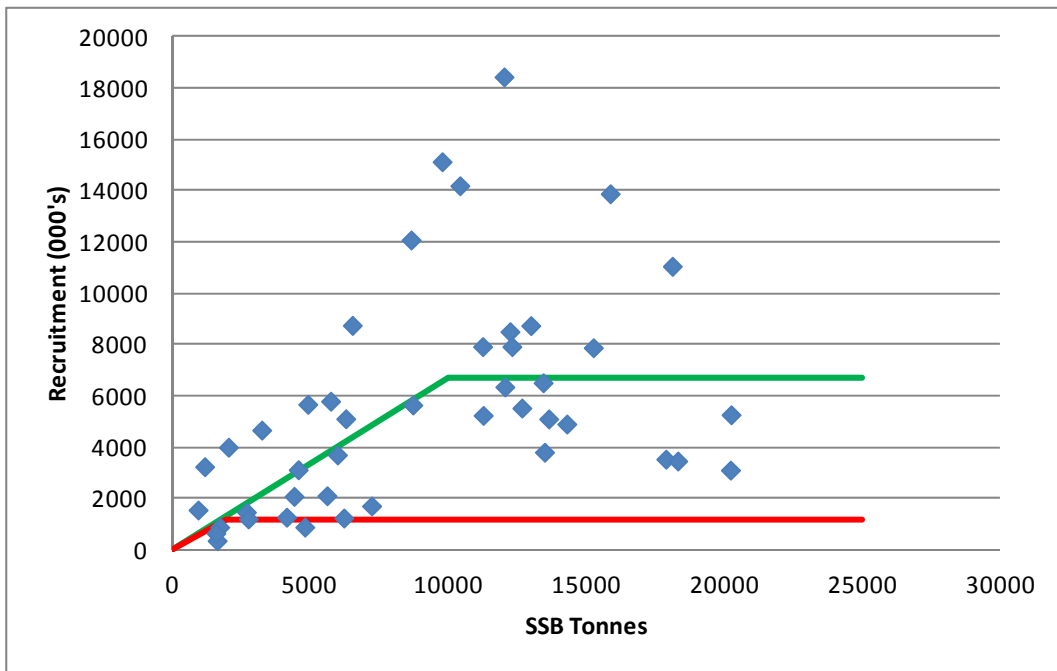

Figure 2. Stock-recruitment estimates for Irish Sea cod. Recruitment and spawning stock biomass were positively related between1968 and 2010 (r^2 = 0.16; P = 0.004; n = 43). Note that the red and green reference lines indicate the geometric mean of low and high recruitment events, respectively, as well as MSY $B_{trigger}$.
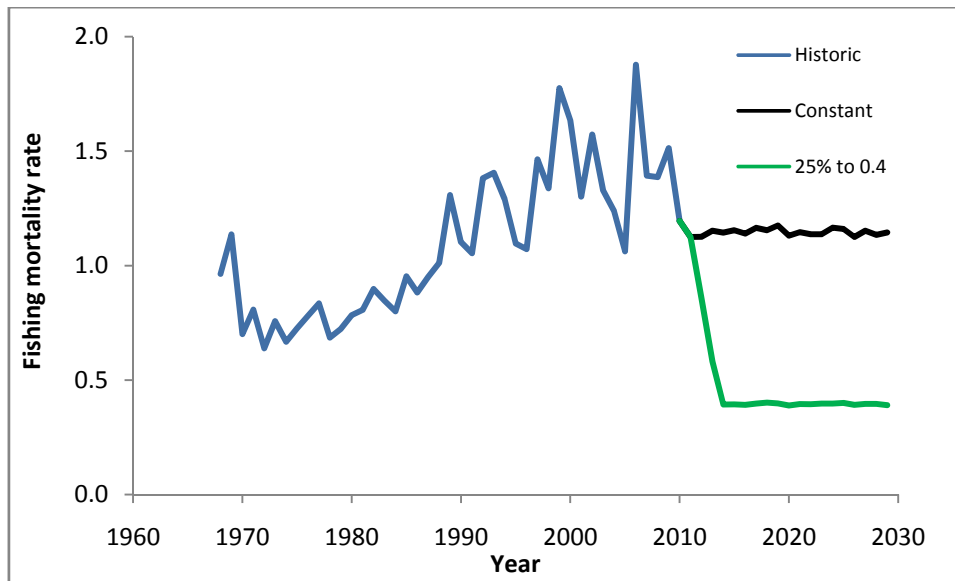
Figure 3. Irish Sea cod historic and representative future fishing mortality scenarios; black line – continued exploitation at the current level, green line – 25% reductions in fishing mortality per annum to achieve the Fmsy target.
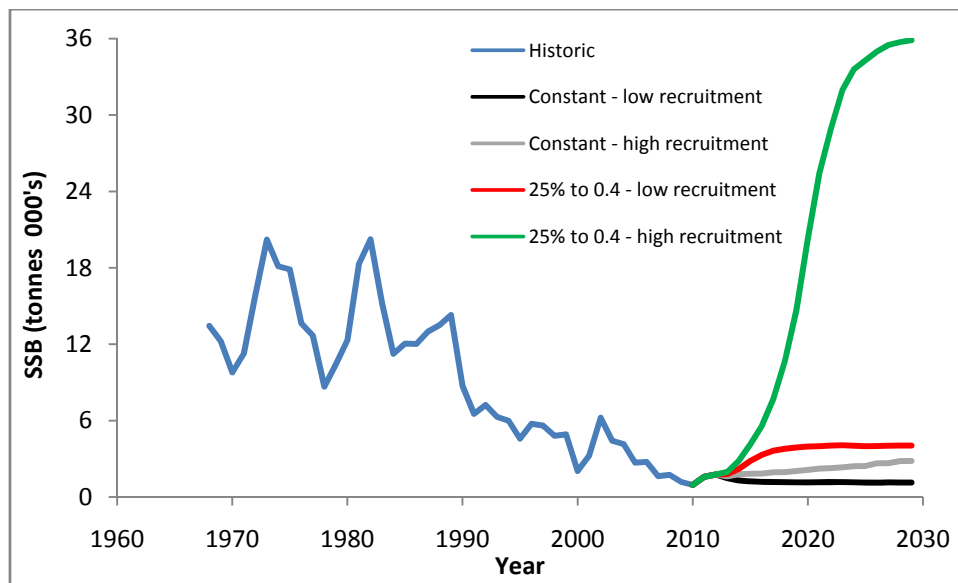

Figure 4. Irish Sea cod historic and projected spawning stock biomass; black line – continued exploitation at the current level under low recruitment, grey line – continued exploitation at the current level under high recruitment, red line – 25% reductions in fishing mortality per annum to reach the Fmsy target under low recruitment, green line – 25% reductions in fishing mortality per annum to achieve the Fmsy target under high recruitment.
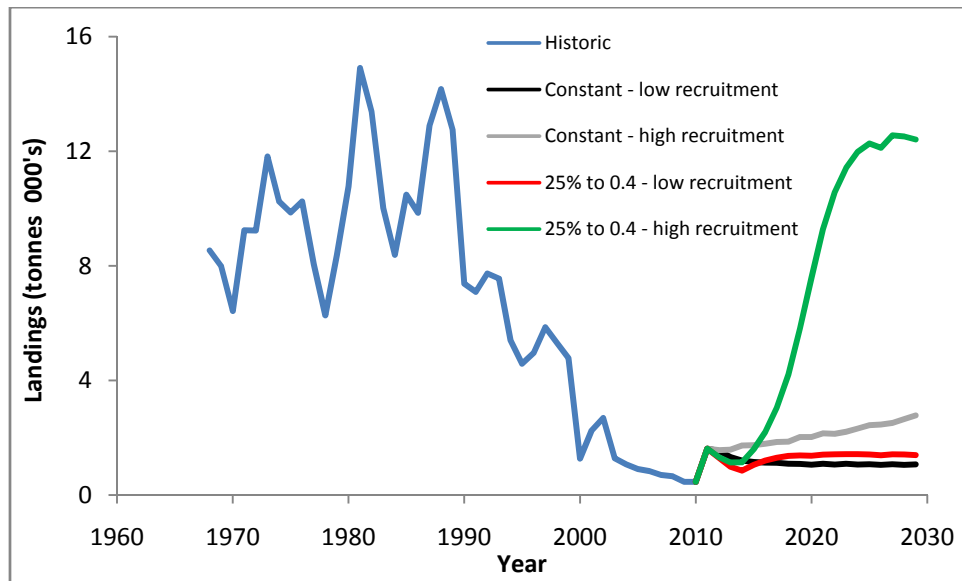
Figure 5. Irish Sea cod historic and projected landings; black line – continued exploitation at the current level under low recruitment, grey line – continued exploitation at the current level under high recruitment, red line – 25% reductions in fishing mortality per annum to reach the Fmsy target under low recruitment, green line – 25% reductions in fishing mortality per annum to achieve the Fmsy target under high recruitment.