Bundesanstalt für Geowissenschaften und Rohstoffe

SENCKENBERG research

Macrofauna in the German Mn-nodule license area of the CCZ

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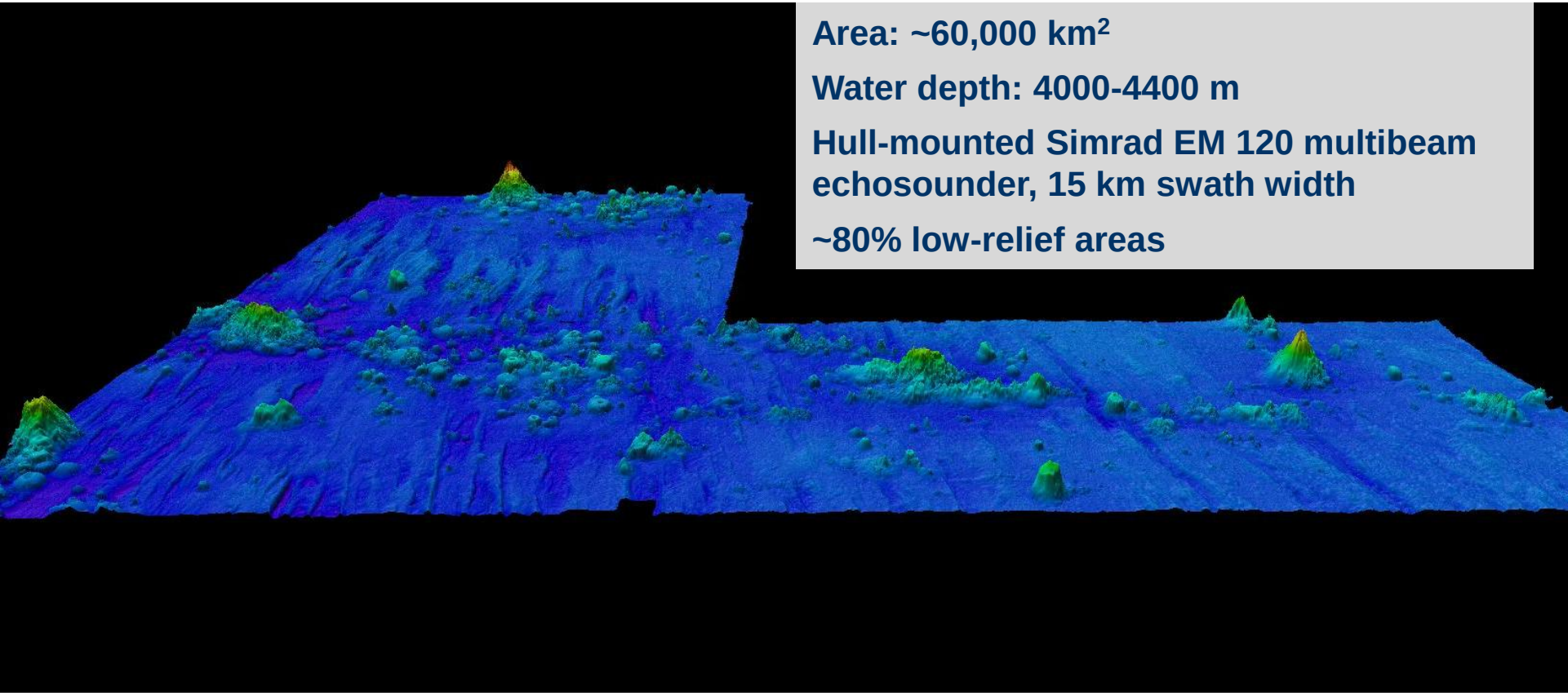
Leibniz Gemeinschaft

Bathymetry eastern German license area



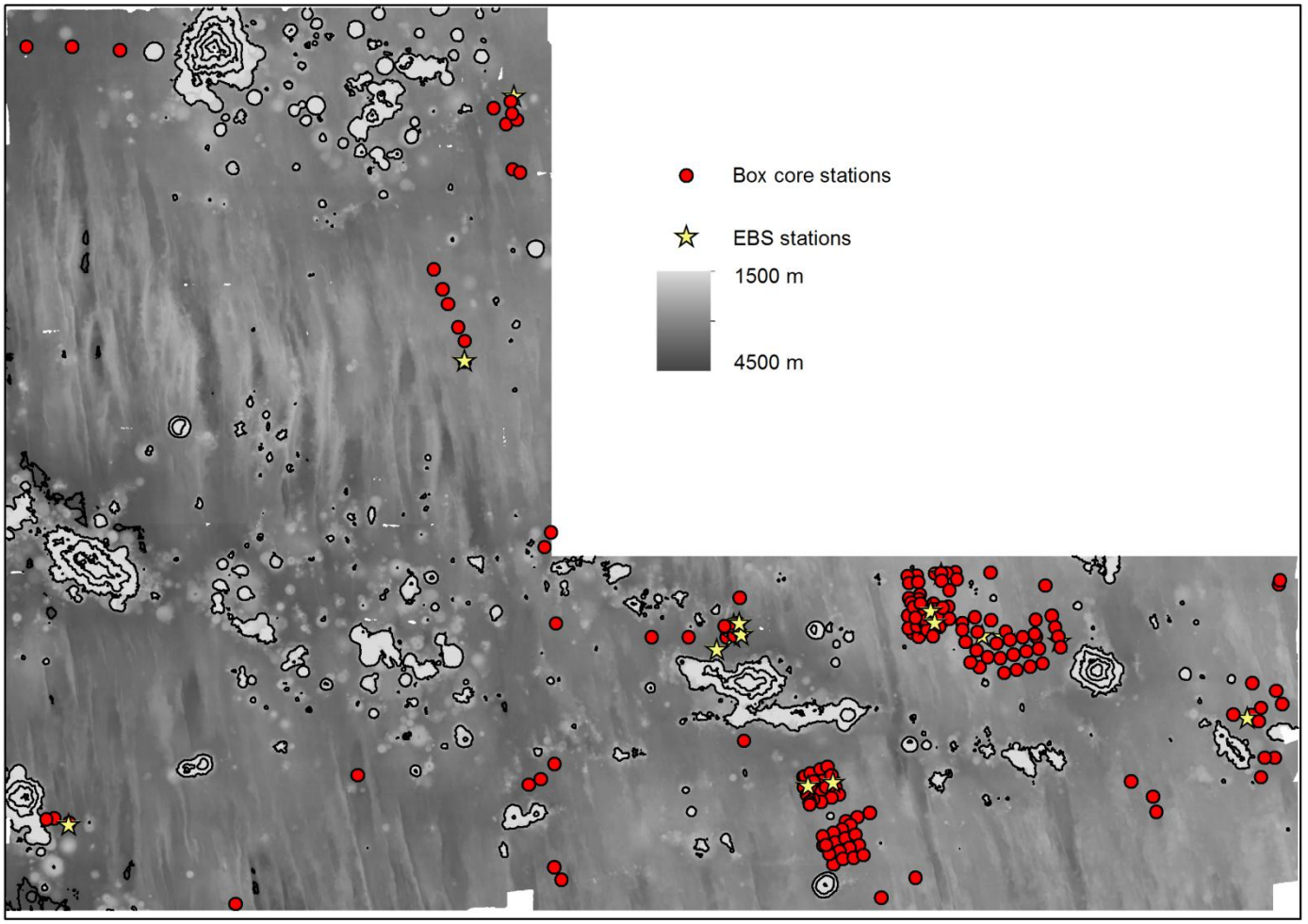
Area: ~60,000 km^2

Water depth: 4000-4400 m

Hull-mounted Simrad EM 120 multibeam echosounder, 15 km swath width

~80% low-relief areas

Sampling positions in eastern German license area

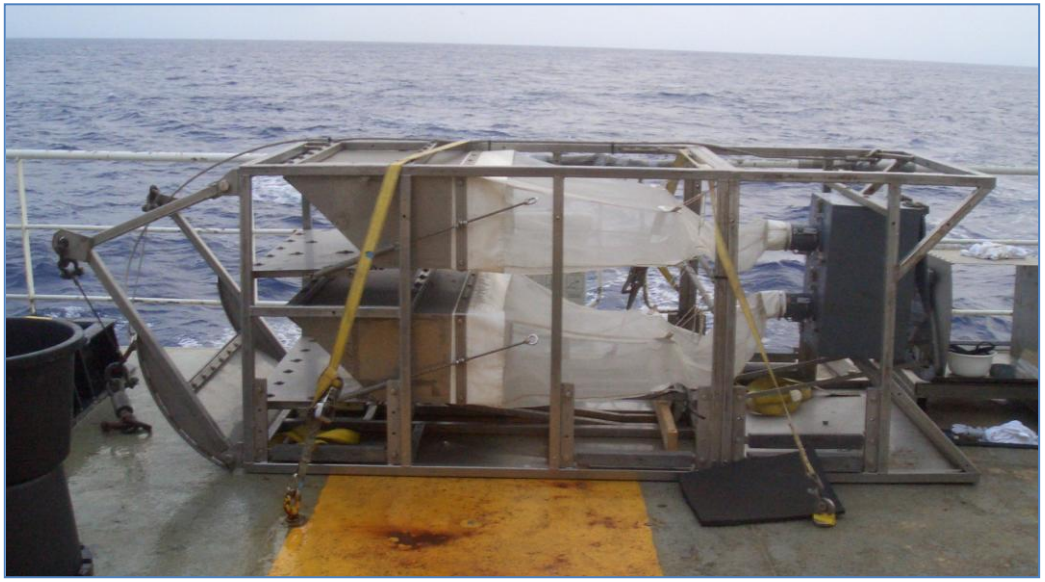


Cruises for sample collection

- sampling started in 2010 on RV SONNE (SO-205)
- continued in 2012 on RV L'ATALANTE (BIONOD 2012)
- 2013 on RV KILO MOANA (MANGAN 2013)
- 2014 on RV KILO MOANA (MANGAN 2014)

Sampling unit: **Epibenthic sledge**

- trawling distance approx. 2000 m



Sampling unit: **Box Core**

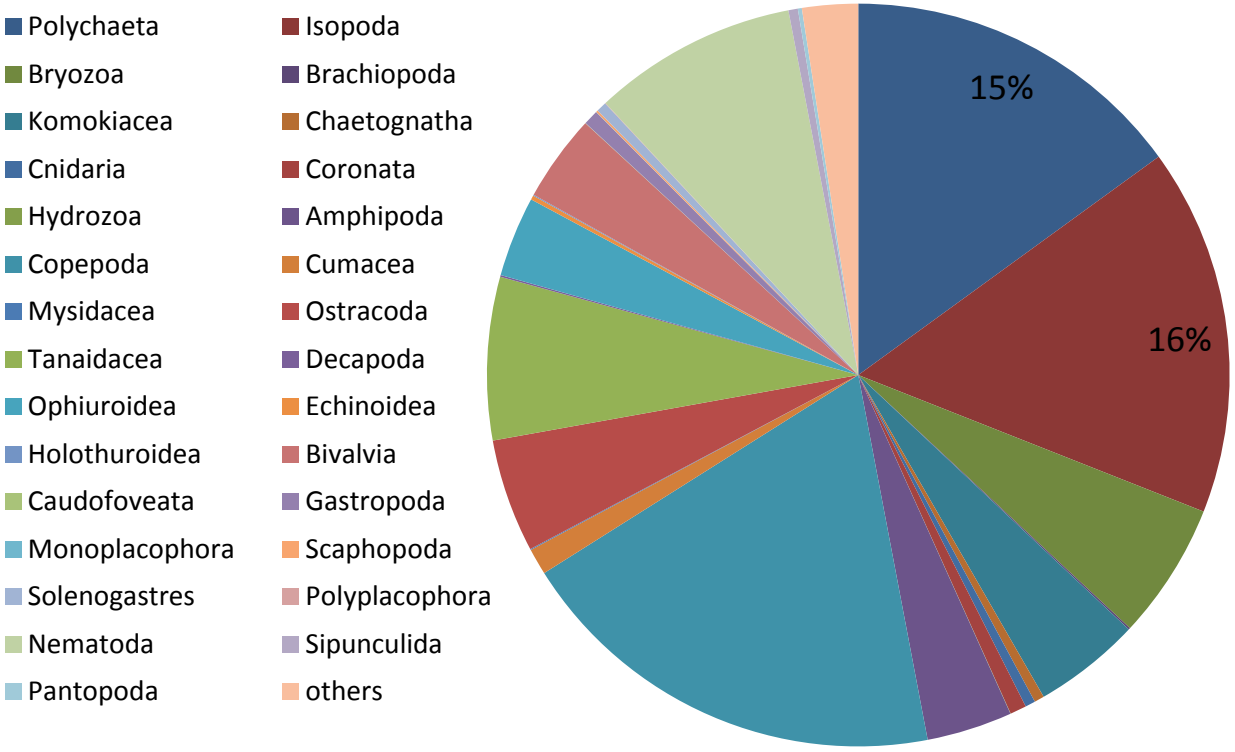
- 50x50x48 cm
- used for determining nodule coverage and obtaining macrofauna samples
- most important gear for the BGR in the CCZ

Number of samples

SO-205:	5 EBS ~ 9.200 specimens
	21 BC ~ 5.600 specimens
BIONOD 2012:	5 EBS in German; 5 in French area
	~ 12.800 specimens
MANGAN 2013:	4 EBS ~ 4.000 specimens
	51 BC ~ 4.000 specimens
MANGAN 2014:	6 EBS ~ 4.800 specimens
	49 BC (7 in western area) ~ work in process

Results SO-205

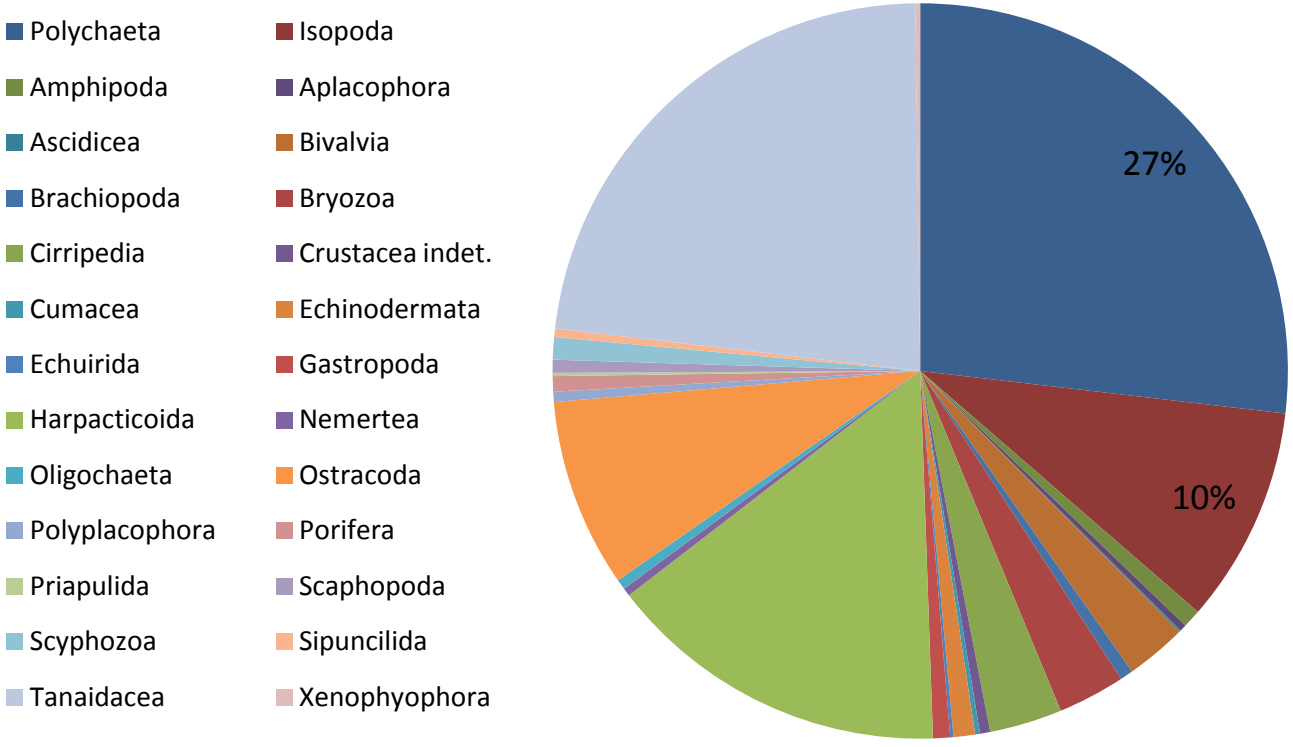
Taxa in EBS



Taxa	number of specimens
Polychaeta	1388
Bryozoa	550
Brachiopoda	7
Komokiacea	432
Chaetognatha	40
Cnidaria	41
Coronata	66
Hydrozoa	1
Amphipoda	345
Copepoda	1762
Cumacea	106
Isopoda	1480
Mysidacea	4
Ostracoda	457
Tanaidacea	656
Decapoda	7
Ophiuroidea	324
Echinoidea	17
Holothuroidea	4
Bivalvia	351
Caudofoveata	1
Gastropoda	60
Monoplacophora	1
Scaphopoda	8
Solenogastres	41
Polyplacophora	2
Nematoda	824
Sipunculida	38
Pantopoda	16
others	225
total	9254

Results SO-205

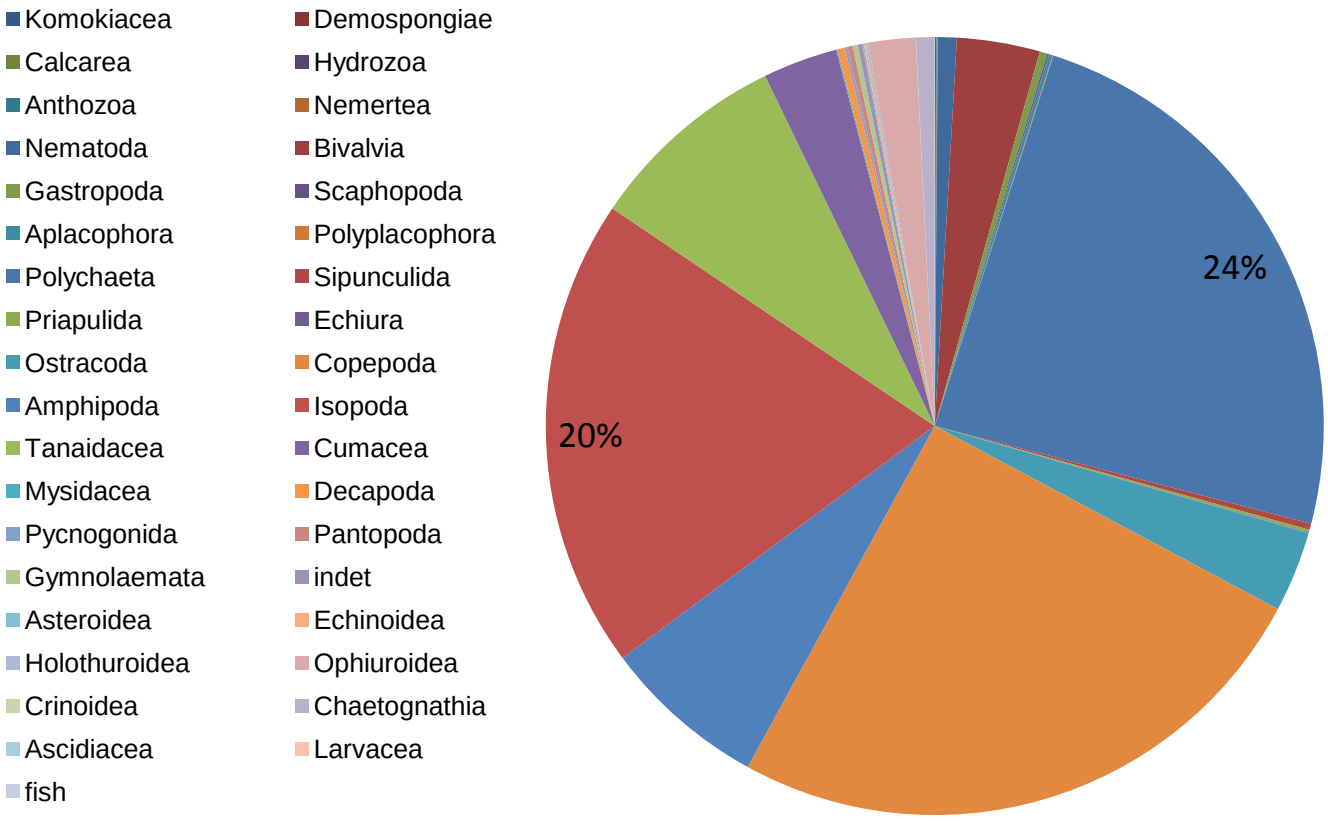
Taxa in BC



Taxa	number of specimens
Polychaeta	1505
Isopoda	534
Amphipoda	45
Aplacophora	17
Ascidicea	4
Bivalvia	150
Brachiopoda	32
Bryozoa	166
Cirripedia	179
Crustacea indet.	25
Cumacea	12
Echinodermata	53
Echuirida	8
Gastropoda	42
Harpacticoida	847
Nemertea	20
Oligochaeta	25
Ostracoda	465
Polyplacophora	25
Porifera	38
Priapulida	8
Scaphopoda	32
Scyphozoa	55
Sipuncilida	21
Tanaidacea	1286
Xenophyophora	12
total	**5606**

Results BIONOD 2012

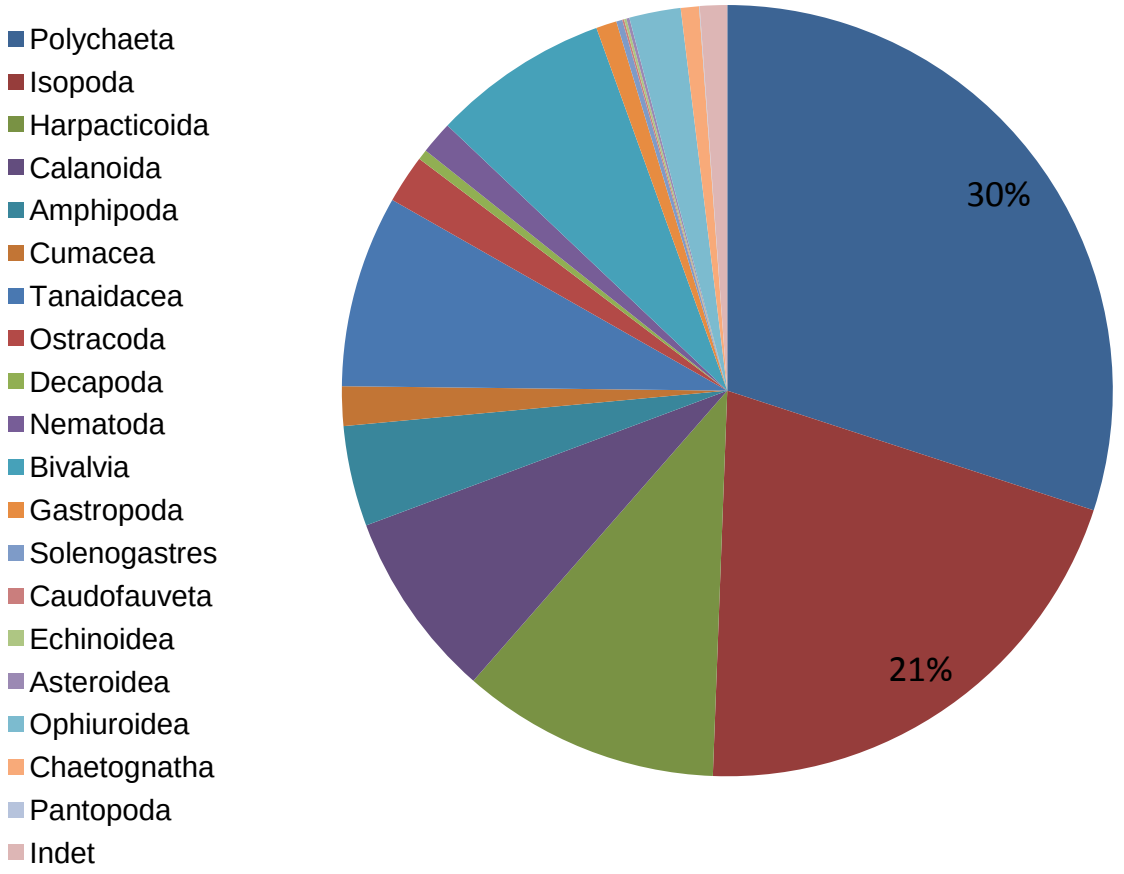
Taxa in EBS



Taxa	number of specimens
Komokiacea	2
Demospongiae	5
Calcarea	2
Hydrozoa	1
Anthozoa	3
Nemertea	3
Nematoda	99
Bivalvia	437
Gastropoda	40
Scaphopoda	9
Aplacophora	20
Polyplacophora	4
Polychaeta	3054
Sipunculida	33
Priapulida	15
Echiura	3
Ostracoda	425
Copepoda	3190
Amphipoda	867
Isopoda	2485
Tanaidacea	1060
Cumacea	393
Mysidacea	7
Decapoda	39
Pycnogonida	14
Pantopoda	28
Gymnolaemata	27
indet	24
Asteroidea	8
Echinoidea	11
Holothuroidea	12
Ophiuroidea	248
Crinoidea	1
Chaetognathia	94
Ascidiacea	2
Larvacea	1
fish	1
total	12667

Results MANGAN 2013

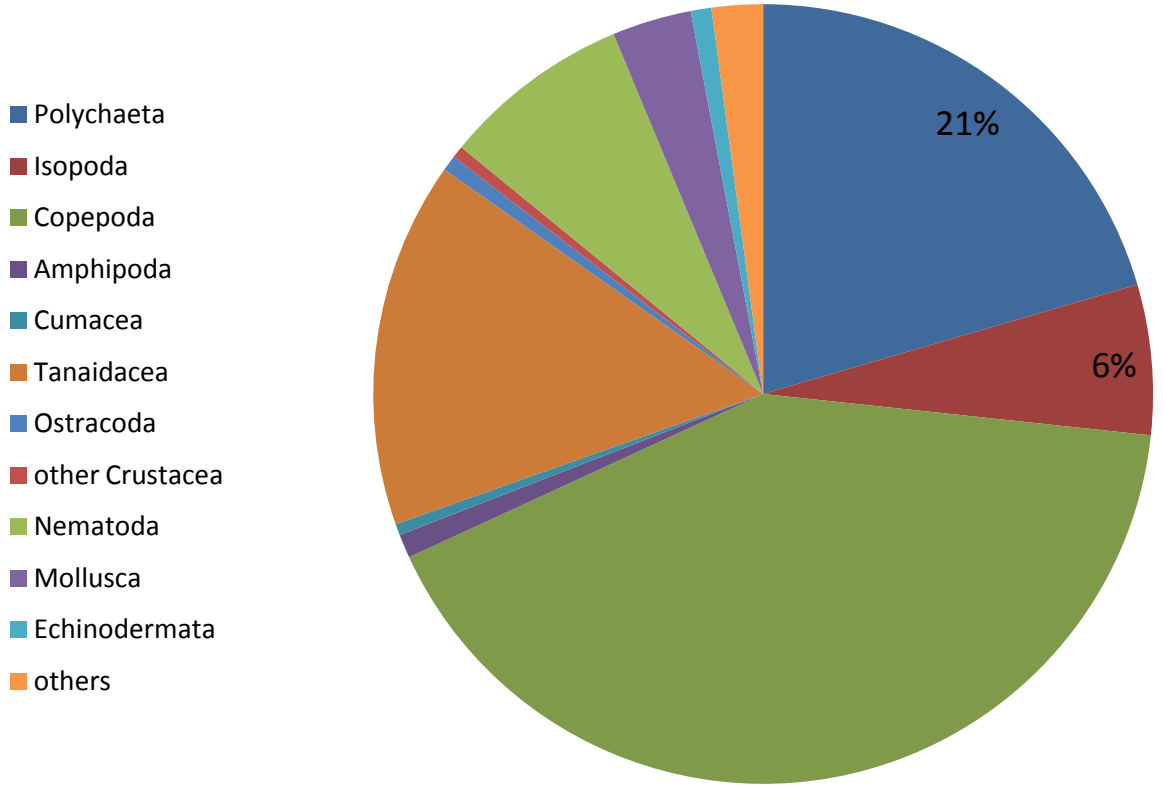
Taxa in EBS



Taxa	number of specimens
Polychaeta	1182
Isopoda	810
Harpacticoida	427
Calanoida	310
Amphipoda	166
Cumacea	65
Tanaidacea	317
Ostracoda	80
Decapoda	17
Nematoda	54
Bivalvia	292
Gastropoda	34
Solenogastres	10
Caudofauveta	3
Echinoidea	4
Asteroidea	5
Ophiuroidea	85
Chaetognatha	30
Pantopoda	1
Indet	45
Total	3937

Results MANGAN 2013

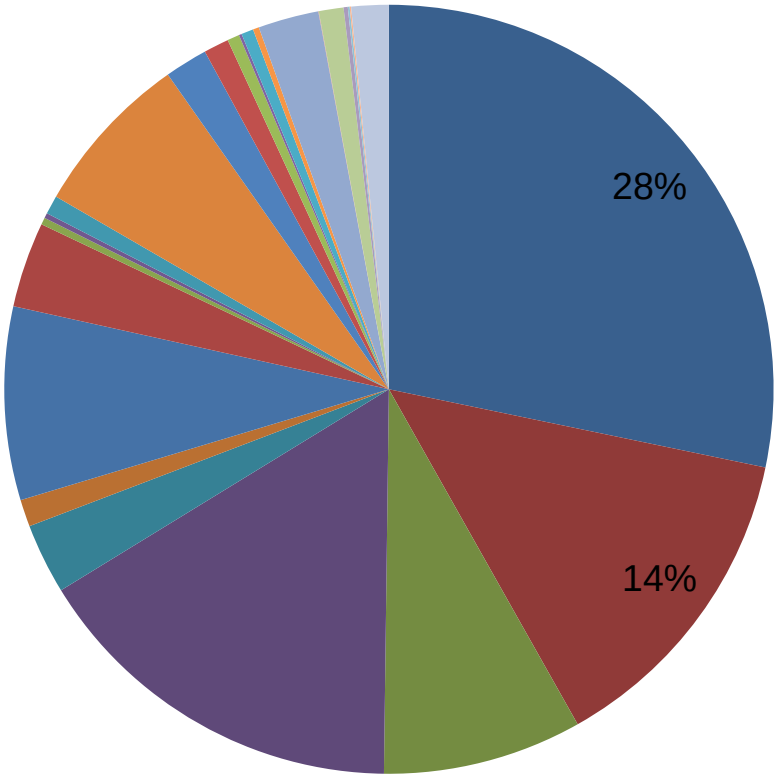
Taxa in BC



Taxa	number of specimens
Polychaeta	790
Isopoda	240
Copepoda	1599
Amphipoda	38
Cumacea	18
Tanaidacea	586
Ostracoda	25
other Crustacea	19
Nematoda	302
Mollusca	127
Echinodermata	33
others	82
Total	3859

Results MANGAN 2014

Taxa in EBS

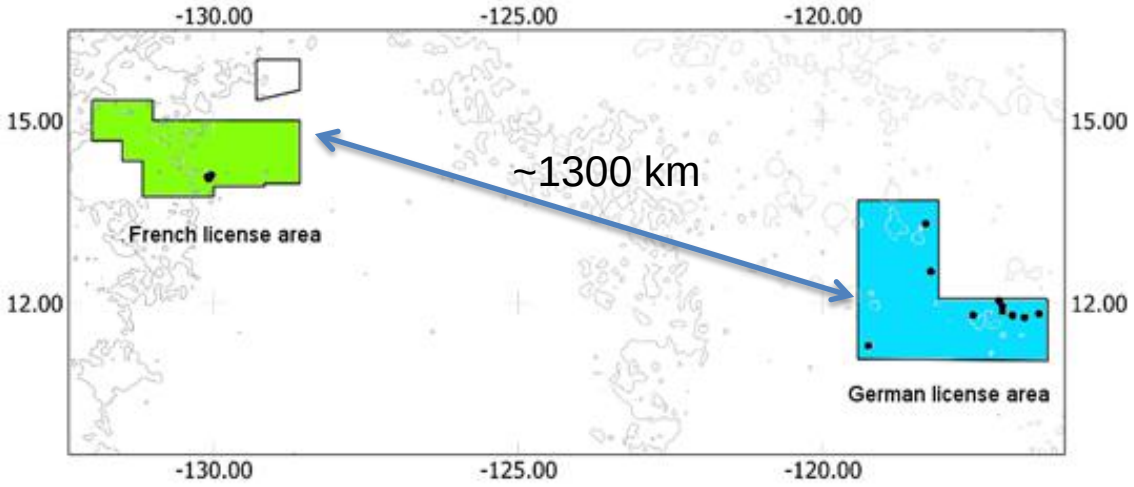


Taxa	number of specimens
Polychaeta	1441
Isopoda	692
Harpacticoida	427
Calanoida	818
Amphipoda	151
Cumacea	58
Tanaidacea	414
Ostracoda	183
Mysidacea	15
Decapoda	11
Nematoda	40
Bivalivia	352
Gastropoda	92
Scaphopoda	54
Solenogastres	26
Sipunculida	6
Asteroidea	26
Echinoidea	13
Ophiuroidea	130
Crinoidea	1
Chaetognatha	53
Pantopoda	9
Cnidaria	4
Polyplacophora	3
indet	80
total	4841

Comparison between French and German license areas

(Janssen *et al.* 2014 submitted)

- variation in diversity and distribution patterns of polychaetes and isopods
- molecular analysis and morphology (i.e. reverse taxonomy) were used for species discrimination

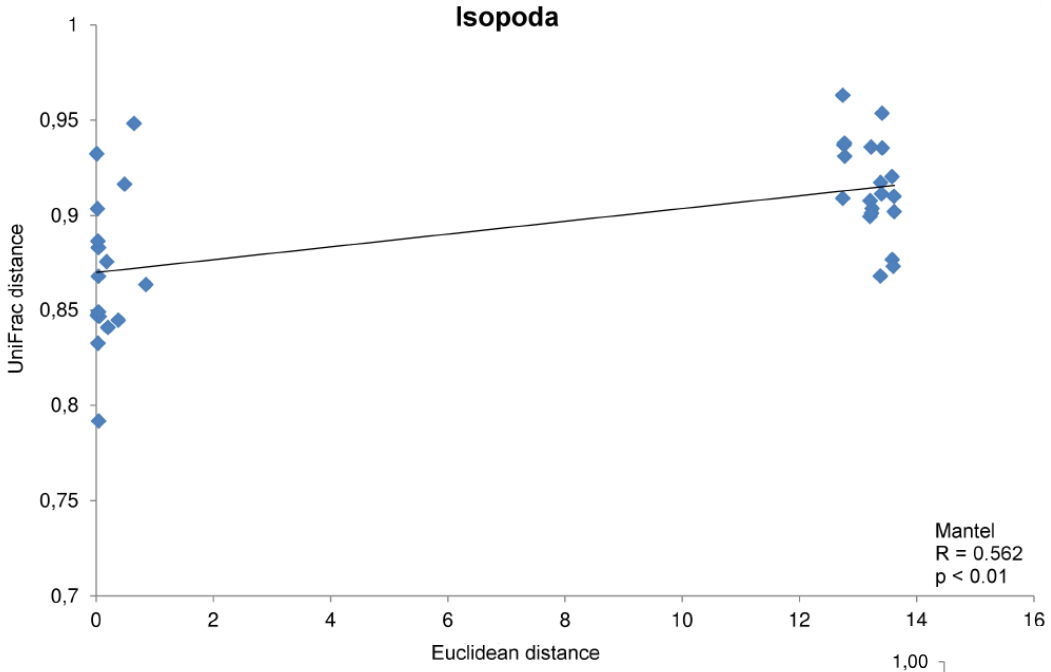


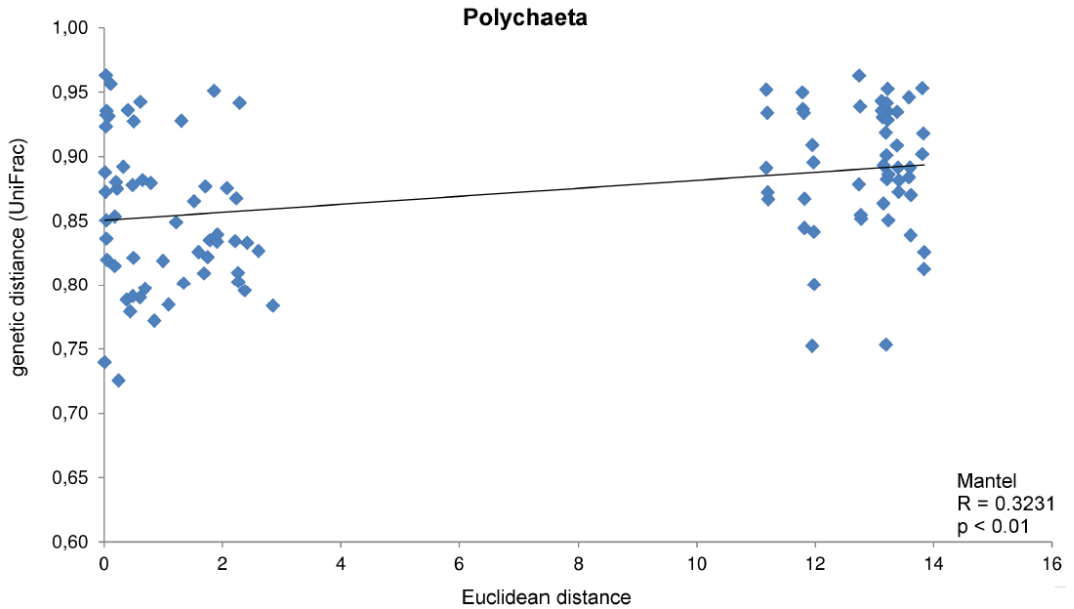
Results genetics Polychaeta

occurrence	number of MOTUs	number of singletons
German claim only	158	102
French claim only	48	36
German and French claim	27	0
sum	233	138 (25% of individuals) 60% of MOTUs

Results genetics Isopoda

occurrence	number of MOTUs	number of singletons
German claim only	45	31
French claim only	48	34
German and French claim	2	0
sum	95	65 (43% of individuals) 70% of MOTUs


Isopoda
UniFrac distance
Euclidean distance
Mantel
R = 0.562
p < 0.01


Polychaeta
genetic distiance (UniFrac)
Euclidean distance
Mantel
R = 0.3231
p < 0.01

Conclusion

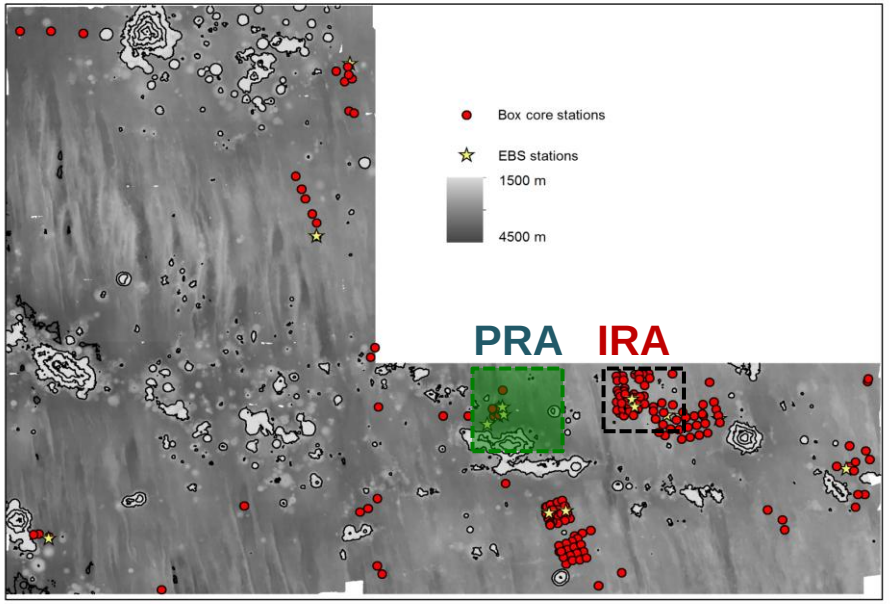
- this study is only a first step of inventory in the CCZ
- sample size is still too small to assess connectivity
- CCZ has a highly diverse deep-sea ecosystem

⇒ high number of rare species

- several species are distributed in both distant areas (27 polychaete and 2 isopod MOTUs)
- significant positive correlation of genetic and geographical distance

Comparison of two reference areas in the eastern German license area (Msc. Raschka 2014)

- ISA-regulations require the definition of (test)mining areas (impact reference areas) where the influence of future mining shall be investigated and pristine areas (preservation reference areas) from where recolonization to an IRA is possible
- BGR has defined an IRA and PRA
- molecular analysis for isopods and polychaetes to assess species distribution
- comparison of these two reference areas in space and time



Results genetics

- COI success rate ~ 50%

isopods:

area of occurrence	number of MOTUs	number of individuals	number of singletons
Preservation reference area	36	149 (42.7%)	21 (14%)
Impact reference area	36	65 (18.6%)	24 (37%)
preservation and impact areas	11	135 (38%)	0
sum	83	349	45 (12%)

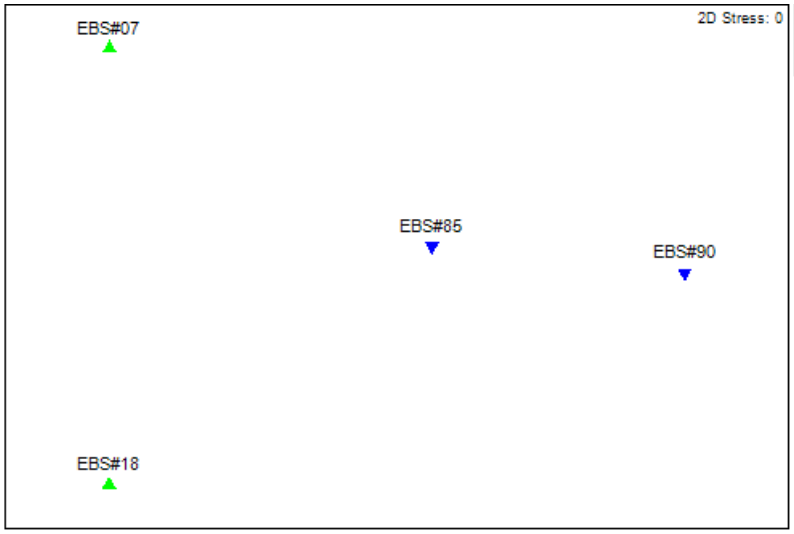
Results genetics

- Col success rate ~ 50%

polychaetes:

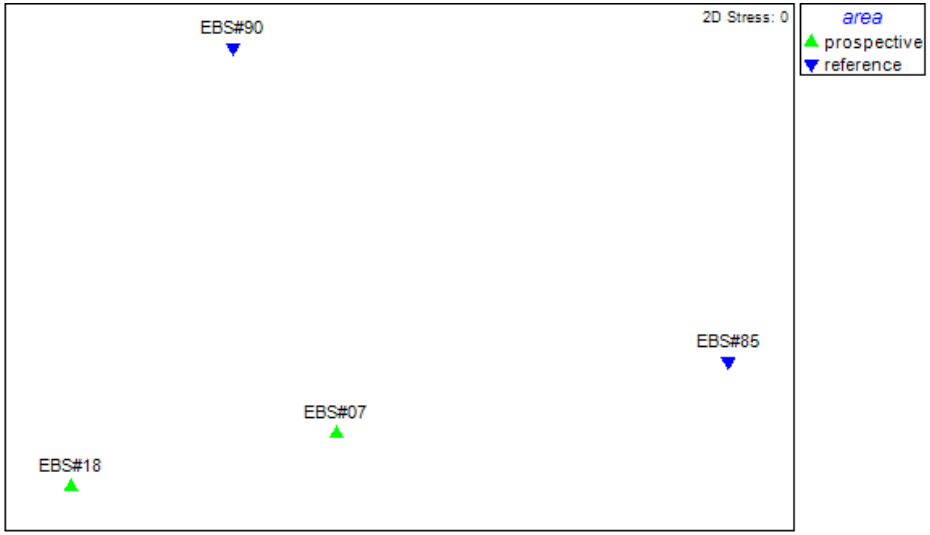
area of occurrence	number of MOTUs	number of individuals	number of singletons
Preservation reference area	88	165 (30%)	53 (32%)
Impact reference area	19	25 (4.5%)	14 (56%)
reference and impact areas	40	360 (65.5%)	0
sum	147	550	67 (12%)

Results genetics



genetic distance between sample sites in polychaetes

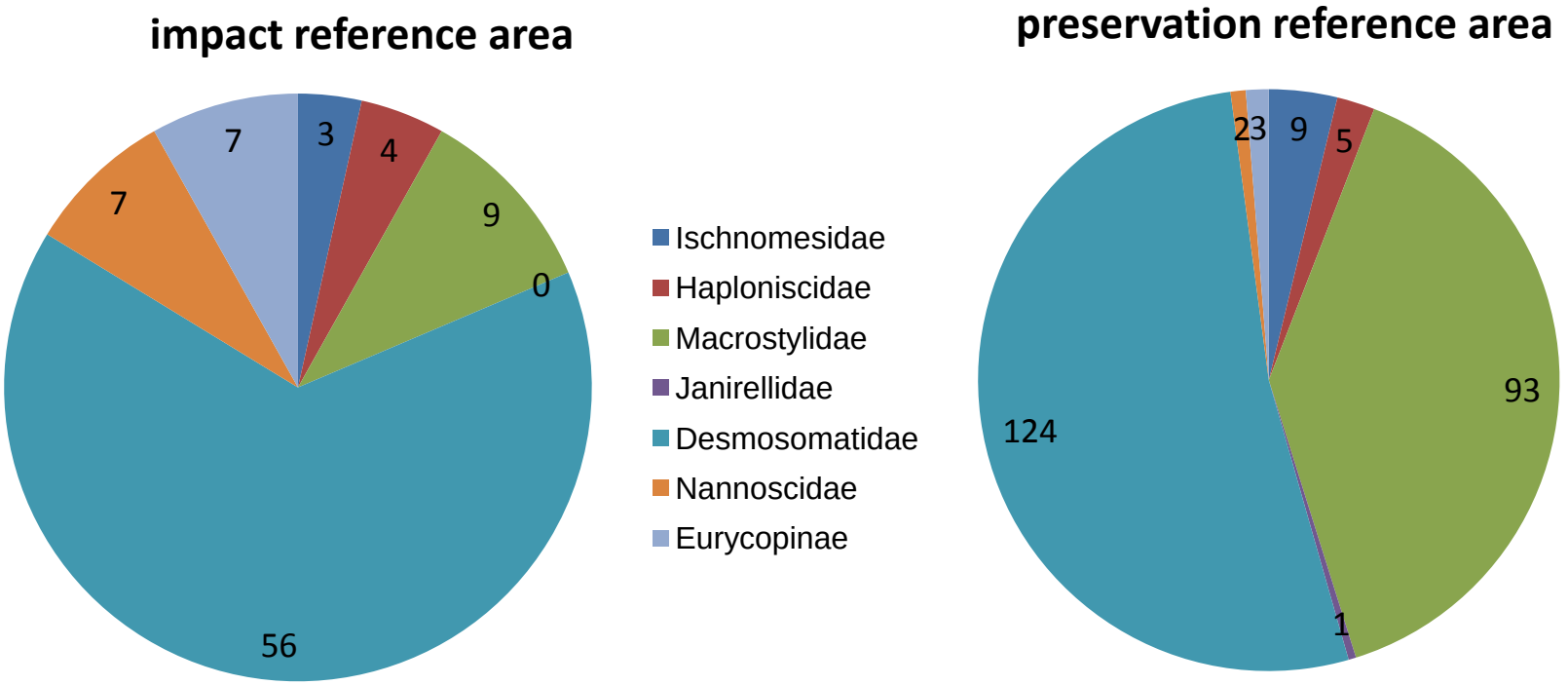
ANOSIM: R=0.5
p=0.33



genetic distance between sample sites in isopods

ANOSIM: R=0.25
p=0.67

Results morphology

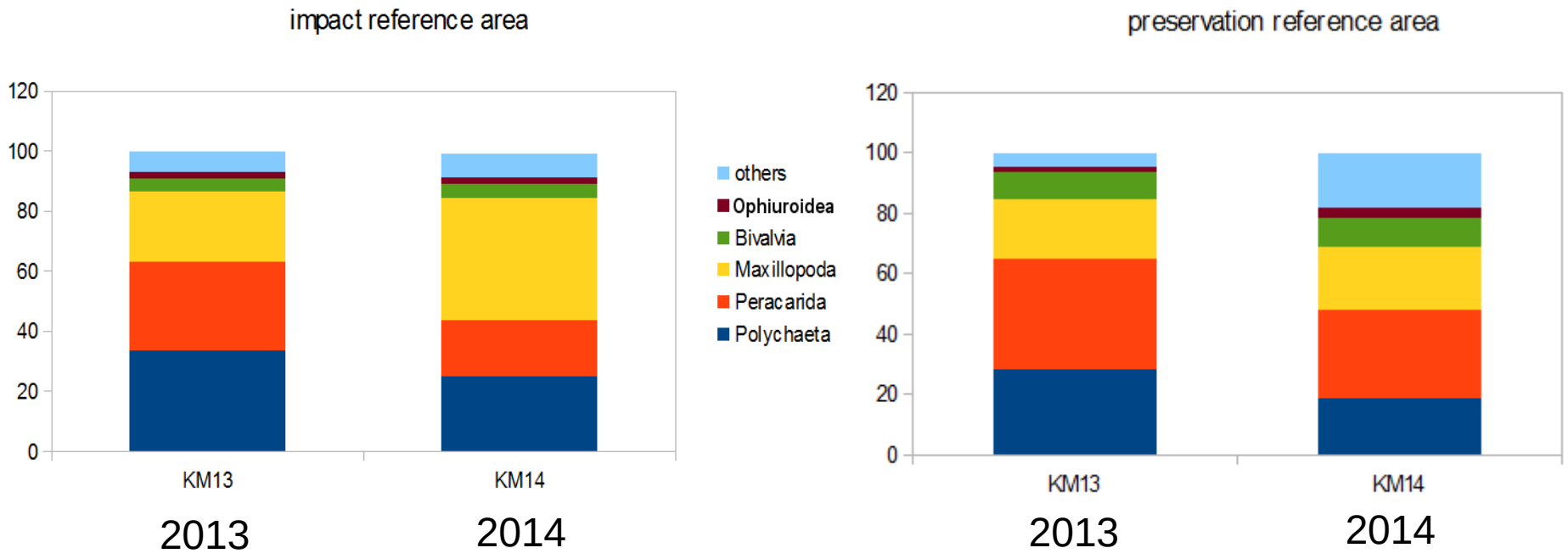


Results

- Unifrac distance, cosine similarity and ANOSIM showed no significant distance between the two areas

- number of shared species higher than between German and French license areas

Annual comparison between impact reference area and preservation reference area



Outlook

Planned future cruises:

- JPI-O “Eco-Mining” (financed a.o. by the German Ministry of Education and Research)
  - March/April 2015 with RV Sonne
  - ROV – AUV – EBS – BC in CCZ (German, French, Belgian license areas; APEI?)

- “FLUM” (financed by the German Ministry of Education and Research)
  - May/June 2015 with RV Sonne
  - BC in German eastern license area

- Planned for 2016: exploration cruise eastern license area
  - high-resolution AUV – EBS – BC in prospective areas