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**Scientific background document in support of the development of a  
CCAMLR MPA in the Weddell Sea (Antarctica) – Version 2016 – Part  
B: Description of available spatial data**

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K. Teschke, H. Pehlke and T. Brey on behalf of the German Weddell Sea MPA (WSMPA) project team, with contributions from the participants at the International Expert Workshop on the WSMPA project (7–9 April 2014, Bremerhaven)



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# **Scientific background document in support of the development of a CCAMLR MPA in the Weddell Sea (Antarctica) – Version 2016**

## **-Part B: Description of available spatial data-**

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On behalf of the German Weddell Sea MPA (WSMPA) project team, with contributions from the participants at the International Expert Workshop on the WSMPA project (7-9 April 2014, Bremerhaven)

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## **Introduction**

**Part B** of the scientific background document informs on the data retrieval process within the Weddell Sea MPA (WSMPA) project. Chapter 1 describes the environmental data sets that were acquired for the evaluation of a MPA in the Weddell Sea planning area (see Table 1-1). These are satellite data mainly with a high temporal resolution. For example, satellite observations on daily sea ice concentration, derive from the Advanced Microwave Scanning Radiometer – Earth Observing System (AMSR-EOS) instrument on board the Aqua satellite, are available by several Internet web sites. Further oceanographic data were obtained e.g. from the global Finite Element Sea Ice-Ocean Model (FESOM; Timmermann et al. 2009). Chapter 2 provides a systematic overview of the current data situation regarding ecological data sets. In total, more than 20 ecological data sets on zooplankton, zoobenthos, fish, birds and mammals were acquired (see Tab. 2-1). These data sets consist of point or areal data mainly, are snapshots in time and are stored in data portals, such as AntaBIF/biodiversity.aq (primarily contains presence/absence data) or PANGAEA.

Those data sets or parts of data sets that were acquired for our study, but were not incorporated into further analyses are marked grey in Table 1-1 and 2-1. Those data sets mostly (i) represent parameters that are already covered by other data sets, (ii) show an inappropriate spatial and/or temporal resolution or (iii) are not quantifiable. Most data sets are already presented in our background document SC-CAMLR-XXXIII/BG/02, which the Scientific Committee had welcomed and endorsed as a foundation reference document for the WSMPA planning (SC-CAMLR-XXXIII, § 5.21). The data retrieval process within the WSMPA project was pushed forward in the 2014/15 intersessional period, and a corresponding background document 'Part B: Description of available spatial data' was submitted to the CAMLR Scientific Committee in 2015 (see SC-CAMLR-XXXIV/BG/16). Final additions in the 2015/16 intersessional period include some newly acquired data sets on (i) sediment related environmental parameters (e.g. calcium carbonate, total organic carbon), (ii) observations on nesting sites of demersal fish, (iii) Adélie penguin movements in the border area between Planning Domain 1 and Planning Domain 3 and (iv) Antarctic Petrel distribution patterns.

Please note that this document constitutes the final version of Part B of the WSMPA background document.

### **1. Environmental parameters**

#### **1.1 Bathymetry & Geomorphology**

Bathymetric data are provided by the first regional digital bathymetric model established in the International Bathymetric Chart of the Southern Ocean (IBCSO) programme and published by Arndt et al. (2013). The bathymetric model Version 1.0 has a horizontal resolution of 500 m x 500 m and a vertical resolution of 1 m. This chart model is based on satellite data and in situ data (multi-beam and single beam data) from many hydrographic offices, scientific institutions and data centres. The derivatives of the bathymetry (e.g. slope, hillshade, geomorphology) are derived from the IBCSO data set.

## 1.2 Sedimentology

A substantial data set on grain size derives from the scientific data information system PANGAEA, an ICSU World Data Centre, hosted by the AWI and the Centre for Marine Environmental Science, University Bremen (doi:10.1594/PANGAEA.730459, doi:10.1594/PANGAEA.55955). These data are published by Petschick et al. (1996) and Diekmann & Kuhn (1999). The sediment samples were taken with large box corer, multi- or mini-corer during several *Polarstern* cruises (1983-1997). This data set was complemented by unpublished data that are merged by now in a new compilation (G. Kuhn & K. Jerosch, AWI).

## 1.3 Oceanography

Data on temperature, salinity and currents (speed and direction of water movement) are derived from the coupled Finite Element Sea Ice Ocean Model (FESOM; Timmermann et al. 2009). FESOM combines a hydrostatic, primitive-equation ocean model with a dynamic/thermodynamic ice model. For the simulations analysed here, FESOM was initialised on February 1, 1980 with hydrographic data from the Polar Science Center Hydrographic Climatology (Steele et al. 2001) and forced with atmospheric reanalysis data such as wind speed, temperature, humidity, and cloudiness.

## 1.4 Sea ice

Three large data sets on sea ice were acquired (see Tab. 1-1):

(1) Satellite observations of daily sea ice concentration derive from the Advanced Microwave Scanning Radiometer - Earth Observing System (AMSR-EOS) instrument on board the Aqua satellite. High resolution AMSR-E 89 GHz sea ice concentration maps (Jun 2002 – Oct 2011) were downloaded from the Institute of Environmental Physics, University of Bremen (<http://www.iup.uni-bremen.de/>). The ARTIST Sea Ice (ASI) concentration algorithm was used with a spatial resolution of 6.25 km x 6.25 km (Kaleschke et al. 2001, Spreen et al. 2008). We refrained from using AMSR2 data (available since Aug 2012) on board the new `Shizuku` satellite as a thorough calibration of the AMSR2/ASI data has not been accomplished yet.

(2) Data on daily polynya distribution derive from the Special Sensor Microwave / Imager (SSM/I). The data were downloaded from the Integrated Climate Data Center (ICDC) of the University of Hamburg ([http://icdc.zmaw.de/polynya\\_ant.html](http://icdc.zmaw.de/polynya_ant.html); Kern et al. 2007, Kern 2012). Here, polynyas are defined as areas of open water and/or thin (< 20 cm) sea ice in regions of typically thick sea ice (> 20 cm). A basic algorithm, described by Markus & Burns (1995) and Hunewinkel et al. (1998), was used with a spatial resolution of 5 km x 5 km. Data on daily polynya distribution focus on coastal polynyas and temporally cover the austral winter (May - Sept) for a period from 1992 to 2008.

(3) Data on monthly sea ice thickness derive from the coupled Finite Element Sea Ice Ocean Model (FESOM; Timmermann et al. 2009). For analysis, we only used data on ice thickness from the 20 year time period (1990-2009) with a spatial resolution of 6.90 km x 8.65 km.

## **2. Ecological parameters**

### **2.1 Chl-a concentration**

Chlorophyll-a (chl-a) concentration values derive from the Sea-Viewing Wide Field-of-View Sensor (SeaWiFS) measurements. The data were downloaded via the NASA's OceanColor website (<http://oceancolor.gsfc.nasa.gov/>) as monthly level 3 standard mapped images with a spatial resolution of 9 km x 9 km.

### **2.2 Pelagic ecosystem**

Many data sets on zooplankton, mainly data on krill, were acquired (see Tab. 2-1). Studies focusing on zooplankton communities, including meso-, macro-zooplankton and micro-nekton, were identified as relevant data sources (e.g. Boysen-Ennen & Piatkowski 1988, Flores et al. 2014). These data sets are quite diverse taxonomically, and principal groups include salps, juvenile cephalopods or paralarvae, crustaceans (e.g. euphausiids, copepods) and fish (mainly mesopelagic species). Data on adult squid are extremely scarce particularly catch data refer to very few records (e.g. Nesis et al. 1998). Most data on the occurrence of squid are obtained from stomach analysis of birds and marine mammals (Piatkowski & Pütz 1994, Plötz et al. 1991).

#### ***Krill***

The largest data set on adult Antarctic krill, *Euphausia superba*, consists of more than 700 stations sampled between 1928 and 2013 (see Tab. 2-1). Next to some snapshot studies from research operations in the 1970s and 1980s (Fevolden 1979; Makarov & Sysoeva 1985; Siegel 1982), most historical abundance data on krill (until 2004) are available in the data base krillbase (<http://www.iced.ac.uk/science/krillbase.htm>) and are published in e.g. Atkinson et al. (2004, 2008 and 2009) and Siegel (1982). More recent data on krill (2004 to 2008) are published in Siegel (2012) and are complemented by unpublished data from B. Krafft (Institute of Marine Research; Bergen, Norway). Moreover, we acquired data on adult ice krill, *Euphausia crystallorophias* (Siegel 1982 and 2012; Siegel et al. 2013). Abundance data on Antarctic krill larvae and ice krill larvae derive from studies between 1977 and 1989 and are published in e.g. Fevolden (1979 and 1980), Hempel and Hempel (1982) and Menshenina (1992). These data are complemented by more recent data from 2004 and 2006 (Siegel 2012). Haul-by-haul krill catch data from commercial operations are stored as a summary data base by CCAMLR.

#### ***Pelagic fish***

Unpublished data are available on the distribution of oceanic pelagic fish (held by R. Knust, AWD). Moreover, we acquired data on mesopelagic fish, such as Antarctic silverfish (*Pleuragramma antarctica*), from the LAzarev Sea KRill Study (LAKRIS) project (e.g. Flores et al. 2014), and older studies e.g. from Boysen-Ennen & Piatkowski (1988) and Hubold et al. (1988) (see Tab. 2-1).

## 2.3 Benthic ecosystem

### *Zoobenthos – Shelf and slope*

Three substantial zoobenthic data sets are listed in Table 2-1. Gutt et al. (2013) provide a comprehensive data set on the geographical distribution of Antarctic macrobenthic communities. This descriptive data set, consisting of approx. 90 individual data sets, has a temporal coverage from 1956 to 2010 and covers almost the entire Southern Ocean (Gutt et al. 2013). Although the data show a considerable patchiness at regional scale, the south-eastern Weddell Sea is covered well, and thus the data set provides unique geo-referenced biological basic information. Furthermore, an unpublished quantitative macrobenthos data set (abundance, biomass) is held by D. Gerdes (AWI). Macrobenthic samples were taken during 10 *Polarstern* cruises in the south-eastern and eastern Weddell Sea shelf area from 1984 to 2011 (e.g. Gerdes et al. 1992). A third zoobenthic data set (semi-quantitative data) was digitised for the WSMMPA project based on *Polarstern* cruise reports and on unpublished data held by W. Arntz (AWI, retired). Additional data sources on macrofaunal communities are available e.g. from Galéron et al. (1992) and Voß (1988). Moreover, there is a considerable number of data sets referring to specific taxonomic groups - particularly polychaetes (e.g. Stiller 1995), molluscs (e.g. Hain 1990), and echinoderms (e.g. Gutt 1988, Piepenburg et al. 1997) - sampled along the Weddell Sea shelf and slope. So far more than 10 such smaller data sets, partly stored in the ANTABIF data portal (primarily as presence data) have been made available for the WSMMPA project.

### *Zoobenthos – Deep Sea*

There is a considerable number of data sets on abyssal benthic deep-sea fauna in the Weddell Sea. Most of these data sets are based on ANDEEP I-III (ANtartic benthic DEEP-sea biodiversity: colonization history and recent community patterns) expeditions in 2002 and 2005 (Brandt & Hilbig 2004, Brandt & Ebbe 2007), and referring to specific taxonomic groups - particularly sponges (e.g. Janussen & Tendal 2007), polychaetes (e.g. Hilbig 2001, Schüller & Ebbe 2007, Schüller et al. 2009), molluscs (e.g. Linse et al. 2006, Schwabe et al. 2007), crustaceans (e.g. Brandt et al. 2007, De Broyer et al. 2006) and echinoderms (e.g. Bohn 2006).

### *Demersal fish*

During *Polarstern* cruises between 1983 and 2011 the demersal fish fauna was sampled particularly along the Weddell Sea shelf, but also in deeper waters (see Drescher et al. 2012, Ekau et al. 2012 a, b, Hureau et al. 2012, Kock et al. 2012, Wöhrmann et al. 2012 and unpublished data held by R. Knust, AWI; Tab. 2-1).

Observations on nest-guarding behaviour of demersal fish, such as *Chaenodraco wilsoni* and *Neopagetopsis ionah*, derive from unpublished data held by Dieter Gerdes (AWI), Tomas Lundälv (Swedish Institute for the Marine Environment) and Emilio Riginella (University of Padova). Furthermore, those observations are complemented by published data from La Mesa et al. (2009) for the north of the tip of the Antarctic Peninsula.

*Dissostichus* spp. catch data from long line surveys are stored as a summary data base by CCAMLR. Data on *Dissostichus mawsoni* conducted by the Russian Federation in Subarea

48.5 in 2012/13 and 2013/14 have been submitted to the CCAMLR secretariat. They are still awaiting a thorough analysis by CCAMLR's Working Group on Fish Stock Assessment.

## **2.4 Birds**

### ***Seabirds***

There are few data sets on flying seabirds (i.e. petrels or Procellariiformes), their distribution and abundance patterns in the Weddell Sea. Two substantial seabird data sources provide relevant information about Antarctic Petrel (van Franeker et al. 1999) and Snow Petrel breeding colonies (Croxall et al. 1995; see Tab. 2-1) from Coats Land, Dronning Maud Land and the Antarctic Peninsula between 1905 and the early 90s. Those data were complemented by transect data on flying seabirds from the Ross Sea (see Ainley & Jacobs 1981).

### ***Penguins***

Data on emperor penguin population estimates are available from Fretwell et al. (2012, 2014). This data set was complemented by data on Adélie penguin population estimates (Lynch & LaRue 2014), and by six data sets - stored in the seabird tracking database and based on BAS Inventory and US AMLR Program - on movements of breeding and non-breeding Adélie penguins in the border area between Planning Domain 1 and Planning Domain 3.

## **2.5 Marine Mammals**

### ***Pinnipeds***

A pinniped survey within the Antarctic Pack Ice Seals (APIS) programme, which was developed and executed by members of the Scientific Committee on Antarctic Research (SCAR) Group of Specialists on Seals and their national programmes, was carried out along the eastern coast of the Weddell Sea from 1996 to 2001 (Ackley et al. 2006; Plötz et al. 2011a-e; Southwell et al. 2012). During five fixed-wing aircraft flight campaigns, which covered an area of more than 80,000 km of aerial transects, approx. 2,300 seals were counted in total. An additional APIS survey, based on helicopter flights from aboard RV *Polarstern* in 1998 - a year with unusually low sea ice coverage - covered the area from 7°W to 45°W with 15 transects (Bester & Odendaal 2000). Moreover, pack-ice seal line-transect data were collected during an aerial survey, conducted as the UK contribution to the APIS programme, in the western part of the Weddell Sea (Forcada & Trathan 2009; Forcada et al. 2012). A methodologically congruent "pre-APIS"-helicopter survey was carried out more easterly in the Weddell Sea (0° - 5° W) by Bester et al. (1995). Post-APIS-helicopter surveys from aboard RV *Polarstern* were flown in 2004 / 2005 (ANT-XXII/2; *Polarstern* cruise reports are available on <http://expedition.awi.de/expeditions>), and were concentrated north of 69°S (Flores et al. 2008). Most recent photographic and video footage were taken during the research survey of the AWI aircraft *Polar 6* in November 2013, and additional species specific helicopter based counts were carried during RV *Polarstern*'s ANT-XXIX/9 2013/2014 research mission, both in the southern Weddell Sea. The most recent data are currently in analyses. Acoustic data, i.e. year-round records of the presence of pinnipeds since 2005, derive from the coastal Perennial Acoustic Observatory in the Antarctic Ocean (PALAOA) near Neumayer Station, and additionally from several oceanographic moorings distributed along the Greenwich meridian and throughout the Weddell Sea (Van Opzeeland



2010). However, the International Expert Workshop noted that there is limited information available particularly on elephant seal abundance and migration patterns (more details see Teschke et al. 2014, supplement). Few tracking data sets are available on southern elephant seals (Tosh et al. 2009; James et al. 2012), Ross seals (Blix & Nordøy 2007), leopard seals (Nordøy & Blix 2009), and Weddell seals (McIntyre et al. 2013).

### ***Whales***

The presence of cetaceans is also recorded year-round since 2005 by PALAOA, and additionally by several oceanographic moorings distributed along the Greenwich meridian and throughout the Weddell Sea (Van Opzeeland 2010). Regarding cetacean sightings, two data sets were evaluated. Since 2005, the AWI systematically and continuously logs all sightings of cetaceans near RV *Polarstern* in the Southern Ocean (Marine Mammal Perimeter Surveillance, MAPS). By means of the MAPS project more than 1300 individuals from nine cetacean taxa were identified in the Weddell Sea from 2005 to date (Burkhardt 2009a-i, 2011, 2012, 2013a-b, 2014). Those data were used to build a habitat suitability model of humpback and Antarctic minke whales in the Southern Ocean (see Bombosch et al. 2014). Furthermore, quantitative cetacean sightings, surveyed during five *Polarstern* cruises from 2006 to 2013, could serve as a basis for estimating local cetacean densities in the Weddell Sea (Herr et al. 2014 and unpublished data).

**Table 1-1:** List of environmental data sets for marine protected area evaluation in the Weddell Sea. Data sets or parts of data sets that were sighted, but were not incorporated into further analyses are grey-shaded.

Parameter	Spatial and temporal resolution			Source (contact person, publication, web site)
	Spatial resolution	Period	Temporal resolution	
<b>Bathymetry</b>				
Bathymetry (m)	500 x 500 m	not applicable	not applicable	Arndt et al. (2013); <a href="http://www.ibcso.org">www.ibcso.org</a>
<b>Sediment characteristics</b>				
Grain size, i.e. gravel, sand, silt, clay (%)	> 400 samples were taken with large box corer, multi- or mini-corer	1983 - 1997	depending on local sedimentation rates: 1-1000 years	Petschick et al. (1996) <a href="http://doi.pangaea.de/10.1594/PANGAEA.55955">http://doi.pangaea.de/10.1594/PANGAEA.55955</a> Diekmann & Kuhn (1999) <a href="http://doi.pangaea.de/10.1594/PANGAEA.730459">http://doi.pangaea.de/10.1594/PANGAEA.730459</a> G. Kuhn & K. Jerosch, AWI (compiled data set)
Biogenic silica	> 100 samples from the sediment surface of the Eastern and Western Weddell Gyre	1987 - 2003	Different time intervals	Geibert et al. (2005) <a href="http://doi.pangaea.de/10.1594/PANGAEA.230042">http://doi.pangaea.de/10.1594/PANGAEA.230042</a>
Calcium carbonate and silica		1983 - 1992	Different time intervals	Seiter et al. (2004a) <a href="http://doi.pangaea.de/10.1594/PANGAEA.733692">http://doi.pangaea.de/10.1594/PANGAEA.733692</a>
Total organic carbon (TOC) content in surface sediments	242.39 km x 242.39 km	1983 - 1992	Different time intervals	Seiter et al. (2004b) <a href="http://doi.pangaea.de/10.1594/PANGAEA.199835">http://doi.pangaea.de/10.1594/PANGAEA.199835</a>
<b>Water column properties</b>				
Sea temperature (°C), salinity (PSU), currents, i.e. speed (m) and direction of water movement (°) - Model data (FESOM)	1.5° x 1.5° (horizontal) Surface & bottom value (vert.) Coastal polynia model 3 km – 50 km (horizontal)	1990 - 2009	Monthly	Timmermann et al. (2009)  Haid and Timmermann (2013)
Sea surface temperature (°C)	1/8° x 1/8° (MODAS) 1/12° x 1/12° (HYCOM)	1993 - ongoing	daily	Barron & Kara (2006) MODAS: <a href="http://www7320.nrlssc.navy.mil/modas/">http://www7320.nrlssc.navy.mil/modas/</a> HYCOM: <a href="http://www7320.nrlssc.navy.mil/GLBhycom1-12/skill.html">http://www7320.nrlssc.navy.mil/GLBhycom1-12/skill.html</a>
Sea temperature (°C), Salinity (PSS), Dissolved oxygen (ml l-1), dissolved inorganic nutrients (phosphate, nitrate, silicate)	1° x 1°	1955 - 2006	Monthly, seasonal, annual	Garcia et al. (2014a, b), Locarnini et al. (2013), Zweng et al. (2013) <a href="http://www.nodc.noaa.gov/OC5/woa13/woa13data.html">http://www.nodc.noaa.gov/OC5/woa13/woa13data.html</a>

**Table 1-1 (contd.)**

Parameter	Spatial and temporal resolution			Source (contact person, publication, web site)
	Spatial resolution	Period	Temporal resolution	
<b>Sea ice dynamic</b>				
Sea ice concentration (%)	6.25 km x 6.25 km	Jun 2002 - Oct 2011; Aug 2012 - ongoing	daily	Kaleschke et al. (2001), Spreen et al. (2008) Institute of Environmental Physics, University of Bremen: <a href="http://www.iup.uni-bremen.de/seaice/amsr/">http://www.iup.uni-bremen.de/seaice/amsr/</a>  Integrated Climate Data Center (ICDC), University of Hamburg: <a href="http://www.icdc.zmaw.de/seaiceconcentration_as1_amsre.html">http://www.icdc.zmaw.de/seaiceconcentration_as1_amsre.html</a>
Sea ice thickness (cm) - Polynya distribution	5 km x 5 km	1992 - 2008	Daily (May-Sept)	Markus & Burns (1995), Hunewinkel et al. (1998), Kern et al. (2007), Kern (2012) Integrated Climate Data Center (ICDC), University of Hamburg: <a href="http://icdc.zmaw.de/polynya_ant.html">http://icdc.zmaw.de/polynya_ant.html</a>
Sea ice thickness (cm) - Model data (FESOM)	1.5° x 1.5° (horizontal)  Coastal polynya model 3 km – 50 km (horizontal)	1990 - 2009	Monthly	Timmermann et al. (2009)  Haid and Timmermann (2013)
<b>Frontal areas</b>				
Weddell system	8 repeat hydrographic sections, moored instruments and profiling floats on 0°	1984 - 2008	Different time intervals	Fahrbach et al. (1995, 2004, 2007, 2011)  Data are available at e.g. <a href="http://www.pangaea.de/">http://www.pangaea.de/</a>
Weddell Gyre	206 ice-compatible vertically profiling floats	1999 - 2010	Snapshot in time	Klatt et al. (2007)

**Table 2-1:** List of ecological data sets for marine protected area evaluation in the Weddell Sea. Data sets or parts of data sets that were sighted, but were not incorporated into further analyses are grey-shaded.

Parameter	Sampling design and temporal resolution			Source (contact person, publication, web site)
	Sampling design	Period	Temporal resolution	
<b>Chlorophyll-a</b>				
Chlorophyll-a concentration (mg/m <sup>3</sup> )	0.83 km x 0.83 km	1997 - 2010	daily	National Aeronautics and Space Administration (NASA) Goddard Space Flight Center's Ocean Data Processing System (ODPS) <a href="http://oceandata.sci.gsfc.nasa.gov/SeaWiFS/L3SMI/">http://oceandata.sci.gsfc.nasa.gov/SeaWiFS/L3SMI/</a>
<b>Zooplankton</b>				
Abundance data on adult Antarctic krill, <i>Euphausia superba</i> (N/m <sup>2</sup> ; N/1000 m <sup>3</sup> )	> 700 stations; e.g. IKMT, RMT nets	1928 - 1997  1977 - 1983  2001 - 2013	Different time intervals	Krillbase: <a href="http://www.iced.ac.uk/science/krillbase.htm">http://www.iced.ac.uk/science/krillbase.htm</a> Atkinson et al. (2004, 2008, 2009); Siegel (1982)  Fevolden (1979), Makarov & Sysoeva (1985); Siegel (1982, unpublished data)  Siegel (2012, unpublished data), Siegel et al. (2013), B. Krafft (Institute of Marine Research, Bergen; unpubl. data)
Abundance data on adult ice krill, <i>Euphausia crystallophias</i> (N/1000 m <sup>3</sup> )	> 400 stations; RMT nets	1976 - 1989  2004 - 2013	Different time intervals	Siegel (1982, unpublished data)  Siegel (2012), Siegel et al. (2013)
Abundance data on Antarctic krill larvae and ice krill larvae (N/m <sup>2</sup> )	> 300 stations; e.g. Juday, RMT1, Bongo nets	1977 - 1989  2004, 2006	Different time intervals	Fevolden (1979, 1980), Hempel & Hempel (1982), Menshenina (1992), Siegel (2005, unpublished data)  Siegel (2012)
Krill data from commercial operations (catch in kg)	Bottom and midwater trawls	1974 - 2009	Different time intervals	David Ramm, CCAMLR data manager; <a href="http://www.ccamlr.org">www.ccamlr.org</a>
Abundance data on meso- and macrozooplankton (N/1000m <sup>3</sup> )	39 stations; RMT1, RMT8	1983	Snapshot in time	Boysen-Ennen & Piatkowski (1988)
Abundance data on macrozooplankton and micro-nekton (N/1000m <sup>3</sup> )	RMT, SUIT nets along 3-4 transects; station spacing 20-30 nm, approx. 50-80 stations per expedition	2004 - 2008	Different time intervals	Hunt et al. (2011), Flores et al. (2014)

**Table 2-1** (contd.)

Parameter	Sampling design and temporal resolution			Source (contact person, publication, web site)
	Sampling design	Period	Temporal resolution	
<b>Zoobenthos</b>				
Macrobenthic communities (descriptive)	± 90 data sets, Weddell Sea shelf	1956 - 2010	Summary data set, Snapshots in time	Gutt et al. (2013) and references therein in regards to results and data <a href="http://ipt.biodiversity.aq/resource.do?r=macrobenthos">http://ipt.biodiversity.aq/resource.do?r=macrobenthos</a>
Macrozoobenthos (N/m <sup>2</sup> , g C/m <sup>2</sup> )	Various German Antarctic expeditions; almost 300 samples	1984 - 2011	Different time intervals	Data originators: Dieter Gerdes (AWI); Ute Mühlenhardt-Siegel (DZMB); e.g. Gerdes et al. (1992)
Macrozoobenthos (semi-quantitative data)	Various German Antarctic expeditions (ANT VII/4, ANT VII/5, ANT IX/1-4, ANT XIII/3, ANT XV/3, ANT XVII/3, ANT XXI/2)	1989 - 2004	Different time intervals	<i>Polarstern</i> cruise reports (see <a href="http://expedition.awi.de/expeditions">http://expedition.awi.de/expeditions</a> ) and data originator W. Arntz (AWI, retired)
Considerable number on specific higher taxonomic groups (primarily abundance data)	Several <i>Polarstern</i> cruises; mainly sampled along the Weddell Sea shelf, but also in deeper waters	1983 - 2005	Snapshots in time	Polychaetes (e.g. Montiel et al. 2005, Schüller & Ebbe 2007, Stiller 1995), molluscs (e.g. Hain 1990, Linse et al. 2006), crustaceans (e.g. Brandt et al. 2007), echinoderms (e.g. Dahm 1996, Gutt 1988, Brey & Gutt 1991, Gutt 1991, Piepenburg et al. 1997)
<b>Fish</b>				
Mostly abundance and biomass data on demersal fish, but also pelagic fish	> 10 <i>Polarstern</i> cruises, > 300 hauls, mostly Weddell Sea shelf, but also deeper waters	1983 - 2011	Different time intervals	Contact: Julian Gutt (AWI), Rainer Knust (AWI), Karl-Hermann Kock (TI) Drescher et al. (2012), Ekau et al. (2012 a, b), Hubold et al. (1988), Hureau et al. (2012), Kock et al. (2012), Wöhrmann et al. (2012) – Data sets published in PANGAEA ( <a href="http://www.pangaea.de">www.pangaea.de</a> ): doi:10.1594/PANGAEA.786877, doi:10.1594/PANGAEA.786883, doi:10.1594/PANGAEA.786884, doi:10.1594/PANGAEA.786886, doi:10.1594/PANGAEA.786888, doi:10.1594/PANGAEA.786887  Moreover, unpublished data are held by R. Knust, AWI (see <i>Polarstern</i> cruise reports for following cruises: ANT XIII/3, ANT XV/3, ANT XVII/3, ANT XIX/5, ANT XXI/2, ANT XXIII/8, ANT XXVII/3 and ANT XXIX/9)
Observations on nesting sites of demersal fish species (e.g. <i>Chaenodraco wilsoni</i> , <i>Neopagetopsis ionah</i> )	German Antarctic expeditions ANT XXVII/3, ANT XXIX/9 and ANT XXXI/2	2006/2007, 2011, 2014, 2015	Snapshots in time	Published data (La Mesa et al. 2009) and unpublished data held by D. Gerdes (AWI), T. Lundälv (Swedish Institute for the Marine Environment) and E. Riginella (University of Padova)
Fishery operations (catch in kg); mainly <i>Dissostichus</i> spp. catches	Longline surveys	2005 - 2013	Summary data base (annual and bi-annual)	David Ramm, CCAMLR data manager; <a href="http://www.ccamlr.org">www.ccamlr.org</a>

**Table 2-1** (contd.)

Parameter	Sampling design and temporal resolution			Source (contact person, publication, web site)
	Sampling design	Period	Temporal resolution	
<b>Birds</b>				
Antarctic Petrel breeding localities	± 20 breeding localities, Coats Land and Dronning Maud Land	1971-1994	Summary data set, Snapshots in time	Van Franeker et al. (1999)
Antarctic Petrel transect data (birds/km <sup>2</sup> )	Ship surveys, transects, Ross Sea	1976-1980	Different time intervals	Ainley & Jacobs (1981)
Snow Petrel breeding localities	± 60 breeding localities, Coats Land, Dronning Maud Land, Antarctic Peninsula	1905-1992	Summary data set, Snapshots in time	Croxall et al. (1995)
Adélie penguin breeding colonies	high resolution (0.6 m) satellite imagery with spectral analysis, Antarctic Peninsula	2000s	Snapshot in time	Lynch & LaRue (2014)
Adélie penguin breeding and non-breeding distribution	Platform terminal transmitters	1999-2014	Snapshots in time	BAS Inventory (partly unpublished data; contact person: P. Trathan, BAS) US AMLR Program, NOAA (data provider: J. Hinke, W. Trivelpiece) BirdLife International; seabird tracking database, <a href="http://www.seabirdtracking.org">www.seabirdtracking.org</a>
Emperor penguin breeding colonies	High resolution satellite imagery	2009 (Sept-Dec); 2012	Snapshot in time	Fretwell et al. (2012, 2014)
<b>Mammals</b>				
Pinniped line-transect data (N/km <sup>2</sup> )	Flight campaigns	1992 - 2014	Different time intervals	Ackley et al. (2006), Bester et al. (1995, 2002), Bester & Odendaal (2000), Flores et al. (2008), Plötz et al. (2011 a-e; <a href="http://www.pangaea.de">http://www.pangaea.de</a> ), Forcada et al. (2012), Southwell et al. (2012), and unpublished data held by H. Bornemann, AWI
Tracking data on pinnipeds	Tagging of up to 15 individuals of southern elephant seals, Ross seals, leopard seals and Weddell seals, respectively	1999-2008	Snapshots in time, different tracking times	Blix & Nordøy (2007); Nordøy & Blix (2009); Tosh et al. (2009), <a href="https://doi.org/10.1594/PANGAEA.692856">doi:10.1594/PANGAEA.692856</a> ; James et al. (2012), <a href="https://doi.org/10.1594/PANGAEA.785852">doi:10.1594/PANGAEA.785852</a> ; McIntyre et al. (2013)
Acoustic data on pinniped and cetacean presence	Oceanographic moorings	2006-2012	Daily, different starting times for single recorders	Kindermann (2013), <a href="https://doi.org/10.1594/PANGAEA.773610">doi:10.1594/PANGAEA.773610</a> Van Opzeeland (2010)
Opportunistic cetacean sightings	14 <i>Polarstern</i> cruises	2005 - 2013	Snapshot in time	Burkhardt (2009 a-i, 2011, 2012, 2013 a-b, 2014); Bombosch et al. (2014); <a href="http://www.pangaea.de/search?count=10&amp;minlat=&amp;minlon=&amp;maxlat=&amp;maxlon=&amp;mindate=&amp;maxdate=&amp;env=All&amp;q=elke+burkhardt+">http://www.pangaea.de/search?count=10&amp;minlat=&amp;minlon=&amp;maxlat=&amp;maxlon=&amp;mindate=&amp;maxdate=&amp;env=All&amp;q=elke+burkhardt+</a>
Quantitative cetacean sightings (N/km <sup>2</sup> )	5 helicopter surveys from RV <i>Polarstern</i>	2006 - 2013	Time interval: 1-2 years	Herr et al. (2014 and unpublished data)

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