## 2.3.2 Cod (*Gadus morhua*) in Division 5.a (Iceland grounds)

### ICES stock advice

ICES advises that when the Icelandic management plan is applied, catches in the fishing year 2016/2017 should be no more than 244 000 tonnes.

### Stock development over time

The spawning-stock biomass (SSB) of Icelandic cod is increasing and is higher than has been observed over the last four decades. Fishing mortality (F) has declined significantly in the last decade and is presently at a historical low. Year classes are estimated to have been relatively stable since 1988, but with the mean around the lower values observed in the period 1955 to 1985. Year classes 2014 and 2015 are estimated to be above the long-term average.

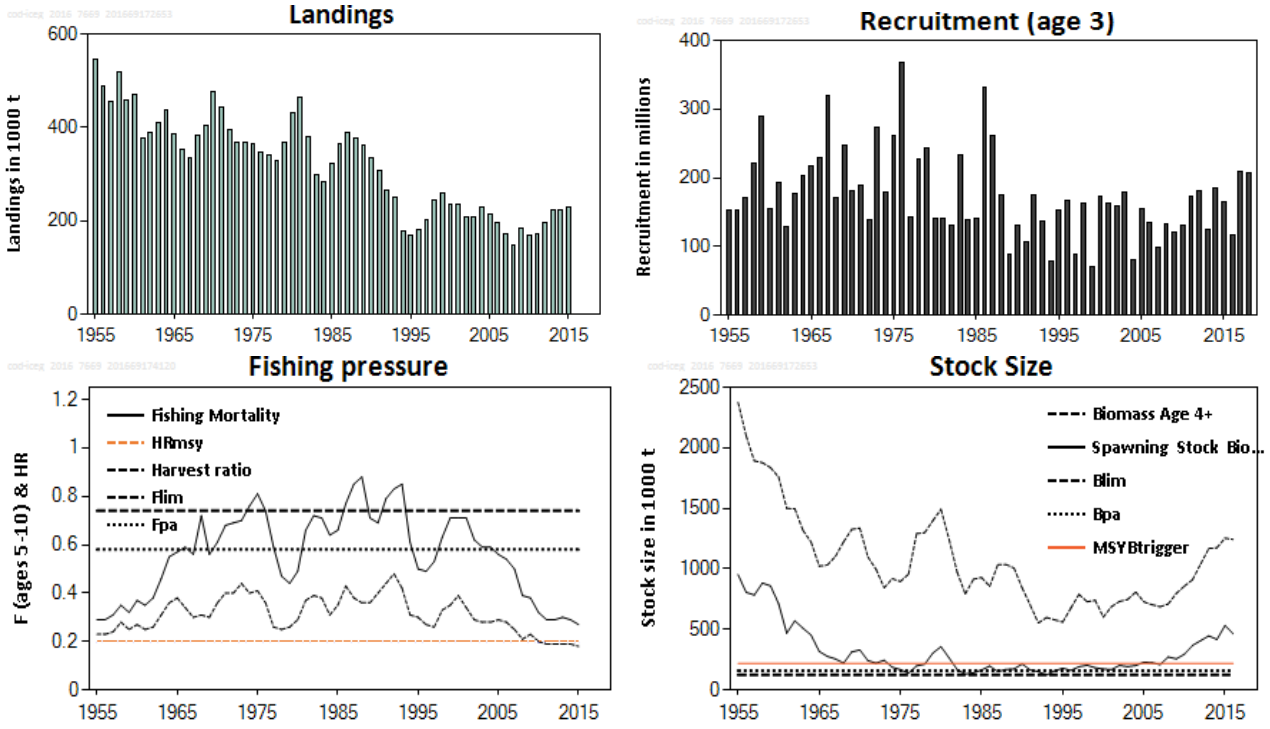


**Figure 2.3.2.1** Cod in Division 5.a. Summary of the stock assessment. Harvest rates are calculated based on biomass age 4+. All biomass reference points refer to SSB levels. $HR_{MGT} = HR_{MSY}$ and MGT $B_{trigger}$ = MSY $B_{trigger}$; therefore, the horizontal lines displaying these points in the graph overlap.

### Stock and exploitation status

**Table 2.3.2.1** Cod in Division 5.a. State of the stock and fishery relative to reference points. The expected range of realized harvest rate (HR) following the management plan ($HR_{MGT}$) can be found in the North-Western Working Group report (ICES, 2016a).

| | | Fishing pressure | | | | Stock size | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 2013 | 2014 | 2015 | | 2014 | 2015 | 2016 | |
| Maximum sustainable yield | $HR_{MSY}$ | ✓ | ✓ | ✓ | Below | MSY $B_{trigger}$ | ✓ | ✓ | ✓ Above trigger |
| Precautionary approach | $F_{pa}$, $F_{lim}$ | ✓ | ✓ | ✓ | Harvested sustainably | $B_{pa}$, $B_{lim}$ | ✓ | ✓ | ✓ Full reproductive capacity |
| Management plan | $HR_{MGT}$ | ✓ | ✓ | ✓ | Within expected range | MGT $B_{trigger}$ | ✓ | ✓ | ✓ Above |

## Catch options

**Table 2.3.2.2** Cod in Division 5.a. The basis for the catch options.

| Variable | Value | Source | Notes |
|---|---|---|---|
| $F_{ages\ 5–10}$ (2016) | 0.30 | ICES (2016a) | TAC constraint |
| SSB (2017) | 481 kt | ICES (2016a) | |
| $B_{4+}$(2017) | 1191 kt | ICES (2016a) | |
| $R_{age3}$(2016) | 117 million | ICES (2016a) | From the assessment |
| $R_{age3}$(2017) | 208 million | ICES (2016a) | From the assessment |
| $R_{age3}$(2018) | 208 million | ICES (2016a) | From the assessment |
| Total catch (2016) | 246 kt | ICES (2016a) | Estimated catch until the end of the fishing season (31.08.2016) and estimated catch in the first four months of the next fishing season (01.09–31.12.2016). |
| Discards (2016) | - | ICES (2016a) | Negligible |

**Table 2.3.2.3** Cod in Division 5.a. The catch options. Weights in thousand tonnes.

| Rationale | Landings (2016/17) | Basis | F (2017) | SSB (2018) | Biomass of age 4+ (2018) | %SSB change* | % TAC change |
|---|---|---|---|---|---|---|---|
| Management plan | 244 | Harvest control rule (HCR) in the Management Plan ** | 0.30 | 492 | 1266 | 2% | 2% |

* $SSB_{2018}$ relative to $SSB_{2017}$.

** Because $SSB_{2016}$ is bigger than MGT $B_{trigger}$, the TAC for 2016/17 is calculated as (0.2 x $B_{4+,2016}$ + $TAC_{2015/16}$) / 2.

## Basis of the advice

**Table 2.3.2.4** Cod in Division 5.a. The basis of the advice.

| Advice basis | Management plan |
|---|---|
| Management plan | The Icelandic Ministry of Industries and Innovation's fisheries management plan for Icelandic cod (MII, 2015).<br>In 2015, the plan was extended until 2020. The plan, aimed at providing maximum sustainable yield, has been evaluated by ICES and is considered to be precautionary. According to the management plan, the TAC for the fishing year Y/Y+1 (September 1 of year Y to August 31 of year Y+1) is calculated as follows:<br>$$TAC_{Y/Y+1} = \frac{\min\left(\frac{SSB_Y}{MGT\ B_{trigger}}, 1\right) 0.2\ B_{4+,Y} + TAC_{Y-1/Y}}{2}$$<br>where $B_{4+,Y}$ is the biomass of cod aged 4 and older in year Y, and MGT $B_{trigger}$ = 220 000 tonnes. |

## Quality of the assessment

This assessment is considered consistent.

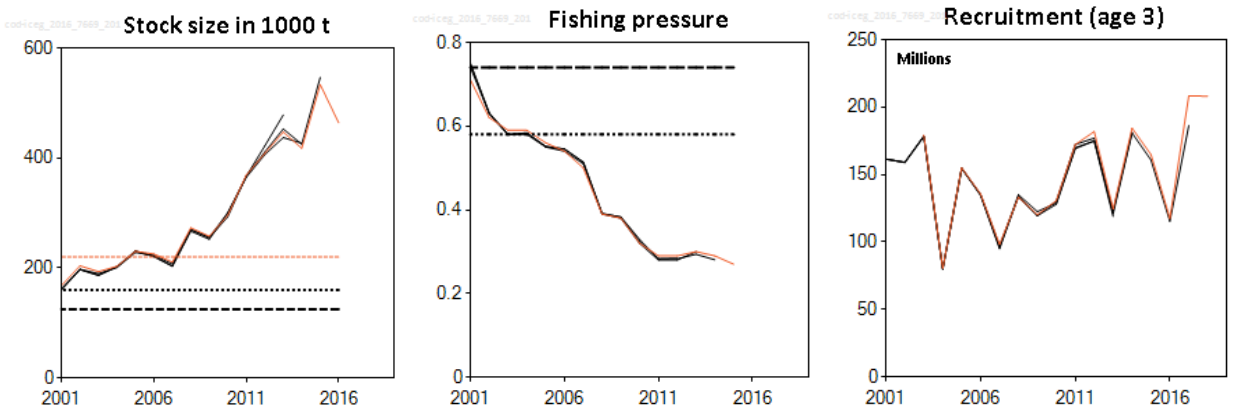


**Figure 2.3.2.2** Cod in Division 5.a. Historical assessment results (final-year recruitment estimates included).

## Issues relevant for the advice

There is no information to present for this stock.

## Reference points

**Table 2.3.2.5** Cod in Division 5.a. Reference points, values, and their technical basis.

| Framework | Reference point | Value | Technical basis | Source |
|---|---|---|---|---|
| MSY approach | MSY $B_{trigger}$ | 220 000 t | Trigger point in HCR considered consistent with ICES MSY framework. | ICES (2010) |
| | $HR_{MSY}$ | 20% | Stochastic HCR evaluation. Percentage of age 4+ biomass. | ICES (2010) |
| Precautionary approach | $B_{lim}$ | 125 000 t | $B_{loss}$ | ICES (2010) |
| | $B_{pa}$ | 160 000 t | $B_{pa} = B_{lim} \times \exp(1.645\sigma_B)$, $\sigma_B = 0.15$ | ICES (2016a) |
| | $F_{lim}$ | 0.74 | Equilibrium F which will maintain the stock above $B_{lim}$ with a 50% probability. | ICES (2016a) |
| | $F_{pa}$ | 0.58 | 5% probability that true F has been above $F_{lim}$. $F_{pa} = F_{lim} \times \exp(-1.645\sigma_F)$ and $\sigma_F = 0.15$. | ICES (2016a) |
| Management plan | MGT $B_{trigger}$ | 220 000 t | The 5th percentile on the distribution of SSB when the TAC is based on $HR_{MGT}$. | ICES (2009) |
| | $HR_{MGT}$ | 20% | Percentage of age 4+ biomass. Leads to long-term MSY. | ICES (2009) |

## Basis of the assessment

**Table 2.3.2.6** Cod in Division 5.a. The basis of the assessment.

| | |
|---|---|
| ICES stock data category | 1 (ICES, 2016b) |
| Assessment type | A forward-based statistical catch-at-age model that is implemented in the AD model builder, using catches in the model and in the forecast. |
| Input data | Landings-at-age and age-structured spring and autumn survey indices. |
| Discards and bycatch | Discarding is considered negligible and is not included. |
| Indicators | None |
| Other information | Immigration has been taken into account. |
| Working group | North-Western Working Group (NWWG) |

## Information from stakeholders

There is no available information.

## History of the advice, catch, and management

**Table 2.3.2.7** Cod in Division 5.a. History of ICES advice, the agreed TAC, and ICES estimates of landings by national fishing year (September to August the following year). Weights are in thousand tonnes.

| Year | ICES advice | Predicted catch corresp. to advice | Agreed TAC[#] | ICES landings for the fishing year | ICES landings for the calendar year |
|---|---|---|---|---|---|
| 1988* | National advice | 300 | 350 | | 378 |
| 1989* | National advice | 300 | 325 | | 356 |
| 1990* | National advice | 250 | 300 | | 335 |
| 1991* | National advice | 240 | 245 | | 309 |
| 1991/1992 | National advice | 250 | 265 | 274 | 274 |
| 1992/1993 | Reduce F by 40% | 154 | 205 | 241 | 241 |
| 1993/1994 | Reduce F by 40% | 150 | 165 | 197 | 197 |
| 1994/1995 | Reduce F by 50% | 130 | 155 | 165 | 169 |
| 1995/1996 | Apply catch rule | 155 | 155 | 170 | 182 |
| 1996/1997 | Apply catch rule | 186 | 186 | 202 | 203 |
| 1997/1998 | Apply catch rule | 218 | 218 | 227 | 243 |
| 1998/1999 | Apply catch rule | 250 | 250 | 254 | 260 |
| 1999/2000 | Apply catch rule | 247 | 250 | 257 | 236 |
| 2000/2001 | Apply catch rule | 203 | 220** | 221 | 238 |
| 2001/2002 | Apply catch rule | 164 | 190** | 219 | 210 |
| 2002/2003 | Apply catch rule | 183 | 179** | 202 | 207 |
| 2003/2004 | Apply catch rule | 210 | 209 | 227 | 228 |
| 2004/2005 | Apply catch rule | 205 | 205 | 217 | 214 |
| 2005/2006 | Apply catch rule | 198 | 198 | 207 | 197 |
| 2006/2007 | Apply catch rule | 187 | 193 | 191 | 172 |
| 2007/2008 | Apply catch rule | 152 | 130 | 143 | 148 |
| 2008/2009 | Apply $F_{max}$ | < 124 | 160^ | 171 | 183 |
| 2009/2010 | Apply $F_{max}$ | < 135 | 150^^ | 170 | 170 |
| 2010/2011 | Apply catch rule | 160 | 160 | 167 | 172 |
| 2011/2012 | Apply catch rule | 177 | 177 | 185 | 196 |
| 2012/2013 | Apply catch rule | 196 | 196 | 213 | 224 |
| 2013/2014 | Apply catch rule | 215 | 215 | 226 | 222 |
| 2014/2015 | Apply catch rule | 218 | 218 | 223 | 230 |
| 2015/2016 | Apply catch rule | 239 | 239 | | |
| 2016/2017 | Management plan | 244 | | | |

* Calendar year.

** Amended catch rule.

^ Initial TAC set to 130 according to the catch rule, raised to 160 in January 2009.

^^ Set according to the catch rule.

[#] The catch rule prior to 2010/2011 is different from the one was used since then (0.25 vs. 0.20 multiplier).

## History of catch and landings

**Table 2.3.2.8** Cod in Division 5.a. Catch distribution by fleet in 2015 as estimated by ICES.

| Total catch (2015) | Commercial landings | | | | | Commercial discards |
|---|---|---|---|---|---|---|
| 230 kt | 45% bottom trawl | 35% longline | 8% gillnet | 6% Danish seine | 6% hooks | Negligible |
| | 230 kt | | | | | |

## Summary of the assessment

**Table 2.3.2.9** Cod in Division 5.a. Assessment summary.

| Year | Recruitment | Stock size | | Landings | Fishing pressure | |
|---|---|---|---|---|---|---|
| | Age 3 | SSB | Biomass age 4+ | | $F_{Ages\ 5–10}$ | Harvest rate age 4+ |
| | (millions) | (kilotonnes) | (kilotonnes) | (kilotonnes) | Year−1 | Year−1 |
| 1955 | 152.016 | 953.278 | 2375.036 | 545.25 | 0.288 | 0.23 |
| 1956 | 152.792 | 806.298 | 2098.032 | 486.909 | 0.288 | 0.23 |
| 1957 | 170.639 | 785.078 | 1892.57 | 455.182 | 0.309 | 0.24 |
| 1958 | 220.984 | 883.799 | 1877.055 | 517.359 | 0.352 | 0.28 |
| 1959 | 289.373 | 859.929 | 1836.372 | 459.081 | 0.321 | 0.25 |
| 1960 | 154.337 | 712.439 | 1758.278 | 470.121 | 0.37 | 0.27 |
| 1961 | 193.074 | 469.374 | 1500.279 | 377.291 | 0.354 | 0.25 |
| 1962 | 128.938 | 571.614 | 1495.842 | 388.985 | 0.382 | 0.26 |
| 1963 | 177.51 | 510.186 | 1318.431 | 408.8 | 0.457 | 0.31 |
| 1964 | 203.898 | 453.246 | 1221.569 | 437.012 | 0.547 | 0.36 |
| 1965 | 216.388 | 318.588 | 1023.463 | 387.106 | 0.575 | 0.38 |
| 1966 | 229.16 | 277.969 | 1032.152 | 353.357 | 0.588 | 0.34 |
| 1967 | 320.303 | 257.009 | 1103.398 | 335.721 | 0.56 | 0.30 |
| 1968 | 171.801 | 221.959 | 1223.332 | 381.77 | 0.72 | 0.31 |
| 1969 | 247.395 | 314.034 | 1326.003 | 403.205 | 0.557 | 0.30 |
| 1970 | 180.418 | 331.527 | 1337.314 | 475.077 | 0.61 | 0.36 |
| 1971 | 188.597 | 242.925 | 1098.217 | 444.248 | 0.683 | 0.40 |
| 1972 | 139.216 | 222.252 | 997.449 | 395.166 | 0.692 | 0.40 |
| 1973 | 273.174 | 245.944 | 844.349 | 369.205 | 0.703 | 0.44 |
| 1974 | 178.982 | 187.669 | 919.1 | 368.133 | 0.762 | 0.40 |
| 1975 | 260.861 | 169.023 | 896.324 | 364.754 | 0.806 | 0.41 |
| 1976 | 367.683 | 139.357 | 956.675 | 346.253 | 0.742 | 0.36 |
| 1977 | 143.32 | 199.795 | 1291.284 | 340.086 | 0.587 | 0.26 |
| 1978 | 227.589 | 213.472 | 1299.594 | 329.602 | 0.473 | 0.25 |
| 1979 | 243.438 | 305.369 | 1398.864 | 366.462 | 0.443 | 0.26 |
| 1980 | 140.028 | 358.371 | 1491.73 | 432.237 | 0.489 | 0.29 |
| 1981 | 140.305 | 265.714 | 1243.885 | 465.032 | 0.658 | 0.37 |
| 1982 | 131.676 | 169.082 | 972.541 | 380.068 | 0.724 | 0.39 |
| 1983 | 232.626 | 132.004 | 793.208 | 298.049 | 0.708 | 0.38 |
| 1984 | 139.027 | 143.098 | 915.231 | 282.022 | 0.635 | 0.31 |
| 1985 | 140.638 | 165.594 | 928.907 | 323.428 | 0.663 | 0.35 |
| 1986 | 331.207 | 197.834 | 856.099 | 364.797 | 0.768 | 0.43 |
| 1987 | 261.938 | 152.472 | 1034.126 | 389.915 | 0.854 | 0.38 |
| 1988 | 175.76 | 169.571 | 1037.275 | 377.554 | 0.883 | 0.36 |
| 1989 | 89.215 | 174.449 | 1006.952 | 363.125 | 0.71 | 0.36 |
| 1990 | 130.949 | 215.606 | 843.546 | 335.316 | 0.692 | 0.40 |
| 1991 | 107.033 | 165.986 | 700.65 | 307.759 | 0.791 | 0.44 |
| 1992 | 175.343 | 152.494 | 553.176 | 264.834 | 0.833 | 0.48 |
| 1993 | 135.945 | 123.097 | 598.878 | 250.704 | 0.853 | 0.42 |
| 1994 | 78.225 | 158.854 | 580.018 | 178.138 | 0.612 | 0.31 |
| 1995 | 152.067 | 179.591 | 561.283 | 168.592 | 0.497 | 0.30 |
| 1996 | 166.349 | 161.85 | 676.22 | 180.701 | 0.495 | 0.27 |
| 1997 | 89.332 | 192.442 | 789.809 | 203.112 | 0.531 | 0.26 |
| 1998 | 162.422 | 204.859 | 729.154 | 243.987 | 0.631 | 0.33 |
| 1999 | 71.254 | 183.618 | 741.204 | 260.147 | 0.712 | 0.35 |
| 2000 | 172.49 | 173.878 | 602.062 | 235.092 | 0.714 | 0.39 |
| 2001 | 163.252 | 167.932 | 687.981 | 236.705 | 0.71 | 0.34 |
| 2002 | 159.586 | 203.796 | 731.859 | 209.537 | 0.619 | 0.29 |
| 2003 | 179.232 | 193.407 | 748.012 | 207.246 | 0.587 | 0.28 |

| Year | Recruitment | Stock size | | Landings | Fishing pressure | |
|---|---|---|---|---|---|---|
| | Age 3 | SSB | Biomass age 4+ | | $F_{Ages\ 5–10}$ | Harvest rate age 4+ |
| | (millions) | (kilotonnes) | (kilotonnes) | (kilotonnes) | Year−1 | Year−1 |
| 2004 | 80.593 | 202.944 | 809.603 | 228.337 | 0.594 | 0.28 |
| 2005 | 154.973 | 230.364 | 728.167 | 213.865 | 0.557 | 0.29 |
| 2006 | 135.56 | 225.566 | 704.547 | 197.247 | 0.537 | 0.28 |
| 2007 | 98.209 | 210.642 | 687.892 | 171.646 | 0.499 | 0.25 |
| 2008 | 133.187 | 273.051 | 710.846 | 147.668 | 0.389 | 0.21 |
| 2009 | 120.241 | 257.608 | 798.076 | 183.302 | 0.381 | 0.23 |
| 2010 | 130.644 | 295.656 | 858.715 | 170.009 | 0.318 | 0.20 |
| 2011 | 172.196 | 368.713 | 911.068 | 172.207 | 0.289 | 0.19 |
| 2012 | 181.809 | 408.345 | 1042.222 | 196.177 | 0.287 | 0.19 |
| 2013 | 124.534 | 447.024 | 1169.133 | 223.594 | 0.299 | 0.19 |
| 2014 | 184.339 | 417.504 | 1175.369 | 221.99 | 0.285 | 0.19 |
| 2015 | 164.774 | 533.186 | 1253.847 | 230.225 | 0.273 | 0.18 |
| 2016 | 117.45 | 464.02 | 1240.7 | | | |
| 2017 | 208.38 | | | | | |
| 2018 | 207.996 | | | | | |

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