Consequences of discard survival under the landing obligation

Reporting validation and reprocessing project outcomes of "demersal discard processing

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Summary

This report describes the results of a short and medium term forecast over the period 2016-2019 given different scenarios of discard survival rates (10-50%) of North Sea plaice and North Sea sole. Additionally, average value of landings over the year 2019 is calculated per scenario using the landings derived from the biomass and the average price per kg of both stocks. Potential loss in average gross revenue from value of landings can be inferred from these.

The results suggest that expected differences in biomass are relatively small for both stocks. Potential loss of gross revenue from landing all catches of North Sea plaice (survival 0 %) in 2019, are on average 3994 kEUR for a 10 % discard survival scenario and 21914 kEUR for a 50 % discard survival scenario. For North Sea sole, a 10 % discard survival scenario would result in a difference of 1137 kEUR compared to landing all catches (0 % survival) in 2019; for 50% survival this difference would be 5778 kEUR.

North Sea plaice

Discard survival scenario	Average biomass (tonnes) in 2019	Average value of landings (kEUR) in 2019	Difference in value of landings (kEUR) compared to baseline (0% survival) in 2019
0	970527	119804	0
0.1	991275	123798	3994
0.2	1012914	127977	8173
0.3	1035485	132349	12545
0.4	1059033	136927	17123
0.5	1083606	141718	21914

North Sea sole

Discard survival scenario	Average biomass (tonnes) in 2019	Average value of landings (kEUR) in 2019	Difference in value of landings compared to baseline (0% survival) (kEUR) in 2019
0	53352	135409	0
0.1	53796	136546	1137
0.2	54245	137682	2273
0.3	54699	138838	3429
0.4	55158	140003	4594
0.5	55623	141187	5778

1 Background and Request

The European Union (EU) has incorporated a landing obligation (LO) as part of the Common Fisheries Policy (CFP). Under the LO species subject to a TAC may not be put discarded at sea anymore but must be landed. As of January 2016 the LO will be true practice for the target species of the demersal fisheries. The introduction of the LO takes place in phases, with each year (between 2016 and 2019) more species for which this policy will apply. In 2019 the LO will apply for all quota species in all demersal fisheries (Ministry of Economic Affairs, 2015). The LO presents a serious challenge for the demersal fisheries sector.

The Dutch Cooperative Fisheries Organisation (CVO) is carrying out a project called 'Demersal discard processing: Chain analysis and exploration for product valorisation'. The goal of this project is to develop market-oriented and economically realistic solutions for unwanted catches that fit within the expected regulations, while reducing costs for processing the catches considerably.

The Dutch demersal fisheries are typically characterised by high discarding rates (van der Reijden et al., 2016). The impact of discards in a fishery depends however on the survival rate that is linked to the species and the fishing gear (Guilen et al., 2014). The survival rate of discards is generally low for fishes and can reach 0% (STECF, 2012). Experimentations have shown however that this survival rate could increase as a result of improvements in the sorting process (Ulmestrand et al., 1998, Charuau et al., 1982).

Discard survivability of North Sea sole and North Sea plaice is currently under investigation. Under a landings obligation overall fishing mortality could increase when discard survival is substantial. Such an increase in fishing mortality would likely result in disadvantageous effects for the stock. In turn this could lead to economic loss for fishermen. Therefore, CVO has asked IMARES to investigate what the effect is of 10-50% discard survivability under the landings obligation on the biomass of North Sea sole and North Sea plaice and in what potential economic loss this could result.

This report describes the results of a short and medium term (2016-2019) forecast given different discard survival rates (10-50%) of North Sea plaice and North Sea sole. Under the landings obligation, the survival rate equals 0%, since all catches, including discards, have to be landed. In this report the change of stock biomasses of North Sea sole and plaice are estimated in case the discards survive after returning them to sea. Additionally, the potential loss in gross revenue is calculated by estimating the difference in catch resulting from discard survivability.

2 Materials and methods

The change of stock biomass and potential loss in gross revenue is calculated for six scenarios:

1. **Landings obligation**: In this scenario discard mortality (Fdisc) is 100% since all catches, including discards, of North Sea sole and North Sea plaice are landed and chances of survivability when returned to sea are eliminated. This is the **baseline scenario** against which scenarios (2-6) are compared.
2. **10% survival rate**: In this scenario discards are returned to sea and 10% of the discards survive and are included in the stock again and have the potential to grow and reproduce, this way Fdisc=0.9 over the period 2016-2019.
3. **20% survival rate**: In this scenario discards are returned to sea and 20% of the discards survive and are included in the stock again and have the potential to grow and reproduce, this way Fdisc=0.8 over the period 2016-2019.
4. **30% survival rate**: In this scenario discards are returned to sea and 30% of the discards survive and are included in the stock again and have the potential to grow and reproduce, this way Fdisc=0.7 over the period 2016-2019.
5. **40% survival rate**: In this scenario discards are returned to sea and 40% of the discards survive and are included in the stock again and have the potential to grow and reproduce, this way Fdisc=0.6·over the period 2016-2019.
6. **50% survival rate**: In this scenario discards are returned to sea and 50% of the discards survive and are included in the stock again and have the potential to grow and reproduce, this way Fdisc=0.5·over the period 2016-2019.

To explore the differences in biomass due to possible discard survival both stocks are forecasted in two parts.

First, a **deterministic short term forecast** (STF) using the same model and following the same procedure as was done at the ICES WGNSSK in 2015 (ICES, 2015c) was conducted. Input to the STF is presented in Table 1.

Weight-at-age in the stock and weight-at-age in the catch are taken to be the average over the last 3 years. The exploitation pattern was taken to be the mean value of the last three years. The proportion of landings at age was taken to be the mean of the last three years, this proportion was used for the calculation of the discard and landings partial fishing mortality. Population numbers at ages 2 and older are survivor estimates from the assessment procedure. Numbers at age 1 and recruitment of the 2015 year class are taken from the long-term geometric mean (1957-2014).

Table 1: Assumptions for STF: all assumptions match those made at WGNSSK 2015 for the advice of 2016 (ICES, 2015).

Variable	North Sea sole	North Sea plaice	Explanation
Landings 2015	11900	99253	North Sea sole: Assume TAC_{2015} is fully landed North Sea plaice: Assume same F as previous year
Catches 2015	12769	140164	Catch assuming same discard ratio as the last three years
Mean F_{2-6} 2015	0.25	0.18	North Sea sole: F required to land TAC_{2015} North Sea plaice: F status quo 2014
Biomass 2016	55000	771000	Projected from WGNSSK 2015 assessment SSB
Recruitment 2015	104000	651000	RCT3 2015 recruitment index analysis output
Recruitment 2016	111000	970000	Geometric mean recruitment 1957-2011

The output of the STF is then used as a starting point for the medium term forecast that starts in 2016. From 2016 onwards the harvest control rule of both stocks follow the EU management plan and

fishing mortality is set at maximum sustainable yield (Council Regulation No. 676/2007). This is 0.20 for North Sea sole and 0.19 for North Sea plaice (Table 2).

Table 2: Overview of assumed fishing mortality in STF and medium term forecast.

	2015	2016	2017	2018	2019
North Sea sole	0.25	0.20	0.20	0.20	0.20
North Sea plaice	0.18	0.19	0.19	0.19	0.19

The medium term forecast is stochastic, with 1000 iterations projected. Recruitment varies between each iteration. This allows estimations taking into account the uncertainty we have about future recruitment. The methodology used was adapted from the EQSIM methodology developed at WKMSYREF4. The method was altered to start the medium term simulations from specific stock numbers at age, and specific discard mortalities and to output the stock numbers and landings rather than simply long term reference points. The forecasting procedure and handling of uncertainty remains the same. Stock numbers at age are projected to survivors of the following year taking into account recruitment and mortality rates. The medium term forecast starts with the numbers at age in 2016 from the STF and projects the stocks to 2019.

The loss in gross revenue among scenarios are calculated from landings under the baseline scenario (landings obligation) and scenarios 2-6. The landings are then multiplied by the average price per kg over 2014. This was the most recent year for which a whole year of information on the pricing of both stocks was available and easily accessible. The average price per kg of North Sea sole and North Sea plaice is found in Table 3. Within the scope of this project more detailed economic analyses, for example by taking into account average prices for different market sizes or calculations of net revenue losses, were not possible. The loss in gross revenue is therefore indicative.

Table 3: Average price per kg over 2014 of North Sea sole and plaice in Dutch fish auctions (CBS: http://statline.cbs.nl/StatWeb/publication/?DM=SLNL&PA=71483ned).

	EUR/kg
North Sea sole	9.55
North Sea plaice	1.28

In the North Sea, individuals of the North Sea sole population are mainly discarded at ages 1 to 3. Individuals of the North Sea plaice population are mainly discarded at age 2 (Table 4).

Table 4: Relative proportion of North Sea sole and Plaice in the discard fraction of the catch as a function of age. Discards fractions are calculated as discards/catch: if the fraction is equal to 1, all catches of individuals at this age are discarded.

Age	Sole	Plaice
1	1.00	1.00
2	0.45	0.98
3	0.25	0.70
4	0.10	0.30
5	0.05	0.06
6	0.00	0.05
7	0.00	0.00
8	0.00	0.00
9	0.00	0.00
10	0.00	0.00

3 Results and discussion

The effect of discard survival on the biomass of North Sea plaice is shown in Figure 2. Scenarios 2-6 are presented relative to the baseline scenario (discard survival is 0%). There is an increase in biomass with increasing discard survivability.

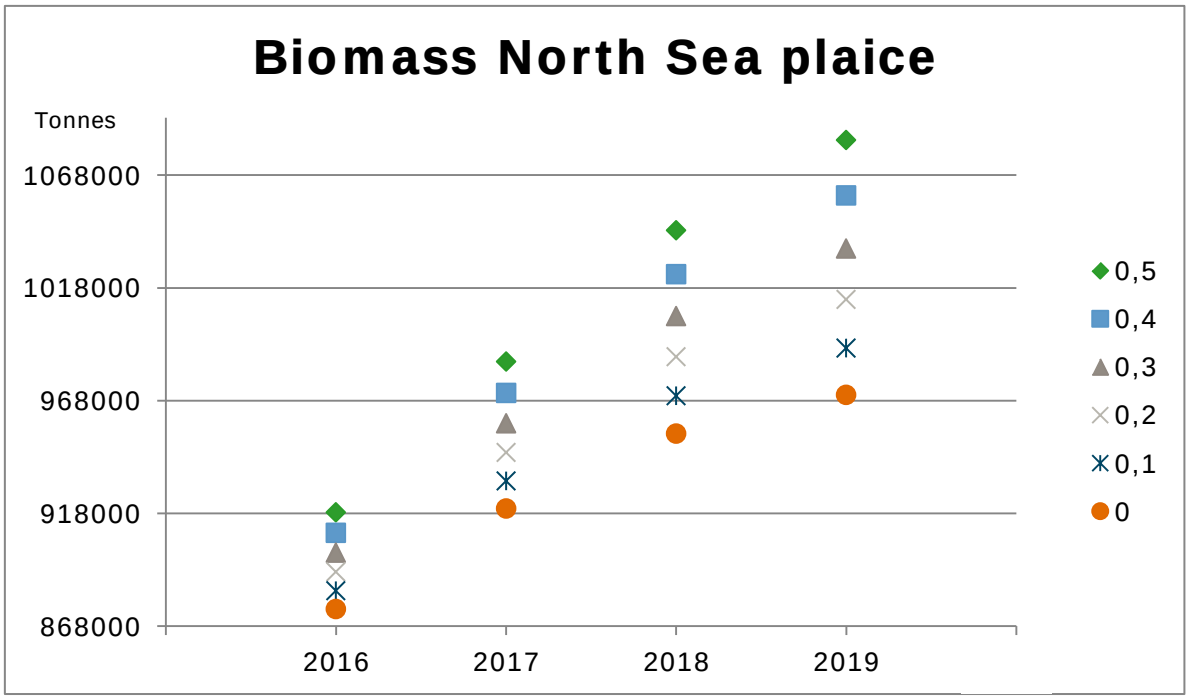

Figure 1: Effect of discard survival on North Sea plaice biomass. Different colours are different scenarios (0%, 10%, 20%, 30%, 40% and 50% survival).

Figures 2a-c show the biomass, landings and discards of North Sea plaice from 2016 to 2019 under the baseline scenario (discard survival is 0%). Fishing mortality is set at Fmsy (F=0.19) from 2016-2019. Average biomass increases and average landings decrease, showing trends that are consistent with a constant fishing mortality of 0.19 and average recruitment. Average biomass increases toward 950 kT at equilibrium conditions, but the 95% confidence intervals are wide, ranging between approximately 880 – 1100 kT in 2019. Average landings gradually decrease to 92 kT in 2019, also with wide 90% confidence intervals, spanning 78 kT to 118 kT. Discards, however, increase after a slight decrease towards 31 kT.

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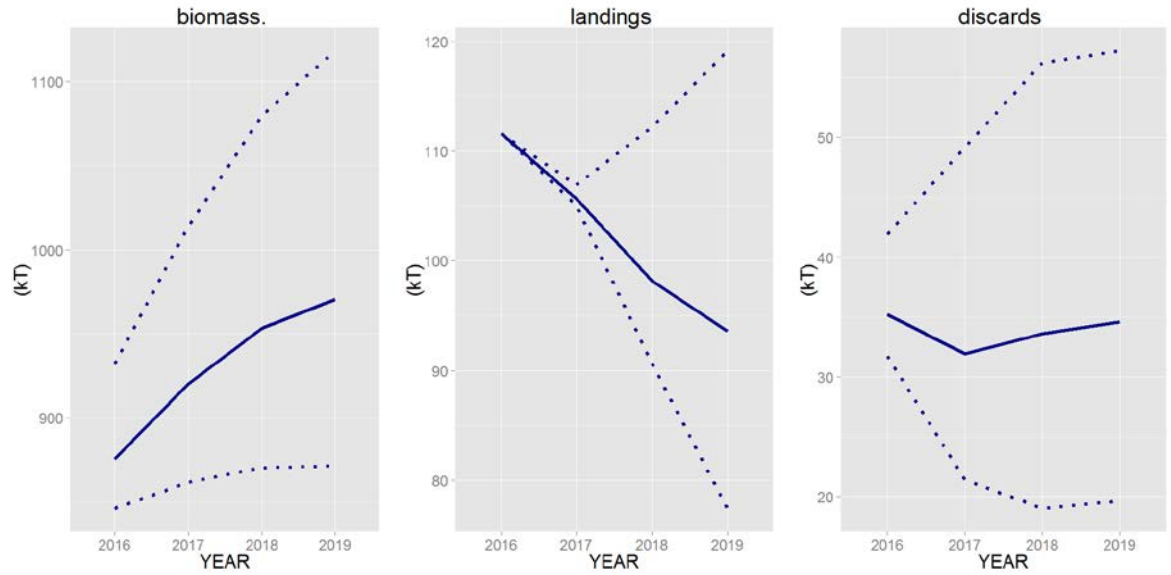

Figure 2a-b-c: Results of the medium time forecast of North Sea plaice on biomass, landings and discards under the baseline scenario, 0% discard survival. Dotted lines represent the 95% confidence interval of the forecast with varying recruitment in 1000 iterations.

The effect of discard survival on North Sea sole is shown in Figure 3. Scenarios 2-6 are presented relative to the baseline scenario (discard survival is 0%). There is an increase in biomass with increasing discard survivability.

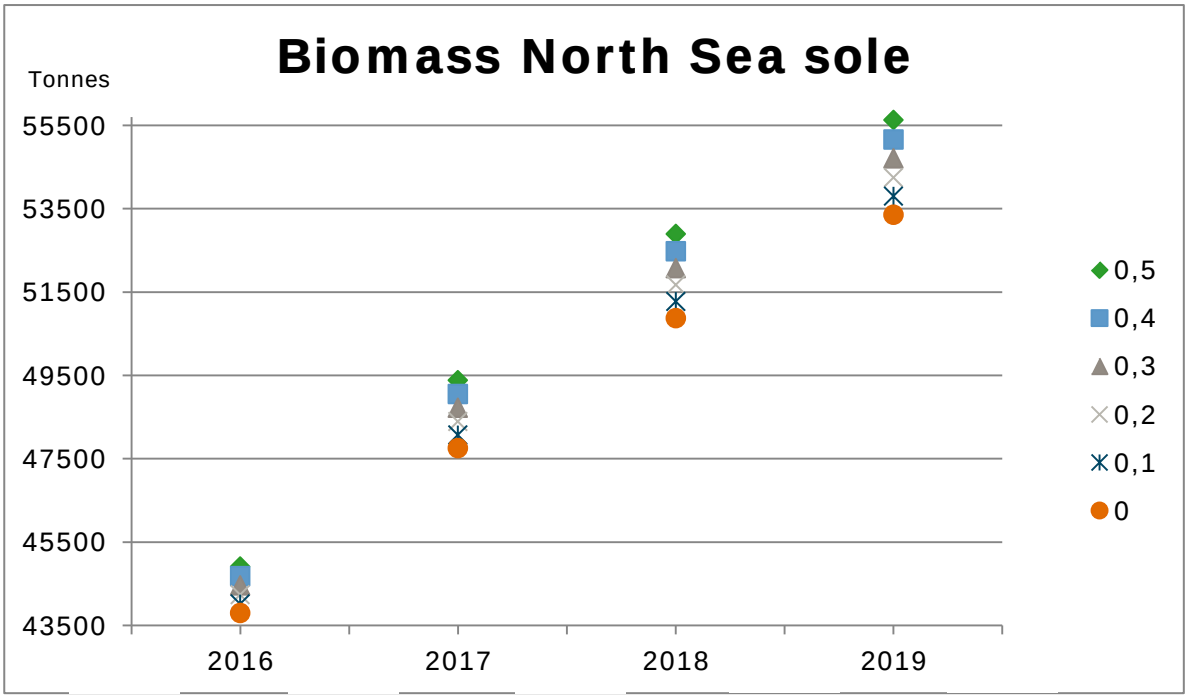

Figure 3: Effect of discard survival on North Sea sole biomass. Different colours are different scenarios (0%, 10%, 20%, 30%, 40% and 50% survival).

Figure 4a-c show the biomass, landings and discards of North Sea sole from 2016 to 2019 under the baseline scenario (discard survival is 0%). Biomass and landings show a slight increase towards 52 kT and 14 kT respectively at equilibrium condition at average yearly recruitment and F=0.2.

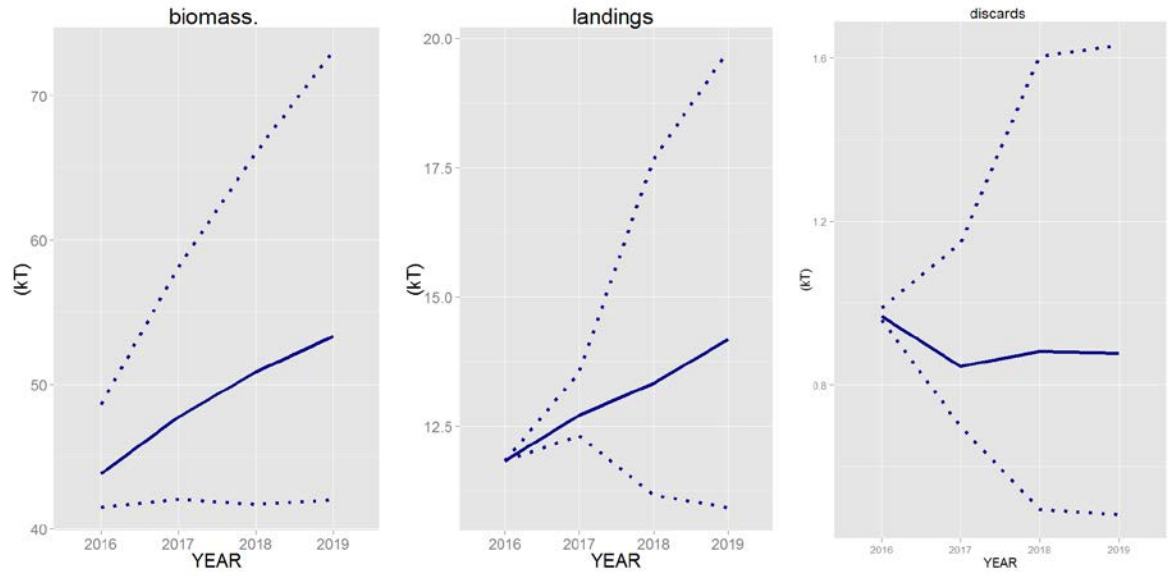

Figure 4a-b-c: Results of the medium time forecast of North Sea sole on biomass, landings and discards under the baseline scenario, 0% survival of discards. Dotted lines represent the 95% confidence interval of the forecasts with varying recruitment and 1000 iterations.

Results for North Sea sole and North Sea plaice from the other scenarios show a similar trend as the baseline scenario. Differences in scenarios are relatively slight for North Sea sole and larger for North Sea plaice. This is due to the nature of both stocks: the North Sea plaice stock is a tenfold size of the North Sea sole stock, and discarding is more prominent, therefore the effect of discard survival is much more apparent.

Table 5 shows the projected biomass and landings of North Sea plaice in 2019. Table 6 shows the projected value of the landings at auction for this stock under all scenarios. The value of the landings was calculated using the average price per kg of North Sea plaice over 2014 (Table 3). Table 6 also shows the difference in value of landings of each of the scenarios to the baseline.

The average value of landings for North Sea plaice differs between 102017 to 158035 kEUR for the 10 % discard survival scenario and between 115185 to 183648 kEUR for the 50 % discard survival scenario. Gross revenue can, however, vary at any given time in the year since only the average price of plaice was used. North Sea plaice shows a substantial pricing dynamic over the year (source: CBS, http://statline.cbs.nl/StatWeb/publication/?DM=SLNL&PA=71483ned). Given a similar average price per kg as in 2014, potential gross revenue losses from landing all catches of North Sea plaice, are on average 3994 kEUR for 10% discard survival and 21914 kEUR for 50% discard survival.

Table 5: Projected biomass and landings of North Sea plaice in 2019 for all scenarios. For each estimate upper(U95) and lower (L95) bound of 95% confidence interval is given.

Discard survival	Biomass (tonnes) in 2019	L95	U95	Landings (tonnes) in 2019	L95	U95
0	970527	871331	1118158	93597	77417	119138
0.1	991275	887591	1144964	96717	79701	123465
0.2	1012914	905001	1172476	99982	82103	128112
0.3	1035485	923149	1200947	103398	84643	132978
0.4	1059033	941100	1232625	106974	87261	138138
0.5	1083606	959402	1265138	110717	89988	143475

Table 6: Projected value of North Sea plaice landings in 2019 for all scenarios and difference to baseline. For value of landings upper(U95) and lower (L95) bound of 95% confidence interval is given.

Discard survival	Average value of landings (kEUR) in 2019	L95	U95	Difference in value of landings compared to baseline (0% survival) (kEUR) in 2019
0	119804	99094	152497	0
0.1	123798	102017	158035	3994
0.2	127977	105092	163983	8173
0.3	132349	108343	170212	12545
0.4	136927	111694	176817	17123
0.5	141718	115185	183648	21914

Table 7 shows the projected biomass and landings of North Sea sole. Table 8 shows the projected difference in revenue at auction for this stock under all scenarios. The economic difference was calculated using the estimated landings and the average price per kg of North Sea sole over 2014 (Table 3). Table 8 also shows the difference in value of landings of each of the scenarios to the baseline.

Table 7: Projected biomass and landings of North Sea sole in 2019 for all scenarios. For each estimate upper(U95) and lower (L95) bound of 95% confidence interval is given.

Discard survival	Biomass (tonnes) in 2019	L95	U95	Landings (tonnes) in 2019	L95	U95
0	53352	41999	73100	14179	10921	19762
0.1	53796	42343	73736	14298	11016	19929
0.2	54245	42692	74376	14417	11112	20099
0.3	54699	43044	75022	14538	11209	20269
0.4	55158	43400	75616	14660	11307	20441
0.5	55623	43761	76168	14784	11405	20616

Table 8: Projected value of North Sea sole landings in 2019 for all scenarios and difference to baseline. For value of landings upper(U95) and lower (L95) bound of 95% confidence interval is given.

Discard survival	Average value of landings (kEUR) in 2019	L95	U95	Difference in value of landings compared to baseline (0% survival) (kEUR) in 2019
0	135409	104296	188727	0
0.1	136546	105203	190322	1137
0.2	137682	106120	191945	2273
0.3	138838	107046	193569	3429
0.4	140003	107982	195212	4594
0.5	141187	108918	196883	5778

Taking into account 10 % discard survival, the value of landings vary between 105203 to 190322 kEUR; for 50 % survival these vary between 108918 and 196883 kEUR. Given a similar average price per kg as in 2014, potential gross revenue losses from landing all catches of North Sea sole are on average 1137 kEUR for the 10% discard survival scenario, and 5778 kEUR for 50% survival.

4 Conclusions

In this report results of a short and medium term (2016-2019) forecast are described given different discard survival rates (10-50 %) of North Sea plaice and North Sea sole. Under the landings obligation, the survival rate equals 0 %, since all catches, including discards, are then landed. In this report the change in stock biomass is estimated in case the discards survive after returning them to sea. Additionally, the potential loss in gross revenue is calculated by estimating the difference in catch resulting from discard survivability.

Changes in biomass and landings are relatively small for both North Sea plaice and sole. Trends are the same over all scenarios. Projections of biomass of plaice and sole in 2019 vary between 871331 and 1265138 tonnes for plaice, and 41999 and 76168 tonnes for sole under different scenarios of discard survivability. Projected landings of North Sea plaice and sole in 2019 vary between 77417 and 143475 tonnes for plaice, and 10921 and 20616 tonnes for sole. Potential losses in average gross revenue resulting from differences in value of landings under the landings obligation vary between 3394 and 21914 kEUR for North Sea plaice and 1137 and 5778 kEUR for North Sea sole, over all discard survival scenarios.

5 Quality Assurance

IMARES utilises an ISO 9001:2008 certified quality management system (certificate number: 124296-2012-AQ-NLD-RvA). This certificate is valid until 15 December 2015. The organisation has been certified since 27 February 2001. The certification was issued by DNV Certification B.V. Furthermore, the chemical laboratory of the Fish Division has NEN-EN-ISO/IEC 17025:2005 accreditation for test laboratories with number L097. This accreditation is valid until 1th of April 2017 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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The scientific quality of this report has been peer reviewed by a colleague scientist and the head of the department of IMARES.

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Senior fisheries scientist

Signature: 

Date: 10 December 2015

Approved: Dr. Ir. Nathalie Steins
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Date: 10 December 2015

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