Supplementary material for

Seasonal productivity drives aggregations of killer whales and other cetaceans over submarine canyons of the Bremer Sub-Basin, south-western Australia

Chandra Salgado Kent[A,B,C,H]*, Phil Bouchet*[D,E]*, Rebecca Wellard*[A,F]*,*
Iain Parnum[A]*, Leila Fouda*[A,G] *and Christine Erbe*[A]

[A]Centre for Marine Science and Technology, Curtin University, Kent Street, Bentley, WA 6102, Australia.
[B]Oceans Blueprint, Coogee, WA 6166, Australia.
[C]Centre for Marine Ecosystems Research, Edith Cowan University, Joondalup Drive, Joondalup, WA 6027, Australia.
[D]School of Biological Sciences, University of Western Australia, Crawley, WA 6009, Australia.
[E]Centre for Research into Ecological & Environmental Modelling, The Observatory, Buchanan Gardens, University of St Andrews, Fife KY16 9LZ, Scotland, UK.
[F]Project ORCA, Perth, WA 6026, Australia.
[G]School of Biological and Chemical Sciences, Queen Mary University of London, Mile End Road, London E1 4NS, UK.
[H]Corresponding author. Email: c.salgado@oceansblueprint.com

Contents

Appendix S1. Additional relevant literature, listed by topic.

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Appendix S2. Summary of vessels and their specifications used as platforms of opportunity (PoPs) in the Bremer Sub-Basin between 2015 and 2017.

Year	Vessel Name	Vessel Type	Vessel Length (m)	Specifications
2015, 2016	*Cetacean Explorer*	Tourist Vessel	17	Catamaran with twin 500-hp diesel engines
2015, 2016	*Due Force*	Chartered fishing vessel (as a Research Vessel)	18	Monohull with single 840-hp diesel engine
2017	*Big Dreams*	Research Vessel	16.6	Monohull with single 1050-hp diesel engine

Appendix S3. Summary of cetacean sightings during ship-borne and aerial surveys conducted in the Bremer Sub-Basin between 2015 and 2017. *Number of individuals is considered a minimum estimate.

	Species	Number of Groups Sighted		Number of Individuals Sighted*	
		Ship-borne	Aerial	Ship-borne	Aerial
2015	Common dolphin (*Delphinus delphis*)	1	-	20	-
	Long-finned pilot whale (*Globicephala melas*)	7	-	193	-
	Killer whale (*Orcinus orca*)	71	-	439	-
	Sperm whale (*Physeter macrocephalus*)	1	-	20	-
	Indo-Pacific bottlenose dolphin (*Tursiops aduncus*)	2	-	11	-
2016	Common dolphin (*Delphinus delphis*)	4	-	33	-
	Long-finned pilot whale (*Globicephala melas*)	6	-	168	-
	Strap-toothed beaked whale (*Mesoplodon layardii*)	1	-	1	-
	Killer whale (*Orcinus orca*)	92	-	610	-
	Sperm whale (*Physeter macrocephalus*)	13	-	37	-
	False killer whale (*Pseudorca crassidens*)	2	-	40	-
	Indo-Pacific bottlenose dolphin (*Tursiops aduncus*)	4	-	42	-
	Bottlenose dolphin (*Tursiops sp.*)	1	-	1	-
	Common Bottlenose dolphin (*Tursiops truncatus*)	2	-	1	-
2017	Long-finned pilot whale (*Globicephala melas*)	8	8	240	306
	Killer whale (*Orcinus orca*)	7	7	50	57
	Sperm whale (*Physeter macrocephalus*)	23	32	24	34
	Bottlenose dolphin (*Tursiops sp.*)		3		61
	Unidentified large cetacean		6		6
	Unidentified small cetacean		4		76
Total		245	60	1930	540
Grand Total		305		2470	

Appendix S4. Spatial variation in survey effort aboard ship-borne platforms of opportunity in the Bremer Sub-Basin. The data shown represent both the 2015 and 2016 field seasons combined. Sightings of killer whale groups appear as red dots.
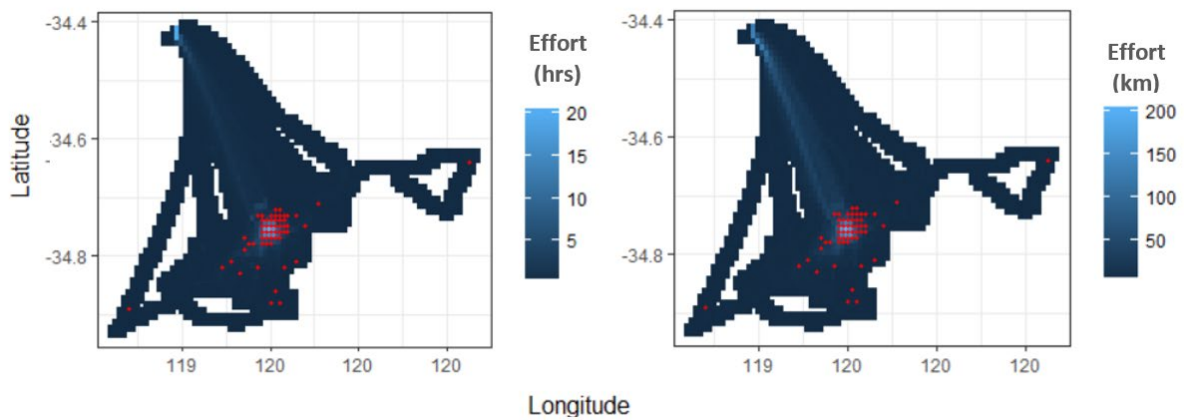
Appendix S5. Description of cetacean occurrence in the Bremer Sub-Basin based on published records.

Our study corroborates the possible occupancy of a number of cetacean species that past reported sightings, stranding records and habitat suitability modelling have alluded to, all of which depend upon opportunistic reports biased towards locations of prevalent human activity.

For example, along canyon systems eastward of the Bremer and adjacent submarine canyons, proximal to where the Albany Whaling Station was located, thousands of sperm whales were taken by the whaling industry in the 1970's. Recent modelling indicates that suitable conditions extend from submarine canyon systems off Albany to the Bremer sub-Basin (Johnson *et al.* 2016), however, published evidence of sperm whale occupancy in the Bremer region did not yet exist. Stranding records are also a good source of information for species that may range broadly, however, because strandings occur along the coast and are generally of individuals in poor health or deceased, they can only be indicative of animals having occupied or transited somewhere seaward prior to the stranding event. The stranding record off the southwest coast of Australia between 1981 and 2010 provided evidence of sperm whales in the general region, with 36 stranding events totalling 57 individuals (some that were calves) showing a peak in spring (Groom and Coughran 2012). Other species' confirmed occupancy in this study recorded in past stranding events in Australia's south-west included long-finned pilot whales (22 stranding events with a total of 446 animals, some that were calves) and killer whales (Groom and Coughran 2012). Killer whales are rare in the stranding records and mainly reported ~500 km west, however, a search on the Australian Antarctic Division's (AAD) National Marine Mammal Database (https://data.marinemammals.gov.au/nmmdb; 12 March 2020) resulted in at least 30 sightings of killer whales in the general region (reported in 1979). False killer whales have been recorded in 18 stranding events involving a total of 397 animals in the south-west region (Groom and Coughran 2012). In a study on beaked whale strandings in Western Australia between 1940's and 2010, 9 strapped-toothed beaked (*Mesoplodon layardii*) and 33 Gray's (*Mesoplodon grayi*) whale strandings were recorded in the region. In addition, Gray's beaked whale has been observed in the Bremer Sub-Basin during a killer whale predation event (Wellard *et al.* 2016). While stranding events of bottlenose and common dolphins have been recorded (Groom and Coughran 2012), the

core habitat of these species is known to include coastal waters (principle authors' observations), thus strandings could be of individuals from inshore communities. The AAD National Marine Mammal Database contained over 250 recorded sightings of common bottlenose dolphins in offshore waters westward off Albany (reported in 1979). Neither long-finned pilot whales nor common dolphins were reported in the AAD National Marine Mammal Database.

A range of species were not sighted in the Bremer and adjacent submarine canyons during this study but may occupy it based on their presence in the south-west Australian region stranding record. In a study on beaked whale strandings in Western Australia between 1940's and 2010, 8 Cuvier's (*Ziphius cavirostris*), 3 Shepherd's (*Tasmacetus shepherdi*), 1 Arnoux's (*Berardius arnuxii*), 7 True's (*Mesoplodon mirus*) and 5 Andrew's (*Mesoplodon bowdoini*) beaked whale were recorded from the southwest (Groom *et al.* 2014). Minke whales (*Balaenoptera acutorostrata)*, fin whales *(Balenoptera physalis),* pygmy right whales (*Caperea marginata*), pygmy sperm and dwarf sperm whales (*Physeter macrocephalus*, *Kogia breviceps*, *Kogia sima,* respectively*),* also have stranded in the region (Groom and Coughran 2012; Groom *et al.* 2014). In addition, striped dolphins and short-finned pilot whales (*Globicephala macrorhynchus*) have mass stranded (27 events with 97 individuals and 7 events with 52 individuals, respectively) (Groom and Coughran 2012). These species may transit through and/or have distributions overlapping the Bremer and adjacent submarine canyons. The Australian Antarctic Division's National Marine Mammal Database (https://data.marinemammals.gov.au/nmmdb; searched on 12 March 2020) returned a southern bottlenose whale (*Hyperoodon planifrons*) and two fin whale (*Balaenoptera physalus*) sightings in 1979 and 1990/1991, respectively.

Other species either recorded in the Western Australian stranding report with an unspecified location in WA or that have habitat and latitudinal distribution consistent with those of the Bremer and adjacent submarine canyons include Risso's dolphin (*Delphinus griseus*), pantropical spotted dolphin (*Stenella attenuata*), southern right whale dolphin (*Lissodelphis peronii*), Blainville's beaked whale (*Mesoplodon densirostris*) (Ross 2006). Some species records from the south-west corner of Western Australia, such as that of pantropical spotted dolphins which is generally considered to have a more sub-tropical/tropical distribution, may be from transport in the Leeuwin Current and not constitute the core home range (Bannister *et al.* 1996). In addition, humpback (*Megaptera* novaeangliae), southern right (*Eubalaena australis)*, Antarctic blue (*Balaenoptera musculus)*, and pygmy blue whales (*Balaenoptera musculus brevicauda*) may also transit through the area at different times (Jenner *et al.* 2001; Ward *et al.* 2017; McCauley *et al.* 2018).

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Appendix S6. Incidence of killer whale sightings relative to environmental conditions in the Bremer Sub-Basin. Counts of whale groups (red) were tallied for each 1 km^2 grid cells surveyed in the 2015 and 2016. Visual search effort (in km) is displayed in grey (in 10 km increments). For comparison, the range of conditions in which no killer whales were observed is shown in blue.