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Alternative Method to Estimate Catches Based on the Scientific Observers.
by

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Abstract

Good stock assessments need good input data. With the goal to have the best input data possible for the assessment, for several years Portugal have presented alternative catch estimates based on the scientific observers onboard of the its national fleet. These estimates were not always adopted by Scientific Council. This paper describes the methodology used to derive the catch estimates.

Introduction

The Portuguese fleet operating in NAFO has an opportunistic behaviour; target species change based on the quota allocation and industry strategy. There are no segments of the fleet with a specific target species or a specific behaviour, so all the vessels are assumed to behave more or less in the same way.

The scientific sampling program, implemented by Portugal for the NAFO Area, consists of having scientific observers onboard of its fleet. The main objective of this program is to collect length and biological samples associated with the catch and effort data of the hauls they came from. The catch recorded by these observers has the main goal to raise the samples to the total vessel catch and not estimate the total fleet catches. Nevertheless the Portuguese catch estimation method is based on these scientific observers. The exercise to estimate catches became routine when it was needed to improve the input data for the assessment of several stocks.

Material and Methods

Data collected:

The haul by haul catch and effort information collected by the scientific observers is summarized in the following table:

Data Type	Description
Haul number	Sequential number from the beginning to the end of the trip (never repeated in the same trip).
Code Vessel	Vessel name or code assigned to it.
Fishing Area	NEAFC and NAFO.
Division	Statistical Division (e.g. 3L, I, XII, ...).
Gear	Gear type (e.g. bottom or pelagic trawl, gillnets, ...).
Mesh Size	Mesh size in the codend.
Start date	Starting date of the haul. When finish dropping the cable.
Data Type	Description
Start time	Starting hour of the haul. When finish dropping the cable.
Start Depth	Depth at the start of the haul. Is the depth at which the net operates.
Start Longitude	Longitude in the start of the haul.
Start Latitude	Latitude in the start of the haul.
End date	Ending date of the haul. When start haul in the cable.
End time	Ending hour of the haul. When start haul in the cable.
End Depth	Depth at the end of the haul. Is the depth at which the net operates.
End Longitude	Longitude at the end of the haul.
End Latitude	Latitude at the end of the haul.
Landings	Processed and landing catch by species, corresponding to its live weight, for each species is used the conversion factor into force on the ship.
Discards	Discarded catch by species, corresponding to its live weight. Any catch that are not landed are consider discards (e.g. human consumption, ...) The majority of this discards are based on a visual estimation and so is subjective and depends on the observer experience.
Observations	Any observed events during the haul (breakdowns, ...)

CPUE calculation:

The Catch Per Unit Effort (CPUE) by species/month/division corresponds to the total catch (landings plus discards) of one species during a month in one Division divided by the total effort in that Division during that month:

$$CPUE_{Sp/Month/Div} = \frac{\sum c_{Sp/Month/Div}}{\sum e_{Month/Div}}$$

Where c is the observed catch in a haul and e the respective effort.

For example - the CPUE of the *Species 1* in *January* in *Div. 3L* ($CPUE_{Sp1/Jan/3L}$)

$$CPUE_{Sp1/Jan/3L} = \frac{\sum c_{Sp1/Jan/3L}}{\sum e_{Jan/3L}}$$

Where:

$\sum c_{Sp1/Jan/3L}$ - total observed catch of *Species 1* during *January* in *Div. 3L*.

$\sum e_{Jan/3L}$ - total observed effort during *January* in *Div. 3L*.

So for Div. 3L the following *CPUEs* matrix is calculated:

Division	Month	Observed Effort (hours)	<i>Sp1</i>	<i>Sp2</i>	...	<i>Spn</i>
3L	Jan	$e_{Jan/3L}$	$CPUE_{Sp1/Jan/3L}$	$CPUE_{Sp2/Jan/3L}$	...	$CPUE_{Spn/Jan/3L}$
3L	Feb	$e_{Feb/3L}$	$CPUE_{Sp1/Feb/3L}$	$CPUE_{Sp2/Feb/3L}$	...	$CPUE_{Spn/Feb/3L}$
3L	Mar	$e_{Mar/3L}$	$CPUE_{Sp1/Mar/3L}$	$CPUE_{Sp2/Mar/3L}$	...	$CPUE_{Spn/Mar/3L}$
3L	Apr	$e_{Apr/3L}$	$CPUE_{Sp1/Apr/3L}$	$CPUE_{Sp2/Apr/3L}$	...	$CPUE_{Spn/Apr/3L}$
3L	May	$e_{May/3L}$	$CPUE_{Sp1/May/3L}$	$CPUE_{Sp2/May/3L}$	...	$CPUE_{Spn/May/3L}$
3L	Jun	$e_{Jun/3L}$	$CPUE_{Sp1/Jun/3L}$	$CPUE_{Sp2/Jun/3L}$	...	$CPUE_{Spn/Jun/3L}$
3L	Jul	$e_{Jul/3L}$	$CPUE_{Sp1/Jul/3L}$	$CPUE_{Sp2/Jul/3L}$	...	$CPUE_{Spn/Jul/3L}$
3L	Sep	$e_{Sep/3L}$	$CPUE_{Sp1/Sep/3L}$	$CPUE_{Sp2/Sep/3L}$	...	$CPUE_{Spn/Sep/3L}$
3L	Oct	$e_{Oct/3L}$	$CPUE_{Sp1/Oct/3L}$	$CPUE_{Sp2/Oct/3L}$	...	$CPUE_{Spn/Oct/3L}$
3L	Nov	$e_{Nov/3L}$	$CPUE_{Sp1/Nov/3L}$	$CPUE_{Sp2/Nov/3L}$	...	$CPUE_{Spn/Nov/3L}$
3L	Dec	$e_{Dec/3L}$	$CPUE_{Sp1/Dec/3L}$	$CPUE_{Sp2/Dec/3L}$	...	$CPUE_{Spn/Dec/3L}$

Missing Data:

The observer coverage is not 100% which leads to missing observations in some month/Div. In these cases, a mean between the nearest months weighted by the respective effort is used to fill that gap.

$$CPUE_{Spn/Month/Divx} = (CPUE_{Spn/Month-1/Divx} * e_{Month-1/Divx} + CPUE_{Spn/Month+1/Divx} * e_{Month+1/Divx}) / (e_{Month-1/Divx} + e_{Month+1/Divx})$$

For example if *CPUE* in *May* for *Species 1* in *Div. 3L* is missing

$$CPUE_{Sp1/May/3L} = (CPUE_{Sp1/Abr/3L} * e_{Abr/3L} + CPUE_{Sp1/Jun/3L} * e_{Jun/3L}) / (e_{Abr/3L} + e_{Jun/3L})$$

If it is not possible just to have a mean, the nearest month is used to fill that gap:

$$CPUE_{Spn/Month/Divx} = CPUE_{Spn/Month-1/Divx} \quad \text{or} \quad CPUE_{Spn/Month/Divx} = CPUE_{Spn/Month+1/Divx}$$

In the cases where it is not possible or reasonable to generate a *CPUE* in one month, the assumed catches for that month are, by default, the official catches.

Catch Estimation:

The Total Official Effort (*E*) by month and Division of the fleet is provided by the Portuguese Fisheries Directorate.

The Catch (*C*) for any species during one month in a specific Division is calculated multiplying the observed *CPUE* by the respective official effort (*E*):

$$C_{Sp/Month/Div} = E_{Month/Div} * CPUE_{Sp/Month/Div}$$

So, as example, for Div. 3L the following catch matrix is calculated:

Division	Month	Official Effort (hours)	$Sp1$	$Sp2$	...	Spn
3L	Jan	$E_{Jan/3L}$	$C_{Sp1/Jan/3L}$	$C_{Sp2/Jan/3L}$	...	$C_{Spn/Jan/3L}$
3L	Feb	$E_{Feb/3L}$	$C_{Sp1/Feb/3L}$	$C_{Sp2/Feb/3L}$	...	$C_{Spn/Feb/3L}$
3L	Mar	$E_{Mar/3L}$	$C_{Sp1/Mar/3L}$	$C_{Sp2/Mar/3L}$	...	$C_{Spn/Mar/3L}$
3L	Apr	$E_{Apr/3L}$	$C_{Sp1/Apr/3L}$	$C_{Sp2/Apr/3L}$	...	$C_{Spn/Apr/3L}$
3L	May	$E_{May/3L}$	$C_{Sp1/May/3L}$	$C_{Sp2/May/3L}$	...	$C_{Spn/May/3L}$
3L	Jun	$E_{Jun/3L}$	$C_{Sp1/Jun/3L}$	$C_{Sp2/Jun/3L}$	...	$C_{Spn/Jun/3L}$
3L	Jul	$E_{Jul/3L}$	$C_{Sp1/Jul/3L}$	$C_{Sp2/Jul/3L}$	...	$C_{Spn/Jul/3L}$
3L	Sep	$E_{Sep/3L}$	$C_{Sp1/Sep/3L}$	$C_{Sp2/Sep/3L}$	...	$C_{Spn/Sep/3L}$
3L	Oct	$E_{Oct/3L}$	$C_{Sp1/Oct/3L}$	$C_{Sp2/Oct/3L}$	...	$C_{Spn/Oct/3L}$
3L	Nov	$E_{Nov/3L}$	$C_{Sp1/Nov/3L}$	$C_{Sp2/Nov/3L}$	...	$C_{Spn/Nov/3L}$
3L	Dec	$E_{Dec/3L}$	$C_{Sp1/Dec/3L}$	$C_{Sp2/Dec/3L}$	...	$C_{Spn/Dec/3L}$

The sum of the monthly catches give the total catch:

Total catch in Div. 3L by species	$\sum_{Jan}^{Dec} C_{Sp1/3L}$	$\sum_{Jan}^{Dec} C_{Sp2/3L}$...	$\sum_{Jan}^{Dec} C_{Spn/3L}$
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Scientific sampling effort:

Total effort by Division (days), observed effort by Division (days, sets and hours), % observed effort days and catch estimation provided are presented in the following table. These estimates were not always adopted by Scientific Council.

	DIVISION	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
TOTAL DAYS FISHED (STATLANT 21B)	3L	519	770	607	503	435	492	408	295	307	512	495	432	587
	3M	248	477	263	257	400	407	454	359	464	727	643	770	886
	3N	297	361	532	783	406	218	106	162	179	237	214	320	309
	3O	329	262	490	753	464	359	517	421	213	188	242	233	246
	TOTAL	1393	1870	1892	2296	1705	1476	1485	1237	1163	1664	1594	1755	2028

	DIVISION	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
OBSERVED DAYS FISHED	3L	105	90	141	98	60	37	112	77	68	93	133	72	61
	3M	38	67	86	66	130	32	91	56	78	213	200	155	87
	3N	45	41	79	136	77	0	25	19	1	19	44	39	37
	3O	51	47	59	74	77	0	124	70	1	24	104	19	17
	TOTAL	239	245	365	374	344	69	352	222	148	349	481	285	202
OBSERVED SETS	3L	274	226	328	218	113	93	225	152	126	153	254	144	133
	3M	69	175	205	135	319	98	228	132	248	631	593	554	294
	3N	109	105	194	385	186	0	50	39	1	42	133	159	137
	3O	154	167	164	206	260	0	408	237	3	72	343	48	43
	TOTAL	606	673	891	944	878	191	911	560	378	898	1323	905	607
OBSERVED HOURS FISHED	3L	1602	1407	1878	1240	683	524	1801	1161	958	1122	1893	1108	846
	3M	398	949	1076	745	1703	245	998	594	823	2697	2433	1671	1305
	3N	380	371	759	1464	698	0	235	164	4	173	269	228	213
	3O	398	629	675	850	1090	0	1926	904	8	206	1037	120	135
	TOTAL	2777	3356	4387	4299	4173	769	4960	2823	1793	4197	5632	3127	2498

	DIVISION	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
DAYS FISHED OBSERVED/TOTAL (%)	3L	20.2%	11.7%	23.2%	19.5%	13.8%	7.5%	27.5%	26.1%	22.1%	18.2%	26.9%	16.7%	10.4%
	3M	15.3%	14.0%	32.7%	25.7%	32.5%	7.9%	20.0%	15.6%	16.8%	29.3%	31.1%	20.1%	9.8%
	3N	15.2%	11.4%	14.8%	17.4%	19.0%	0.0%	23.6%	11.7%	0.6%	8.0%	20.6%	12.2%	12.0%
	3O	15.5%	17.9%	12.0%	9.8%	16.6%	0.0%	24.0%	16.6%	0.5%	12.8%	43.0%	8.2%	6.9%
	TOTAL	17.2%	13.1%	19.3%	16.3%	20.2%	4.7%	23.7%	17.9%	12.7%	21.0%	30.2%	16.2%	10.0%

	DIVISION	2000 ⁽¹⁾	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010 ⁽²⁾	2011	2012
CATCH ESTIMATION PROVIDED	3L	×	✓	✓	✓	✓	×	✓	✓	✓	✓	✓	×	×
	3M	×	✓	✓	✓	✓	×	✓	✓	✓	✓	✓	×	×
	3N	✓	✓	✓	✓	✓	×	✓	✓	×	✓	✓	×	×
	3O	×	✓	✓	✓	✓	×	✓	✓	×	✓	✓	×	×

(1) Only RED, PLA & YEL

(2) Only COD, RED, PLA, YEL, WIT & GHL

Comments and problems with the method

- The catch recorded by these observers has the main goal to raise the samples to the total vessel catch and not estimate the total fleet catches.
- Discards are based on a visual estimation and so is subjective and depends on the observer experience.
- No confidence intervals were provided.
- % of observed effort it is not constants over time.
- Scientific catch estimations are not revised when the official data (e.g. *E*, ...) are revised.