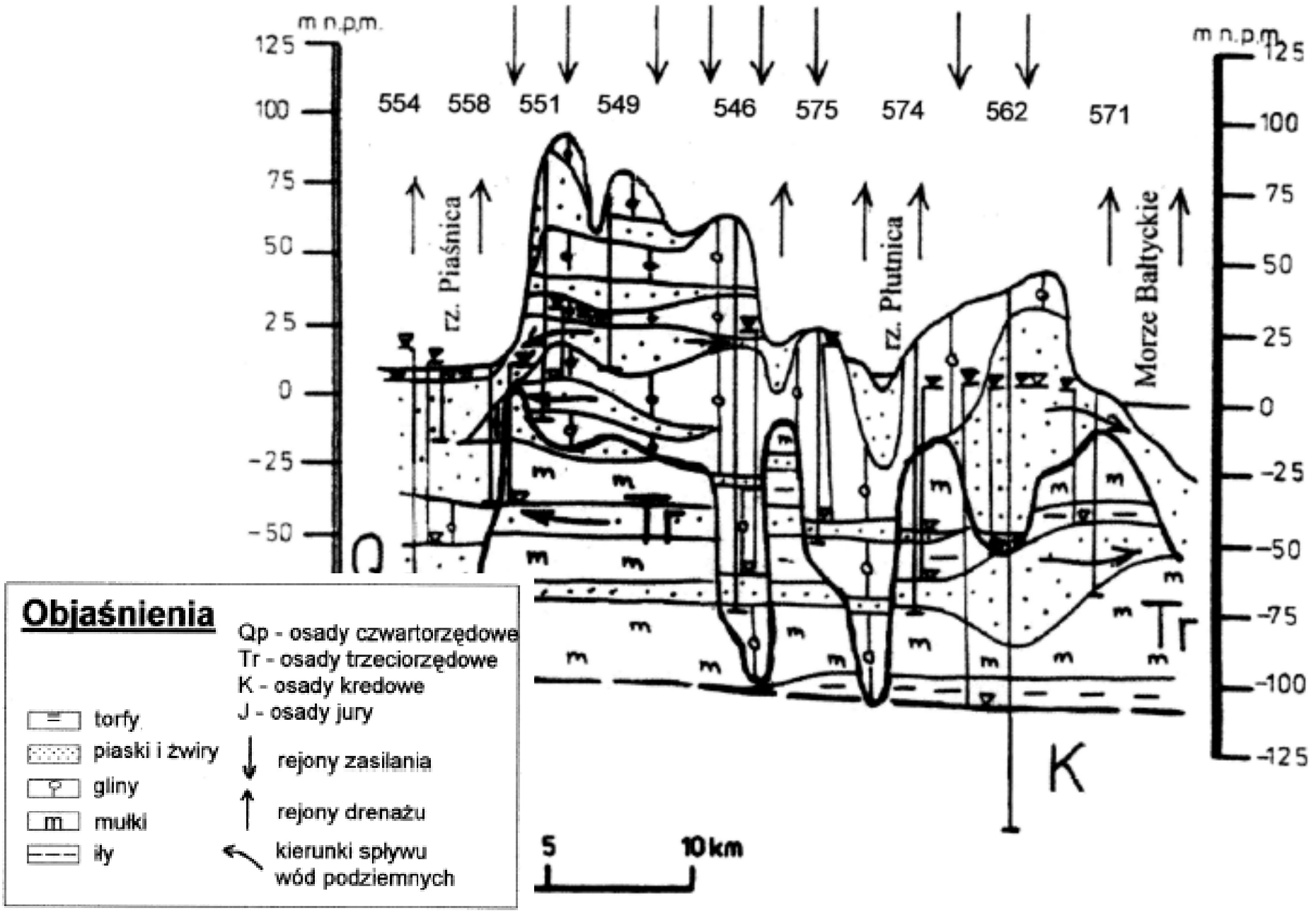
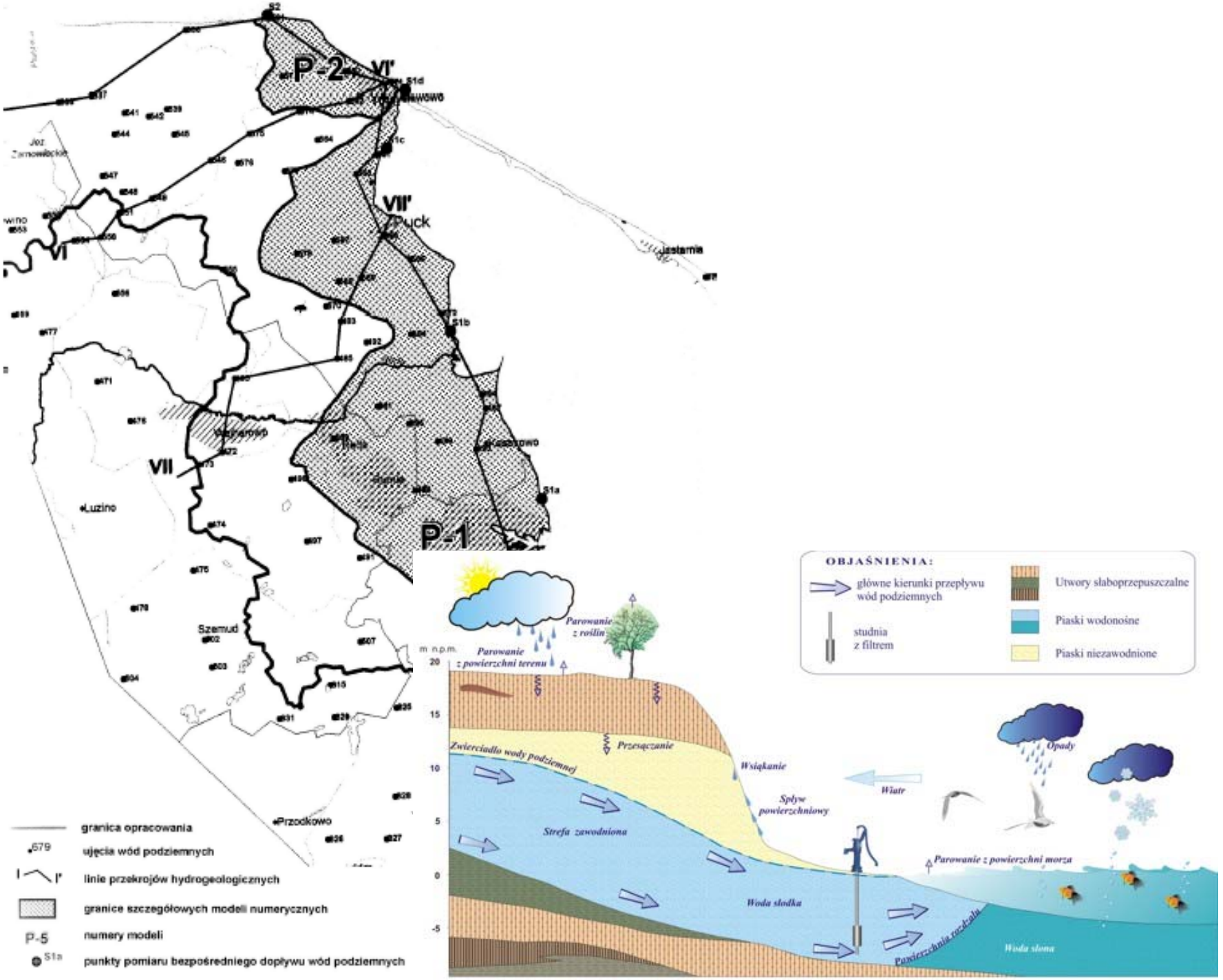
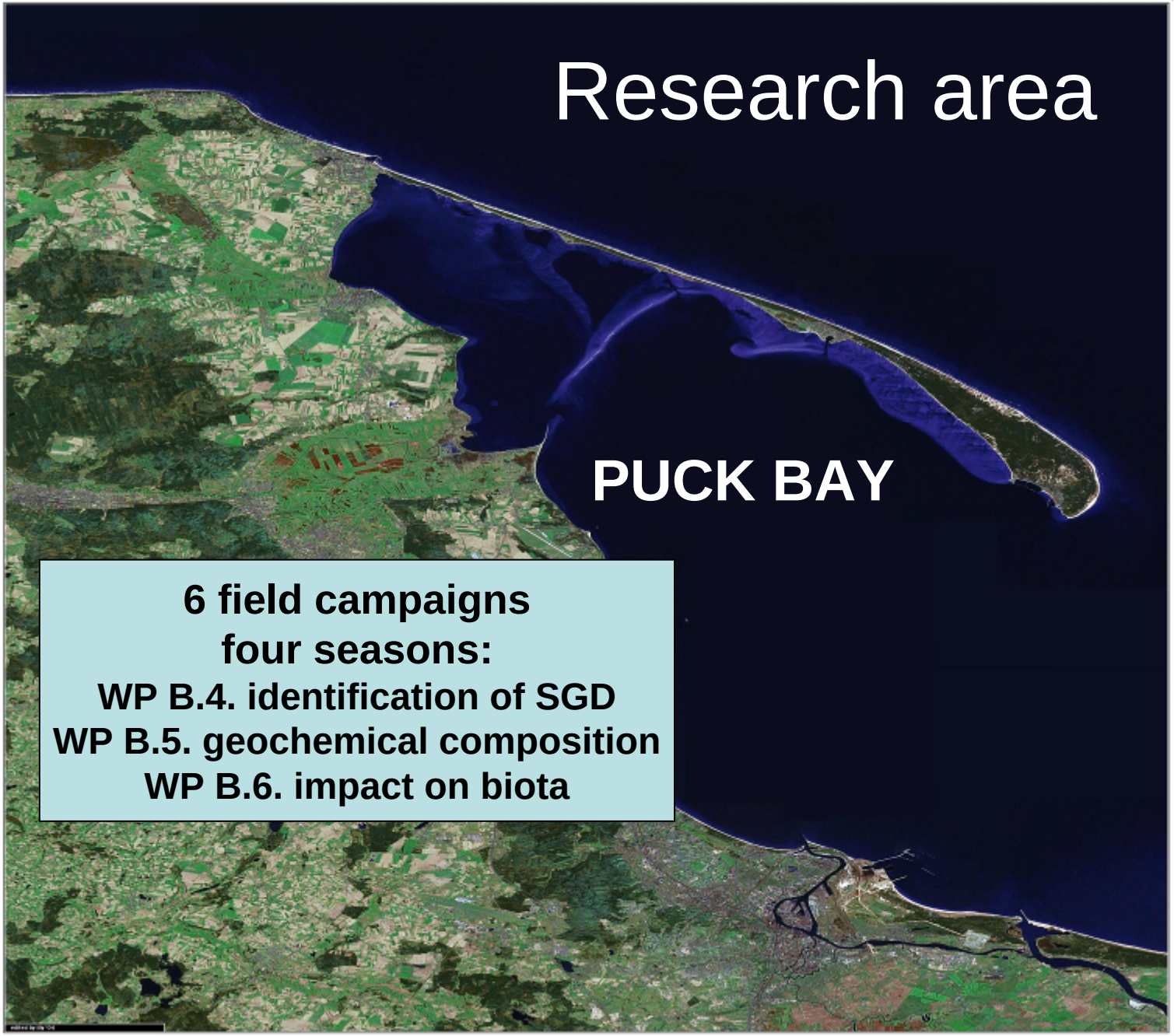
Groundwater seepage at Hel Peninsula

Lech Kotwicki and **amber** cooperators

„SGD has recently been recognised as another important input source from land (Moore 1999) which contributes to the biogeochemical elemental budgets of costal waters. Although global estimates vary widely, SGD is known to be highly enriched in nutrients, organic compounds, and trace metals. The knowledge of SGD nutrient loads is of major importance for coastal eutrophication (Valiela et al. 2002, McCallister et al. 2006). Additionally, SGD has been identified as critical threats to biodiversity around the world with reference to inland investigations (Carlton 2006, Eamus et al. 2006). Thus, climate induced changes in the amount of groundwater input are assumed to cause intermittent and even permanent shifts in faunal species density and biodiversity in the coastal environment. In spite of the increasing acceptance of the relevance of SGD on coastal zones and enclosed seas, relatively little is known for the Baltic Sea. Exceptions are investigations in the Eckernförder Bay, Germany (Purkl & Eisenhauer 2004) and in the Puck Bay, Poland (Jankowska et al. 1994, Piekarek- Jankowska 1996). A first quantitative water balance approach has demonstrated the importance of the existing lithology for ground water flow into the coastal Baltic Sea (Schafmeister et al. 2004).”


m n.p.m.
125
100
75
50
25
0
-25
-50
554
558
551
549
546
575
574
562
571
rz. Piaśnica
rz. Płutnica
Morze Bałtyckie
Q
K
5
10 km
Objaśnienia
Qp - osady czwartorzędowe
Tr - osady trzeciorzędowe
K - osady kredowe
J - osady jury
torfy
piaski i żwiry
gliny
mułki
iły
rejony zasilania
rejony drenażu
kierunki spływu wód podziemnych


P-2
P-1
VI'
VII'
VII
VI
Puck
Jastarnia
Władysławowo
Luzino
Szemud
Przodkowo
granica opracowania
ujęcia wód podziemnych
linie przekrojów hydrogeologicznych
granice szczegółowych modeli numerycznych
numery modeli
punkty pomiaru bezpośredniego dopływu wód podziemnych
OBJAŚNIENIA:
główne kierunki przepływu wód podziemnych
studnia z filtrem
Utwory słaboprzepuszczalne
Piaski wodonośne
Piaski niezawodnione
m n.p.m.
Parowanie z roślin
Parowanie z powierzchni terenu
Przesączanie
Wsiąkanie
Zwierciadło wody podziemnej
Spływ powierzchniowy
Wiatr
Opady
Strefa zawodniona
Parowanie z powierzchni morza
Woda słodka
Powierzchnia rozdziału
Woda słona


Research area
PUCK BAY
6 field campaigns
four seasons:
WP B.4. identification of SGD
WP B.5. geochemical composition
WP B.6. impact on biota

WP B.4 Identification and quantification of submarine groundwater discharge (30 mo)

***Aim*:** Identification of sites of significant SGD and quantification of groundwater contributed to the coastal environments of the Baltic Sea leading to a hydrological mass balance.

***Purpose*:** Identification of sites of SGD for selection of appropriate locations for seasonal field campaigns and fixed groundwater samplings. Localisation of groundwater hot spots.

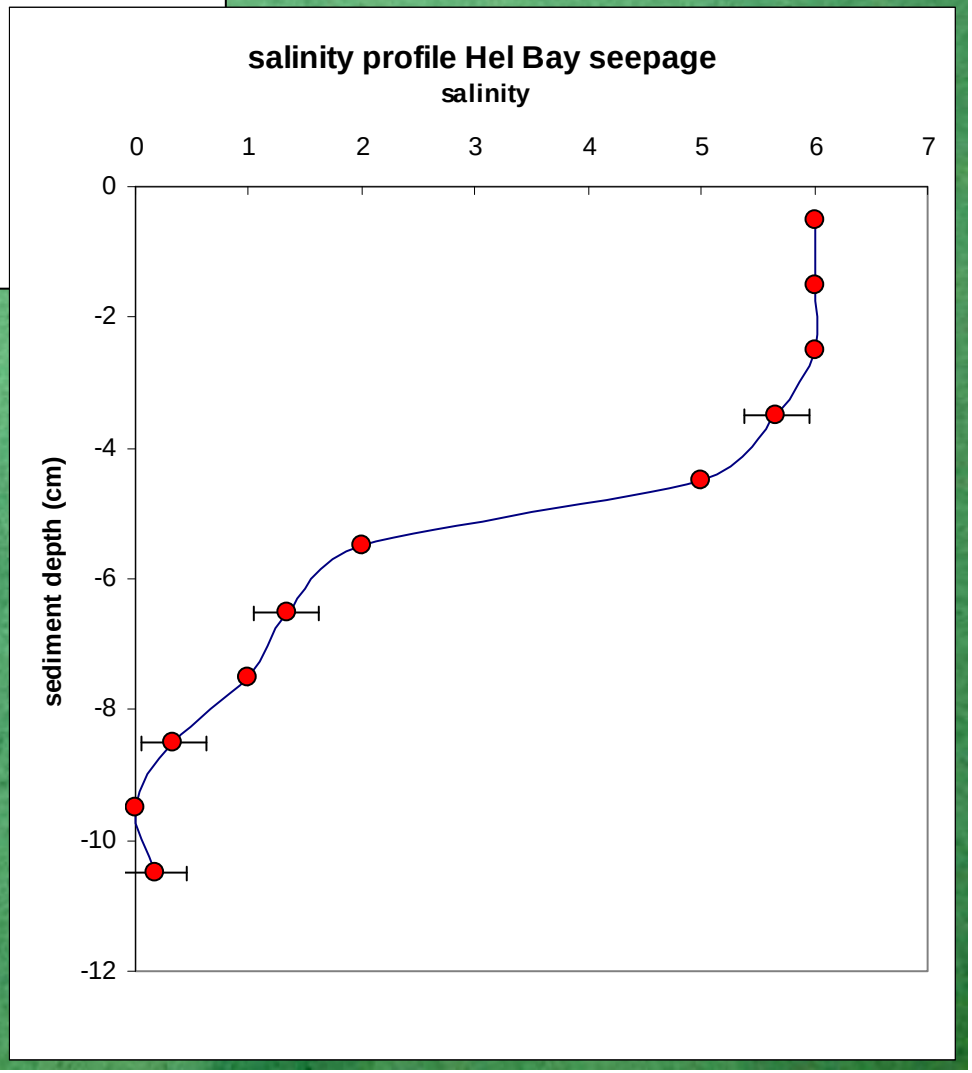
***Method*:** The identification and quantification of SGD

Resulting data will be used for establishing a hydrological mass balance.

***Deliverables*:** Estimate of the quantitative groundwater influence on the coastal environment.

Seepage area (salinity <5):
3000 m² (5 cm depth)
6000 m^2 (25 cm depth)

Seepage rate (lowest): 2.9 l m^{-2} d^{-1}
Seepage rate (highest): 96.2 l m^{-2} d^{-1}
Seepage bau (lowest): 8700 l d^{-1}
Seepage bau (highest): 288600 l d^{-1}



Piętro wodonośne	Dopływ całkowity Q [m^3/d]	Udział w dopływie [%]	Szerokość strefy dopływu do Bałtyku [m]	Dopływ jednostkowy (na 1 km strefy dopływu) q [$m^3/d/km$]	Dopływ jednostkowy (na 1 km długości wybrzeża) q [$m^3/d/km$]
Czwartorzęd	273 873	68,9	462 250	592	546
Trzeciorzęd	70 584	17,8	149 750	471	141
Kreda	24 445	6,1	107 500	227	49
Kreda + jura	28 730	7,2	135 000	213	57
Suma	397 632	100,0			793

Deliverables WP B.4

- Seepage rate for investigated area

up to 288.6 $m^3\ d^{-1}$ [1443 $m^3\ d^{-1}\ km^{-1}$]

WP B.5 Geochemical composition of groundwater seepage (30 mo)

***Aim*:** Characterization of the geochemical (nutrients, DOM, trace metals) and isotopic (C, S, N) composition of groundwater contributed to the coastal environment at seepage sites.
***Purpose*:** The knowledge of the geochemical composition of groundwater is of essential importance as it contributes to the biogeochemical budgets of near-shore waters.
Method: Fixed pore water lances (Beck et al. 2007) will be modified for the requirement of study sites. Conventional sampling techniques onboard ship will be carried out seasonally in the water column. Key parameters include nutrients, redox-sensitive trace metals, DOC, and sulphur and carbon species. The cycles of C, N, and S will be also investigated by means of stable isotope techniques.
Deliverables: The involvement of geochemical data into budget calculations enables estimates of mass balances for the study area. Measurements within the open water column will provide information about the fate and biogeochemical transformations of groundwater constituents.

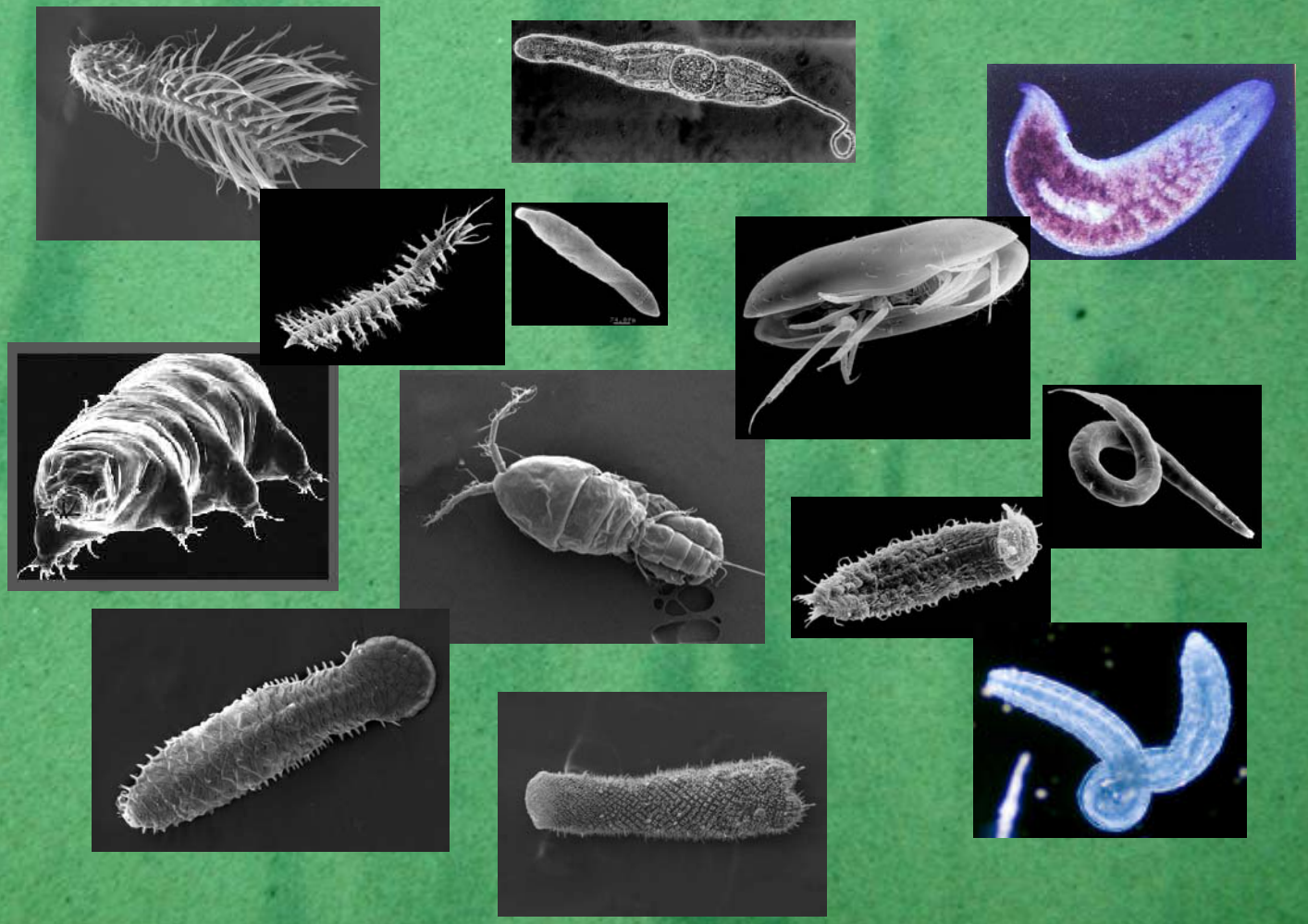
Data provide by team of Susan & Beata

WP B.6 Groundwater seepage impact on biota (30 mo)

***Aim*:** Investigation on the impact of groundwater seepage on the existing flora and fauna on a seasonal scale and the effects of SGD on biodiversity in coastal areas of the Baltic Sea.
***Purpose*:** To identify the potential threats of SGD on the biodiversity in the coastal area.
***Method*:** Biota will be sampled at seepage sites detected by WP B.4 and in areas which are not directly influenced by groundwater for comparison. Macrofauna and most abundant meiofauna (Nematoda, Harpacticoida) organisms will be identified to species level.
***Deliverables*:** Data on variations of biological communities in a SGD influenced ecosystem.

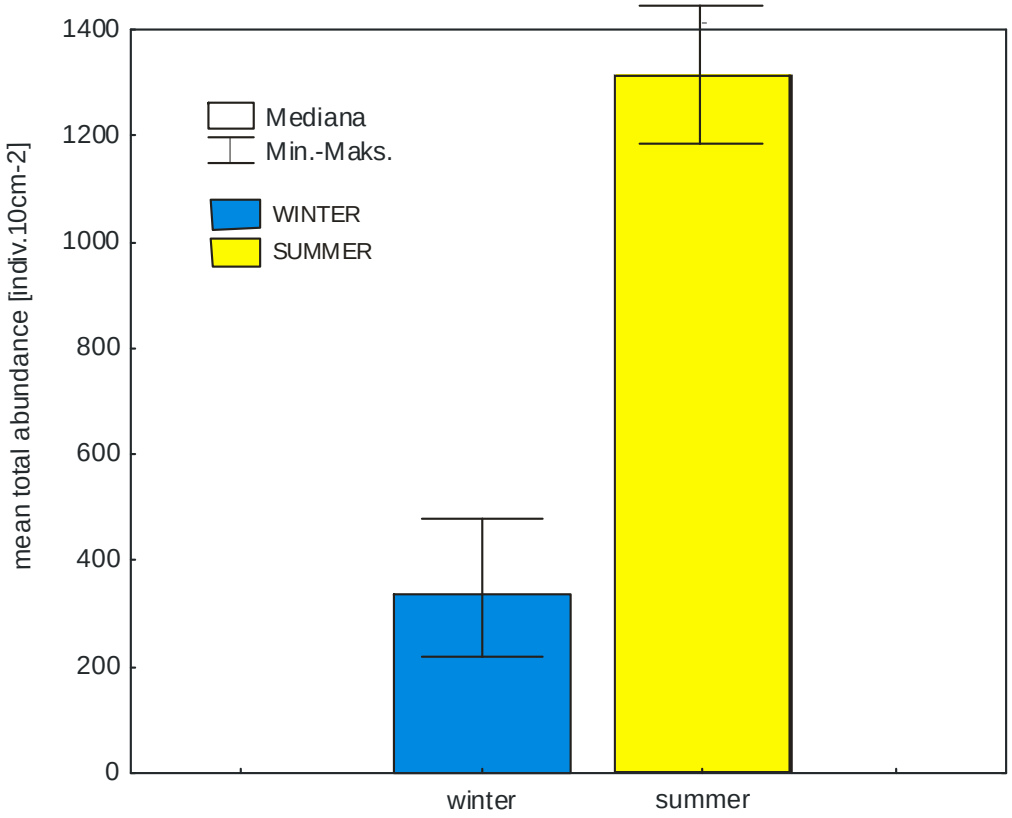
Meiofauna

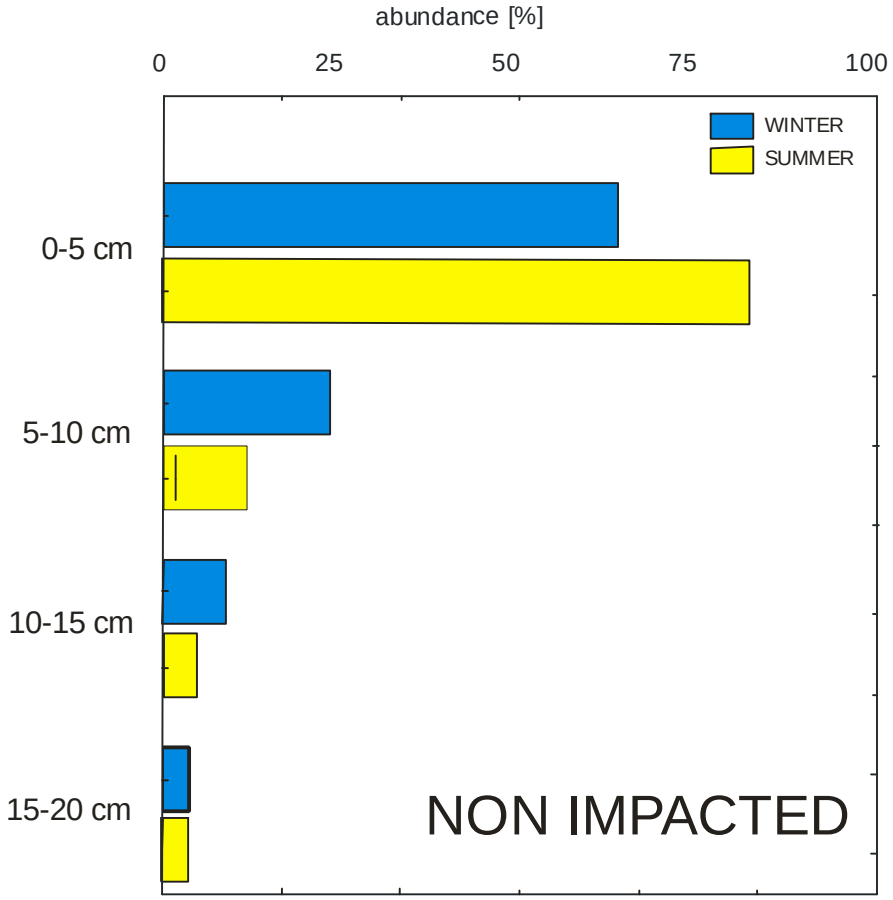
- Nematoda
- Harpacticoida
- Oligochaeta
- Gastrotricha
- Turbellaria
- Bivalvia
- Ostracoda
- Acari
- Tardigrada
- Polychaeta
- Cumacea
- Insecta



Meiofauna

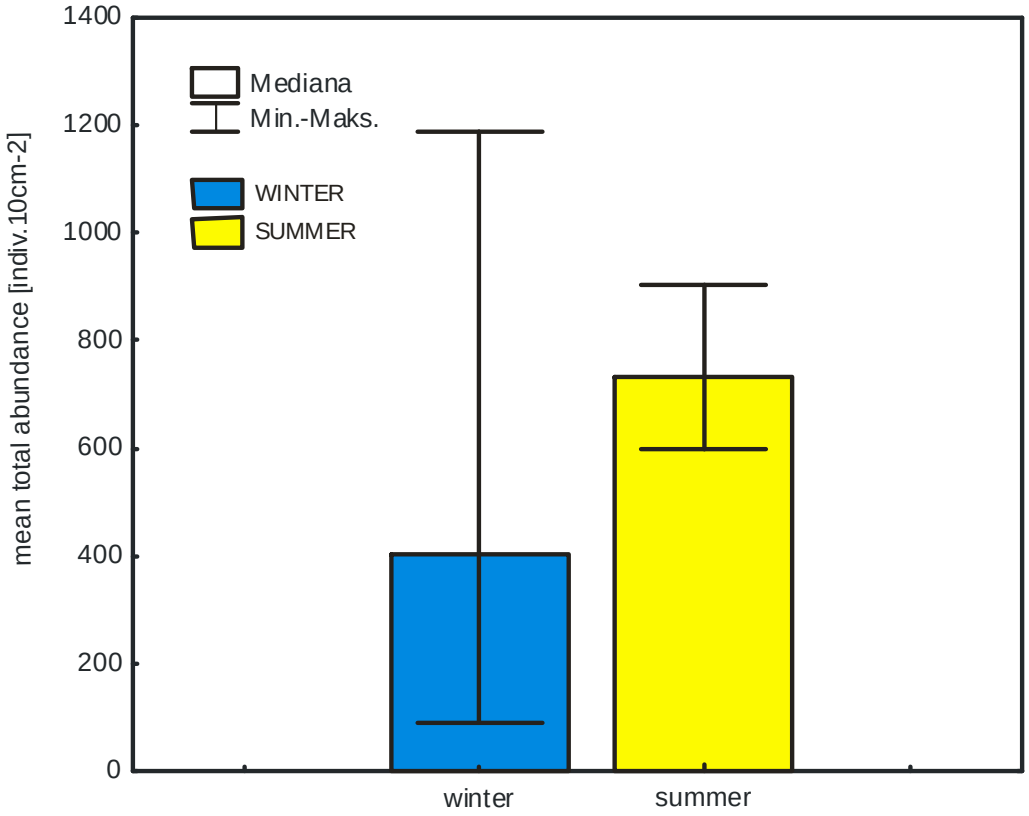
non impacted area

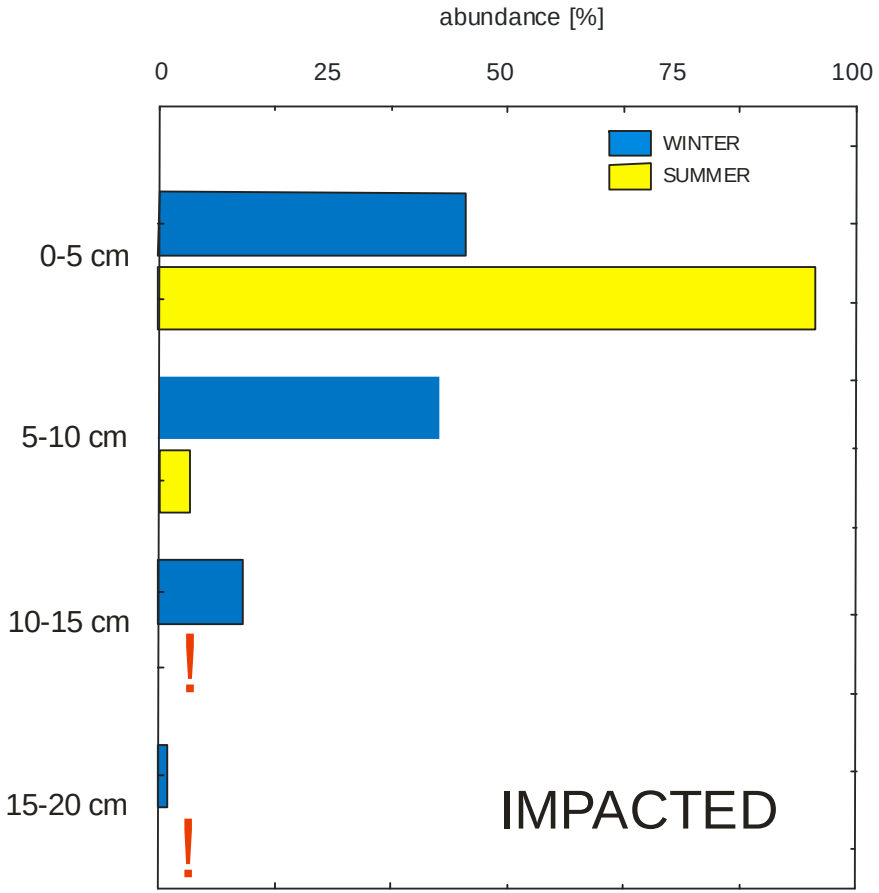




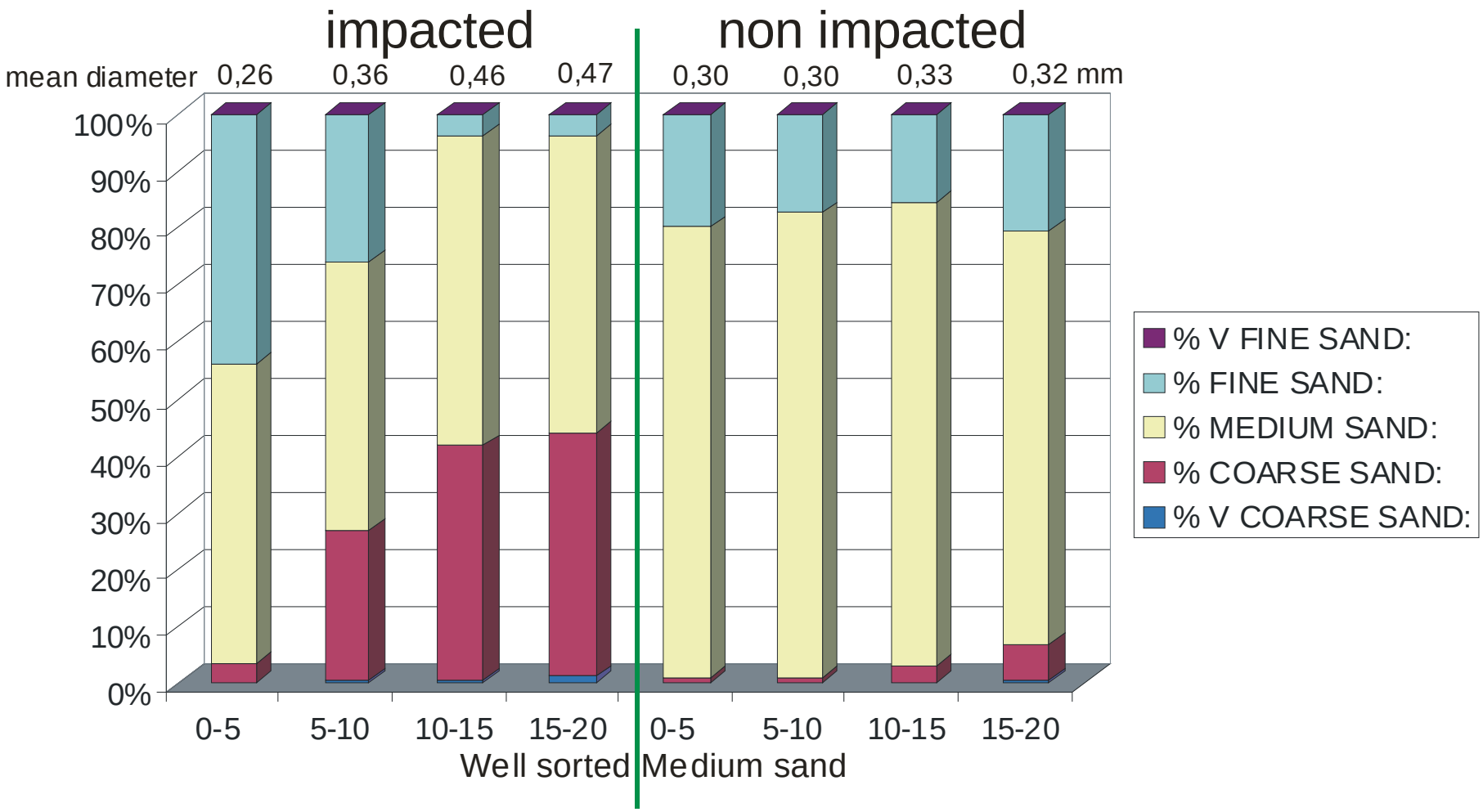
Meiofauna

impacted area



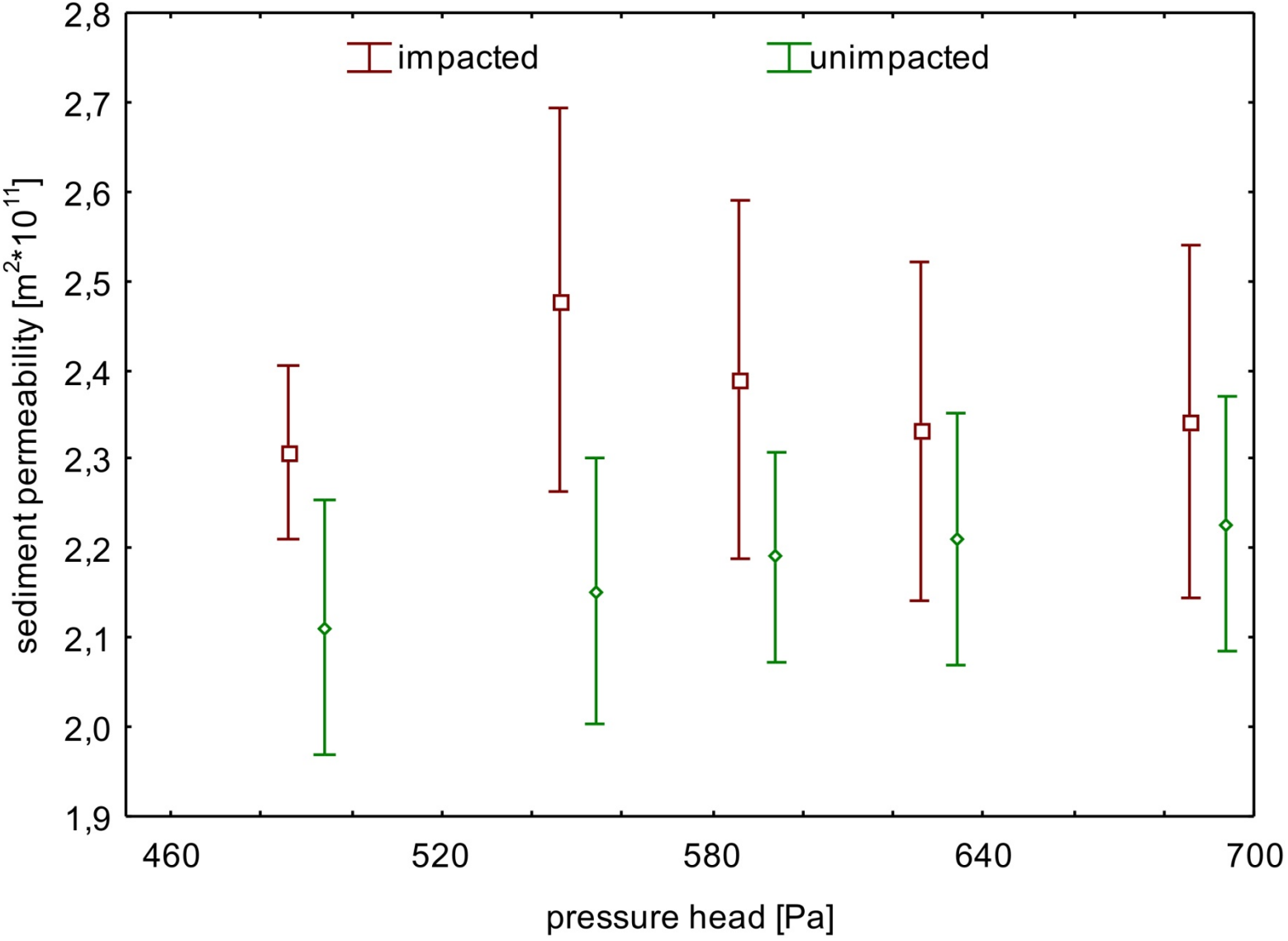


Sediment characterisation

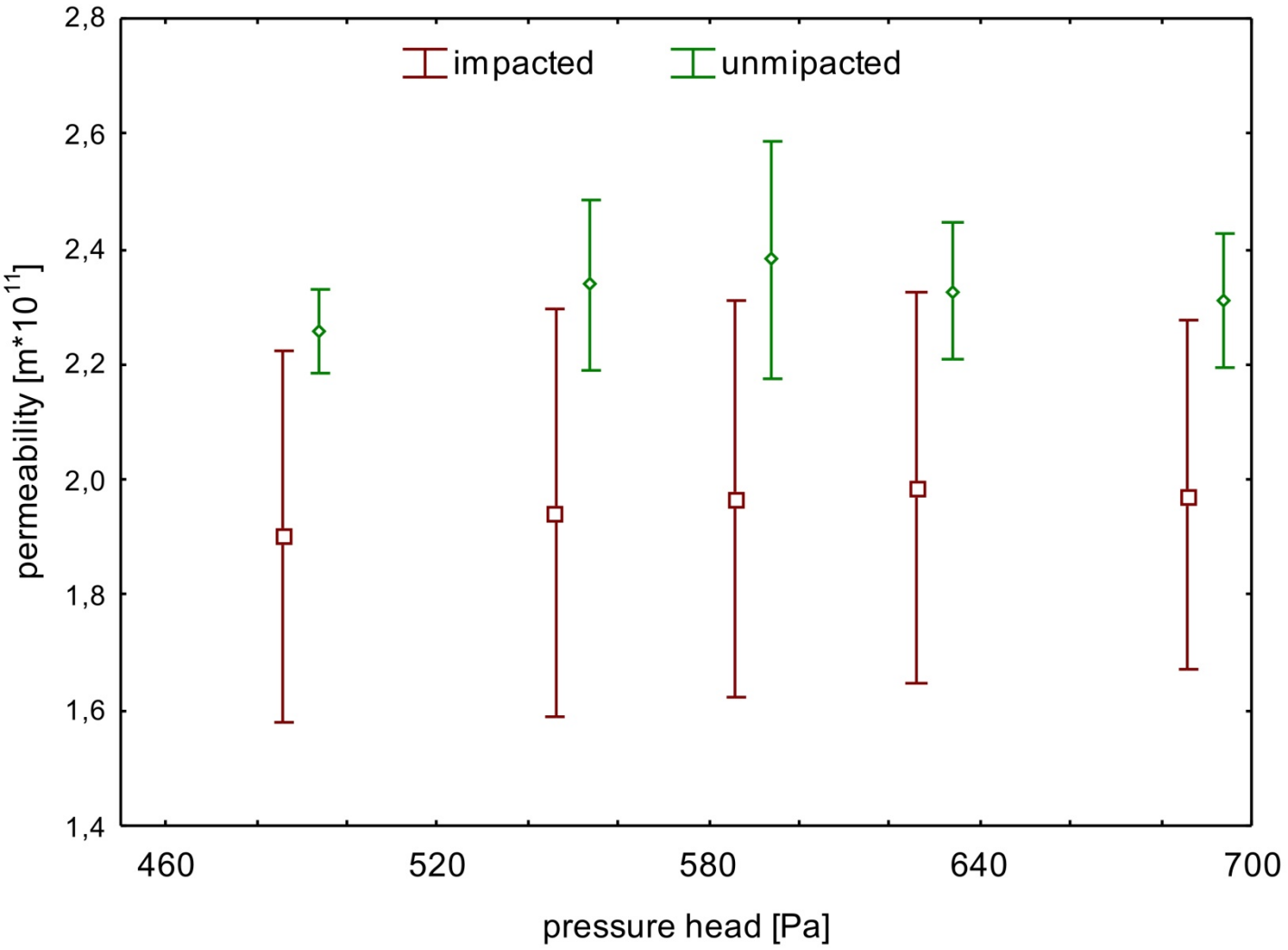


Sorting:	1.4 - 1.6	Sorting:	1.3 - 1.4
Skewness:	-0.02 - 0.03	Skewness:	0.00 - 0.03
Kurtosis:	0.8 - 1.0	Kurtosis:	1.0 - 1.2

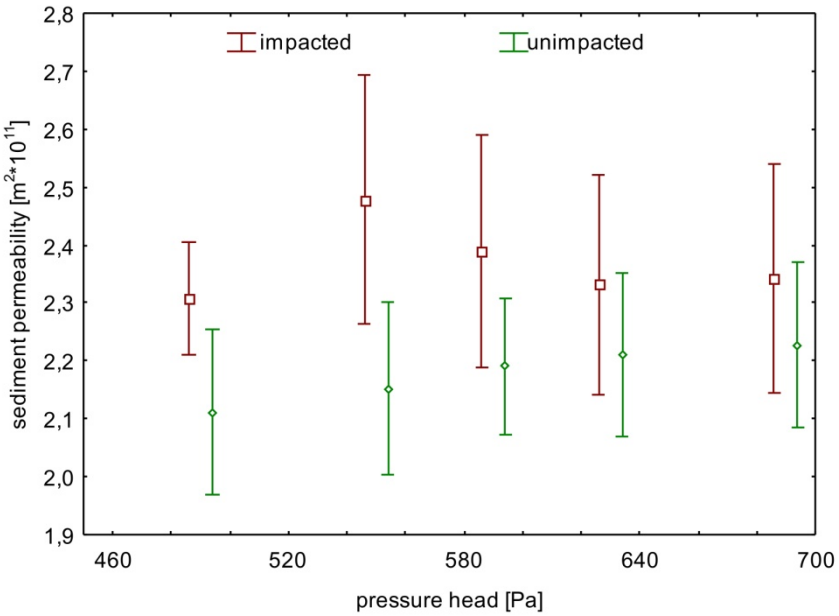
Permeability winter

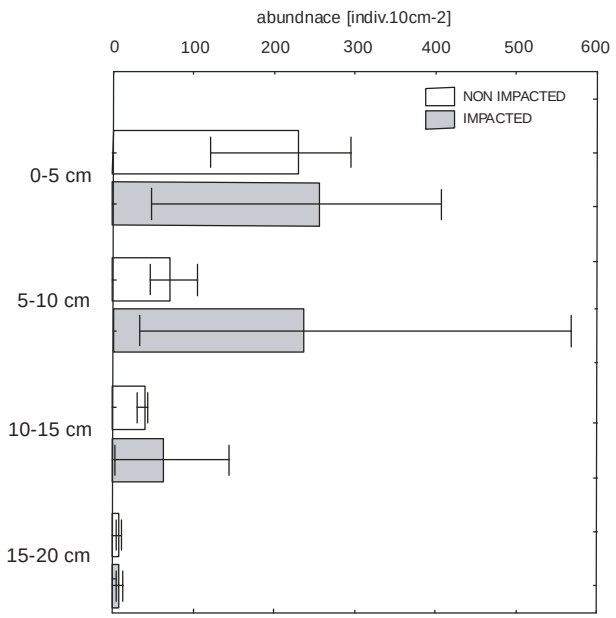


Permeability - summer

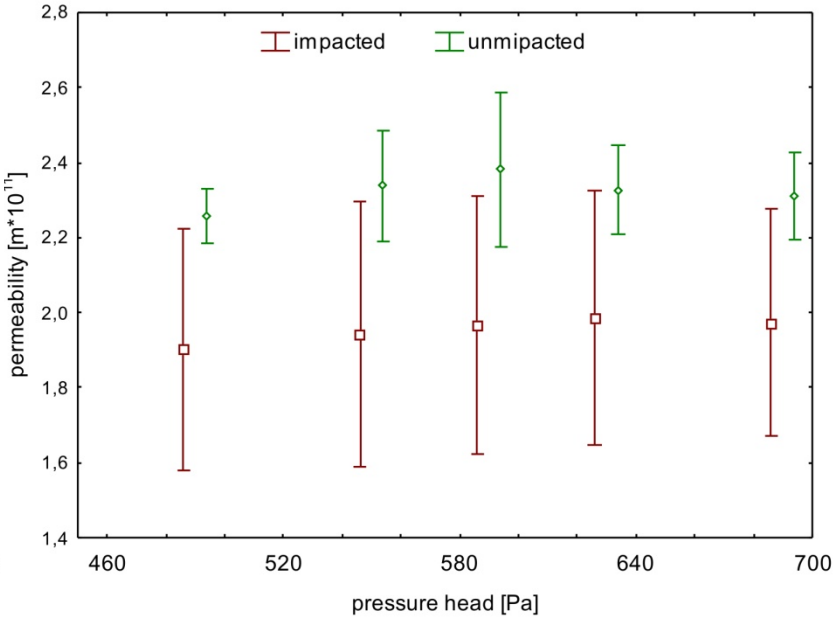


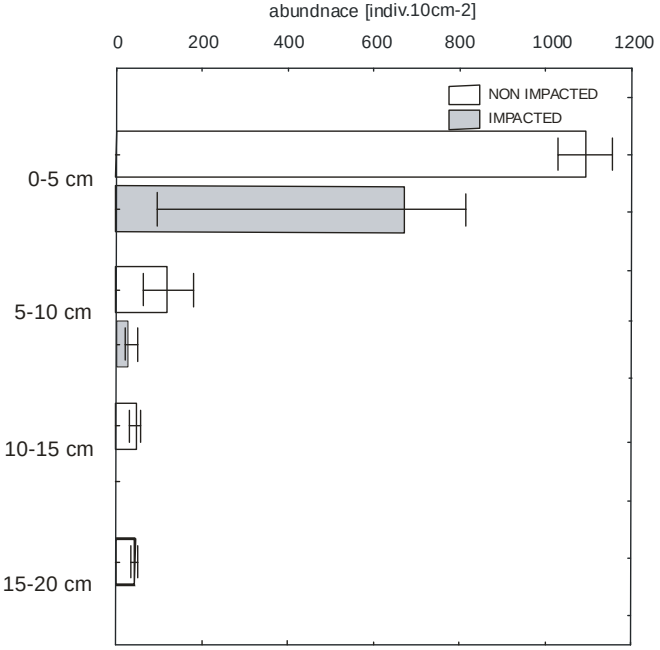
winter





summer





METHANE – mr Troublemaker

Large methane bubbles in sediment cores in the shallow sublittoral at Hel – result of groundwater seepage