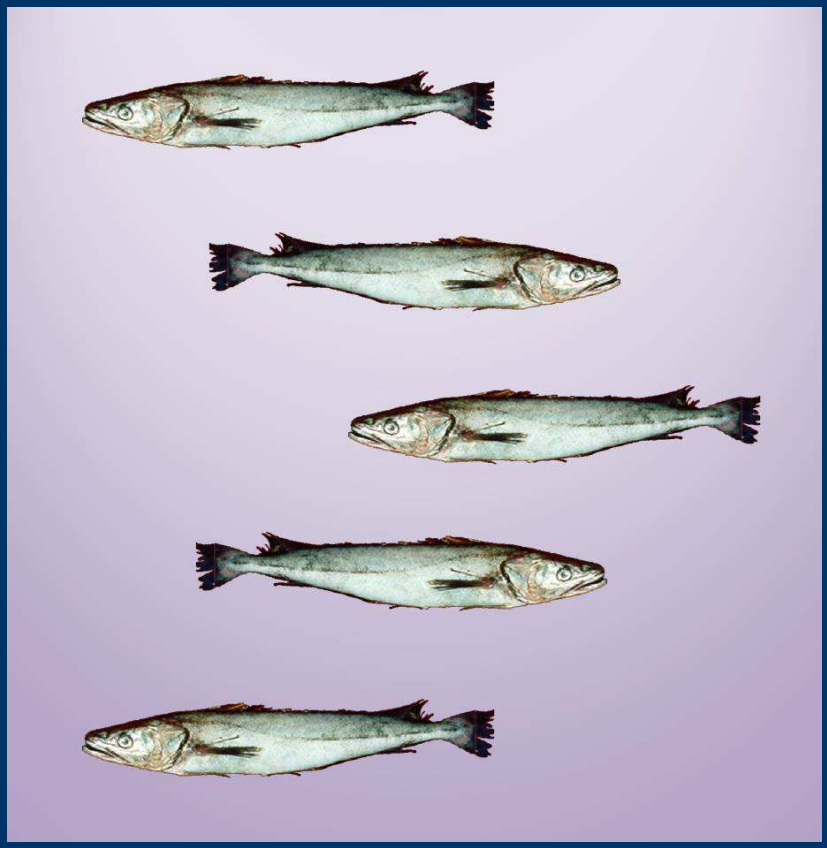
Stock Assessment Southern Hake

Merluccius australis



Andreas Winter, Jorge E. Ramos

Natural Resources - Fisheries
Falkland Islands Government
Stanley, Falkland Islands

March 2021

SA - 2021 - PAT

Winter, A., Ramos, J.E. 2021. Stock assessment of southern hake (*Merluccius australis*) in the Falkland Islands. SA–2021–PAT. Fisheries Department, Directorate of Natural Resources, Falkland Islands Government, Stanley, Falkland Islands. 13 p.

Acknowledgements

We thank the captains and crews of the commercial fishing vessels, and the scientific observers of the Falkland Islands Fisheries Department that facilitated and assisted in catch and biological data collection.

Distribution: Public Domain

Reviewed and approved 2 March 2021

Table of Contents

Stock assessment of southern hake (*Merluccius australis*) in the Falkland Islands

Andreas Winter*, Jorge E. Ramos

Fisheries Department, Directorate of Natural Resources, Falkland Islands Government, Bypass Road, Stanley FIQQ 1ZZ, Falkland Islands

*AWinter@fisheries.gov.fk

Summary

Merluccius australis commercial catches in Falkland Islands licenced fisheries were 73.12 tonnes in 2020; estimated from FIFD observer species proportions of *M. australis* vs. *M. hubbsi*. The estimate of 73.12 tonnes is the lowest on record, since 1988. Following recommendations of the MacAlister Elliott & Partners external review, total allowable catch (TAC) was calculated according to the ICES category 5 advice rule: three-year average, for a species with landings data but not reliable indices from surveys or catch-per-unit-effort. The category 5 *M. australis* TAC for 2022 is 87.74 tonnes. However, given the comparatively marginal quantities of *M. australis* caught annually in Falkland Islands fisheries, and the potential for error in distinguishing *M. australis* from *M. hubbsi*, it is advised that at present, *M. australis* not be designated as a FIFD managed species.

February parallel trawl surveys have estimated *M. australis* biomasses in the Falkland Islands zone decreasing from 5,540.9 tonnes in 2010 to 500.9 tonnes in 2019, but slightly higher in 2020 at 650.9 tonnes. July parallel trawl surveys estimated *M. australis* biomass of 524.2 tonnes in 2017 and 168.8 tonnes in 2020.

Introduction

Southern hake *Merluccius australis* is a predatory benthopelagic species of which the Patagonian population is found from Chiloé Island in the Pacific, southward around the southern tip of South America to the continental shelf to 59°S, and on the slope north to 38°S in the Atlantic (Froese and Pauly 2019). Post-spawning *M. australis* arrive to the southwest of Falkland Islands waters in spring[a]. In summer most individuals are in resting condition and located to the southwest and along the north of the Falkland Islands. In autumn *M. australis* occurs more commonly to the west; from May it is found mainly at the western limit of the Falkland Interim Conservation Zone and then migrates to spawning grounds out of Falkland Islands waters (Arkhipkin et al. 2015). Females are larger than males, with maximum sizes in the Falkland Islands fishery at 106 cm TL for females and 101 cm TL for males; maximum age has been estimated at 19 years old (Arkhipkin et al. 2015).

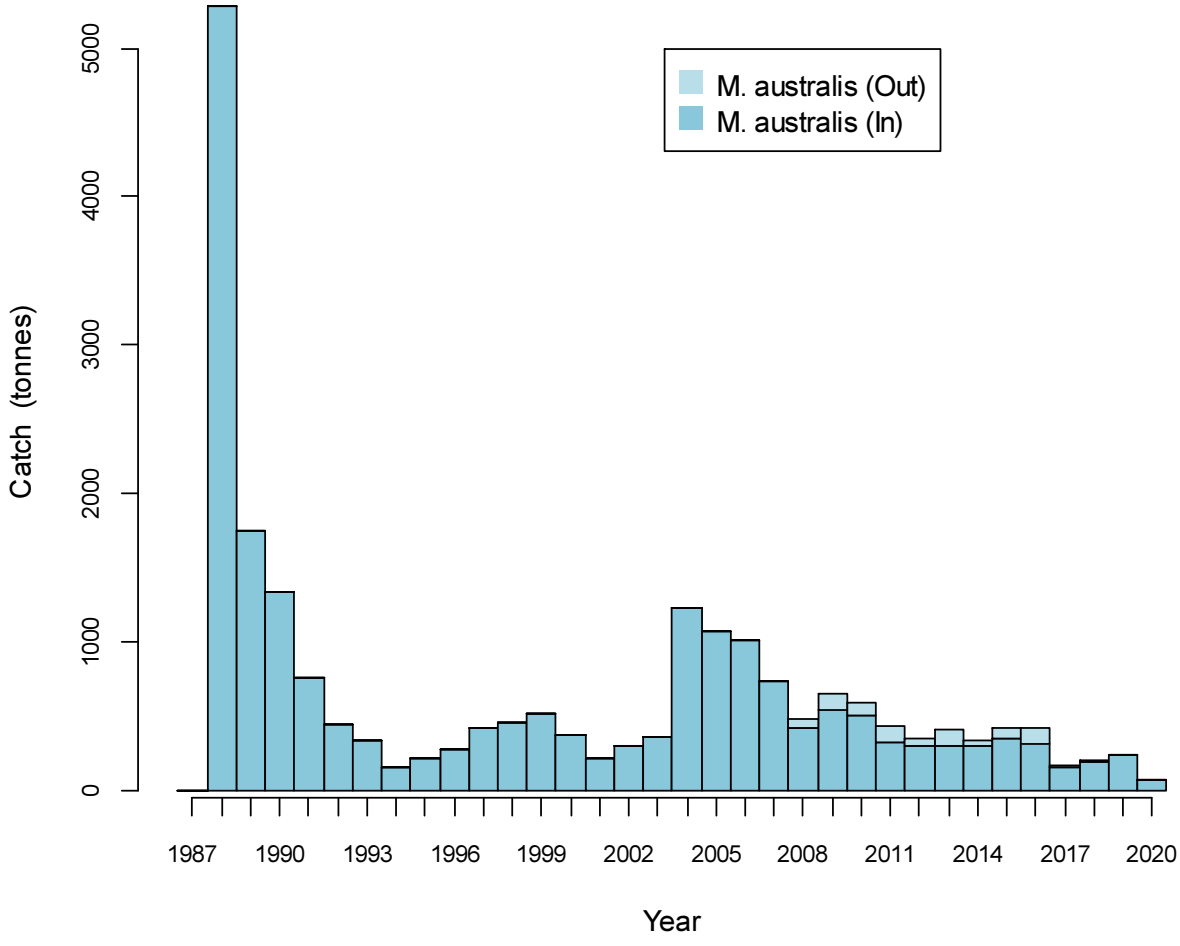


Figure 1. Annual commercial catches of *M. australis* from FIFD catch reports, since 1987. *M. australis* (out) are *M. australis* caught outside the Falkland Islands conservation zones but reported to the FIFD (as regulatory required for Falkland-flagged vessels), and entered in the database as licence category "O".

[a] Austral seasons are referenced throughout this report: summer (January to March); autumn (April to June); winter (July to September); spring (October to December).

M. australis shares the Falkland Islands zone with *M. hubbsi*; both species occur over the shelf and upper continental slope but are spatially separated, with *M. hubbsi* mainly present to the north of 52°S at 100–250 m depth and *M. australis* to the south of 52°S at 150–500 m depth in colder waters (Lloris et al. 2005, Arkhipkin et al. 2015). Data analyses around Falkland waters have shown that the two hake species can occupy the same feeding grounds by segregating spatially, temporally, and possibly in their diets (Arkhipkin et al. 2003). *M. australis* is a commercially more valuable fishery product than *M. hubbsi* (Tingley et al. 1995, Arkhipkin et al. 2015) but is taken in much lower quantities, representing only 0.2% of total reported hake catch in Falkland Islands fisheries from 1987 to 2019 (Winter and Ramos 2020).

Methods

ICES advice rules

In 2020, hake was included in the Falkland Islands Government finfish stock assessment and management review conducted by MacAlister Elliott & Partners Ltd, UK (MEP 2020). The MEP report recommended stock assessments for most commercial finfish species to be based on the ICES advice rules (ICES 2012, 2018a), referencing applicable categories of data availability and quality. Hakes (*M. hubbsi* and *M. australis*) were advised at category 5, as species for which landings data are available, but not reliable indices from surveys or catch-per-unit-effort.

For category 5 the recommended assessment framework is based on the average catches[b] from the last 3 years (MEP 2020). Year-to-year change is further limited to an 'uncertainty cap' of ±20% (ICES 2018a). Falkland Islands-licenced catches for any species are available routinely from the Fisheries Department database. However, Falkland Islands commercial fisheries were not required to separately report *M. hubbsi* and *M. australis* catches before 2015 (A. Blake, Falkland Islands Fisheries Department [FIFD], pers. comm.), and the two species remain difficult to distinguish (Cousseau and Cotrina 1980). Annual hake catches were therefore combined between the two species and then proportioned according to a LOESS smooth (degree = 2, span = 0.90) of observer catch composition samples[c].

When a species represents only quantitatively minor bycatch, caution is advised that realized catches may correlate more with the primary fishing targets than with the actual biomass of that bycatch species. However, precision of trends can potentially be improved by restricting the fishing categories in which catches were taken (Biseau 1998). Accordingly, options were examined for modulating *M. australis* catch averages by CPUE restricted to the licence(s) that predominantly took *M. australis*, the areas in which *M. australis* was primarily caught, or the combination of licence(s) and area. These options were examined over the 6 most recent years, 2015 – 2020. Licenced catch reports are much more numerous than observer reports. For practical purposes of examining these options, licence and area distributions reporting *M. australis* catches were not re-proportioned according to observer samples.

Surveys

[b] It is not explicitly stated in the reference but inferred that 'average' catches signifies the 'mean' of the annual total catches, by weight.

[c] As observer coverage is variable from year to year, it is understood that this approach introduces a certain amount of stochasticity into the estimation.

Parallel trawl surveys of the Falkland Islands finfish zone and *D. gahi* fishing zone (Loligo Box) have been conducted in February of 2010, 2011, and 2015 to 2020. Catch data of these surveys provide biomass trends for major commercial finfish species, but have not yet been utilized for *M. australis* (Ramos and Winter 2019, 2020). The February biomass estimates of *M. australis* were therefore calculated for these years, according to the inverse distance weighting methods described in Ramos and Winter (2020). In contrast to *M. hubbsi*, *M. australis* attains highest stock biomass around the Falkland Islands during summer months (Arkhipkin et al. 2012).

Additionally, in two recent years finfish trawl surveys have been conducted during July for the primary purpose of apprehending hake (Gras et al. 2017, Randhawa et al. 2020). Like the February surveys, these July surveys were also paralleled with *D. gahi* pre-season surveys (Winter et al. 2017, 2020) for a complete inventory of the Falkland Islands fishing zone. *M. australis* biomass estimates were therefore also calculated from the July survey data. While two sets of data cannot serve as a time series index, they provide an additional indicator for the recent biomass of *M. australis* in Falkland Islands waters.

Results

Catch

Table 1. Falkland Islands *M. australis* catches by licence in 2020.

Licence		*M. australis* catch	
Code	Type	Tonnes	%
A	Unrestricted finfish	0.02	<0.1
G	Restricted finfish + *Illex*	1.13	1.5
W	Restricted finfish	71.91	97.8
F	Skate	0.00	0.0
C	Calamari 1st season	0.03	<0.1
X	Calamari 2nd season	0.02	<0.1
B	*Illex* squid	0.00	0.0
L	Toothfish longline	0.00	0.0
E	Experimental	0.06	0.1
O	Other (outside)	0.34	0.5
Total		[d]73.51	100.0

During 2020 a total of 73.51 tonnes *M. australis* were estimated caught in the Falkland Islands fisheries, with catch by licence distributions shown in Table 1. *M. australis* was recorded on one single of the 748 A-licence catch reports; as the 12th-highest species catch, on 18 of the 506 G-licence catch reports where it was as much as the 6th-highest species catch (twice), and on 192 of the 735 W-licence catch reports, where it was as much as the 4th-highest species catch (5 times). Other than finfish licences, *M. australis* was recorded on 13 of the 2005 calamari (C- and X-licence) catch reports, where it was as much as the 4th-highest species catch (twice), and on three of the 174 out-of-zone trawl catch reports, where it was 2nd (twice) and 6th-highest species catch.

[d] The difference between this total and the sum of 2020 licenced catches in Table A1 (in-zone + out-of-zone) is the E-licence catches, rounded to 0.01 tonnes.

Category 5

During the six years 2015 – 2020, *M. australis* catches were highest under W licence in 2015, 2016, 2019, and 2020; and highest under B licence in 2017 and 2018. *M. australis* catches were completely absent from B licence in all four years except 2017 and 2018, rendering this licence by itself unsuitable for a restricted index. The combination of W + G licences accounted for less than 50% of reported *M. australis* catch only once; in 2018 (44%). W + G licence *M. australis* catches were furthermore strongly concentrated in the south-west of the FICZ (Figure A1); between 33.5% and 65.7% in just the six contiguous grids XTAC, XUAB, XUAC, XUAD, XVAC and XVAD. Accordingly CPUE indices were examined under W + G licences only, in grids XTAC, XUAB, XUAC, XUAD, XVAC and XVAD only, and in the combination of W + G licence in those six grids only.

Effectively, no qualitative difference was found between the trend of *M. australis* total in-zone catches and any of these CPUE indices, and year-to-year variation over the three most recent years was not monotonic in any case (Figure A2). Therefore catch averages were used for category 5 without modification.

The *M. australis* catches for calculating the last three years' average are the in-zone catches only, summarized in Table A1, as these are the catches subject to licensing:

$$\text{TAC-5}_{2022} = \overline{\text{Catches}_{2018\text{ to }2020}},$$

$$= \overline{194.32, 233.69, 73.12} = 167.04 \text{ tonnes.}$$

Note that the year jumps from 2020 to 2022. Standard procedure is to inform *next* year's allowable catch with data up to the last completed year, i.e., the *previous* year, as licencing advice must be issued while the *current* year is still in progress.

TAC-5_{2022} represented an increase of >20% from the total *M. australis* in-zone catch in 2020 (which was still allocated by total allowable effort): 73.12 tonnes (Table A1). The category 5 principle of limitation to a 20% uncertainty cap thus requires:

$$\text{TAC-}_{\text{cap}}5_{2022} = 73.12 \text{ tonnes} \times 1.2 = 87.74 \text{ tonnes.}$$

Surveys

In February surveys, estimated *M. australis* biomass decreased significantly through the period from 2010 to 2020, but 2020 was not the lowest year, suggesting the start of a stabilizing trend (Table 2). Consistent with highest catches (Figure A1), highest biomass densities were regularly in the south-west of the FICZ (Figure A3). In the two July surveys, 2020 estimated biomass was ~3× lower than 2017 estimated biomass (Table 3), a slightly less steep decrease than February, although the comparison is not statistically verifiable with this number of data. In July 2017 the highest concentration of *M. australis* was south-west as in February, but in July 2020 the highest concentration had shifted to the south of the FICZ (Figure A4).

Table 2 [below]. February survey trawl effort, *M. australis* catches, and *M. australis* Falkland Islands zone biomass estimates ± 95% confidence intervals.

Year	February Survey	Trawls	Catch (kg)	Biomass (t)
2010	groundfish	87	821.6	5540.9 (4196.2 – 6739.2)
	D. gahi	55	0.0	
2011	groundfish	88	754.4	5495.8 (3692.9 – 9065.5)
	D. gahi	58	18.3	
2015	groundfish	89	323.1	2955.7 (1645.4 – 4487.2)
	D. gahi	57	34.4	
2016	groundfish	90	215.4	2091.9 (1144.9 – 3127.6)
	D. gahi	56	30.9	
2017	groundfish	90	178.9	2076.3 (1014.9 – 2818.2)
	D. gahi	58	17.3	
2018	groundfish	97	268.0	1482.4 (992.9 – 2012.7)
	D. gahi	59	32.6	
2019	groundfish	[d]79	41.3	500.9 (104.9 – 663.6)
	D. gahi	52	10.0	
2020	groundfish	[d]80	89.4	650.9 (256.8 – 984.8)
	D. gahi	59	5.9	

Table 3. July survey trawl effort, *M. australis* catches, and *M. australis* Falkland Islands zone biomass estimates ± 95% confidence intervals.

Year	July Survey	Trawls	Catch (kg)	Biomass (t)
2017	groundfish	74	43.4	524.2 (224.5 – 738.2)
	D. gahi	[e]59	17.7	
2020	groundfish	[f]33	12.1	168.8 (1.2 – 448.6)
	D. gahi	55	9.1	

Conclusion

Because of the current high volume of hake catches, A licence has been redirected from the status of unrestricted finfish licence to *de facto* hake licence over the past two years (FIFD 2019, 2020). The redirected status obtained that A licence was exempt from effort adjustments in relation to the finfish index species (rock cod), but also that any species caught under A licence other than *M. hubbsi* and *M. australis* would be subject to regulation as bycatch. For restricted finfish and skate licences, hakes remain ostensibly categorized as a bycatch, although also representing the highest catches in the past few years (FIFD 2019, 2020). Accordingly, hakes are suitable species for management by total allowable catch, subject to partitioning among licences.

$TAC\text{-}_{cap}5_{2022}$ = 87.74 tonnes is therefore recommended as the guideline allowable catch for *M. australis*. However, a marginally caught (and potentially erroneously identified) species like *M. australis* presents the concern that total allowable catch could both be set and subsequently breached on the relatively haphazard basis of a few catch reports more or less. It

[e] An additional one-day transect of four trawls was taken in shallow inshore waters to sample for juvenile toothfish. These four trawls were not included in analyses as their locations were not relevant to the distribution of *M. australis*.

[f] Twelve additional trawls were conducted on the high seas (out-of-zone) during the July 2020 survey; these high seas survey trawls were not included in the analyses.

is advised that at present, *M. australis* not be designated as a FIFD managed species. Progression of *M. australis* catches should still be monitored with possible review of the licences and areas involved, as past years have shown that B licence may or may not take any *M. australis*, and substantial proportions may come from outside the Falkland Islands zones.

References

Arkhipkin, A.I., Middleton, D.A.J., Portela, J.M., Bellido, J.M. 2003. Alternative usage of common feeding grounds by large predators: the case of two hakes (*Merluccius hubbsi* and *M. australis*) in the southwest Atlantic. Aquatic Living Resources 16: 487-500.

Arkhipkin, A., Brickle, P., Laptikhovsky, V., Winter, A. 2012. Dining hall at sea: feeding migrations of nektonic predators to the eastern Patagonian Shelf. Journal of Fish Biology 81: 882–902.

Arkhipkin, A.I., Laptikhovsky, V.V., Barton, A.J. 2015. Biology and fishery of common hake (*Merluccius hubbsi*) and southern hake (*Merluccius australis*) around the Falkland/Malvinas Islands on the Patagonian shelf of the Southwest Atlantic Ocean. In: Arancibia, H. (ed) Hakes, Biology and Exploitation, pp. 154-184. Oxford: Wiley.

Biseau, A. 1998. Definition of a directed fishing effort in a mixed-species trawl fishery, and its impact on stock assessments. Aquatic Living Resources 11: 119-136.

Cousseau, M.B., Cotrina, C.P. 1980. Observaciones sobre diferencias morfologicas entre la merluza comun (*Merluccius hubbsi*) y la merluza austral (*Merluccius polylepis*). Revista de Investigación y Desarrollo Pesquero 2: 47–56.

FIFD. 2019. Vessel Units, Allowable Effort, and Allowable Catch 2020. Part 1 – Summary and Recommendations. Fisheries Department, Directorate of Natural Resources, Falkland Islands Government. 21 p.

FIFD. 2020. Vessel Units, Allowable Effort, and Allowable Catch 2021. Summary and Recommendations. Fisheries Department, Directorate of Natural Resources, Falkland Islands Government. 20 p.

Froese, R., Pauly, D. (eds.) 2019. FishBase. World Wide Web electronic publication. www.fishbase.org. (12/2019).

Gras, M., Pompert, J., Blake, A., Busbridge, T., Boag, T., Huillier, J.–T., Concha, F., 2017. Report of the 2017 ground fish survey ZDLT1–07–2017. Technical Document, FIG Fisheries Department. 68 p.

ICES. 2012. ICES Implementation of Advice for Data limited Stocks in its 2012 Advice. http://www.ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/acom/2012/ADHOC/DLS%20Guidance%20Report%202012.pdf

ICES. 2018a. General context of ICES advice. https://www.ices.dk/sites/pub/Publication%20Reports/Advice/2018/2018/Introduction_to_advice_2018.pdf

Lloris, D., Matallanas, J., Oliver, P. 2005. Hakes of the world (Family Merlucciidae). An annotated and illustrated catalogue of hake species known to date. *FAO Species Catalogue for Fishery Purposes*. No. 2. Rome, FAO. 57p.

MEP. 2020. Review of Falkland Islands finfish fisheries. Final Report – in preparation.

Ramos, J.E., Winter, A. 2019. February trawl survey biomasses of fishery species in Falkland Islands waters, 2010-2019. SA–2019–08. Technical Document, FIG Fisheries Department. 46 p.

Ramos, J.E., Winter, A. 2020. February trawl survey biomasses of fishery species in Falkland Islands waters, 2010-2020. SA–2020–04. Technical Document, FIG Fisheries Department. 58 p.

Randhawa, H.S., Blake, A., Trevizan, T., Brewin, J., Evans, D., Kairua, T., Büring, T. 2020. Cruise Report ZDLT1-07-2020: 2020 Hake Demography Survey. Technical Document, FIG Fisheries Department. 135 p.

Tingley, G.A., Purchase, L.V., Bravington, M.V., Holden, S.J. 1995. Biology and fisheries of hakes (*M. hubbsi* and *M. australis*) around the Falkland Islands. In: Alheit, J., Pitcher, T.J. (eds) Hake: Biology, fisheries and markets, pp. 269-303. Chapman & Hall Fish and Fisheries Series, vol. 15. Springer, Dordrecht.

Winter, A., Shcherbich, Z., Iriarte, V., Derbyshire, C., 2017. *Doryteuthis gahi* stock assessment survey, 2nd season 2017. Technical Document, FIG Fisheries Department. 25 p.

Winter, A., Ramos, J.E. 2020. Hake stock assessment, *Merluccius hubbsi*, *Merluccius australis*. Technical Document, FIG Fisheries Department. 36 p.

Winter, A., Ramos, J.E., Shcherbich, Z., Tutjavi, V., Matošević, N. 2020. Falkland calamari (*Doryteuthis gahi*) stock assessment survey, 2nd season 2020. Technical Document, FIG Fisheries Department. 17 p.

Appendix

Table A1. Falkland Islands commercial *M. australis* catches (excluding E licences) by year. Equivalent to the *M. australis* (out) and *M. australis* (in) bars in Figure 1.

Year	*M. australis* catch (tonnes)		Year	*M. australis* catch (tonnes)	
	Out-of-zone	In-zone		Out-of-zone	In-zone
1987	0.0	0.0	2004	0.0	1224.1
1988	0.0	5288.3	2005	0.0	1068.1
1989	0.0	1748.6	2006	0.0	1012.6
1990	0.0	1338.8	2007	6.6	731.8
1991	0.0	759.7	2008	68.0	415.5
1992	0.0	443.1	2009	105.7	543.2
1993	0.0	329.3	2010	81.2	503.1
1994	0.0	153.8	2011	110.9	318.7
1995	0.0	214.0	2012	57.7	293.0
1996	0.0	278.4	2013	100.9	300.8
1997	0.0	414.1	2014	32.8	302.9
1998	0.0	455.1	2015	67.9	352.0
1999	0.0	516.2	2016	109.2	315.0
2000	0.0	373.6	2017	10.6	159.1
2001	0.0	215.6	2018	8.1	194.3
2002	0.0	293.5	2019	1.6	233.7
2003	0.0	360.2	2020	0.3	73.1

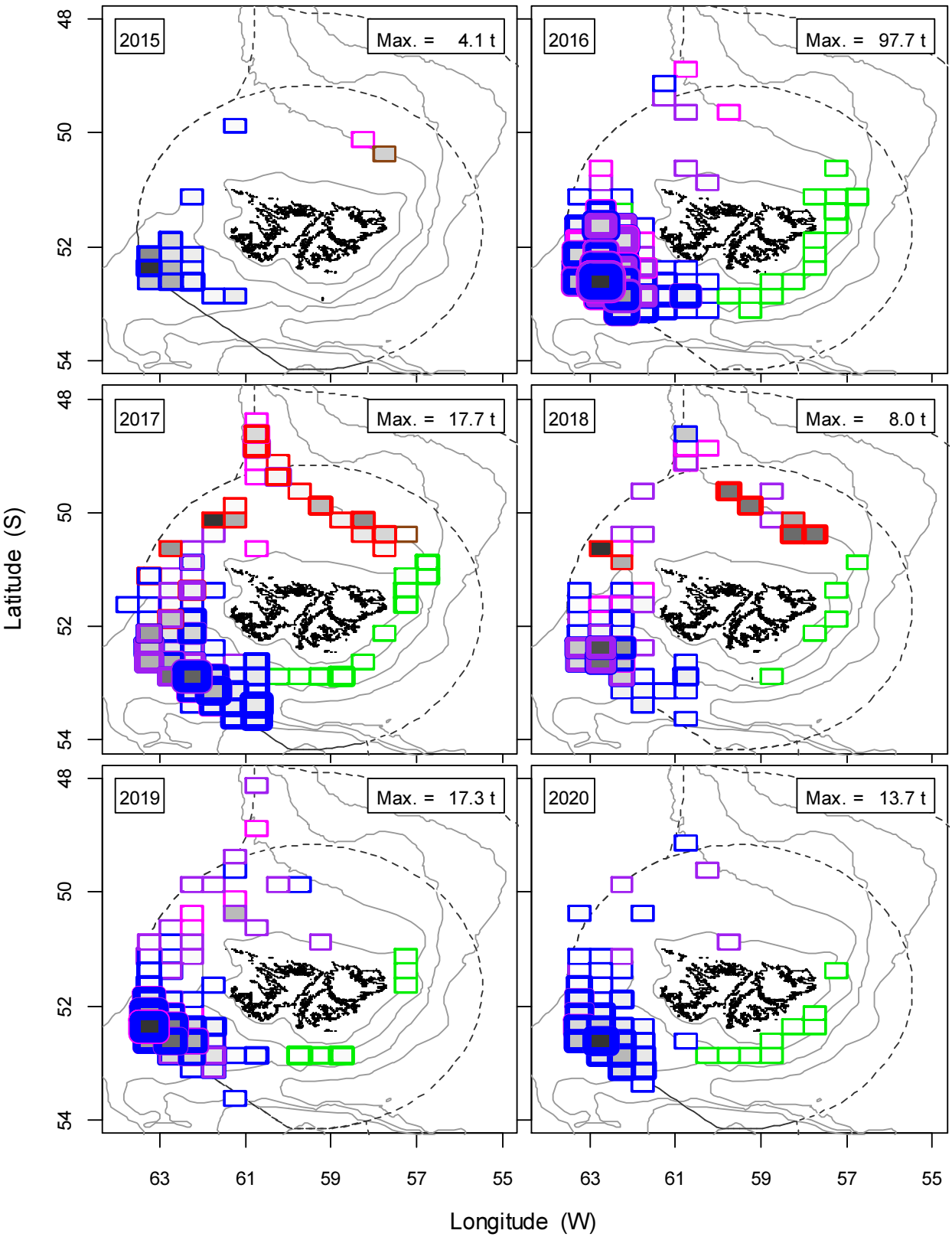


Figure A1. Relative *M. australis* catch per grid; darkest greyscale = yearly maximum. Thickness of grid lines is proportional to numbers of catch reports. For clarity, only grids with any *M. australis* catch are included. Green: calamari licenses (C and X), magenta: A licence, purple: G, blue: W, red: B, brown: F. Licences may overlap on a grid; the most prevalent is on top.

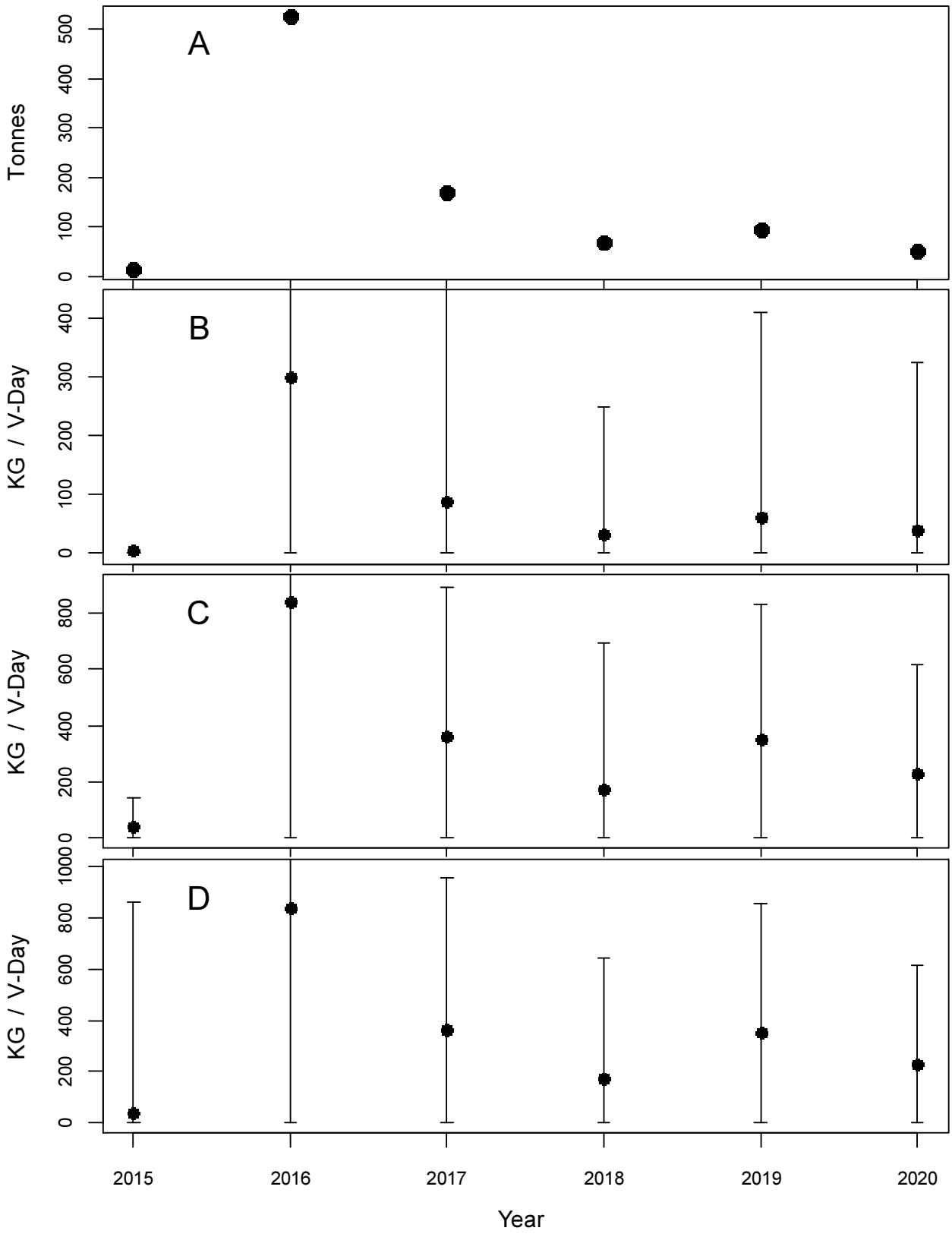


Figure A2. For years 2015 – 2020, A: *M. australis* total in-zone catches; equivalent to Table A1. B: W + G licence CPUE, with 90% confidence intervals. C: CPUE, all licences, but restricted to grids XTAC, XUAB, XUAC, XUAD, XVAC and XVAD, with 90% c. i. D: W + G licence CPUE restricted to grids XTAC, XUAB, XUAC, XUAD, XVAC and XVAD, with 90% conf. intervals.

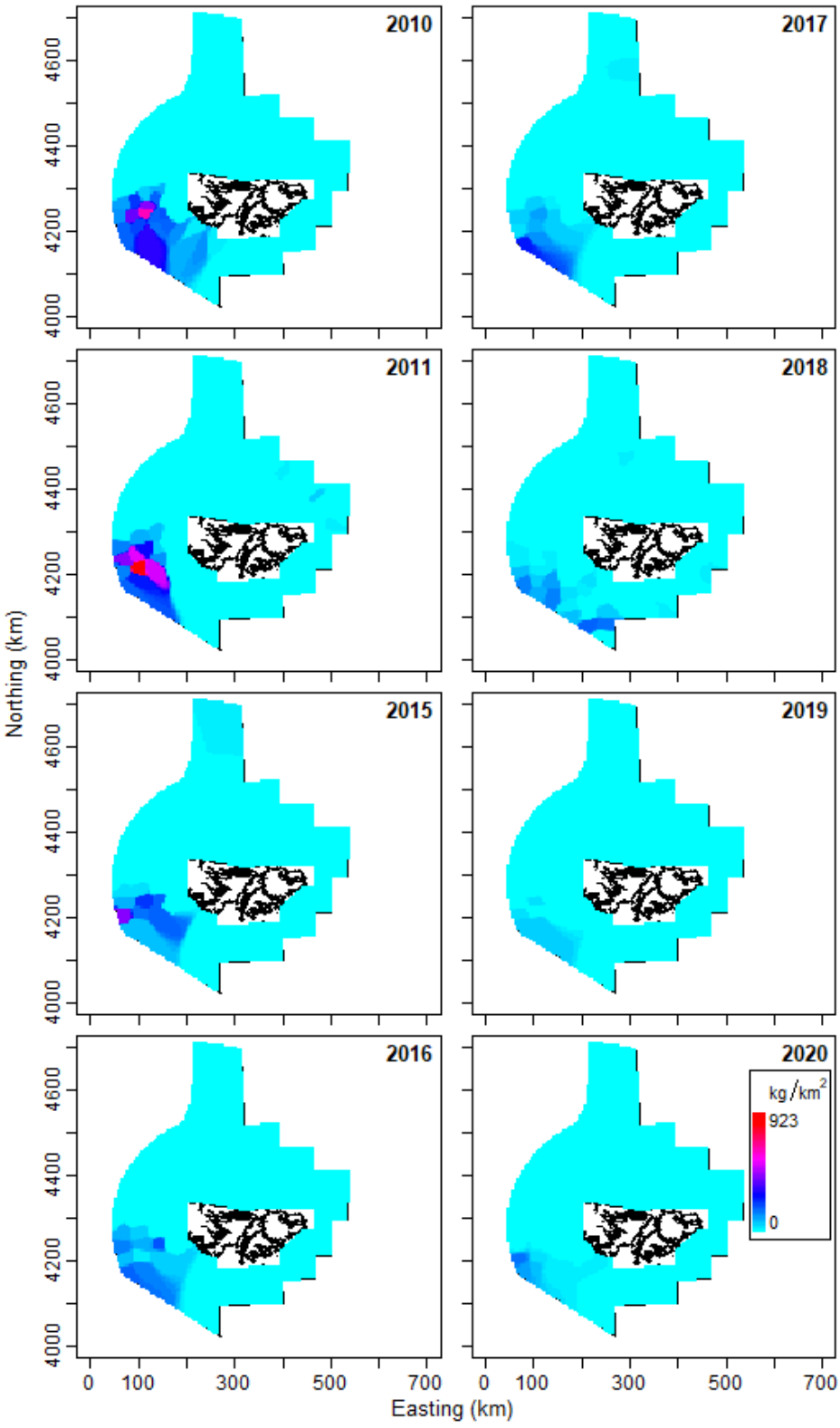


Figure A3. Densities of *M. australis* modelled by inverse distance weighting throughout the Falkland Islands fishing zone, from February parallel surveys by year.

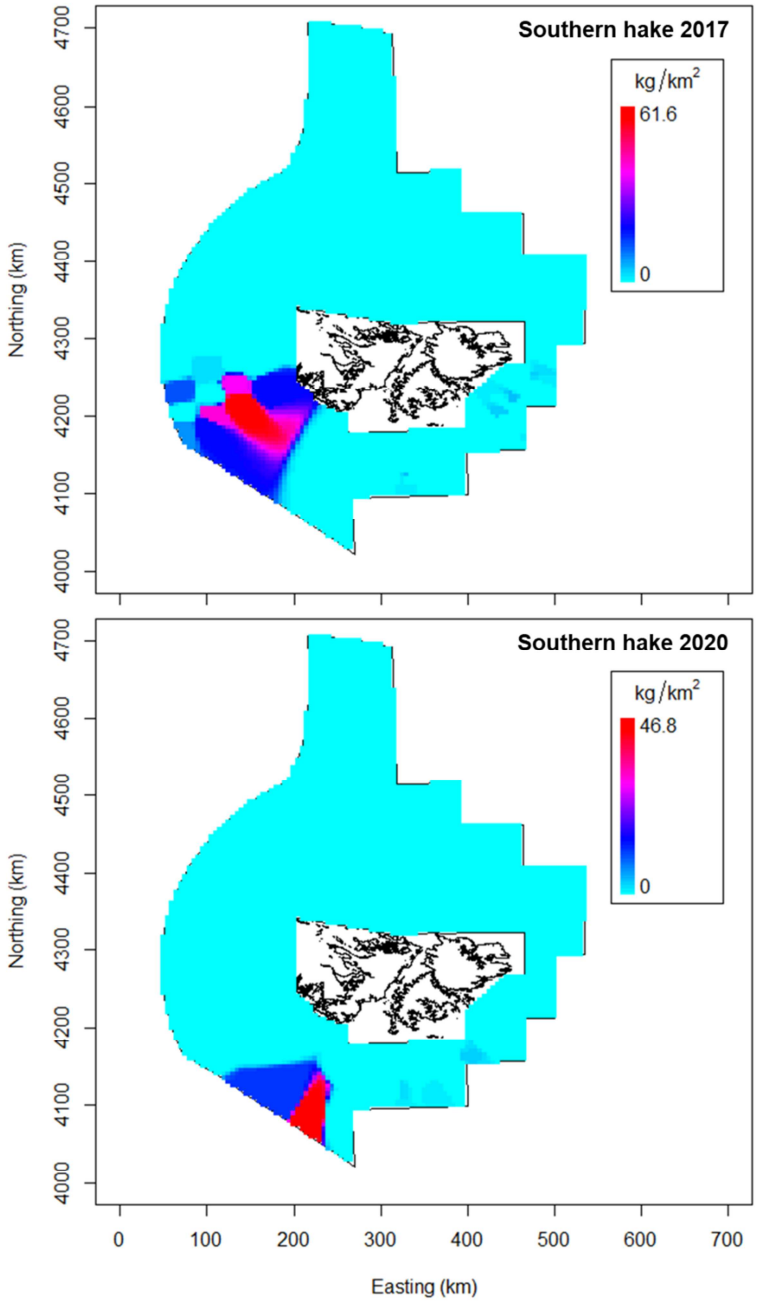


Figure A4. Densities of *M. australis* modelled by inverse distance weighting throughout the Falkland Islands fishing zone, in July 2017 and July 2020.