

**F**alkland  
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## **Vessel Units**

## **Allowable Effort**

## **Allowable Catch**

**2020**

Part 1

*Summary and Recommendations*

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# 1. Foreword

The Licensing Advice 2020 consists of two parts.

Part 1 summarizes licensing advice for all regulated fisheries in Falkland Islands Conservation Zones for 2020 apart from the B-licensed *Illex*-fishery. Current licencing advices are based on data through the end of 2018 for finfish, toothfish and skates, and through the end of first season 2019 for calamari. Summary tables of the licencing advice are presented at the end of the report.

Part 2 comprises detailed stock assessments of these fisheries, and recommendations for their management in terms of effort and total allowable catch, as applicable. Part 2 may be issued as one document or as a series of stock assessments.

Falkland calamari *Doryteuthis (Loligo) gahi* obtained the highest second-season catch in 2018 since 2010 with 35,828 tonnes and 0.9% likelihood of failing the season-end escapement threshold. Falkland calamari obtained the highest first-season catch in 2019 since 1995 – for the third year in a row, and showed effectively zero likelihood of failing the season-end escapement threshold. With robust stock status in both of the past two seasons, allowable effort is set with the expectation of full seasons in 2020, and vessel units were calculated as the average of the past three years: 27.01.

Annual catch of rock cod (*Patagonotothen ramsayi*) exhibited a period of increase (2005–2010) followed by a period of decrease (2010–2018). Estimated total rock cod biomass from the February 2019 parallel finfish / calamari surveys was the lowest of the seven parallel surveys conducted since 2010. However, surplus production modelling suggests that the biomass decrease has levelled off over the past two years. In 2016, with information of a decreasing trend in rock cod biomass, the FIFD followed a precautionary approach and set a total allowable catch at 30,000 t for 2017, superimposed on the total allowable effort. The precautionary approach was kept for 2018 and 2019 and total allowable catch reduced to 20,000 t. The 2019 stock assessment estimated an adjusted maximum sustainable yield of 11,112 tonnes, and this was set as the superimposed total allowable catch for 2020. No fishing year since 2016 has approached its total allowable catch for rock cod.

The licenced Patagonian toothfish (*Dissostichus eleginoides*) fishery in 2018 caught below the target quota of 1040 tonnes, while bycatches in finfish and calamari trawls decreased from the two preceding years following some regulatory changes. The age-structured stock assessment of toothfish was externally reviewed in 2018 to comply with MSC recommendations, and in 2019 a parallel stock assessment based on data-poor methods was undertaken to corroborate the estimation. The current stock assessment estimates a biomass of 30,485 tonnes toothfish and a ratio of current spawning stock biomass to unfished spawning stock biomass of 0.467. This spawning stock ratio meets the target reference point of the harvest control measures, and therefore Total Allowable Catch for toothfish is maintained at the level of 1040 tonnes.

Skate catch (2029 tonnes) and skate-license effort (64 days) in 2018 were both the lowest since 1998, with skate-license effort less than half of the year before. Only 26% of the total skate catch was taken under skate (F) licence. Given the low commercial activity in skate fishing, stock assessment for skates was not updated and the same biomass as the year before was used as the basis for licencing allocation. As in previous years, allocations were equalized among GT categories.

In 2018, 962 tonnes of southern blue whiting (*Micromesistius australis*) were commercially caught in Falkland waters, the lowest annual total on record. Of this total 96% were taken by finfish licence and 4% by calamari licence. Additionally, 30 tonnes were taken under experimental trawl licenses for finfish and calamari. No blue whiting was taken by S license, which was fished by one vessel for 4 days. The statutory Total Allowable Catch of 2,000 metric tonnes under S licence was maintained for blue whiting.

We are grateful to the scientific observers of the FIFD for data collection and to data management staff for processing catch reports from fishing vessels. We also thank our local and foreign-partner fishing companies for their cooperation in providing timely and reliable fisheries data.

## 2. *Doryteuthis gahi* (Loligo) – Falkland calamari

### 2.1. Management and stock trends.

The targeted fishery for Falkland calamari (*Doryteuthis gahi* – colloquially *Loligo*) is managed through two levels of control: 1) season schedule and 2) total biomass to a minimum escapement threshold per season. Season schedules are currently set as: 1<sup>st</sup> season (C licence), 64/65 days opening from February 24<sup>th</sup> to April 28<sup>th</sup>; 2<sup>nd</sup> season (X licence), 64 days from July 29<sup>th</sup> to September 30<sup>th</sup>. Since 2013 a flexible option also allows vessels to start and end either season as much as 6 days later. In either 1<sup>st</sup> or 2<sup>nd</sup> season the minimum escapement threshold is set at 10,000 tonnes biomass (Barton 2002, Arkhipkin et al. 2008). If in-season depletion models project that calamari biomass will fall below 10,000 tonnes, the fishery may be suspended or stopped before the scheduled end date of the season.

With the use of these controls, actual vessel units (VU) play a nominal role in determining the effort allocation to the Falkland calamari fishery. As long as no significant decline in stock biomass is anticipated, all licensed vessels can expect to fish for the duration of the season (except vessels restricted to fixed proportions of the season based on their replacement categories; see below). For the past five years, calamari stock biomass estimates have been variable and the past three years have been exceptionally high (Table 2.1). In 1<sup>st</sup> season 2015 the Loligo Box experienced a large ingress of *Illex*, resulting in early closure of fishing allocated to calamari and relatively high failure risk (28.8%) of the escapement threshold (Winter 2015). In 1<sup>st</sup> season 2016 most calamari immigration came late (possibly as an after-effect of the conditions of the previous year), resulting in low catches early in the season and abundant biomass remaining at the end of the season (Winter 2016). In each successive 1<sup>st</sup> season 2017 to 2019, the highest total catch since 1995 was obtained (Mercopress 2017, Mercopress 2018, Faro de Vigo 2019), whereby effort was 50% higher in 1995.

Table 2.1. Catches, estimated biomass, escapement risks, and VU allocations of Falkland calamari 1<sup>st</sup> seasons 2015-2019.

Year	1 <sup>st</sup> season calamari catch (t)	1 <sup>st</sup> season calamari biomass (t) <sup>a</sup>	Risk of <10,000 t escapement	Total VU allocation
2015	19,383 <sup>b</sup>	52,450 <sup>b</sup>	0.288	26.99
2016	22,616	65,603	0.000	27.01
2017	39,425	113,939	0.000	27.02
2018	43,085	106,237	0.000	27.01
2019	55,586	146,247	0.000	27.01

a: Biomass estimate at the end of the pre-season survey, plus in-season immigration.

b: Calculated only to April 21<sup>st</sup>, for the duration of allocation to calamari target fishing.

### 2.2. Vessel units and q-values.

Because of the absence of negative trends in calamari biomass, the total VU allocation for 2019 was set as the average of the preceding three years (Table 2.1): 27.01 VU. As this procedure has been followed for a number of years, year-to-year fluctuations in VU are expectedly becoming smaller.

Like previous years (e.g., Section 2 in FIFD, 2018), this total VU allocation was partitioned among licensed vessels in proportion to the GT category-averaged catchability coefficients (q-values). Catchability coefficients represent the efficiency of a vessel at fishing (Arreguin-Sanchez 1996), and are calculated as catch per unit effort per available biomass. To smooth variations within seasons, catchability coefficients were averaged over the most recent three years 2017 to 2019 (Table 2.2). Since 2016 catchability coefficients were calculated only on unreplaced vessels, i.e. excluding vessels that had been entered as replacements for a mechanical breakdown. Replacement vessels are less experienced in the fishery and are therefore likely to have lower catch efficiency independently of their GT category.

Table 2.2. Parameters for average q-value calculations. Trends were visualized for the five years 2015 - 2019; q averages were calculated for the most recent three years 2017 – 2019.

Parameter	GT cat	Year					3-year average
		2015	2016	2017	2018	2019	
Biomass		52,450	65,603	113,939	106,237	146,247	
Catch (t)	3	1,015.2	1,156.5	241.5	0.0	0.0	
	4	3,292.7	3,648.5	6603.1	8812.7	11275.0	
	5	5,743.7	6,818.6	12203.7	12805.9	16712.5	
	6	6,450.1	7,531.5	13950.9	13121.6	18320.0	
	7	2,881.3	3,462.2	3389.4	7449.0	9225.3	
Fishing days	3	55	64	7	0	0	
	4	156	178	185	239	232	
	5	272	311	314	297	294	
	6	275	322	311	292	303	
	7	111	130	62	123	124	
CPUE (t day <sup>-1</sup> )	3	18.5	18.1	34.5			
	4	21.1	19.3	35.7	36.9	48.6	
	5	21.1	21.9	38.9	43.1	56.8	
	6	23.5	23.4	44.9	44.9	60.5	
	7	26.0	26.6	54.7	60.6	74.4	
q-values	3	3.52e-4	2.75e-4	3.03e-4			3.03e-4
	4	4.02e-4	2.94e-4	3.13e-4	3.47e-4	3.32e-4	3.31e-4
	5	4.03e-4	3.34e-4	3.41e-4	4.06e-4	3.89e-4	3.79e-4
	6	4.47e-4	3.57e-4	3.94e-4	4.23e-4	4.13e-4	4.10e-4
	7	4.95e-4	4.06e-4	4.80e-4	5.70e-4	5.09e-4	5.20e-4

One category 5 vessel in the fishery is licensed to replace a category 3 vessel, and starting 1<sup>st</sup> season 2018, one category 4 vessel is licensed to replace a category 3 vessel. The standard procedure for replacement vessels has been to adjust their VU allocation to the category they are replacing based on the current calculation of averaged catchability. However, following the latest replacement there is no actual category 3 vessel left in the fishery. Thus the allocation proportions have been fixed at their previous and current values; for the replacement category 5 vessel at 83% of the allocation (FIFD 2015; 2016; 2017), and for the category 4 vessel at 92% of the allocation (based on average catchabilities in 2015, 2016, and 2017) (Table 2.3).

Table 2.3. VU allocations per vessel.

Vessel Callsign	GT category	GT avg. q	VU allocation
EHIS	4	3.31e-4	1.44
MSPL9	5	3.79e-4	1.65
ZDLC1	4	3.31e-4	1.44
ZDLE1	6	4.10e-4	1.78
ZDLF2	5	3.79e-4	1.65
ZDLM3 <sup>a</sup>	4	3.05e-4	<sup>a</sup> 1.32
ZDLO1	6	4.10e-4	1.78
ZDLP1	5	3.79e-4	1.65
ZDLR1	6	4.10e-4	1.78
ZDLS3	5	3.79e-4	1.65
ZDLT1	4	3.31e-4	1.44
ZDLU1	6	4.10e-4	1.78
ZDLV <sup>b</sup>	5	3.14e-4	<sup>b</sup> 1.37
ZDLY	7	5.20e-4	2.26
ZDLZ	7	5.20e-4	2.26
ZDLZ1	6	4.10e-4	1.78
			27.01

<sup>a</sup> ZDLM3 replaced a category 3 vessel, and is restricted to 92% of the season to offset its higher fishing capacity. Last season this switch was allocated to ZDLT1.

<sup>b</sup> ZDLV replaced a category 3 vessel, and is restricted to 83% of the season to offset its higher fishing capacity.

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### 3. Finfish

#### 3.1. Introduction

Finfish trawl catch in the Falkland Islands is allocated by three licenses: A (unrestricted finfish), G (*Illex* squid and restricted finfish), and W (restricted finfish). Specialized fisheries for skates and surimi are separately allocated by F and S licenses. In 2018, catch of major commercial species by A, G and W licenses totalled 38,606 tonnes, as shown in Table 3.1.

Table 3.1. Catches in 2018 of commercial species targeted by finfish licences.

Species	Catch by Licence (tonnes)			
	A	G	W	
<i>Illex</i> squid	61.1	2262.3	125.5	2448.8
Blue whiting	28.1	52.9	846.1	927.1
Hoki	233.7	1779.2	2349.6	4362.5
Red cod	738.7	399.0	468.0	1605.7
Common hake	20416.1	3244.0	3030.5	26690.6
Southern hake	1.8	14.2	15.8	31.8
Kingclip	771.4	286.2	365.4	1423.0
Rock cod	198.1	351.2	172.1	721.3
Grenadier	29.0	106.9	259.5	395.4
	22477.9	8495.8	7632.4	38606.1

Finfish license allocations are set by Total Allowable Effort (TAE). The effort allocations are calculated as a function of the catchability of an index species. The index species is designated to represent the main target of the fishery, which can be assumed to characterize consistent relationships among catch, effort, and biomass. Previously, the index species for finfish TAE was blue whiting (*Micromesistius australis*). With declining catches of blue whiting and concurrently increasing rock cod (*Patagonotothen ramsayi*), the licensing index species was switched to rock cod starting in 2011 (Payá et al. 2010). In the years since, catches of rock cod have decreased from their peak in 2010 (FIG 2018), but no other single species has taken a similar consistent level of predominance. The estimated biomass of rock cod in 2018 was 94079 metric tonnes from the groundfish + calamari surveys, and 147,924 metric tonnes from a modified surplus production model (Winter 2019).

For 2020, rock cod continues to be used as the finfish licensing index species. Given the uncertainties in biomass and distribution of rock cod, in the last two years (FIFD 2017, FIFD 2018), a precautionary total allowable catch (TAC) of 20,000 metric tonnes was superimposed on the TAE, to prevent possible surges of overexploitation. In fact, this TAC was reached in neither year (Winter and Gras 2018, Winter 2019). For 2020, the superimposed TAC is set to 11,112 tonnes; the K-ratio adjusted maximum sustainable yield (Winter 2019).

#### 3.2. Vessel units and fishing time.

TAE is expressed by Vessel Units (VU), a metric of the fishing effort expected to yield a standard level of catch of the target index species. VUs are then used to apportion the total

VU allocation into fishing time, expressed as vessel-months. VUs and fishing times are calculated according to the catchability of the index species averaged over a preceding range of years. For each licence A, G, or W, catchability was averaged over the three most recent completed years, 2016 to 2018. Previously (M. Gras; pers. comm., FIFD 2017, FIFD 2018), catchabilities were averaged over the ostensibly representative years 2009 – 2012; 2014 (A and W licences), or 2008 – 2012 (G licence). However, with the ongoing changes in rock cod catch and biomass (Winter and Gras 2018, Winter 2019) these index years can no longer be considered pertinent.

The switch to years 2016 – 2018 incurred a substantial re-evaluation of VUs. In order to maintain reasonable continuity of fishing allocation, vessel-months for 2020 were set to replicate the vessel-months in 2019, with an adjustment proportional to the rock cod biomass in the most recent assessed year (2018) divided by the 3-year average (2016 – 2018):

$$\begin{aligned} \text{V-month adjustment} &= \frac{\text{biomass}_{2018}}{\text{avg.}(\text{biomass}_{2016,2017,2018})} - 1 = \frac{147924.3}{\text{avg.}(205507.0, 150533.8, 147924.3)} - 1 \\ &= -12\% \end{aligned}$$

The adjustment of – 12% was applied to G and W licences (Table 3.2). For A licence, the outcome was noted that last year >90% of catch taken under this licence had been hake (Table 3.1), which correlates negatively with rock cod catch (Winter 2019). A licence was therefore exempted from the – 12% adjustment, but for 2020 was switched from the status of unrestricted finfish licence to the status of hake licence, with any species other than *Merluccius hubbsi* and *Merluccius australis* caught under A licence subject to bycatch regulation. Further, in relation to the seasonal distribution of hake in Falkland Islands waters (Arkhipkin et al. 2012), A licence in 2020 will be valid only from March 1<sup>st</sup> to October 15<sup>th</sup>.

Table 3.2. VU allocation comparing 2019 and 2020.

Licence	2019 VU	2020 VU
A	12.20	12.20
G	15.30	13.46
W	17.10	15.05

With the same vessel-units per month (VUM) maintained from the year before, vessel-months were concurrently decreased by 12% on G and W licences, and kept the same on A licence:

Table 3.3. Fishing effort VUM and allocated fishing time in vessel-months by GT category, for A licence, 2010 to 2019.

GT category	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Fishing effort VUM										
3	1.87	0.46	0.46	0.45	0.46	0.46	0.46	0.46	0.46	0.46
4	1.87	0.46	0.46	0.45	0.46	0.46	0.46	0.46	0.46	0.46
5	1.87	0.46	0.46	0.45	0.46	0.46	0.46	0.46	0.46	0.46
6	1.87	0.46	0.46	0.45	0.46	0.46	0.46	0.46	0.46	0.46
7									0.46	0.46

Fishing time vessel-months										
3	36.0	28.3	29.3	29.3	26.5	26.6	26.6	26.6	26.6	26.6
4	36.0	28.3	29.3	29.3	26.5	26.6	26.6	26.6	26.6	26.6
5	36.0	28.3	29.3	29.3	26.5	26.6	26.6	26.6	26.6	26.6
6	36.0	28.3	29.3	29.3	26.5	26.6	26.6	26.6	26.6	26.6
7									26.6	26.6

Table 3.4. Fishing effort VUM and allocated fishing time in vessel-months by GT category, for G licence, 2010 to 2019.

GT category	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Fishing effort VUM										
3	0.40	0.39	0.42	0.49	0.37	0.40	0.40	0.40	0.38	0.38
4	0.79	0.73	0.79	0.75	0.72	0.68	0.68	0.68	0.73	0.73
5	0.86	1.07	1.17	1.01	1.06	0.96	0.96	0.96	1.07	1.07
6	1.22	1.41	1.54	1.27	1.40	1.25	1.25	1.25	1.42	1.42
7									1.76	1.76
Fishing time vessel-months										
3	49.0	54.4	52.6	40.7	53.8	49.7	44.8	38.1	40.0	35.2
4	24.8	29.0	28.0	26.6	27.9	29.3	26.3	22.4	21.0	18.5
5	22.8	19.8	18.9	18.9	18.9	20.7	18.7	15.9	14.3	12.6
6	16.1	15.0	14.4	14.4	14.2	16.1	14.5	12.3	10.8	9.5
7									8.7	7.7

Table 3.5. Fishing effort VUM and allocated fishing time in vessel-months by GT category, for W licence, 2010 to 2019.

GT category	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Fishing effort VUM										
3	0.25	0.24	0.24	0.23	0.27	0.31	0.31	0.31	0.40	0.40
4	0.53	0.48	0.51	0.48	0.47	0.49	0.49	0.49	0.56	0.56
5	0.53	0.73	0.78	0.74	0.67	0.66	0.66	0.66	0.72	0.72
6	1.25	0.98	1.04	1.00	0.87	0.84	0.84	0.84	0.88	0.88
7									1.03	1.03
Fishing time vessel-months										
3	88.8	98.8	102.9	97.1	81.2	71.0	64.0	54.4	42.5	37.4
4	41.9	48.9	48.4	46.5	47.0	45.7	41.2	35.0	30.5	26.9
5	41.9	32.5	31.7	30.2	33.1	33.7	30.3	25.8	23.8	21.0
6	17.8	24.2	23.8	22.3	25.5	26.7	24.0	20.4	19.5	17.2
7									16.5	14.5

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## 4. *Dissostichus eleginoides* – Patagonian toothfish

### 4.1. Management and stock trends

A commercial longline fishery targeting Patagonian toothfish (*Dissostichus eleginoides*) has been operating in Falkland Islands waters since 1992, and specifically licensed since 1995 (des Clers et al. 1996, Laptikhovsky and Brickle 2005). Toothfish is allocated to a single quota for target fishing by longline, and management by total allowable catch (TAC).

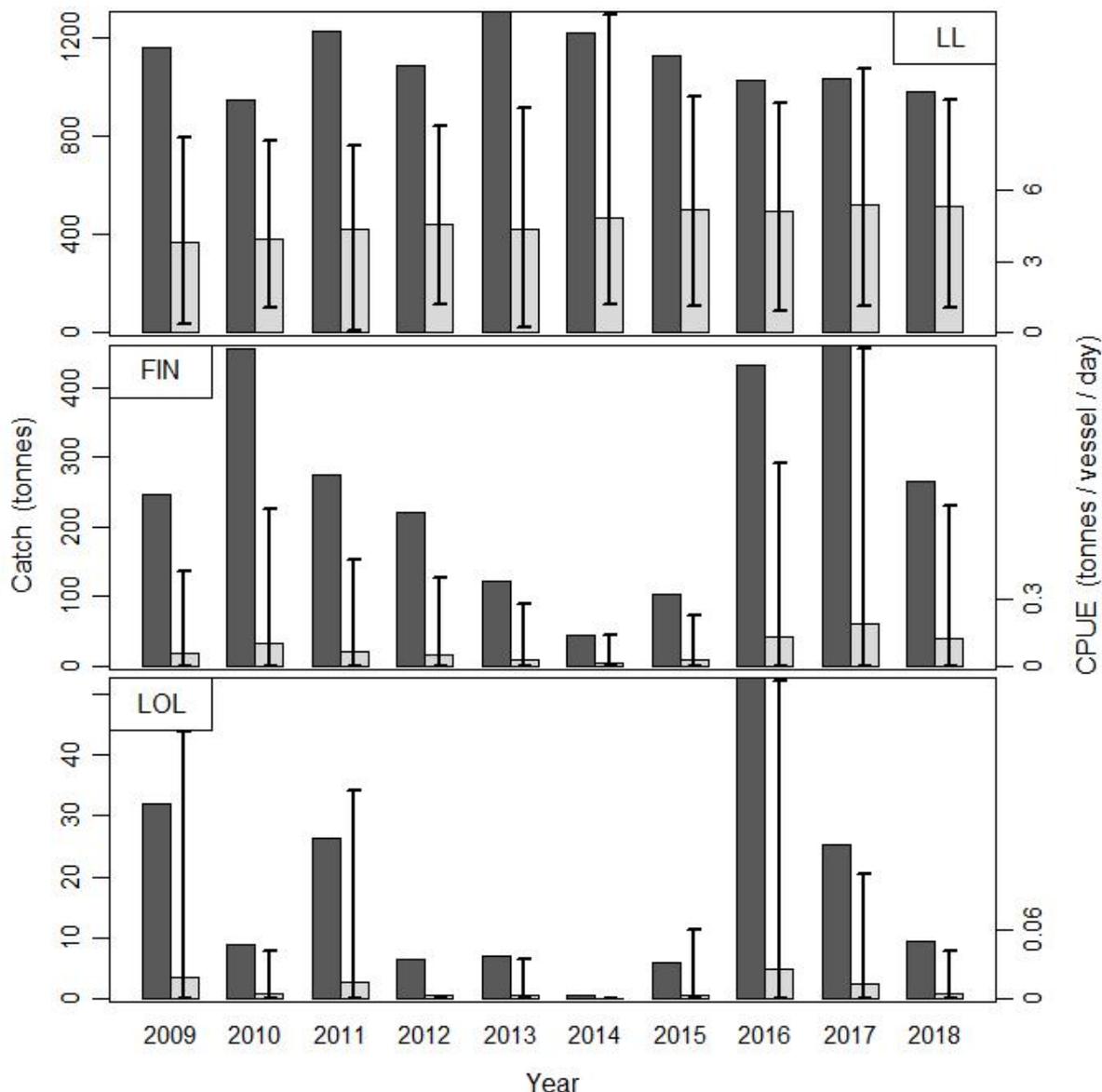


Figure 4.1. Annual catches (tonnes; dark bars) and CPUE (tonnes / vessel / day; light bars with 95% confidence intervals) of toothfish per fishery, 2009 to 2018. Fisheries are toothfish longline (LL), finfish trawl (FIN) and calamari trawl (LOL). From Farrugia and Winter (2019).

In addition to longline, important quantities of toothfish are caught in two other fisheries in the Falkland Islands zone: finfish trawl, in which toothfish is not targeted but is a

commercially valuable bycatch, and *Doryteuthis gahi* squid trawl, in which toothfish is also bycatch but individuals caught in this fishery are too small to be commercially valuable and therefore usually discarded (Figure 4.1).

Stock assessment of toothfish is calculated as an age-structured production model. The stock assessment is based on catch-at-age distributions for longline (both Spanish-system and umbrella gear), finfish trawl (including skate and surimi licenses) and *D. gahi* trawl fisheries and a relative annual index of catch-per-unit-effort (CPUE). This CPUE is estimated as kg per 1,000 hooks, and is standardized across a wide set of covariates (individual vessel, month, soak duration of the reported catch, depth, fishing region, umbrella spacing, and numbers of hooks per umbrella).

The current stock assessment of Falkland Islands toothfish was calculated with updated catch and effort through 2018, 175,002 length measurements between 1988 and 2018, and 6,571 age measurements from otolith readings sampled between 2007 and 2018. Reported toothfish catch in 2018 totalled 1259.26 tonnes, of which 78% by weight was caught by longline (981.7 t in 185 vessel-days), 21.1% by finfish trawl (265.6 t in 2121 vessel-days), and 0.9% by calamari trawl (11.9 t in 1993 vessel-days). Longline vessel-days in 2018 were the lowest since 1993. This led to a decrease in reported longline catches from 1031.6 t in 2017.

## 4.2. Biomass and MSY

The age-structured model estimates the total toothfish biomass time at 30,485 t in 2018, having decreased from 62,243 t in 1987. The spawning stock biomass decreased from 22,665 t in 1987 to 10,596 t in 2018 (Table 4.1). The precautionary model-estimated natural mortality of  $M = 0.176$  is nearly equivalent to the natural mortality used for toothfish in South Georgia (Hillary et al. 2006), and previously in the Falkland Islands as a composite average (Payne et al. 2005). The ratio of current spawning stock biomass to initial spawning stock biomass ( $SSB_{2018}:SSB_0$ ) was 0.467, which places the precautionary model within the ‘Target’ range of the Harvest Control Measures. Under current catch levels, the spawning stock biomass is currently projected to continue decreasing until 2024, at which point it will be 0.425 of  $SSB_0$  (95% CI: 0.357 - 0.559). From the minimum in 2024, SSB is projected to increase back above a ratio of 0.45 by 2031.

Table 4.1. Output parameters of the toothfish age-structured production model. MSY was based on the anticipated future catch partition of 1,040 t longline, 300 t finfish trawl, and 30 t calamari trawl. Lower and upper 95% confidence intervals are based on 5,000 iterations of the Markov Chain Monte Carlo (MCMC) distributions.

Parameter	Output	Lower 95% CI	Upper 95% CI
$SSB_0$	22,669 t	20,394 t	91,805 t
$SSB_{1987}$	22,665 t	20,390 t	91,801 t
$SSB_{2018}$	10,596 t	8,056 t	81,399 t
$SSB_{2018}:SSB_0$	0.467	0.388	0.924
$B_{1987}$	62,243 t	55,272 t	302,258 t
$B_{2018}$	30,485 t	24,373 t	266,479 t
MSY	1,899 t	1,708 t	7,689 t
$M_{natural}$	0.176 yr <sup>-1</sup>	0.160 yr <sup>-1</sup>	0.240 yr <sup>-1</sup>

Maximum sustainable yield (MSY) is the maximum constant annual catch that can be sustained under deterministic recruitment and the assumed constant catch partition. MSY was determined to be 1,899 t (Table 4.1). Deducting from this 300 t for finfish trawl and 30 t for calamari trawl leaves 1,569 t of MSY available for the longline fishery. As a precautionary measure, TAC should not be set exactly at the MSY, but rather below the MSY so as to provide a buffer to account for uncertainties in the model and variability in the toothfish stock and the environmental conditions.

### **4.3. Recommendation**

The Falkland Islands Fisheries toothfish harvest control rules prescribe that a ratio of  $SSB_{current}:SSB_0 \geq 0.45$  is eligible for continuation of the current TAC (FIFD 2018). Therefore the recommendation from this stock assessment is to maintain the toothfish annual TAC for longline fishing at its current level of 1,040 t. This TAC level was set in 2015, when it was reduced from 1,200 t because the SSB ratio was below 0.45. Although the SSB ratio has been above 0.45 in the last few of years, the model predicts that the SSB ratio will actually decrease slightly until 2024 before increasing again. The TAC should not be increased until either the SSB ratio has a sustained increasing trend, or the model no longer predicts a decrease in the near future.

A second recommendation is to develop a strategy to address the bycatch of toothfish in the trawl fisheries, specifically the finfish fishery. There has been a shift in fishing behaviour of the finfish fishery in the last two years, which had led that fishery to catch much more toothfish than in previous years. The shift may be due to a lack of fishing opportunities in the traditional fishing grounds, pushing vessels deeper and further south in the FICZ to capture grenadier, and in doing so they are encountering more toothfish. To minimize the threat to the toothfish stock from bycatch, this change in vessel behaviour could be addressed by closing certain areas or depths to trawling.

### **4.4. References**

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## 5. Rajiformes – Skates

### 5.1. Management and stock trends

Skate (Rajiformes) are since 1994 licensed separately from other groundfish trawl fisheries in the Falkland Islands (F license). The skate fishery is regulated by total allowable effort (TAE) of licensed vessels. However, a large proportion of skate catch is routinely taken in finfish trawls, while skate-licensed vessels may take large amounts of groundfish other than skate. In 2018, 515.4 tonnes of skate were caught under skate target license, together with 115.6 t hake, 5.4 t rock cod, 12.1 t kingclip, 11.5 t red cod, and 3.8 t hoki. Conversely, 1513.7 t skate were caught in 2018 under licenses other than skate target license.

Target catch of skate has decreased strongly, concurrently with a strong decrease in effort. Both total catch and target catch of skate in 2018 were the lowest since 20 years (Figure 5.1). Recent stock assessments (e.g., Winter 2018) have shown stable trends of the skate stock, and reviews of the skate assemblage (Arkhipkin et al. 2012, Winter et al. 2015) have noted high population abundance, species diversity, and habitat structure. Therefore, a new stock assessment was not calculated in 2019. The same biomass as last year is used as a baseline: 43,342.6 metric tonnes (Winter 2018).

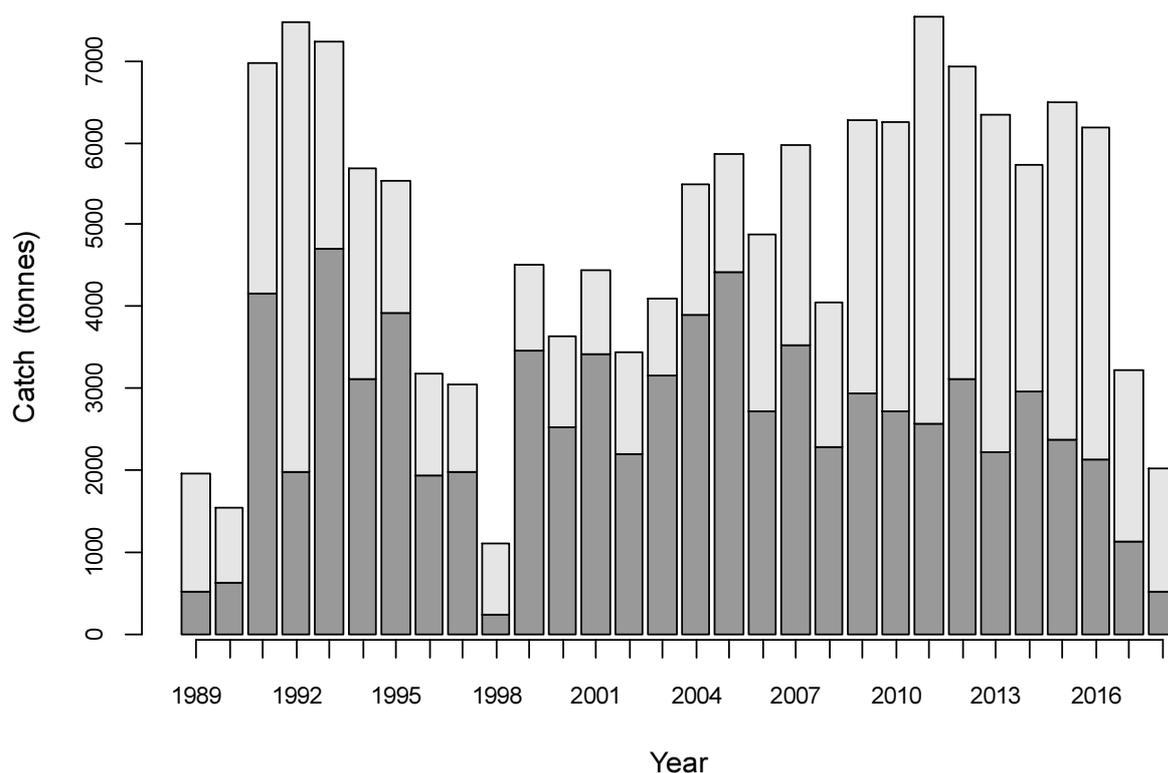


Figure 5.1. Target-licence catches (dark grey) and all catches (light grey) of skates, 1989 to 2018.

### 5.2. Allowable effort and vessel units

The recommendation for 2020 is therefore to maintain skate target catch under F license at the current allowed level. Corresponding effort allocations were calculated by Vessel Units

based on catchability per GT category, averaged over the preceding three years. Catchability coefficients (q-values) per GT category were calculated as:

$$Q_i = \frac{\text{catch}_i \text{ (t)}}{\text{effort}_i \text{ (hrs)} \times \text{biomass} \text{ (t)}} \Bigg|_{2016}^{2018}$$

where catch and effort of the *i*th GT category are obtained from vessel reports, and biomass in each year 2016 to 2018 is the north biomass estimate (Table 5.1). Vessel units per month per GT category were calculated as:

$$VUM_i = Q_i \times \text{biomass}_{2018} \times \frac{\frac{\text{fish hrs}_i}{\text{fish days}_i}}{30.5} \Bigg|_{2016}^{2018} / 100$$

where fishing hours and fishing days of the *i*th GT category are obtained from vessel reports, 30.5 converts month/day, and 100 is a scaling factor of the vessel units. Vessel unit allocations per GT category were calculated as:

$$VU_i = \frac{VUM_i \times \text{licensed days}_{i2018}}{30.5}$$

Table 5.1. Skate-licence fishery parameters 2016 – 2018, used for calculating the 3-year averaged Vessel Unit allocations.

Parameter	GT category	Year		
		2016	2017	2018
Biomass		41,392	43,343	43,343
Catch	3	1,973	1,119	462
	4	48	1	0
	5	48	10	54
	7	0	6	0
	8	59	0	0
Effort Hours	3	2347	2144	798
	4	146	13	0
	5	97	43	311
	7	0	23	0
	8	143	0	0
Licensed Days	3	149	205	174
	4	20	6	0
	5	46	10	84
	7	0	2	0
	8	44	0	0
Fishing Days	3	128	126	45
	4	9	1	0
	5	7	4	19
	7	0	2	0
	8	8	0	0

Fishery parameters for the past three years are summarized in Table 5.1, and the recommended Vessel Unit allocations are summarized in Table 5.2. As in previous years (since FIFD 2014) the vessel units per month were equalized between GT categories. Equalization was implemented because the relatively small scale of this fishery (3 vessels in 2018) and partition between nations (one Korean GT category 3, one Spanish category 5, and one Falklands category 5) confound nation with GT category, thereby rendering differences between GT categories inconclusive. The total allocation is 23.85 VU, corresponding to an expected skate catch of 2,385 tonnes (in effect, VUs are calibrated so that approximately the same amount should be taken each year as a function of averaged catchability).

Total skate catch and skate-licensed-effort decreased again from 2017 to 2018, although it increased in category 5 as fishing effort was taken by a Falklands category 5 vessel that had not fished F licence the year before. However, the Spanish category 4 and Falklands category 7 vessels from 2017 did not fish F licence in 2018, leaving these categories unoccupied.

Table 5.2. Mean catchability coefficients Q and recommended equalized vessel unit allocations by GT category.

GT category	Q ( $\times 10^{-5}$ )	Vessel Units per month	Vessel Unit allocation
3	1.52	2.82	
4	0.51	2.82	
5	0.71	2.82	23.85
7	0.61	2.82	

### 5.3. References

- Arkhipkin, A., Brickle, P., Laptikhovsky, V., Pompert, J., Winter, A. 2012. Skate assemblage on the eastern Patagonian Shelf and Slope: structure, diversity and abundance. *Journal of Fish Biology* 80:1704-1726.
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## 6. Quick reference guide to VUM/GT Category

### 6.1. Falkland calamari fishery (C)

VU = 27.01 – allows for a standard fleet of 16 vessels.

### 6.2. Finfish fishery

VU allocation in 2019 and 2020.

Licence	2019 VU	2020 VU
A	12.20	12.20
G	15.30	13.46
W	17.10	15.05

**A licence.** Fishing effort VUM and fishing time vessel-months.

GT category	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Fishing effort VUM										
3	1.87	0.46	0.46	0.45	0.46	0.46	0.46	0.46	0.46	0.46
4	1.87	0.46	0.46	0.45	0.46	0.46	0.46	0.46	0.46	0.46
5	1.87	0.46	0.46	0.45	0.46	0.46	0.46	0.46	0.46	0.46
6	1.87	0.46	0.46	0.45	0.46	0.46	0.46	0.46	0.46	0.46
7									0.46	0.46
Fishing time vessel-months										
3	36.0	28.3	29.3	29.3	26.5	26.6	26.6	26.6	26.6	26.6
4	36.0	28.3	29.3	29.3	26.5	26.6	26.6	26.6	26.6	26.6
5	36.0	28.3	29.3	29.3	26.5	26.6	26.6	26.6	26.6	26.6
6	36.0	28.3	29.3	29.3	26.5	26.6	26.6	26.6	26.6	26.6
7									26.6	26.6

**G licence.** Fishing effort VUM and fishing time vessel-months.

GT category	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Fishing effort VUM										
3	0.40	0.39	0.42	0.49	0.37	0.40	0.40	0.40	0.38	0.38
4	0.79	0.73	0.79	0.75	0.72	0.68	0.68	0.68	0.73	0.73
5	0.86	1.07	1.17	1.01	1.06	0.96	0.96	0.96	1.07	1.07
6	1.22	1.41	1.54	1.27	1.40	1.25	1.25	1.25	1.42	1.42
7									1.76	1.76
Fishing time vessel-months										
3	49.0	54.4	52.6	40.7	53.8	49.7	44.8	38.1	40.0	35.2
4	24.8	29.0	28.0	26.6	27.9	29.3	26.3	22.4	21.0	18.5
5	22.8	19.8	18.9	18.9	18.9	20.7	18.7	15.9	14.3	12.6
6	16.1	15.0	14.4	14.4	14.2	16.1	14.5	12.3	10.8	9.5
7									8.7	7.7

**W licence.** Fishing effort VUM and fishing time vessel-months.

GT category	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
<b>Fishing effort VUM</b>										
3	0.25	0.24	0.24	0.23	0.27	0.31	0.31	0.31	0.40	0.40
4	0.53	0.48	0.51	0.48	0.47	0.49	0.49	0.49	0.56	0.56
5	0.53	0.73	0.78	0.74	0.67	0.66	0.66	0.66	0.72	0.72
6	1.25	0.98	1.04	1.00	0.87	0.84	0.84	0.84	0.88	0.88
7									1.03	1.03
<b>Fishing time vessel-months</b>										
3	88.8	98.8	102.9	97.1	81.2	71.0	64.0	54.4	42.5	37.4
4	41.9	48.9	48.4	46.5	47.0	45.7	41.2	35.0	30.5	26.9
5	41.9	32.5	31.7	30.2	33.1	33.7	30.3	25.8	23.8	21.0
6	17.8	24.2	23.8	22.3	25.5	26.7	24.0	20.4	19.5	17.2
7									16.5	14.5

**6.3. Skate fishery (F)**

GT category	Q ( $\times 10^{-5}$ )	Vessel Units per month	Vessel Unit allocation
3	1.52	2.82	
4	0.51	2.82	
5	0.71	2.82	23.85
7	0.61	2.82	

**6.4. Toothfish longline fishery (S)**

TAC – 1,040 tonnes.

**6.5. Restricted finfish – Pelagic fishery (S)**

TAC for southern blue whiting – 2,000 tonnes.