The following supplements accompany the article

Assessing the importance of toothfish in the diet of generalist subantarctic killer whales: implications for fisheries interactions

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Supplement 1

Table S1. Prey species confirmed as prey of the Crozet killer whales from stomach contents and direct observations of predation events. For stomach contents, details include the nature of the remains found in the stomach of one sub-adult male from the Crozet population (ID: C041) discovered dead and stranded in Baie de la Hébé (Possession Island) on August 17th 2006. For observations, details include the age class (adults or unweaned juveniles, here referred as "pups" for seal species) and whether predation occurred in inshore waters (observed from Possession Island) or in offshore waters (at the edge of the shelf, observed from fishing vessels).

Data	Species	Details	Source
Stomach contents	**Mammals**		This study
	Southern elephant seal *Mirounga leonina*	One complete skin and accumulated bones (vertebrae and ribs)	
	Fur seal *Arctocephalus* sp.	Lower jaw from a small individual	
	Birds		
	King penguin *Aptenodytes patagonicus*	Bones, feet, tail feathers, stomach from about 3 individuals	
	Cephalopods		
	Octopodidae sp.	One large beak of a benthic octopus	
Observations	**Mammals**		
	Southern elephant seal *Mirounga leonina*	Pups and adult females in inshore waters	(Voisin, 1976; Guinet and Jouventin, 1990; Guinet, 1991, 1992; Guinet and Bouvier, 1995)
	Fur seal *Arctocephalus* spp.	Pups in inshore waters	(Guinet and Jouventin, 1990)
	Southern right whale *Eubalaena australis*	Adults in inshore and offshore waters	(Guinet and Jouventin, 1990), this study
	Minke whale *Baleanoptera acutorostrata*	Adults in inshore waters	(Guinet and Jouventin, 1990; Guinet *et al.*, 2000)
	Birds		
	King penguin *Aptenodytes patagonicus*	Adults in inshore waters	(Ridoux, 1987; Guinet and Jouventin, 1990; Guinet, 1991, 1992)
	Crested penguin *Eudyptes* spp.	Adults in inshore waters	(Ridoux, 1987; Guinet and Jouventin, 1990; Guinet, 1991, 1992)
	Gentoo penguin *Pygoscelis papua*	Adults in inshore waters	Tixier, pers. comm. 2018
	Fish		
	Notothenid fish	Inshore waters	(Guinet and Jouventin, 1990)
	Patagonian toothfish *Dissostichus eleginoides*	Offshore waters (depredated from fishing gear)	(Roche *et al.*, 2007; Tixier *et al.*, 2010, 2015, 2016, 2017)

Table S2. Values of $\delta^{13}C$ and $\delta^{15}N$ (‰) of lipid-extracted skin collected from the Crozet killer whales. Details on individuals include the ID code (as in Tixier et al. 2014), the sex (M: Male, F: Female), the age class (A: Adult, > 10 years old, S: Sub-adult < 10 years old) and whether the whale was sighted interacting with fisheries during the 48 (Depredation 48d) or 24 days (Depredation 24d) preceding the date of sampling. Sampling information includes the date, location (latitude and longitude) and the platform (F/V: toothfish fishing vessel, land: Possession Island shore) of the samples obtained via remote biopsy sampling. C:N is the atomic carbon:nitrogen ratio.

Individuals sampled					**Sampling information**					**Skin isotopic values**		
ID	Sex	Age class	Depredation (24d)	Depredation (48d)	Date	Time	Platform	Lat.	Lon.	$\delta^{13}C$	$\delta^{15}N$	C:N
C041*	M	S	unknown	unknown	17/08/2006	10:00	land	-46.4	51.8	-18.84	13.44	3.30
C019	F	A	1	1	4/02/2011	8:44	F/V	-46.9	51.1	-19.53	13.07	3.15
C148	F	S	1	1	8/02/2011	7:32	F/V	-46.9	51.1	-19.57	13.61	3.19
C121	F	A	1	1	8/02/2011	8:03	F/V	-46.9	51.1	-17.95	13.64	3.17
C018	F	A	1	1	8/02/2011	10:48	F/V	-46.9	51.1	-19.55	13.81	3.21
C161	M	S	1	1	8/02/2011	17:42	F/V	-46.9	51.1	-19.46	12.54	3.16
C020	M	A	1	1	9/02/2011	16:50	F/V	-46.9	51.1	-19.49	13.45	3.23
C143	F	A	1	1	9/02/2011	17:21	F/V	-46.9	51.1	-18.06	13.92	3.17
C138	F	A	1	1	14/02/2011	13:06	F/V	-46.1	51.1	-18.91	13.38	3.13
C172	F	A	1	1	21/02/2011	10:18	F/V	-46.4	51.0	-18.35	13.59	3.11
C187	F	S	0	0	19/11/2011	11:01	land	-46.4	51.8	-19.13	14.21	3.25
C012	F	A	0	0	24/11/2011	15:20	land	-46.4	51.8	-19.34	13.65	3.26
C200	F	S	0	0	25/11/2011	19:24	land	-46.4	51.8	-18.81	14.25	3.13
C128	F	A	0	0	26/11/2011	14:02	land	-46.4	51.8	-18.91	13.41	3.22
C069	F	A	0	0	26/11/2011	14:10	land	-46.4	51.8	-19.05	13.65	3.20
C116	F	A	0	0	3/12/2011	10:47	land	-46.4	51.8	-18.81	13.89	3.20
C068	M	A	0	0	3/12/2011	12:04	land	-46.4	51.8	-18.87	13.33	3.17
C004	F	A	0	1	25/11/2012	18:11	land	-46.4	51.8	-18.81	13.31	3.27
C063	F	A	0	1	4/12/2012	11:18	land	-46.4	51.8	-19.52	13.50	3.39

* Sample from stranded dead individual not included in analyses

Table S3. Values of $\delta^{13}C$ and $\delta^{15}N$ (‰) of lipid-extracted skin collected from sperm whales at Crozet and Kerguelen. Details on individuals include the ID code (as in Labadie et al. 2015) and the sex (M: Male, U: Unknown). Sampling information includes the date, area (Exclusive Economic Zones of Kerguelen or Crozet), the location (latitude and longitude) of the samples obtained from a stranded animal (2007) or via remote biopsy sampling from toothfish fishing vessels (2011).

Individuals sampled		**Sampling information**				**Skin isotopic values**		
ID	Sex	Date	Area	Lat.	Lon.	$\delta^{13}C$	$\delta^{15}N$	C:N
U	M	1/03/2007	Kerguelen	-46.9	51.1	-17.89	14.04	3.23
KER_009	U	17/01/2011	Kerguelen	-46.9	51.1	-18.55	14.17	3.29
KER_037	U	18/01/2011	Kerguelen	-46.9	51.1	-18.82	13.47	3.23
CRO_029	U	14/02/2011	Crozet	-46.2	51.0	-18.92	13.79	3.42
CRO_037	U	14/02/2011	Crozet	-46.1	51.1	-19.17	13.82	3.47
CRO_036	U	17/02/2011	Crozet	-46.8	50.1	-18.51	14.77	3.25

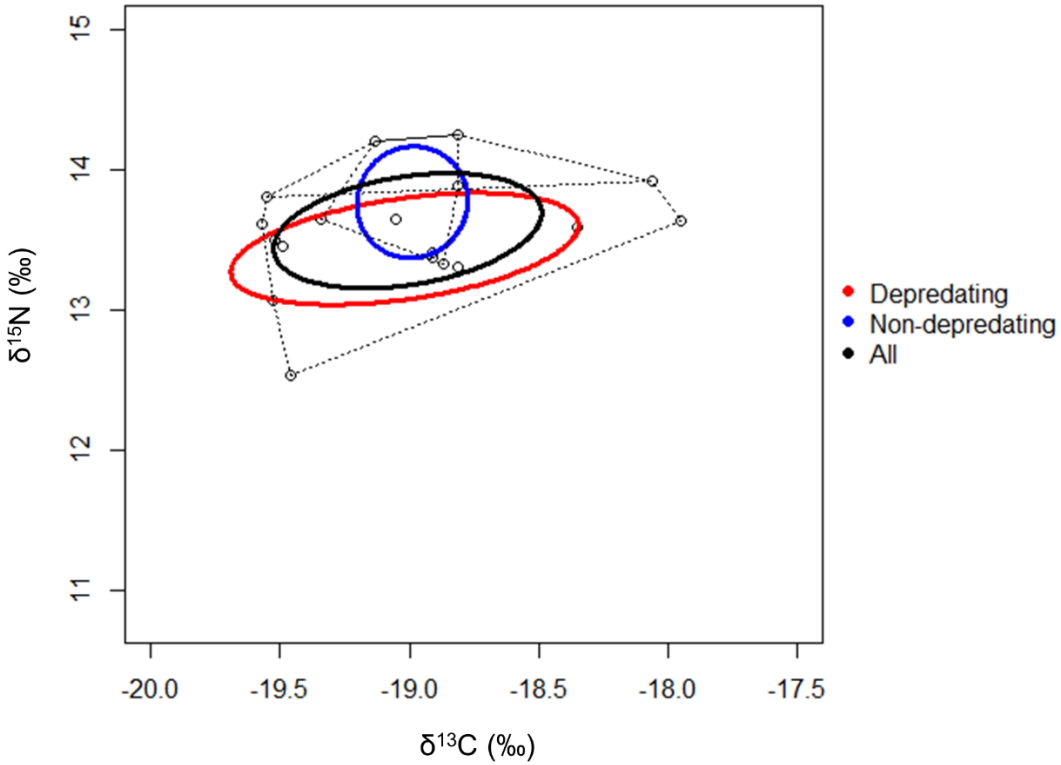

Figure S1. Sample size corrected standard ellipse areas (SEA_C; solid lines) and convex hull areas (dotted lines) for all Crozet killer whales (black), depredating (red) and non-depredating (blue) samples. The depredating state was here assigned to samples if individuals sampled were sighted interacting with fisheries over the 48 days preceding the sampling date.

Table S4. Sighting history of the Crozet killer whales over the 24 and 48 days preceding the date of sampling. Sightings were confirmed by photo-identification conducted from the toothfish fishing vessels during depredation events and from Possession Island.

		Total number of days sighted			
		Fishing vessels		Possession Island	
ID	Sampling date	24 days	48 days	24 days	48 days
C019	4/02/2011	5	5	0	0
C148	8/02/2011	9	9	0	0
C121	8/02/2011	3	3	1	2
C018	8/02/2011	9	9	0	0
C161	8/02/2011	3	3	0	0
C020	9/02/2011	10	10	0	0
C143	9/02/2011	4	4	1	2
C138	14/02/2011	4	4	0	0
C172	21/02/2011	6	6	0	0
C187	19/11/2011	0	0	10	10
C012	24/11/2011	0	0	13	13
C200	25/11/2011	0	0	6	6
C128	26/11/2011	0	0	1	1
C069	26/11/2011	0	0	1	1
C116	3/12/2011	0	0	8	8
C068	3/12/2011	0	0	8	8
C004	25/11/2012	0	2	4	4
C063	4/12/2012	0	6	9	10

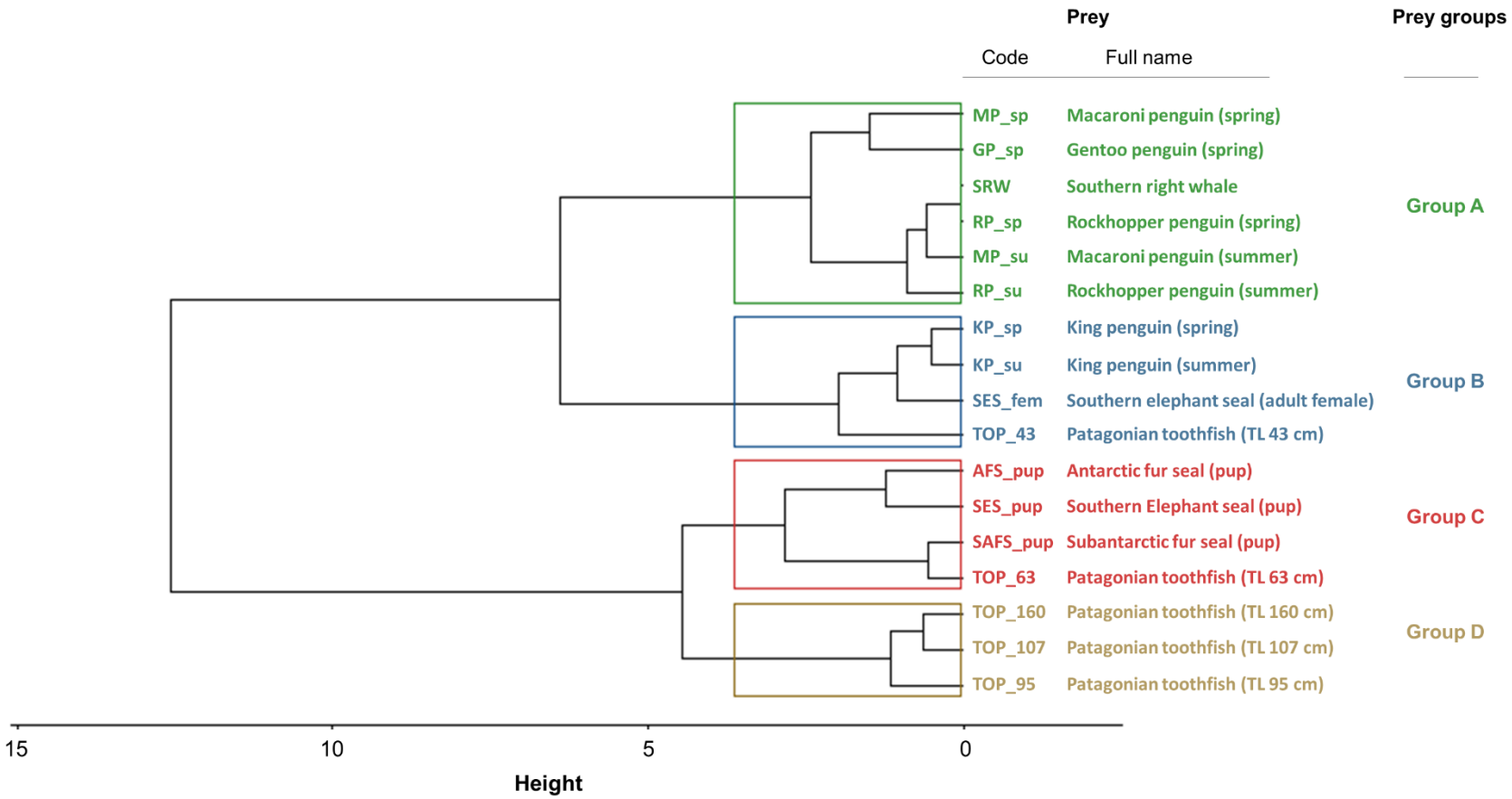

Figure S2. Dendrogram of the Crozet killer whale prey based on isotopic similarities as estimated by Ward's hierarchical clustering.

Table S5. Outputs from the post-hoc Tukey's HSD tests performed on the $\delta^{13}C$ and $\delta^{15}N$ values between all combinations of prey group pairs. Difference in values (‰), the estimated 95% confidence intervals of the differences and p-values are reported

Prey group pairs	$\delta^{13}C$			$\delta^{15}N$		
	Difference	95% CI	*p*	Difference	95% CI	*p*
B - A	-1.94	[-3.62,-0.26]	0.02	2.14	[1.31,2.97]	<0.001
C - A	-1.02	[-2.70,0.66]	0.33	4.42	[3.59,5.25]	<0.001
D - A	0.59	[-1.26,2.43]	0.79	6.21	[5.30,7.13]	<0.001
C - B	0.92	[-0.9,2.76]	0.48	2.28	[1.34,3.21]	<0.001
D - B	2.53	[0.53,4.52]	0.01	4.07	[3.06,5.08]	<0.001
D - C	1.61	[-0.39,3.60]	0.13	1.79	[0.78,2.80]	<0.001

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Supplement 2

The Crozet and Marion Island killer whale populations had similar trophic niche width but showed limited isotopic overlap. Marion Island lies ~ 1000 km west of Crozet at a similar latitude and supports the same prey species. The Marion killer whales have also been observed feeding on elephant seals, fur seals and penguins in inshore waters (Reisinger *et al.*, 2011). While the two populations had similar $\delta^{13}C$ values, indicating that they derived dietary carbon from similar latitudes/environments, $\delta^{15}N$ values of Crozet killer whales were higher by 1 ‰ than those of Marion killer whales. Some of the Marion killer whales (9 individuals out of 58, (Reisinger and de Bruyn, 2014; Tixier *et al.*, 2014) that had been sighted occasionally interacting with fishing vessels around Crozet had significantly higher $\delta^{15}N$ (13.2 ± 0.3 ‰) than those that had never been sighted at Crozet (12.1 ± 0.5 ‰) (Reisinger *et al.*, 2016). We therefore ascribe the isotopic niche differences between the two populations to a higher proportion of toothfish in the diet of the Crozet population. Toothfish stocks around Marion Island may be lower than at Crozet as they were decimated by the early 2000s, largely due to intense illegal fishing (Boonzaier *et al.*, 2012). In addition, the fishing effort and the catch by licenced vessels is lower at Marion (2 licenced vessels catching 200-300 tonnes per year since 2010, CCAMLR 2017a) than at Crozet (7 licenced vessels catching 600-1100 tonnes per year since 2010, CCAMLR 2017b). Such differences in the proportion of toothfish in the diet of the two populations might therefore be due to: i) lower levels of artificial provisioning through longlining around Marion Island compared with Crozet; and/or ii) lower abundance of toothfish around Marion Island due to lower natural stock abundance and/or to the historical stock collapse; and/or iii) reduced opportunities to depredate because of lower fishing effort and catches at Marion.

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Supplement 3

The large beak from a southern giant octopus found in the stomach contents indicated that this species may be part of the Crozet killer whales' natural diet. However, since we did not include this species, nor any other cephalopod species, in our analyses due to data limitations, the relative importance of this prey in the Crozet killer whales' diet is still unclear. Cephalopods are speciose and ecologically diverse and therefore cover a broad range of $\delta^{15}N$ and $\delta^{13}C$ values in the Southern Ocean (Rodhouse and White, 1995; Cherel *et al.*, 2004; Collins and Rodhouse, 2006; Guerreiro *et al.*, 2015). Paired with large ontogenetic diet shifts (Cherel and Hobson, 2005; Cherel *et al.*, 2009), including cephalopods can cause high uncertainty in studies of predator diets if the cephalopod species consumed and their size are not clearly identified. While it has been suggested that Marion killer whales and Kerguelen southern pilot whales both potentially feed on cephalopods in offshore waters (Fontaine *et al.*, 2015; Reisinger *et al.*, 2015, 2016), their $\delta^{15}N$ values were lower by > 1 ‰ than the mean $\delta^{15}N$ value of the Crozet killer whales in the present study. Values of $\delta^{15}N$ of the Crozet killer whales were closer to, but lower than, those of sperm whales in Crozet and Kerguelen and the isotopic niches of these two groups overlapped. In these regions, the high trophic position of sperm whales was attributed to individuals preying primarily upon large adult oceanic squids (Clarke, 1980, 1996). Sperm whales, southern sleeper sharks (*Somniosus antarcticus*) and wandering albatrosses (*Diomedea exulans*), which also feed on large oceanic squids, are considered the apex predators in Kerguelen waters (Cherel and Duhamel, 2004; Cherel *et al.*, 2004, 2017; Cherel and Hobson, 2005). In the Southern Ocean, cephalopods replace the role of fish as mesopredators in the epipelagic zone and are also abundant in the mesopelagic and bathypelagic zones (Rodhouse and White, 1995; Collins and Rodhouse, 2006). As such, this group is theoretically accessible to killer whales, but their importance as prey requires further research.

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