Falkland Islands Fisheries Department

Vessel Units

Allowable Effort

Allowable Catch

2019

Part 1

Summary and Recommendations

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Contents

1. Foreword

The Licensing Advice 2018 consists of two parts.

Part 1 summarizes licensing advice for all regulated fisheries in Falkland Islands Conservation Zones for 2018 apart from the B-licensed *Illex*-fishery. Current licencing advices are based on data through the end of 2017 for finfish, toothfish and skates, and through the end of first season 2017 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.

Falkland calamari *Doryteuthis* (*Loligo*) *gahi* obtained the highest second season catch in 2017 since 2012 with 24,101 tonnes and 2.5% likelihood of failing the season-end escapement threshold. The Falkland calamari first season in 2018 was – for the second year in a row – the highest since 1995, 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 2019, 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 2018 parallel finfish / calamari surveys was the lowest of the six parallel surveys conducted since 2010. However, substantial out-of-zone rock cod catches in the past two years and a surplus production model estimate that was about 2× the survey estimate suggest that some rock cod abundance may have geographically shifted rather than decreased. In 2016, with information of a decreasing trend in rock cod biomass, the Fisheries Department followed a precautionary approach and set a total allowable catch at 30,000 t for 2017, in addition to the total allowable effort. Considering that the 2017 ground fish survey gave evidences of a further decrease in abundance, the precautionary approach was kept for 2018 and the total allowable catch reduced to 20,000 t. For 2019, the total allowable catch of 20,000 t was maintained.

The licenced Patagonian toothfish (*Dissostichus eleginoides*) fishery in 2017 caught just below the target quota of 1040 tonnes, while high bycatches continued to be obtained in finfish and calamari trawls. Stock assessment of toothfish in 2018 was modified by recalculating the proportions of mature fish per age to account for the difference between ‘immature’ and ‘mature resting’ fish, and by adjusting estimated levels of whale depredation according to recent external reports. The stock assessment estimated a current biomass of 31,891 tonnes toothfish and a ratio of current spawning stock biomass to unfished spawning stock biomass of 0.482. 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 and skate-license effort in 2017 were both the lowest since 1998. Skate biomass continued to show high total abundance based on commercial CPUE indices as the trend of the catch-per-unit-effort time series has not yet responded to the decreases in 2017. However, the stock status of skates continues to be cautioned by two conditions: large proportions of the total skate catch are regularly taken as bycatch under other fishing licenses (in 2017: 54.2%), thus not subject to skate license regulation, and individual species may be declining within the overall skate complex. These conditions continue to be monitored. Total vessel units for 2019 were calculated at 26.68, as effort taken in the skate fishery last year remained significantly below the license allocations.

In 2017, 2,210 tonnes of southern blue whiting (*Micromesistius australis*) were commercially caught in Falkland waters, the lowest annual total since 2012. Of this total 87.1% were taken by finfish licence and 12.9% by calamari licence; and a trivial amount by skate licence. Targeted fishing for blue whiting (S licence) was not undertaken in 2017, and therefore no stock assessment was performed in the framework of the 2019 licence advice. The statutory Total Allowable Catch of 2,000 metric tonnes under S licence is maintained for blue whiting.

We are grateful to the scientific observers of the Fisheries Department 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: 1st season (C licence), 64/65 days opening from February 24th to April 28th[1]; 2nd season (X licence), 64 days from July 29th to September 30th. Since 2013 a flexible option also allows vessels to start and end either season as much as 3 days later. In either 1st or 2nd 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 two years have been exceptionally high (Table 2.1). In 1st 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 1st 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 1st season 2017 the highest total catch since 1995 was obtained (Mercopress 2017), and in 1st season 2018 the highest total catch since 1995 was again obtained (Mercopress 2018).

Table 2.1. Catches, estimated biomass, escapement risks, and VU allocations of Falkland calamari 1st seasons 2014-2018.

Year	1st season calamari catch (t)	1st season calamari biomass (t)[a]	Risk of <10,000 t escapement	Total VU allocation
2014	28,117	61,423	0.000	27.07
2015	19,383[b]	52,450[b]	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

a: Biomass estimate at the end of the pre-season survey, plus in-season immigration.
b: Calculated only to April 21st, 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

[1] Exceptionally in 2018, the season was delayed by 3 days for contract marine mammal observers to arrive via commercial flights.

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, 2017), 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 2016 to 2018 (Table 2.2). Catchability coefficients were calculated only entered on unsubstituted vessels, i.e. excluding vessels that had been entered as substitutes for a mechanical breakdown. Substitute 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 2014 - 2018; q averages were calculated for the most recent three years 2016 – 2018.

Parameter	GT cat	Year					3-year average
		2014	2015	2016	2017	2018	
Biomass		61,423	52,450	65,603	113,939	106,237	
Catch (t)	3	1,334.7	1,015.2	1,156.5	241.5	0.0	
	4	4,398.2	3,292.7	3,648.5	6603.1	2304.0	
	5	8,422.4	5,743.7	6,818.6	12203.7	3006.6	
	6	9,791.4	6,450.1	7,531.5	13950.9	2967.1	
	7	4,170.0	2,881.3	3,462.2	3389.4	1139.1	
Fishing days	3	54	55	64	7	0	
	4	163	156	178	185	239	
	5	269	221	258	314	297	
	6	274	275	322	311	292	
	7	112	111	130	62	123	
CPUE (t day^{-1})	3	24.7	18.5	18.1	34.5		
	4	27.0	21.1	20.5	35.7	36.9	
	5	31.3	26.0	26.4	38.9	43.1	
	6	35.7	23.5	23.4	44.9	44.9	
	7	37.2	26.0	26.6	54.7	60.6	
q-values	3	4.02e-4	3.52e-4	2.75e-4	3.03e-4		2.89e-4
	4	4.39e-4	4.02e-4	3.12e-4	3.13e-4	3.47e-4	3.24e-4
	5	5.10e-4	4.96e-4	4.03e-4	3.41e-4	4.06e-4	3.83e-4
	6	5.82e-4	4.47e-4	3.57e-4	3.94e-4	4.23e-4	3.91e-4
	7	6.06e-4	4.95e-4	4.06e-4	4.80e-4	5.70e-4	4.85e-4

One category 5 vessel in the fishery is licensed to replace a category 3 vessel, and starting 1st season 2018, one category 4 vessel has been licensed to replace a category 3 vessel. The standard procedure for replacement vessels is to adjust their VU allocation to the category they are replacing based on the current calculation of 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 90% 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	3.24e-4	1.45
MSPL9	5	3.83e-4	1.71
ZDLC1	4	3.35e-4	1.45
ZDLE1	6	3.91e-4	1.75
ZDLF2	5	3.83e-4	1.71
ZDLM3	4	3.24e-4	1.45
ZDLO1	6	3.91e-4	1.75
ZDLP1	5	3.83e-4	1.71
ZDLR1	6	3.91e-4	1.75
ZDLT1 [a]	4	3.24e-4	[a]1.31
ZDLU1	6	3.91e-4	1.75
ZDLV [b]	5	3.83e-4	[b]1.42
ZDLX	5	3.83e-4	1.71
ZDLY	7	4.85e-4	2.17
ZDLZ	7	4.85e-4	2.17
ZDLZ1	6	3.91e-4	1.75
			27.01

[a] ZDLT1 replaced a category 3 vessel, and is restricted to 90% of the season to offset its higher fishing capacity.

[b] ZDLV replaced a category 3 vessel, and is restricted to 83% of the season to offset its higher fishing capacity.

2.3. References.

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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 2017, catch of major commercial species by A, G and W licenses totalled 30,792 tonnes, as shown in Table 3.1.

Table 3.1. Catches in 2017 of commercial species targeted by finfish licences.

Species	Catch by Licence (tonnes)			
	A	G	W	
Illex squid	73.3	2967.0	20.9	3061.2
Blue whiting	30.6	154.1	1739.7	1924.4
Hoki	259.0	1857.8	1775.3	3892.1
Red cod	254.0	397.6	573.8	1225.3
Common hake	11153.5	3000.6	1128.3	15282.3
Southern hake	1.8	46.2	46.2	94.3
Kingclip	691.7	237.7	668.9	1598.3
Rock cod	180.0	247.9	170.2	598.1
Grenadier	276.8	70.5	2768.6	3115.7
	12920.6	8979.3	8891.9	30791.7

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 represent 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 2017), but no other single species has taken a similar level of predominance. The estimated biomass of rock cod in 2017 was nevertheless 128285 metric tonnes from the groundfish survey (Gras et al. 2017) and 265860 metric tonnes from a surplus production model (Winter and Gras 2018).

For 2019, rock cod continues to be used as the finfish licensing index species. Given the uncertainties in biomass and distribution of rock cod, a precautionary total allowable catch (TAC) of 20,000 metric tonnes was superimposed on the TAE last year (FIFD 2017), to prevent possible surges of overexploitation. The TAC of 20,000 t is maintained for 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 calculated according to the catchability of the index species averaged over a preceding range of years. For 2019 the same total VUs as last year (FIFD 2017) are recommended, as recent annual catches of rock cod have been lower than the estimated maximum sustainable yield (Winter and Gras 2018).

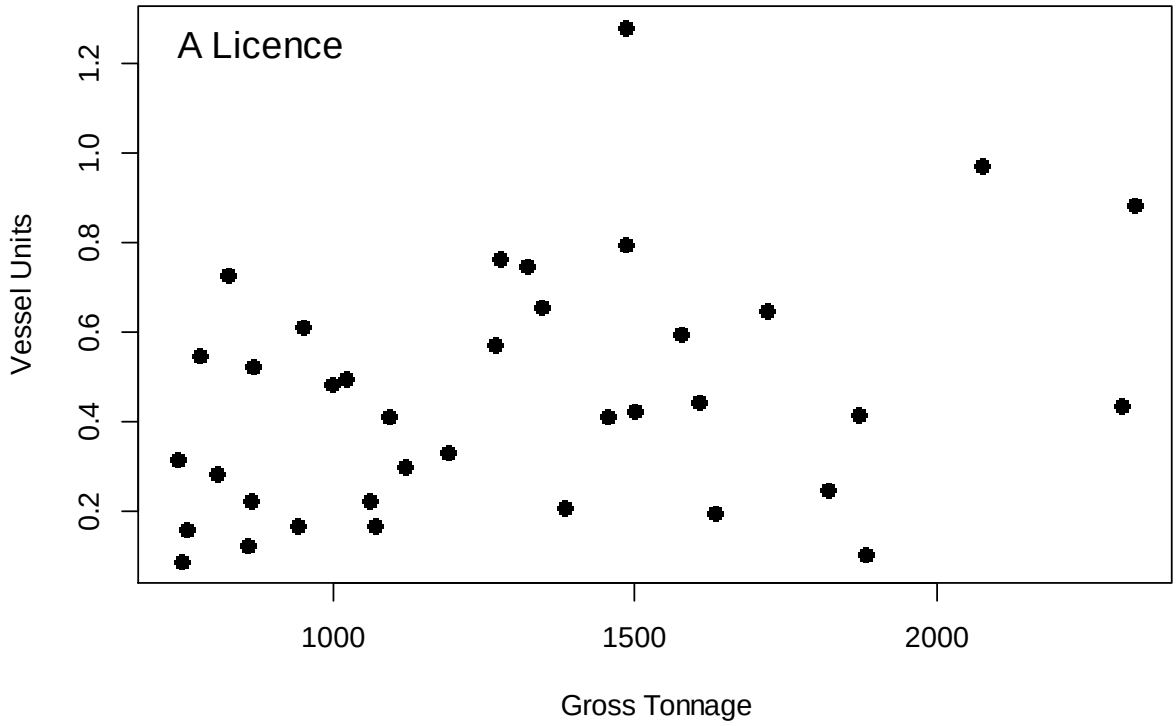

Figure 3.1. Plot of gross tonnage vs. vessel units of individual vessels (N = 37) fishing A licence in 2017.

Table 3.2. Fishing effort VUM and allocated fishing time in vessel-months by GT category, for A licence, 2011 to 2019. Note that the table is structured back to 2010 for compatibility with other tables in this section, but there actually were no VUM calculations for 2010 as A licence was specifically considered a hake licence at that time (Payá et al. 2009). Allocations for category 7 vessels were started only for 2019 as vessels in this category did not previously fish A licence.

GT category	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Fishing effort VUM										
3		1.87	0.46	0.46	0.45	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
5		1.87	0.46	0.46	0.45	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
7										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
4		36.0	28.3	29.3	29.3	26.5	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
6		36.0	28.3	29.3	29.3	26.5	26.6	26.6	26.6	26.6
7										26.6

For A licence, total VU allocation is 12.2. Catchability was averaged over the years 2009 to 2012 and 2014. Year 2013 was skipped because vessels were not targeting rock cod in 2013 due to market closure in eastern Europe. Vessel units per month (VUM) were

equalized among gross tonnage (GT) categories because the positive correlation between individual vessels' VU and GT was significant only due to a few vessels of GT > 2000 (Figure 3.1). A licence VUM allocations and corresponding fishing times are given in Table 3.2 for 2019 and the preceding 8 years.

For G licence, total VU allocation is 15.3. Catchability was averaged over the years 2008 to 2012, as fishing behaviour of G-licensed vessels with respect to rock cod changed after 2012. VU per individual vessel had a significant positive linear correlation with GT (Figure 3.2, R^2 = 58.8%, $p < 0.001$), and VUMs were scaled to the GT category by linear regression (Table 3.3). G licence VUM allocations and corresponding fishing times are given in Table 3.3 for 2019 and the preceding 9 years.

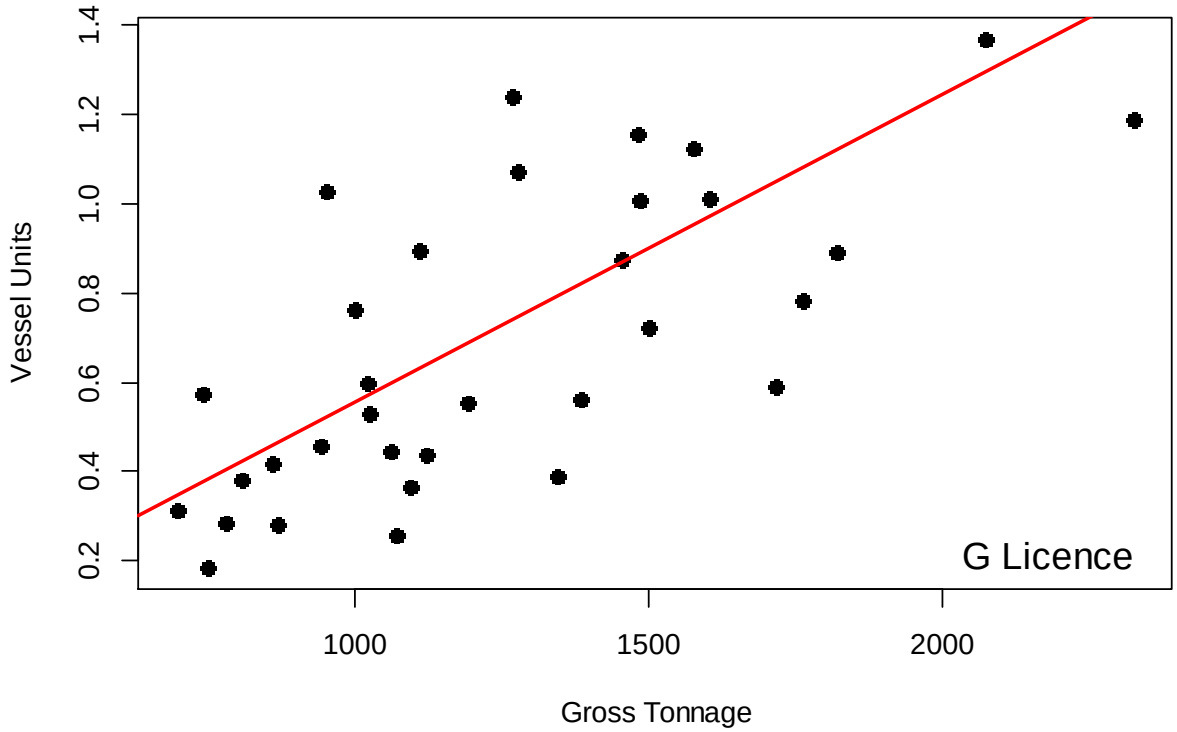

Figure 3.2. Plot of gross tonnage vs. vessel units of individual vessels (N = 33) fishing G licence in 2017. Red line: linear regression, weighted by number of days per fishing vessel.

Table 3.3. Fishing effort VUM and allocated fishing time in vessel-months by GT category, for G licence, 2010 to 2019. Allocations for category 7 vessels were started only for 2019 as vessels in this category did not previously fish G licence.

GT category	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Fishing effort VUM										
3	0.13	0.40	0.39	0.42	0.49	0.37	0.40	0.40	0.40	0.38
4	0.15	0.79	0.73	0.79	0.75	0.72	0.68	0.68	0.68	0.73
5	0.21	0.86	1.07	1.17	1.01	1.06	0.96	0.96	0.96	1.07
6	0.21	1.22	1.41	1.54	1.27	1.40	1.25	1.25	1.25	1.42
7										1.76

Fishing time vessel-months										
3	38.5	49.0	54.4	52.6	40.7	53.8	49.7	44.8	38.1	40.0
4	33.3	24.8	29.0	28.0	26.6	27.9	29.3	26.3	22.4	21.0
5	23.8	22.8	19.8	18.9	18.9	18.9	20.7	18.7	15.9	14.3
6	23.8	16.1	15.0	14.4	14.4	14.2	16.1	14.5	12.3	10.8
7										8.7

For W licence, total VU allocation is 17.1. As for A licence, catchability was averaged over the years 2009 to 2012 and 2014, skipping 2013. VU per individual vessel had a significant positive linear correlation with GT (Fig. 3.3, $R^2 = 23.1\%$, $p < 0.003$), and VUMs scaled to the GT category by linear regression (Table 3.4). W licence VUM allocations and corresponding fishing times are given in Table 3.4 for 2019 and the preceding 9 years.

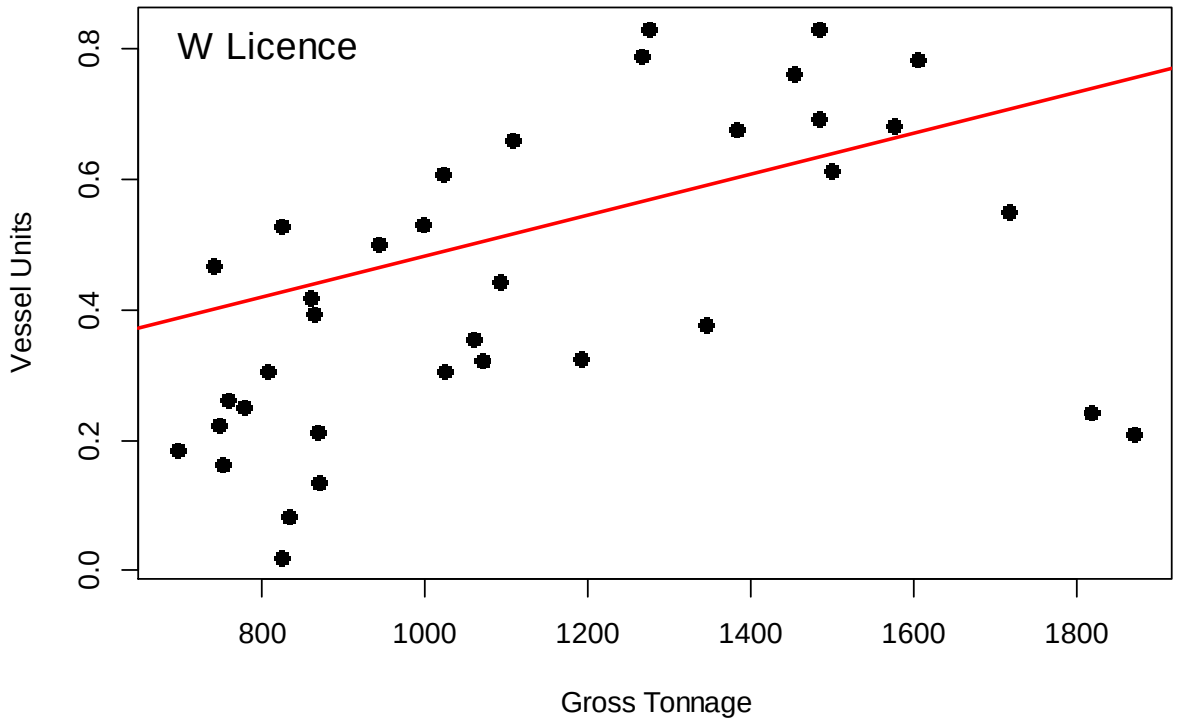

Figure 3.3. Plot of gross tonnage vs. vessel units of individual vessels (N = 36) fishing W licence in 2017. Red line: linear regression, weighted by number of days per fishing vessel.

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

GT category	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Fishing effort VUM										
3	0.45	0.25	0.24	0.24	0.23	0.27	0.31	0.31	0.31	0.40
4	0.82	0.53	0.48	0.51	0.48	0.47	0.49	0.49	0.49	0.56
5	1.99	0.53	0.73	0.78	0.74	0.67	0.66	0.66	0.66	0.72
6	1.99	1.25	0.98	1.04	1.00	0.87	0.84	0.84	0.84	0.88
7										1.03

Fishing time vessel-months										
3	105.5	88.8	98.8	102.9	97.1	81.2	71.0	64.0	54.4	42.5
4	57.9	41.9	48.9	48.4	46.5	47.0	45.7	41.2	35.0	30.5
5	23.9	41.9	32.5	31.7	30.2	33.1	33.7	30.3	25.8	23.8
6	23.9	17.8	24.2	23.8	22.3	25.5	26.7	24.0	20.4	19.5
7										16.5

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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 managed by total allowable catch (TAC). 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* calamari trawl, in which toothfish is also bycatch but individuals caught in this fishery are too small to be commercially valuable (Figure 4.1).

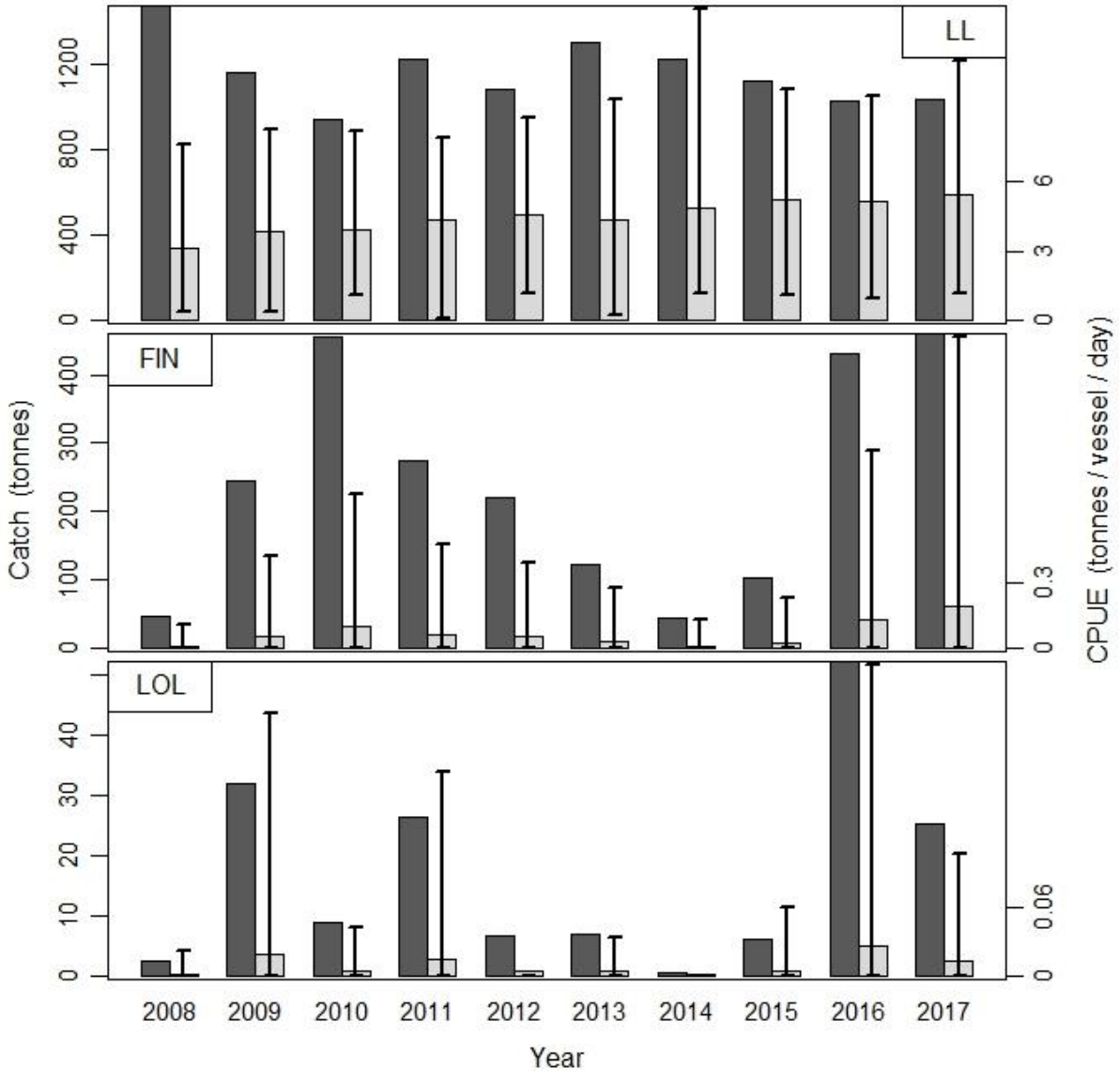

Figure 4.1. Annual catches and unstandardized CPUE of toothfish per fishery. Dark bars: catches (tonnes), light bars: unstandardized CPUE (tonnes / vessel / day) with 95% intervals. Data are shown for the toothfish longline (LL), finfish trawl (FIN) and calamari trawl (LOL) fisheries since 2008 (first full year of umbrella longlining). From Farrugia and Winter (2018).

Stock assessment of toothfish is calculated as an age-structured production model. The stock assessment is based on a relative annual index (longline catch-per-unit-effort), and catch-at-age distributions of the longline, finfish trawl (including skate and surimi licenses), and calamari trawl fisheries.

The current stock assessment of Falkland Islands toothfish was calculated with updated catch and effort through 2017, 169,256 length measurements between 1988 and 2017, and 5,742 age measurements from otolith readings sampled between 2007 and 2017. Reported toothfish catch in 2017 totalled 1520.1 tonnes, of which 67.9% by weight was caught by longline (191 vessel-days), 30.3% by finfish trawl (2431 vessel-days), and 1.9% by calamari trawl (2079 vessel-days). Longline vessel-days in 2017 were the lowest since 1993, due to operational scheduling by the quota holder. Despite this, a relatively high catch per unit effort (CPUE) in 2017 led to a slight increase in reported longline catches compared to 2016.

4.2. Biomass and MSY

The age-structured model estimates the total toothfish biomass at 31,891 t in 2017, having decreased from 63,727 t in 1987. The spawning stock biomass decreased from 23,446 t in 1987 to 11,293 t in 2017 (Table 4.1). The precautionary model, which included estimates of whale depredation and unreported out of zone catches, estimated a natural mortality (M) of 0.174, nearly equivalent to the natural mortality calculated 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_{2017}:SSB_0) was 0.482, which places the precautionary model above the statutory threshold of 0.45 of the Harvest Control Measures (FIFD 2018). However, under current catch levels, spawning stock biomass is projected to continue decreasing until 2024, at which point it will be 0.436 of SSB_0 (95% CI: 0.355 - 0.586). From the minimum in 2024, SSB is projected to increase back above a ratio of 0.45 by 2029.

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 1,932 t (Table 4.1). Deducting from this 300 t for finfish trawl and 30 t for calamari trawl leaves 1,602 t, well above the current longline toothfish TAC (1,040 t).

Table 4.1. Output parameters of the toothfish stock assessment from the CASAL 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 from the Markov Chain Monte Carlo (MCMC) distributions.

Parameter	Output	Lower 95% CI	Upper 95% CI
SSB_0	23,450 t	21,524 t	94,865 t
SSB_{1987}	23,446 t	21,518 t	94,861 t
SSB_{2017}	11,293 t	9,230 t	83,615 t
SSB_{2017}:SSB_0	0.482	0.422	0.908
B_{1987}	63,727 t	57,562 t	303,230 t
B_{2017}	31,891 t	26,991 t	256,319 t
MSY	1,932 t	1,773 t	7,815 t
$M_{natural}$	0.174 yr^{-1}	0.160 yr^{-1}	0.232 yr^{-1}

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 tonnes. 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 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 2017, 1135.9 tonnes of skate were caught under skate target license, together with 189.5 t hake, 4.8 t rock cod, 15.2 t kingclip, 14.2 t red cod, 0.1 t blue whiting and 20.8 t hoki. Conversely, 2064.1 t skate were caught in 20176 under licenses other than skate target license. Given the wide range of catches, allowable effort for skate license must be balanced against the total skate removal in all fisheries that is sustainable for the population. To evaluate the sustainable skate catch, annual biomass assessments of the population are calculated using a biomass dynamic model (Schaefer production model).

Procedures and results of the biomass assessment are described in Winter (2018). The Schaefer production model estimated a maximum sustainable yield of 6403 tonnes in the northern area (north of 51°S), higher than the total reported skate catch (3200 t). Current exploitation of the total skate assemblage in Falkland waters is therefore sustainable in terms of total biomass, although the absence of individual species data in catch reports continues to be a limitation for management. Reviews of the skate assemblage (Arkhipkin et al. 2012, Winter et al. 2015) have nevertheless noted high population abundance, species diversity, and structure of the habitat with refuge areas from commercial fishing, as well as stabilizing population trends.

5.2. Allowable effort and vessel units

The recommendation for 2019 is therefore to maintain skate target catch under F license at the current 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:

$$Q_i = \text{average}\left[\text{catch}_i\,(t) \times \text{effort}_i^{-1}\,(hrs) \times \text{biomass}^{-1}\,(t)\right]_{2015\text{-}2017}$$

where catch and effort of the *i*th GT category are obtained from vessel reports, and biomass in each year 2015 to 2017 is the north biomass estimate (Table 5.1). Vessel units per month per GT category were calculated as:

$$VUM_i = Q_i \times \text{biomass}_{2017} \times \text{average}\left[\text{fish hrs}_i \times \text{fish days}_i^{-1} /30.5/100\right]_{2015\text{-}2017}$$

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:

$$VU_i = VUM_i \times \text{licensed days}_{i,2017} / 30.5$$

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 (6 vessels in 2017) and partition between two nations (vessels greater than GT category 3 were only Spanish or Falklands-flagged; i.e., Spanish-operated) would result in an arbitrary relationship of catch power confounding nation with GT category. The total allocation is 26.68 VU, corresponding to an expected skate catch of 2,668 tonnes (VUs are calibrated so that approximately the same amount should be taken each year as a function of averaged catchability).

Table 5.1. Skate fishery parameters 2015 – 2017, used for calculating the 3-year averaged Vessel Unit allocations.

Parameter	GT category	Year		
		2015	2016	2017
Biomass		39,798	40,808	41,392
Catch	3	1,805	1,973	1,119
	4	299	48	1
	5	262	48	10
	7	0	0	6
	8	0	59	0
Effort Hours	3	2,442	2347	2144
	4	934	146	13
	5	606	97	43
	7	0	0	23
	8	0	143	0
Licensed Days	3	139	149	205
	4	76	20	6
	5	44	46	10
	7	0	0	2
	8	0	44	0
Fishing Days	3	138	128	126
	4	68	9	1
	5	43	7	4
	7	0	0	2
	8	0	8	0

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	1.73	3.65	24.53
4	0.61	3.65	0.72
5	0.95	3.65	1.20
7	0.64	3.65	0.24
Total			26.68

Skate catch, skate-licensed-effort, and CPUE decreased in all GT categories from 2016 to 2017 (Table 5.1). Participation shifted with two Falklands-flagged vessels entering this fishery for the first time; one in GT category 3 and one in category 7, which was the first category 7 vessel since at least 2010. However, the Korean category 8 vessel that had been in the fishery in 2016 did not participate in 2017, and therefore no VU are allocated to category 8 for this assessment (Table 5.2).

5.3. References

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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

A licence. Fishing effort VUM.

GT cat.	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
3		1.87	0.46	0.46	0.45	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
5		1.87	0.46	0.46	0.45	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
7										0.46

A licence. Fishing time vessel-months.

GT cat.	2010	2011	2012	2013	2014	2015	2016	2017	2018	2010
3		36.0	28.3	29.3	29.3	26.5	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
5		36.0	28.3	29.3	29.3	26.5	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
7										26.6

G licence. Fishing effort VUM.

GT cat.	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
3	0.13	0.40	0.39	0.42	0.49	0.37	0.40	0.40	0.40	0.38
4	0.15	0.79	0.73	0.79	0.75	0.72	0.68	0.68	0.68	0.73
5	0.21	0.86	1.07	1.17	1.01	1.06	0.96	0.96	0.96	1.07
6	0.21	1.22	1.41	1.54	1.27	1.40	1.25	1.25	1.25	1.42
7										1.76

G licence. Fishing time vessel-months.

GT cat.	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
3	38.5	49.0	54.4	52.6	40.7	53.8	49.7	44.8	38.1	40.0
4	33.3	24.8	29.0	28.0	26.6	27.9	29.3	26.3	22.4	21.0
5	23.8	22.8	19.8	18.9	18.9	18.9	20.7	18.7	15.9	14.3
6	23.8	16.1	15.0	14.4	14.4	14.2	16.1	14.5	12.3	10.8
7										8.7

W licence. Fishing effort VUM.

GT cat.	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
3	0.45	0.25	0.24	0.24	0.23	0.27	0.31	0.31	0.31	0.40
4	0.82	0.53	0.48	0.51	0.48	0.47	0.49	0.49	0.49	0.56
5	1.99	0.53	0.73	0.78	0.74	0.67	0.66	0.66	0.66	0.72
6	1.99	1.25	0.98	1.04	1.00	0.87	0.84	0.84	0.84	0.88
7										1.03

W licence. Fishing time vessel-months.

GT cat.	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
3	105.5	88.8	98.8	102.9	97.1	81.2	71.0	64.0	54.4	42.5
4	57.9	41.9	48.9	48.4	46.5	47.0	45.7	41.2	35.0	30.5
5	23.9	41.9	32.5	31.7	30.2	33.1	33.7	30.3	25.8	23.8
6	23.9	17.8	24.2	23.8	22.3	25.5	26.7	24.0	20.4	19.5
7										16.5

6.3. Skate fishery (F)

VU = 26.68

GT category	Q ($\times 10^{-5}$)	Vessel Units per month	Vessel Unit allocation
3	1.73	3.65	24.53
4	0.61	3.65	0.72
5	0.95	3.65	1.20
7	0.64	3.65	0.24
Total			26.68

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.