DATRAS Procedure Document

North Sea and Northeast Atlantic IBTS swept area calculation algorithms

Contents

Summary

This document describes mathematical functions for estimation of the missing values of door spread, wing spread and distance for each country for the North Sea Bottom Trawl Survey (NS-IBTS) and Northeast Atlantic International Bottom Trawl Survey (NEA-IBTS) data. The mathematical functions are provided by experts from the national institutes and are used by DATRAS to further facilitate swept area based calculations.

The mathematical functions are calculated based on the observed values over the years of the survey. Owing to changes in the handling of the gear, changes in vessel, or the equipment on the vessels the net geometry might change. There national institutes can provide mathematical functions for specific time periods.

Some of the national institutes use different lengths of the sweeps which alters the net geometry. Therefore, some national institutes provide algorithms for long and short sweeps.

Background

The importance of swept area estimation was highlighted by the International Bottom Trawl Survey Working Group (IBTSWG) in 2013, following recommendations by WGISDAA (Working Group on Improving use of Survey Data for Assessment and Advice) and WKDATR (DATRAS data review priorities and checking procedures). Prior to any process of swept area estimation, it was necessary for national experts to review the recording and subsequent availability of those existing parameter data needed for such estimations, namely door and wing spread and distance travelled during haul. On the background of this a document, algorithms to calculate missing door-spread and wingspread was produced, in order to calculate swept area for North Sea IBTS and this data product was incorporated into DATRAS.

Swept area (tonnes per km^2) based indices can be used to calculate ecological indicators of biodiversity of fish communities and food-webs. However, there is high variability in the area swept by trawls primarily linked to variation in tow speed, depth and door and wing spread separation. In occasions, the information required to estimate the area swept by trawl is missing, especially in the early time-series. Statistical modelling is then necessary to estimate the missing values.

In 2021 at the ICES workshop on the production of swept area estimates for all hauls in DATRAS for biodiversity as assessments (WKSAE_DATRAS). The main objectives of the workshop were to establish tow-by-tow swept area estimates for time series as long as possible back in time, compare different approaches for the estimates of missing observations and harmonize the resulting data series for biodiversity assessments.
To overcome the gaps of missing door-spread and wing-spread the national Institutes have provided algorithms for estimating missing values needed for the calculation of swept area, i.e. towed distance, door spread (for herding species) and wing spread (for non-herding species).

For all countries, distance based on haul duration (in minutes) and speed over ground speed (in knots) is used:

$$Distance = \frac{HaulDur}{60} * 1852 * GroundSpeed$$

Where groundspeed is not available, a formula to calculate distance between two points on a globe, is used to calculate distance:

$$Distance = 1.852 * 360 * \frac{60}{2\pi} * \text{acos}\big(\cos(\text{radians(Start Latitude)}) * \cos(\text{radians(End Latitude)}) * \cos(\text{radians(End Longitude)} - \text{radians(Start Longitude)}) + \sin(\text{radians(Start Latitude)}) * \sin(\text{radians(End Latitude)})\big)$$

North Sea IBTS

The algorithms, values and conditions for calculating the swept area in the NS-IBTS survey can be seen in Table 1.1 and table 1.2 for all countries. The values in this table are based on the values from IBTSWG 2015 report (Annex 7) and from experts at the national institutes not provided in the report. The values from the 2021 report are under evaluation, so for now, these are the values currently used to calculate missing values for doorspread and wingspread in the North Sea in DATRAS.

Denmark, France, Germany, Norway and GB-Scotland

For a more detailed explanation of the base of the algorithms for Denmark, France, Germany and Norway, please refer to **IBTSWG 2015 report Annex 7** from page 186.

The Netherlands, Sweden and GB-England

The Netherlands

The Netherlands algorithm values and conditions are based upon data from 2003-2020, and use only short sweeps (Table 1.1 and 1.2). The door-spread data from 2003-2011 was collected with Scanmar equipment, and in 2012-2014, Marport equipment was used. In 2015 and 2016 English equipment on board the Endeavour was used, and in 2017-2020, new Scanmar equipment was used. The Netherlands do not measure wing spread, they only did it on board of the Endeavour in 2015 and 2016. For all the other years the formula estimated by Scotland is used. In cases where door-spread is missing, the calculated door-spread is used to estimate the wing spread.

Sweden

The Swedish algorithm values and conditions are based upon data from 2004-2020, and Sweden uses both long and short sweeps (Table 1.1 and 1.2). Onboard Mimer and Argos distance was measured using MacSea chart, but after 2005 onboard Argos they calculated the distance as the sum of GPS-loggings, which is also used onboard Dana.

GB-England

The English algorithm values and conditions are based upon data from 2004-2020. For England a separate set of algorithms and conditions are used for 2006 (Table 1.1 and 1.2).

Table 1.1 Conditions for NS-IBTS

Country	Ship	Quarter	Initial Year	Final Year	Dependent Variable (x)	Priority	Independent Var 1 (y)	Independent Var 2 (z)	Independent Var 3 (q)
DK			2004	current year	DoorSpread	1	Depth		
DK			2004	current year	DoorSpread	1	Depth		
DK			2004	current year	WingSpread	1	DoorSpread		
DK			2004	current year	WingSpread	1	DoorSpread		
NL			2003	2004	DoorSpread	1	Depth	Warplngt	
NL			2005	2014	DoorSpread	1	Depth	Warplngt	
NL			2015	2016	DoorSpread	1	Depth	Warplngt	
NL			2017	current year	DoorSpread	1	Depth	Warplngt	
GB-SCT			2005	current year	DoorSpread	1	Warplngt		
GB-SCT			2005	current year	DoorSpread	2	WingSpread		
GB-SCT			2005	current year	WingSpread	1	DoorSpread	Warplngt	
GB-SCT			2005	current year	WingSpread	2	DoorSpread		
FR			2004	current year	DoorSpread	1	Depth		
FR			2004	current year	WingSpread	1	DoorSpread		
FR			2005	current year	WingSpread	2	Depth		
SE			2004	current year	DoorSpread	1	Depth		
SE			2004	current year	DoorSpread	1	Warplngt		
SE			2004	current year	WingSpread	2	Depth		
SE			2004	current year	WingSpread	2	Depth		
SE			2004	current year	WingSpread	2	Warplngt		
SE			2004	current year	WingSpread	2	Warplngt		
GB			2004	current year (- 2006)	DoorSpread	3	Average Depth		
GB			2004	current year (- 2006)	DoorSpread	2	Warplngt		
GB			2004	current year (- 2006)	DoorSpread	1	WingSpread		
GB			2004	current year (- 2006)	WingSpread	3	Average Depth		
GB			2004	current year (- 2006)	WingSpread	2	Warplngt		
GB			2004	current year (- 2006)	WingSpread	1	DoorSpread		
GB			2006	2006	DoorSpread	3	Average Depth		
GB			2006	2006	DoorSpread	2	Warplngt		
GB			2006	2006	DoorSpread	1	WingSpread		
GB			2006	2006	WingSpread	3	Average Depth		
GB			2006	2006	WingSpread	2	Warplngt		
GB			2006	2006	WingSpread	1	DoorSpread		
NO	58G2	1	2009	2015	DoorSpread	1	Depth		
NO	58G2	1	2009	2015	DoorSpread	1	Depth		
NO	58G2	1	2015	2015	WingSpread	1	DoorSpread		
NO	58G2	1	2015	2015	WingSpread	1	DoorSpread		
NO	JHJ	3	2006	2013 (minus 2009, 2012)	DoorSpread	1	Depth		
NO	JHJ; 58UO; HAV	3	2010	2013 (minus 2012)	DoorSpread	1	Depth		
DE			2004	current year	DoorSpread	1	WingSpread	Depth	
DE			2004	current year	DoorSpread	1	WingSpread	Depth	
DE			2004	current year	DoorSpread	2	Warplngt	Depth	
DE			2004	current year	WingSpread	1	DoorSpread	Warplngt	Depth
DE			2004	current year	WingSpread	1	DoorSpread	Warplngt	Depth
DE			2004	current year	WingSpread	2	Warplngt	Depth	

Table 1.2 Algorithms for NS-IBTS

Country	Ship	Quarter	Initial Year	Final Year	Sweep Length Min	Sweep Length Max	Formula	a	b	c	d
DK			2004	current year	0	60	x1= a+b*EXP(c*y)	79.386	-33.695	-0.028	
DK			2004	current year	else	else	x2= a+b*EXP(c*y)	104.502	-316.682	-0.043	
DK			2004	current year	0	60	x= a+b*y	5.867	0.206		
DK			2004	current year	else	else	x= a+b*y	4.9	0.166		
NL			2003	2004			x=a*log10(y)+b*log10(z)+c	29.544	14.116	-3.456	
NL			2005	2014			x=a*log10(y)+b*log10(z)+c	31.165	0.2974	29.321	
NL			2015	2016			x=a*log10(y)+b*log10(z)+c	28.947	23.372	-32.476	
NL			2017	current year			x=a*log10(y)+b*log10(z)+c	15.842	30.868	-24.793	
GB-SCT			2005	current year			x=a*log(y)+b	24.481	-60.895		
GB-SCT			2005	current year			x=(a*y)+b	4.3277	-3.784		
GB-SCT			2005	current year			x=a*log(z)+b	4.6235	-7.3296		
GB-SCT			2005	current year			x=(a*y)+b	0.1909	4.011		
FR			2004	current year			x=a+b*y	47.548	0.296		
FR			2004	current year			x=a+b*y	9.4306	0.131		
FR			2005	current year			x=a+b*y	15.72	0.038		
SE			2004	current year	0	60	x1=a*log(y)+b	13.706	26.853		
SE			2004	current year	else	else	x2=a*log(y)+b	29.489	-67.157		
SE			2004	current year	0	60	x=a*log(x1)+b	15.78	-48.248		
SE			2004	current year	else	else	x=a*log(x1)+b	21.231	-77.605		
SE			2004	current year	0	60	x=a*log(x2)+b	15.78	-48.284		
SE			2004	current year	else	else	x=a*log(x2)+b	21.231	-77.605		
GB			2004	current year (- 2006)			x= a*log(y)+b	15.0306	12.6399		
GB			2004	current year (- 2006)			x= a*log(y)+b	21.78	-47.2		
GB			2004	current year (- 2006)			x=a*y+b	4.616	-15.966		
GB			2004	current year (- 2006)			x= a*log(y)+b	2.92489	7.43486		
GB			2004	current year (- 2006)			x= a*log(y)+b	4.074	-3.137		
GB			2004	current year (- 2006)			x=a*y+b	0.1869	5.7416		
GB			2006	2006			x= a*log(y)+b	12.468	17.5865		
GB			2006	2006			x= a*log(y)+b	16.4421	-25.4727		
GB			2006	2006			x=a*y+b	3.8182	-11.9066		
GB			2006	2006			x= a*log(y)+b	3.1495	8.2192		
GB			2006	2006			x= a*log(y)+b	4.1885	-2.8637		
GB			2006	2006			x=a*y+b	0.2242	5.7889		
NO	58G2	1	2009	2015	0	60	x=a+b*y+(c*y^2)	54.84	0.41	-0.001	
NO	58G2	1	2009	2015	else	else	x=a+b*y+(c*y^2)	55.7	0.56	-0.001	
NO	58G2	1	2015	2015	0	60	x=a+b*y	40.0741	1.9259		
NO	58G2	1	2015	2015	else	else	x=a+b*y	-23.414	6.931		
NO	JHJ	3	2006	2013 (minus 2009, 2012)	0	60	x=a+b*y+(c*y^2)	64.94	0.152	-1.99	
NO	JHJ; 58UO; HAV	3	2010	2013 (minus 2012)	0	60	x=a+b*y+(c*y^2)	64.94	0.152	-1.99	
DE			2004	current year	0	50	x=a+b*y+c*log(z)	-7.456	3.616	3.124	
DE			2004	current year	else	else	x=a+b*y+c*log(z)	-7.935	5.123	2.366	
DE			2004	current year	0	50	x=a+b*log(y)+c*log(z)	-0.441	10.009	4.768	
DE			2004	current year	0	50	x=a+b*y+c*log(z)+d*log(q)	3.359	0.095	1.391	0.261
DE			2004	current year	esle	else	x=a+b*y+c*log(z)+d*log(q)	3.087	0.118	0.445	0.368
DE			2004	current year	0	50	x=a+b*log(y)+c*log(z)	3.317	2.341	0.713	

Northeast Atlantic IBTS

The algorithms, values and conditions for calculating swept area in the NEA-IBTS surveys can be seen in Table 2. These are currently the most up to date values for each survey, since the newest version of the Series of ICES Survey (SISP) manual for NEA-IBTS has not been published yet. The Portuguese International Bottom Trawl Survey (PT-IBTS) has not been included in the NEA-IBTS table (Table 2), because there is not enough data to proceed with the calculations as of yet.

Table 2. Algorithms for NEA-IBTS.

Country	Survey	Ship	Initial Year	Final Year	Dependent Variable (x)	Priority	Independent Variable (y)	Sweep Length Min	Sweep Length Max	Formula	a	b
GB-SCT	**ROCKALL**		2005	2009	Doorspread	1	Depth			x=a+b*log(y)	-23.35	21.27
GB-SCT	**ROCKALL**		2005	2009	Wingspread	1	Depth			x=a+b*log(y)	10.16	2.01
GB-SCT	**SCOROC**		2016	current	Doorspread	1	Depth			x=a+b*log(y)	35.70	12.94
GB-SCT	**SCOROC**		2016	current	Wingspread	1	Doorspread			x=a+b*y	8.61	0.12
GB-SCT	**SCOROC**		2016	current	Wingspread	2	Depth			x=a+b*log(y)	13.24	1.39
GB-SCT	**SWC-IBTS**		2004	2010	Doorspread	1	Depth			x=a+b*log(y)	-23.35	21.27
GB-SCT	**SWC-IBTS**		2004	2010	Wingspread	1	Depth			x=a+b*log(y)	10.16	2.01
GB-SCT	**SCOWCGFS**		2016	current	Doorspread	1	Depth	0	60	x=a+b*log(y)	-14.74	19.28
GB-SCT	**SCOWCGFS**		2016	current	Doorspread	1	Depth	else	else	x=a+b*log(y)	-13.52	22.46
GB-SCT	**SCOWCGFS**		2016	current	Wingspread	1	Doorspread	0	60	x=a+b*y	7.55	0.16
GB-SCT	**SCOWCGFS**		2016	current	Wingspread	1	Doorspread	else	else	x=a+b*y	13.94	0.06
GB-SCT	**SCOWCGFS**		2016	current	Wingspread	2	Depth	0	60	x=a+b*log(y)	1.47	4.03
GB-SCT	**SCOWCGFS**		2016	current	Wingspread	2	Depth	else	else	x=a+b*log(y)	10.28	2.01
GB-NIR	**NIGFS**		2005	current	Doorspread	1	Depth			x=a+b*log(y)	7.49	7.70
GB-NIR	**NIGFS**		2015	current	Wingspread	1	Doorspread			x=a+b*y	5.28	0.27
GB-NIR	**NIGFS**		2015	current	Wingspread	2	Depth			x=a+b*log(y)	8.61	1.79
FR	**FR-CGFS**	35TH	2015	current	Doorspread	1	Depth			x=a+b*log(y)	-1.31	15.58
FR	**FR-CGFS**	35TH	2015	current	Wingspread	1	Doorspread			x=a+b*y	7.04	0.17
FR	**FR-CGFS**	35TH	2015	current	Wingspread	2	Depth			x=a+b*log(y)	6.86	2.61
FR	**EVHOE**		2016	current	Doorspread	1	Depth	0	60	x=a+b*log(y)	-3.34	16.5
FR	**EVHOE**		2016	current	Doorspread	1	Depth	else	else	x=a+b*log(y)	16.42	15.56
FR	**EVHOE**		2016	current	Wingspread	1	Doorspread	0	60	x=a+b*y	9.49	0.14
FR	**EVHOE**		2016	current	Wingspread	1	Doorspread	else	else	x=a+b*y	9.95	0.11
FR	**EVHOE**		2016	current	Wingspread	2	Depth	0	60	x=a+b*log(y)	9.07	2.33
FR	**EVHOE**		2016	current	Wingspread	2	Depth	else	else	x=a+b*log(y)	11.71	1.73
SP	**SP-PORC**		2016	current	Doorspread	1	Wingspread			x=a+b*y	-25.42	7.02
SP	**SP-PORC**		2016	current	Doorspread	2	Depth			x=a+b*log(y)	-31.70	28.81
SP	**SP-PORC**		2016	current	Wingspread	1	Doorspread			x=a+b*y	9.00	0.10
SP	**SP-PORC**		2016	current	Wingspread	2	Depth			x=a+b*log(y)	10.29	2.03
SP	**SP-NORTH**		2016	current	Doorspread	1	Wingspread			x=a+b*y	-5.11	5.09
SP	**SP-NORTH**		2016	current	Doorspread	2	Depth			x=a+b*log(y)	4.39	17.62
SP	**SP-NORTH**		2016	current	Wingspread	1	Doorspread			x=a+b*y	4.74	0.16
SP	**SP-NORTH**		2016	current	Wingspread	2	Depth			x=a+b*log(y)	6.73	2.51
SP	**SP-ARSA**		2016	current	Doorspread	1	Depth	0	60	x=a+b*log(y)	-0.84	14.06
SP	**SP-ARSA**		2016	current	Doorspread	1	Depth	else	else	x=a+b*log(y)	-4.12	18.97
SP	**SP-ARSA**		2016	current	Wingspread	1	Doorspread	0	60	x=a+b*y	4.65	0.23
SP	**SP-ARSA**		2016	current	Wingspread	1	Doorspread	else	else	x=a+b*y	8.17	0.13
SP	**SP-ARSA**		2016	current	Wingspread	2	Depth	0	60	x=a+b*log(y)	-0.43	4.69
SP	**SP-ARSA**		2016	current	Wingspread	2	Depth	else	else	x=a+b*log(y)	7.22	2.51
IE	**IE-IGFS**		2016	current	Doorspread	1	Depth	0	60	x=a+b*log(y)	42.51	9.63
IE	**IE-IGFS**		2016	current	Doorspread	1	Depth	else	else	x=a+b*log(y)	28.78	17.92
IE	**IE-IGFS**		2016	current	Wingspread	1	Doorspread	0	60	x=a+b*y	12.27	0.11
IE	**IE-IGFS**		2016	current	Wingspread	1	Doorspread	else	else	x=a+b*y	13.32	0.08
IE	**IE-IGFS**		2016	current	Wingspread	2	Depth	0	60	x=a+b*log(y)	12.83	2.10
IE	**IE-IGFS**		2016	current	Wingspread	2	Depth	else	else	x=a+b*log(y)	14.29	1.79
IE	**IE-AIMS**		2016	current	Doorspread	1	Depth			x=a+b*log(y)	18.54	14.07
IE	**IE-AIMS**		2016	current	Wingspread	1	Doorspread			x=a+b*y	10.16	0.20
IE	**IE-AIMS**		2016	current	Wingspread	2	Depth			x=a+b*log(y)	14.69	2.70