Falkland Islands Fisheries Department

Vessel Units

Allowable Effort

Allowable Catch

2018

Part 1

Summary and Recommendations

For citation purposes this publication should be referenced as follows:

FIFD (2017) Vessel Units, Allowable Effort, and Allowable Catch 2018. Part 1 – Summary and Recommendations. Fisheries Department, Directorate of Natural Resources, Falkland Islands Government.

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. The current licencing advices are based on data through the end of 2016 for toothfish and skates, through the end of first season 2017 for calamari, and through the end of the February 2017 survey for finfish. 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* produced an above-average second season in 2016, with a total catch of 23,089 tonnes and <0.01% likelihood of failing the season-end escapement threshold. The Falkland calamari first season in 2017 was exceptionally good with 39,433 tonnes caught – the highest since 1995 – and effectively zero likelihood of failing the season-end escapement threshold. The outcomes of these past two seasons confirm that the stock has recovered from the unusual *Illex* ingress in 2015. Consequently, allowable effort is set with the expectation of full seasons in 2018, 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 (2010–2016). This change in trend was the consequence of varying biomass and abundance of the stock but also varying target species in the finfish fleet. Decrease in biomass and abundance were highlighted by both fishery dependent and independent data collected since 2005. According to survey data, there was a shift in rock cod biomass being only 10% in 2017 of what it was in 2011. The structure of the stock also changed and small fish are now much more abundant than they were in 2010–2011 when the first surveys were conducted. However, some stock indicators like length and age–at–maturity did not show signs of rock cod being overfished. Moreover, fishing captains operating outside Falkland waters mentioned that rock cod seems to be abundant there. 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. As in 2017, vessels will be instructed to stop targeting rock cod when the total allowable catch is reached, irrespective of the remaining effort allocation.

The Patagonian toothfish (*Dissostichus eleginoides*) fishery in 2016 caught just below the target quota of 1040 tonnes, while unusually high bycatches were obtained in finfish and calamari trawls. Stock assessment of toothfish in 2017 was modified by introducing separate abundance indices for Spanish-system longlining (until 2007) vs. umbrella longlining (since 2007), and adding estimates of unreported catch and undetected whale depredation. The stock assessment estimated a current biomass of 30,288 tonnes toothfish and a ratio of current spawning stock biomass to unfished spawning stock biomass of 0.452. 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.

The skate (Rajiformes) biomass continued to show robust total abundance based on commercial CPUE indices that in 2016 were the highest ever for Korean trawlers and the second-highest of the past 6 years by Spanish trawlers. Total skate biomass estimate in 2016 was 40,631 tonnes. 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 2016: 49.6%), 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 2018 were calculated at 28.78, as effort taken in the skate fishery last year remained significantly below the license allocations.

In 2016, 5,415 t of southern blue whiting (*Micromesistius australis*) were caught in Falkland waters. This catch was the result of recently increased fishing effort in the southwest of the FICZ, in deep waters. In this area fishers targeted hoki throughout the first quarter of the year 2016 and took significant amounts of southern blue whiting as bycatch. Due to the absence of a targeted fishery and scarce fishery–dependent and independent information on stock abundance and structure, no stock assessment was performed in the framework of the 2018 licence advice. However, southern blue whiting showed some signs of recovering with the older cohort being relatively more abundant than some years ago.

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 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 (exceptionally in 2017, the season was delayed 3 days for vessels to participate in 30th anniversary activities); 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 calamari 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 one vessel for a fixed proportion of the season based on its replacement category; see below). For the past five years, calamari stock biomass estimates have been variable but shown no general declining trend (Table 2.1). In 1st season 2015 the Loligo Box experienced a large ingression 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 unusually 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).

Table 2.1. Catches, estimated biomass, escapement risks, and VU allocations of Falkland calamari 1st seasons 2013-2017.

Year	1st season calamari catch (t)	1st season calamari biomass (t)[a]	Risk of <10,000 t escapement	Total VU allocation
2013	19,906	33,833	0.102	26.98
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

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 2018 was set as the average of the preceding three years (Table 2.1): 27.01 VU.

Table 2.2. Parameters for average catchability (q) calculations. Trends were visualized for the five years 2013 - 2017; q averages were calculated for the most recent 3 years 2015 – 2017.

Parameter	GRT cat	Year					3-year average
		2013	2014	2015	2016	2017	
Biomass		33,833.0	61,423.0	52,450	65,603	113,939.0	
Catch (t)	3	1,014.6	1,334.7	1,015.2	1,156.2	1532.7	
	4	3,328.1	4,398.2	3,292.7	3,648.5	6603.1	
	5	6,056.1	8,422.4	5,743.7	6,818.6	13948.8	
	6	6,653.7	9,791.4	6,450.1	7,531.5	13950.9	
	7	2,854.0	4,170.0	2,881.3	3,462.2	3389.4	
Fishing days	3	48	54	55	64	62	
	4	147	163	156	193	185	
	5	237	269	272	311	377	
	6	250	274	275	322	311	
	7	100	112	111	130	62	
CPUE (t day^{-1})	3	21.1	24.7	18.5	18.1	24.7	
	4	22.6	27.0	21.1	18.9	35.7	
	5	25.6	31.3	21.1	21.9	37.0	
	6	26.6	35.7	23.5	23.4	44.9	
	7	28.5	37.2	26.0	26.6	54.7	
q-values	3	6.25e-4	4.02e-4	3.52e-4	2.75e-4	2.17e-4	2.81e-4
	4	6.69e-4	4.39e-4	4.02e-4	2.88e-4	3.13e-4	3.35e-4
	5	7.55e-4	5.10e-4	4.03e-4	3.34e-4	3.25e-4	3.54e-4
	6	7.87e-4	5.82e-4	4.47e-4	3.57e-4	3.94e-4	3.99e-4
	7	8.44e-4	6.06e-4	4.95e-4	4.06e-4	4.80e-4	4.60e-4

Table 2.3. VU allocations per vessel.

Vessel Callsign	GRT category	GRT avg. q	VU allocation
EHIS	4	3.35e-4	1.532
MSPL9	5	3.54e-4	1.620
ZDLB2	3	2.81e-4	1.289
ZDLC1	4	3.35e-4	1.532
ZDLE1	6	3.99e-4	1.828
ZDLF2	5	3.54e-4	1.620
ZDLO1	6	3.99e-4	1.828
ZDLP1	5	3.54e-4	1.620
ZDLR1	6	3.99e-4	1.828
ZDLT1	4	3.35e-4	1.532
ZDLU1	6	3.99e-4	1.828
ZDLV*	6*	3.99e-4	1.289*
ZDLX	5	3.54e-4	1.620
ZDLY	7	4.60e-4	2.107
ZDLZ	7	4.60e-4	2.107
ZDLZ1	6	3.99e-4	1.828
			27.008

* ZDLV is a larger vessel that entered the fishery to replace a category 3 vessel, and is restricted to 83% of the season to offset its higher fishing capacity.

As in previous years, this total VU allocation was partitioned among licensed vessels in proportion to the GRT category-averaged catchability coefficients (q-values). One vessel was licensed as a substitute for a smaller vessel, and its VU allocation was set to the GRT category of the smaller vessel. 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 2015 to 2017 (Table 2.2). The VU allocations per vessel are given in Table 2.3.

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3. Finfish fishery

3.1. Introduction

Finfish species are one of the principal marine resources of the Falkland Islands (FIG, 2017). The fishery is regulated by a total allowable effort (TAE). This TAE is derived from the 5–year average fishing effort required to reach the catch limit that was defined in 2010 (Winter et al. 2010; FIFD 2016). Several species are exploited by finfish trawlers in Falkland waters (FIG 2017). However, one species has always been used as an index to set the TAE, generally the most harvested species. The first index species used for TAE calculations was southern blue whiting (*Micromesistius a. australis*). The decrease in southern blue whiting abundance observed over the period 2004–2007 led the Fisheries Department to establish a new licensing system (FIFD 2013). The new species used as an index was rock cod (*Patagonotothen ramsayi*). From 2007, it became the most abundant finfish stock exploited by trawlers in Falkland waters (Laptikhovsky 2013).

In recent decades, scientists have shown that fishing activity has significant effects on targeted and bycatch species. Effects include changes in abundance, age structure and life history traits (Bianchi et al. 2000; Shin et al. 2005). The Fisheries Department runs an observer program to collect biological data on board commercial fishing vessels in Falkland waters and conducts surveys designed to assess rock cod biomass and abundance. During these surveys, biological data are collected to describe the stock using fishery independent data. In the framework of the 2018 licence advice, age distributions of catch and abundance data were estimated to give more insight into the structure of the stock and the catch.

The primary objective of the current report was to establish catch and effort limits for the finfish fishery. However, prior to estimating these limits, indicators about the stock status had to be provided. Analyses of abundance data are presented to elucidate the dynamic of the rock cod stock over the last 12 years are presented. Based on biological data collected by the Fisheries Department, indicators were derived (time series of life history traits) to highlight the fishing impact on the stock. The dynamic of other commercial species exploited by finfish trawlers are presented to give a better insight of the dynamic of the ecosystem. Finally, and considering the status of the stock, the Vessel Units and Fishing Times for 2018 are presented in tables together with historical values.

3.2 Historical catches

Catches of rock cod by trawlers operating in Falkland waters started to be reported consistently in 2005. Prior to 2005, rock cod was an unvalued bycatch species and reported sporadically. Rock cod catches followed first an increasing trend from 8,641 t in 2005 to 76,458 t in 2010. A period of decrease then appeared until 2013 and annual catch was 32,436 t. the low catch of 2013 was explained by a restricted access to the markets purchasing rock cod. Annual catch rebounded in 2014 to reach 56,694 t and then sharply decreased until 2016 when annual catch was 7,034 t.

3.3. Analysis of life history traits

Biological data collected by scientific observers on board commercial vessels were used to derive indicators of rock cod life history traits: the average total length of the catch and the

size–at–maturity. Commercial fishing can impact life history traits of harvested fish and as a result these traits can give an indication of overfishing of a stock. The average total length of commercial catches increased from 2003 to 2008. From 2007, when the targeted fishery started, this indicator followed a decreasing trend until 2013. After 2013, the average length of the catch varied without trend and in 2016 reached its lowest value since 2003. This low value was probably the result of the recruitment of significant amounts of small fish in the fishery in 2016. Length–at–maturity varied without trend from 2003 to 2007. From 2007 to 2012, the period of the targeted fishery, length–at–maturity decreased. From 2013, some indications of increase were seen at the end of the time series. In conclusion, these two indicators do not show signs that the Falkland rock cod stock is overfished.

3.4. Analyses of survey data

Since 2010, five ground fish surveys have been conducted by the Fisheries Department in February, using a standard protocol. The primary objective of these surveys is to estimate the rock cod biomass in the fishing zone and the structure of the stock. The spatial distribution of rock cod has been fairly stable since 2010 with a hot spot of large fish in the northwest of the FICZ and another hot spot of small fish in the northeast. When the first two surveys were conducted in 2010–2011, biomass estimation non–significantly increased from 653,039 t to 803,763 t. The surveys in 2015–2016 showed that the biomass had decreased to an average of 200,000 t. In 2017, a further decrease of the biomass was observed to 83,342 t, an estimated 10× decrease since 2011. However, the stock abundance (numbers of fish) did not decrease as much as the biomass. This is the result of a shift in stock structure. In 2010–2011 the stock consisted mostly of large fish and recruitment was weak. Over the period 2015–2017, many pre–recruits were observed but large fish were not observed anymore in the stock.

3.5. Age-structured data

In the framework of the 2018 licence advice, rock cod data were examined by age using the FLR framework (Kell et al., 2007). Validated age data (available from 2013 onward age data) were used to build an age–length key to structure length data by age. This computation enabled visualization of temporal trends in catch–at–age, abundance–at–age, age–at–full recruitment and total mortality per cohort. Catch–at–age showed that the targeted fishery started in 2007 harvested animals older than 3 years. However, in years when rock cod was not targeted, significant catches of young animals appeared, probably caught by trawlers operating in the *Loligo* box, a nursery ground for this species. Age–at–full recruitment was first found to be decreasing from 5 to 3 years for cohorts hatched from 2001 to 2003. It was then stable at 3 years for all subsequent cohorts. Total mortality exhibited a non–significant decreasing trend for cohorts hatched from 2001 to 2005. That was followed by an increase of the mortality throughout the following cohorts. Regarding age–at–maturity, no clear trend appeared over the years 2003–2007. That was followed by a period of decreasing age–at–maturity until 2015, followed by an increase in 2016. Finally, abundance–at–age data were also derived from survey data. Results showed that the most abundant cohorts were between 3 and 5 years of age in 2010–2011. In 2015–2016, the most abundant cohorts were between 1 and 3 years of age. Results also highlighted a possible migration of fish to Falkland waters in 2010–2011.

3.6. Dynamic of other commercial species

The groundfish surveys since 2010 were also an opportunity to look at the abundance of other species inhabiting Falkland waters. Total catches of the surveys decreased from 207–212 t in 2010–2011 to 137 t in 2015, 102 in 2016 and finally 58 t in 2017. This highlights a significant decrease of the biomass in the surveyed zone over the last 7 years. Regarding commercial species, decreases in biomass and abundance were observed for red cod (*Salilota australis*), southern blue whiting, and kingclip (*Genypterus blacodes*) over the last two years. Decreases of toothfish (*Dissostichus eleginoides*) and hoki (*Macruronus magellanicus*) were also observed from 2016 to 2017. The surveys may not cover the entire southern blue whiting and hoki distribution area, but red cod, kingclip and juvenile toothfish habitats are thoroughly covered. Two commercial species were found to be increasing in recent years, common hake (*Merluccius hubbsi*) and Argentine shortfin squid (*Illex argentinus*). However, the surveys are conducted a few weeks prior to the migration of these two species and more in depth analyses of the survey results along with CPUE data are needed to conclude on the abundance of these stocks in Falkland waters. As these stocks are partly in Argentine waters, the re–establishment of data exchange with Argentina would benefit abundance estimations of the whole stocks.

3.7. Conclusion

Rock cod biomass and abundance have significantly decreased since 2010–2011. In 2017, the biomass was estimated to be 10% of what it was at its maximum in 2011 (Gras et al., 2017). The analysis of length frequencies from commercial and survey data showed that the rock cod stock consisted of smaller fish in recent years than in 2010–2011. This was further confirmed by catch–at–age data that showed a decrease of the age–at–full recruitment over the last two years. Finally, the total mortality estimated by cohort appeared to have increased in recent years, albeit not significantly. However, not all the indicators presented in this report showed worrying signs. If the length–at–maturity decreased during the period of higher exploitation (2007–2012), it then stabilized and showed in 2016 an increasing trend. The age–at–maturity showed also a decreasing trend from 2007 to 2015 followed by an increasing trend in 2016. Moreover, information has been gathered in recent months from fishing captains that rock cod was abundant outside Falkland waters to the north of the FICZ/FOCZ. At the time of writing this report there was however no quantitative data that could be used to corroborate this information.

Rock cod was not the only species to have been found on the low side in 2017. Abundance and biomass derived from groundfish surveys conducted in recent years showed that most of the commercial species exhibited a decreasing biomass and abundance between 2016 and 2017, and some species even since 2015. Even if these results must be interpreted with caution, there is an overall sign that biomass in the groundfish zone is decreasing.

3.8. Recommendations

As a result of the low biomass observed for some years, it is recommended to keep the rock cod precautionary total allowable catch (TAC) in addition to the TAE limit, reflecting the approach used in 2017. Considering the decreasing trend in abundance observed between 2016 and 2017, this TAC should be reduced for 2018. As no forecasting tool is available to simulate the abundance and the fishing impact on the rock cod stock for 2018, the TAC

should be based on historical data. Survey data showed a two-fold decrease of the biomass. However, information gathered from vessels operating on the high seas led to the conclusion that rock cod might have been abundant outside Falkland waters and the stock might not be depleted in the region as a whole. Based on the aggregate of these indicators, a reduction of the TAC for rock cod from 30,000 to 20,000 t is recommended for 2018.

Survey data have shown that other commercial species were also low in recent years. As a result, the TAE should also be reduced in order to reduce the impact of fishing on the other commercial species. The decrease was shown on domestic species such as kingclip, red cod and toothfish but also on straddling stocks such as hoki and southern blue whiting. However, hake and Argentine shortfin squid were shown to be increasing. Again, as no simulation tool is available to forecast the impact of fishing on abundance and biomass, the reduction of TAE was decided to be of 15% for G and W licences based on historical data. Hake does not seem to have decreased; therefore no reduction of the TAE for A–licence was advised. Suggested VUM and Fishing Times per licence and GRT category are presented in Table 3.1 and Table 3.2.

Table 3.1: Suggested VUM for A–, G– and W–licensed vessels by GRT category.

Licence Type	VU	GRT category	Suggested VUM
A	12.2	3	0.46
		4	0.46
		5	0.46
		6	0.46
G	15.3	3	0.40
		4	0.68
		5	0.96
		6	1.25
W	17.1	3	0.31
		4	0.49
		5	0.66
		6	0.84

Table 3.2: Historical and suggested values of VUM and fishing times by GRT category for licences A, G and W. Results shown are rounded from exact calculations.

A licence. Fishing effort VUM.

GRT cat.	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
3				1.87	0.46	0.46	0.45	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
5				1.87	0.46	0.46	0.45	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

A licence. Fishing time vessel-months.

GRT cat.	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
3				36	28.3	29.3	29.3	26.5	26.6	26.6	26.6
4				36	28.3	29.3	29.3	26.5	26.6	26.6	26.6
5				36	28.3	29.3	29.3	26.5	26.6	26.6	26.6
6				36	28.3	29.3	29.3	26.5	26.6	26.6	26.6

G licence. Fishing effort VUM.

GRT cat.	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
3	0.19	0.13	0.13	0.40	0.39	0.42	0.49	0.37	0.40	0.40	0.40
4	0.23	0.15	0.15	0.79	0.73	0.79	0.75	0.72	0.68	0.68	0.68
5	0.31	0.21	0.21	0.86	1.07	1.17	1.01	1.06	0.96	0.96	0.96
6	0.31	0.21	0.21	1.22	1.41	1.54	1.27	1.4	1.25	1.25	1.25

G licence. Fishing time vessel-months.

GRT cat.	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
3	39.5	38.5	38.5	49.0	54.4	52.6	40.7	53.8	49.7	44.8	38.1
4	32.6	33.3	33.3	24.8	29.0	28.0	26.6	27.9	29.3	26.3	22.4
5	24.2	23.8	23.8	22.8	19.8	18.9	18.9	18.9	20.7	18.7	15.9
6	24.2	23.8	23.8	16.1	15.0	14.4	14.4	14.2	16.1	14.5	12.3

W licence. Fishing effort VUM.

GRT cat.	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
3	0.59	0.45	0.45	0.25	0.24	0.24	0.23	0.27	0.31	0.31	0.31
4	0.85	0.82	0.82	0.53	0.48	0.51	0.48	0.47	0.49	0.49	0.49
5	1.86	1.99	1.99	0.53	0.73	0.78	0.74	0.67	0.66	0.66	0.66
6	1.86	1.99	1.99	1.25	0.98	1.04	1.00	0.87	0.84	0.84	0.84

W licence. Fishing time vessel-months.

GRT cat.	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
3	89.0	105.5	105.5	88.8	98.8	102.9	97.1	81.2	71.0	64.0	54.4
4	61.8	57.9	57.9	41.9	48.9	48.4	46.5	47.0	45.7	41.2	35.0
5	28.2	23.9	23.9	41.9	32.5	31.7	30.2	33.1	33.7	30.3	25.8
6	28.2	23.9	23.9	17.8	24.2	23.8	22.3	25.5	26.7	24.0	20.4

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4. *Dissostichus eleginoides* – Patagonian toothfish

4.1. Management and stock trends

Patagonian toothfish (*Dissostichus eleginoides*) 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, of which toothfish is not targeted but commercially valuable bycatch, and *Doryteuthis gahi* squid trawl, of which toothfish is also bycatch but individuals caught in this fishery are too small to be commercially valuable (Figure 4.1). The fisheries access different parts of the toothfish population in different areas: longlining occurs on the slope and in deep water, finfish trawling on the shelf primarily north and west of the Falkland Islands, and *D. gahi* trawling also on the shelf, east of the Falkland Islands.

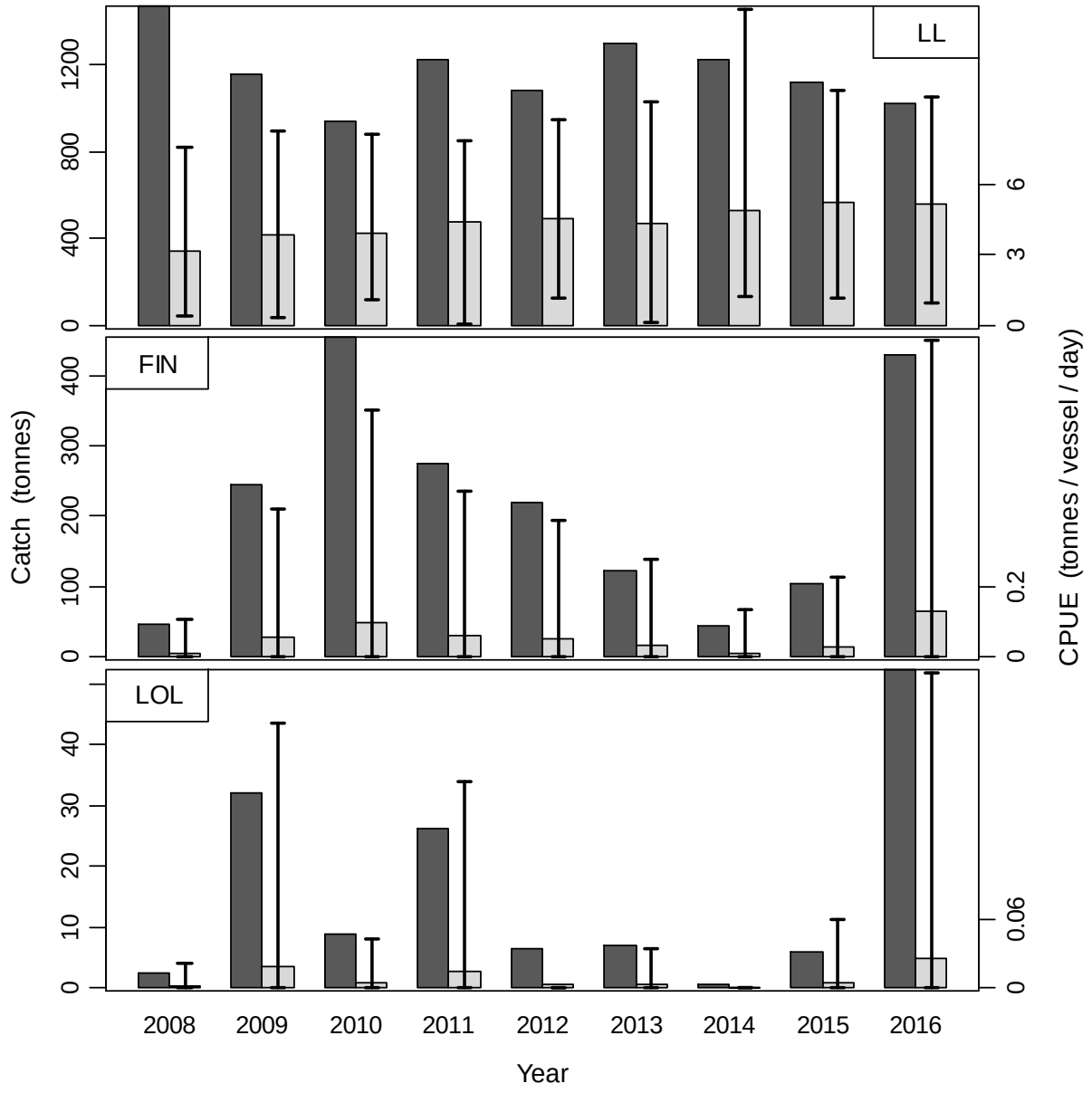

Figure 4.1 [previous page]. Annual catches (tonnes; dark bars) and unstandardized CPUE (tonnes / vessel / day; light bars with 95% intervals) of toothfish in each of the toothfish longline (LL), finfish trawl (FIN) and *D. gahi* trawl (LOL) fisheries since 2008 (first full year of 'umbrella' longlining). From Winter (2017).

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

The current stock assessment of Falkland Islands toothfish was calculated with updated catch and effort through 2016, 138689 length measurements between 1988 and 2016, and 4965 age measurements from otolith readings sampled between 2007 and 2015. Reported toothfish catch in 2016 totalled 1495.8 tonnes, of which 68.4% by weight by longline (199 vessel-days, 1023 tonnes), 28.1% by finfish trawl (2498 vessel-days), and 3.5% by calamari trawl (2024 vessel-days). Longline vessel-days in 2016 were the lowest since 1993, due to operational scheduling by the quota holder. Concurrently longline toothfish catch in 2016 was the lowest since 2010.

4.2. Biomass and MSY

From the age-structured production model, total toothfish biomass in 2016 was estimated at 30,288 tonnes with a 95% confidence interval of 25,759 to 282,956 tonnes. Spawning stock biomass in 2016 was estimated at 10,337 tonnes with a 95% confidence interval of 8,150 to 84,487 tonnes. Natural mortality was estimated at M = 0.168, 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 $SSB_{current}$:SSB_0 (current spawning-stock biomass to initial population spawning-stock biomass) was 10,337 tonnes / 22,868 tonnes = 0.452. Projections of the age-structured production model forecast that under current catch levels the ratio $SSB_{current}$:SSB_0 would decrease to 40.6% - 41.6% by 2022, but increase thereafter with higher recruitment.

Maximum sustainable yield (MSY) calculated by the age-structured production model was 1,843 tonnes. MSY is the maximum constant annual catch that can be sustained under deterministic recruitment and the assumed constant catch partition. Deducting from 1843 t recent average values of 300 t for finfish trawl and 30 t for calamari trawl leaves 1513 t, well above the current longline toothfish TAC.

4.3. Recommendation

The Falkland Islands Fisheries toothfish harvest control rule prescribes that a ratio $SSB_{current}$:$SSB_0 \geq 0.45$ is eligible for continuation of the current TAC (Brewin et al. 2017). Standardized CPUE in the target longline fishery continues to show a slight declining trend and the modal age distribution of catches appears to be increasing (Winter 2017). Forward projection of the age-structured production model suggests that spawning stock biomass will decrease to 0.40-0.41 by 2022, before increasing again. These metrics should be taken with caution for continued monitoring of the fishery. However, based on the $SSB_{current}$:SSB_0 ratio now being above threshold, the recommendation from this stock assessment is to maintain TAC for longline fishing at its current level of 1040 tonnes.

4.4. References

Brewin, P., Randhawa, H.S., Winter, A., Arkhipkin, A. 2017. Patagonian toothfish sustainability measures 2016-2017. Falkland Islands Government Directorate of Natural Resources, 14 p.

Hillary R.M., Kirkwood G.P., Agnew D.J. 2006. An assessment of toothfish in subarea 48.3 using CASAL. *CCAMLR Science* 13: 65-95.

Payne A.G., Agnew D.J., Brandão A. 2005. Preliminary assessment of the Falklands Patagonian toothfish (*Dissostichus eleginoides*) population: Use of recruitment indices and the estimation of unreported catches. Fisheries Research 76: 344-358.

Winter, A. 2017. Patagonian toothfish stock assessment - 2016. Technical Document, Falkland Islands Fisheries Department. 33 p.

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 2016, 2125.6 tonnes of skate were caught under skate target license, together with 406.5 t hake, 119.3 t rock cod, 12.6 t kingclip, 23.6 t red cod, 8.1 t blue whiting and 55.0 t hoki. Conversely, 3754.0 t skate were caught in 2016 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), described in Winter (2017).

The Schaefer production model estimated a maximum sustainable yield of 6726 tonnes in the northern area (north of 51°S), higher than the total reported skate catch (5879.6 tonnes). 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. A review of the skate assemblage (Arkhipkin et al. 2012) has nevertheless noted high population abundance, species diversity, and structure of the habitat with refuge areas from commercial fishing.

5.2. Allowable effort and vessel units

Table 5.1. Skate fishery parameters 2014 – 2016, used for calculating the 3-year averaged Vessel Unit allocations.

Parameter	GRT category	Year		
		2014	2015	2016
Biomass		38,423	39,726	40,631
Catch	3	1,823	1,805	1,973
	4	844	299	48
	5	0	262	48
	8	287	0	59
Effort Hours	3	2,620	2,442	2347
	4	985	934	146
	5	0	606	97
	8	620	0	143
Licensed Days	3	148	139	149
	4	76	76	20
	5	0	44	46
	8	35	0	44
Fishing Days	3	148	138	128
	4	76	68	9
	5	0	43	7
	8	35	0	8

Because of the overall high, stable skate abundance, the recommendation for 2017 is to maintain skate target catch under F license at the current level. Corresponding effort allocations were calculated by Vessel Units based on catchability per GRT category, averaged over the preceding three years.

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 (FIFD 2014; 2015; 2016) the vessel units per month were equalized between GRT categories. Equalization was implemented because the relatively small scale of this fishery (8 vessels in 2016) and partition between two nations (two Korean category 3 vessels; one Spanish category 3 vessel; two Spanish category 4 vessels; two Spanish category 5 vessels) and one Korean category 8 vessel would result in an arbitrary relationship of catch power as a function of GRT category. The total allocation is 28.78 VU, corresponding to an expected skate catch of 2,878 tonnes (in effect, VUs are calibrated so that approximately the same amount should be taken each year as a function of averaged catchability).

Catches and effort of categories 4 and 5 decreased strongly from 2015 to 2016, whereby CPUE increased moderately for these two categories. Catches and effort also decreased strongly in category 8 from 2014 to 2016, with a moderate decrease of CPUE (Table 1).

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

GRT category	Q ($\times 10^{-5}$)	Vessel Units per month	Vessel Unit allocation
3	1.91	3.39	16.56
4	1.28	3.39	2.22
5	1.15	3.39	5.11
8	1.11	3.39	4.89
Total			28.78

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.

FIFD. 2014. Vessel Units, Allowable Effort, and Allowable Catch 2015. Fisheries Dept., Directorate of Natural Resources, Falkland Islands Government. 54 p.

FIFD. 2015. Vessel Units, Allowable Effort, and Allowable Catch 2016. Fisheries Dept., Directorate of Natural Resources, Falkland Islands Government. 44 p.

FIFD. 2016. Vessel Units, Allowable Effort, and Allowable Catch 2017. Part 1 Summary and recommendations. Fisheries Dept., Directorate of Natural Resources, Falkland Islands Government. 21 p.

Winter, A. 2017. Skate (Rajiformes) stock assessment, 2016. Technical Document, Falkland Islands Fisheries Department. 15 p.

6. Quick reference guide to VUM/GRT 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.

GRT cat.	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
3				1.87	0.46	0.46	0.45	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
5				1.87	0.46	0.46	0.45	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

A licence. Fishing time vessel-months.

GRT cat.	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
3				36	28.3	29.3	29.3	26.5	26.6	26.6	26.6
4				36	28.3	29.3	29.3	26.5	26.6	26.6	26.6
5				36	28.3	29.3	29.3	26.5	26.6	26.6	26.6
6				36	28.3	29.3	29.3	26.5	26.6	26.6	26.6

G licence. Fishing effort VUM.

GRT cat.	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
3	0.19	0.13	0.13	0.40	0.39	0.42	0.49	0.37	0.40	0.40	0.40
4	0.23	0.15	0.15	0.79	0.73	0.79	0.75	0.72	0.68	0.68	0.68
5	0.31	0.21	0.21	0.86	1.07	1.17	1.01	1.06	0.96	0.96	0.96
6	0.31	0.21	0.21	1.22	1.41	1.54	1.27	1.4	1.25	1.25	1.25

G licence. Fishing time vessel-months.

GRT cat.	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
3	39.5	38.5	38.5	49.0	54.4	52.6	40.7	53.8	49.7	44.8	38.1
4	32.6	33.3	33.3	24.8	29.0	28.0	26.6	27.9	29.3	26.3	22.4
5	24.2	23.8	23.8	22.8	19.8	18.9	18.9	18.9	20.7	18.7	15.9
6	24.2	23.8	23.8	16.1	15.0	14.4	14.4	14.2	16.1	14.5	12.3

W licence. Fishing effort VUM.

GRT cat.	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
3	0.59	0.45	0.45	0.25	0.24	0.24	0.23	0.27	0.31	0.31	0.31
4	0.85	0.82	0.82	0.53	0.48	0.51	0.48	0.47	0.49	0.49	0.49
5	1.86	1.99	1.99	0.53	0.73	0.78	0.74	0.67	0.66	0.66	0.66
6	1.86	1.99	1.99	1.25	0.98	1.04	1.00	0.87	0.84	0.84	0.84

W licence. Fishing time vessel-months.

GRT cat.	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
3	89.0	105.5	105.5	88.8	98.8	102.9	97.1	81.2	71.0	64.0	54.4
4	61.8	57.9	57.9	41.9	48.9	48.4	46.5	47.0	45.7	41.2	35.0
5	28.2	23.9	23.9	41.9	32.5	31.7	30.2	33.1	33.7	30.3	25.8
6	28.2	23.9	23.9	17.8	24.2	23.8	22.3	25.5	26.7	24.0	20.4

6.3. Skate (F)

VU = 28.78

GRT category	Q ($\times 10^{-5}$)	Vessel Units per month	Vessel Unit allocation
3	1.91	3.39	16.56
4	1.28	3.39	2.22
5	1.15	3.39	5.11
8	1.11	3.39	4.89
Total			28.78

6.4. Restricted finfish – Pelagic (S)

TAC for southern blue whiting – 2,000 tonnes.

6.5. Toothfish Longline (L)

TAC – 1,040 tonnes.