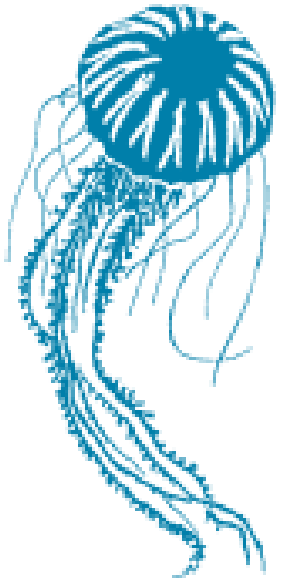
Entwicklung eines MSRL-Zooplankton-Indikators in der Nordsee



Maarten Boersma, Henriette Horn & Inga Kirstein

(zusammen mit vielen Anderen)

ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

LLUR Minisymposium 2019

HELMHOLTZ
GEMEINSCHAFT

Importantly….

- “Since all models are wrong the scientist cannot obtain a “correct” one by excessive elaboration. On the contrary (…) she should **seek an economical description of natural phenomena**. Just as the ability to devise simple but evocative models is the signature of the great scientist so overelaboration and overparameterization is often the mark of mediocrity.”

(George E.P. Box)

Ziele des Projekts

- Anwendung bestehender und vorgeschlagene Zooplanktonindikatoren anhand der Helgoland Reede-Langezeitdaten
- Analyse der Beziehungen zu Umweltparametern und deren Aussagekraft für eine Bewertung

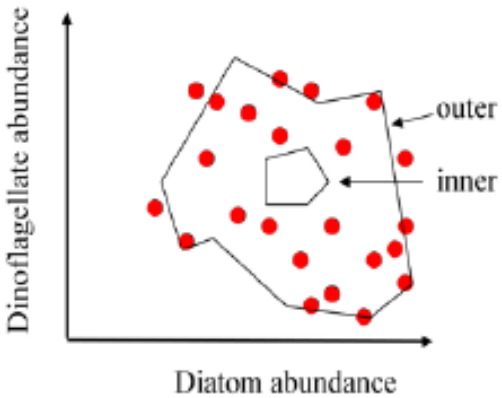
Qualitätsindikatoren:

Descriptor	Lifeform pair 1		Lifeform pair 2		Lifeform pair 3	
D1: Biodiversity	Diatoms	Dinoflagellates	Gelatinous zooplankton	Fish larvae	Holoplanktonic crustaceans	Non gelatinous and non crustacean holoplankton
Lifeform feature(s)	All diatoms	All dinoflagellates	Ctenophores & Coelenterates	Excluding fish eggs	Excluding eggs	
Reasoning:	Evolutionary distinct groups with different attributes and general biology		Indicators of alternative ecosystem states and potential services in food provision		Evolutionary distinct groupings that capture all holoplankton not included in Lifeform pair 2	
Pressure(s):	Nutrient enrichment; change in hydrographic conditions		Fishing		Fishing; Nutrient enrichment	
D4: Food-webs	Phytoplankton	Zooplankton	Large phytoplankton	Small phytoplankton	Large copepods	Small copepods
Lifeform feature(s)	Chlorophyll (mg m^{-3})	Abundance (m^{-3})	> 20 µm	< 19.9 µm	> 2 mm	<1.9mm
Reasoning:	A gauge of the magnitude of energy flow and the balance between successive trophic levels		Energy transfer from primary to secondary producers a size-based gauge of the potential efficiency of energy flow to higher trophic levels		Food web structure and efficiency of energy flow through food web	
Pressure(s):	Fishing		Fishing		Fishing, nutrient enrichment, change in stratification	
D5: Eutrophication	Diatoms	Dinoflagellates	Ciliates	Microflagellates	Pseudo-nitzschia spp.	Toxin producing dinoflagellates
Lifeform feature(s)	All diatoms	Autotrophs and mixotrophs	Including tintinids	All species < 20 µm	Excluding P. delicatissima	All species on the Food Standards Agency list (Table 4)
Reasoning:	Shift in community composition towards potentially harmful groups		Shift from primarily autotrophic to a more heterotrophic system		Shift in algal community towards dinoflagellate HABs	
Pressure(s):	Nutrient enrichment		Nutrient enrichment		Nutrient enrichment	

(Gowen et al 2013)

Und dann:

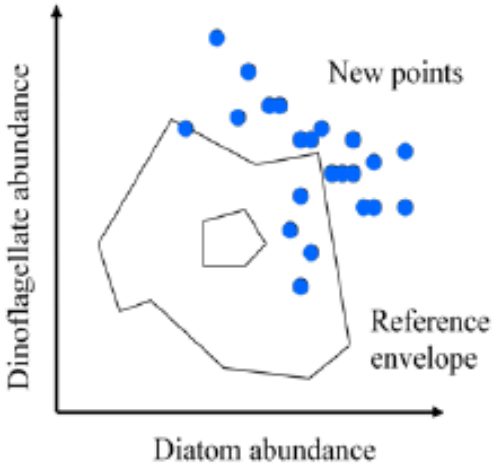
Plotting the abundance of 2 lifeforms in state space to create a 'reference envelope'



Calculating the Index

$$PCI = \frac{\text{new points between inner/ outer envelopes}}{\text{total new points}}$$

PCI = 1: no change from reference condition
PCI = 0: a complete change.



(Gowen et al 2011)

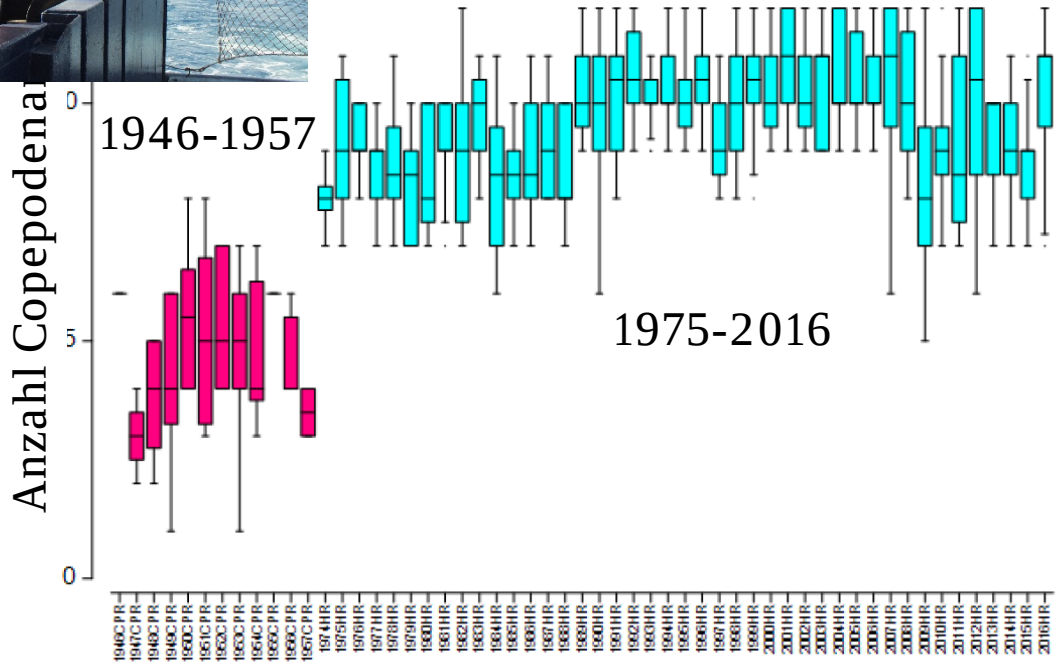
Probleme:

- Was sind Referenzzustände?
- Was bedeuten diese Life-form pairs genau?
- Was zeigen sie, und Fokus nur auf Eutrophierung und Fischerei?
  - Was ist mit anderen Stressoren (Temp, pH, O_2)
- Wie Gebietspezifisch sind die Deskriptoren?
- Benutzt man Anzahl oder Biomasse

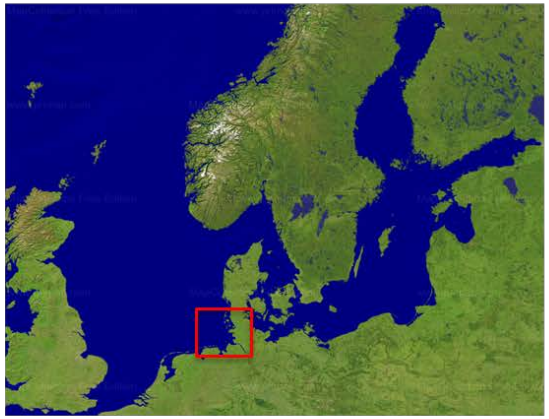
The Helgoland Roads Zeitreihen

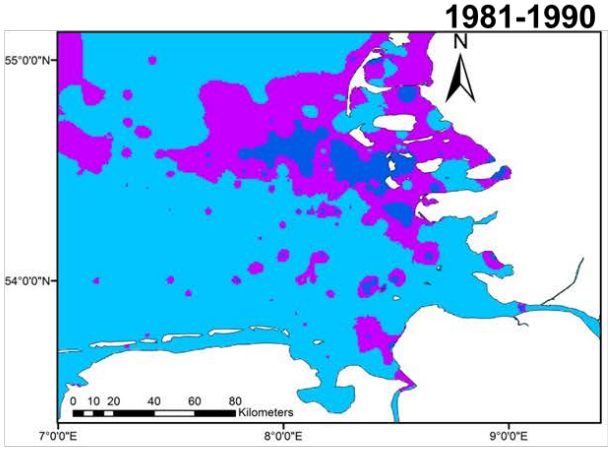
- Seit 1962, täglich:
  - Temperatur, Salinität, Secchi
  - Nährstoffe
  - Phytoplankton
- Seit 1975, 3-mal wöchentlich:
  - Zooplankton
  - Ichthyoplankton
- Seit 2008, kontinuierlich
  - Ferrybox

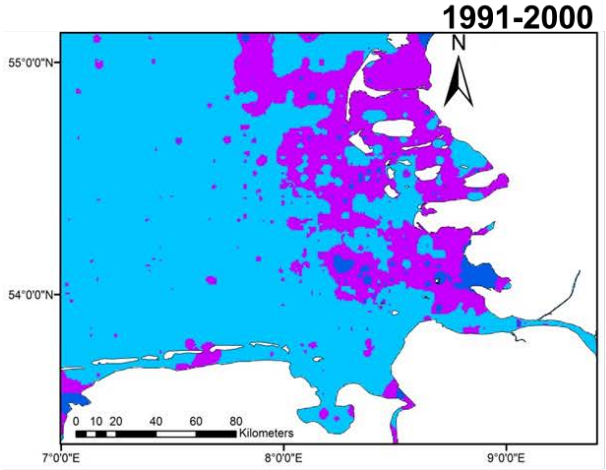
Referenz?

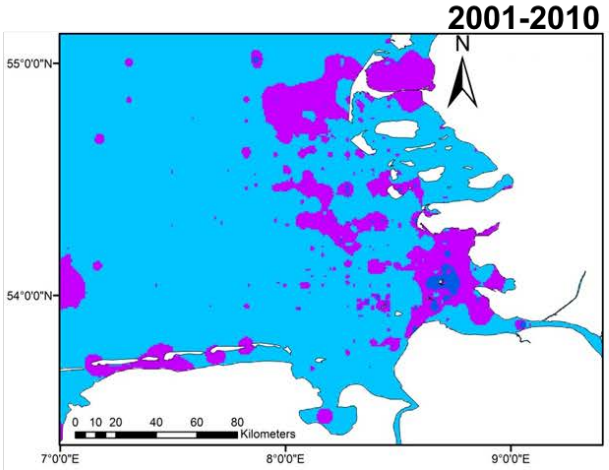


Aber es ändert sich vieles









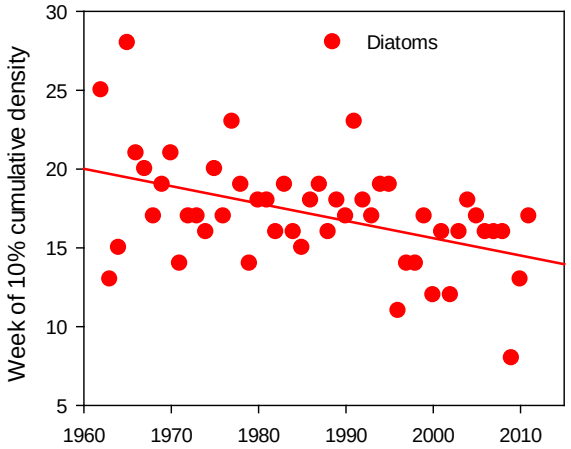
N-limited
N/P ratio < 15

Redfield
N/P ratio=15-17

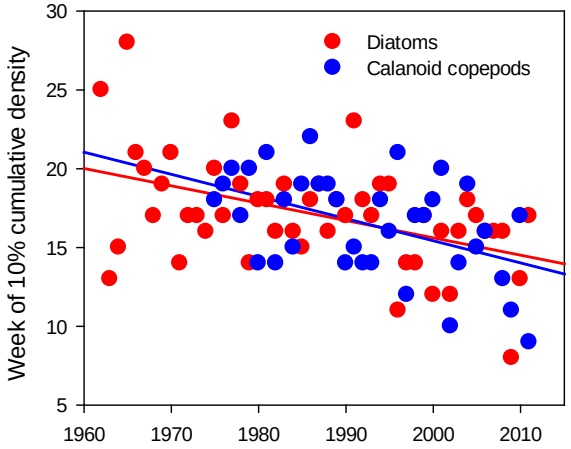
P-limited
N/P ratio > 17

Sarker et al. In prep

Das was passiert ist is klar:



Feststellung:
Saisonsanfang für **Diatomeen** und kleine Copepoden haben sich gleichzeitig geändert.



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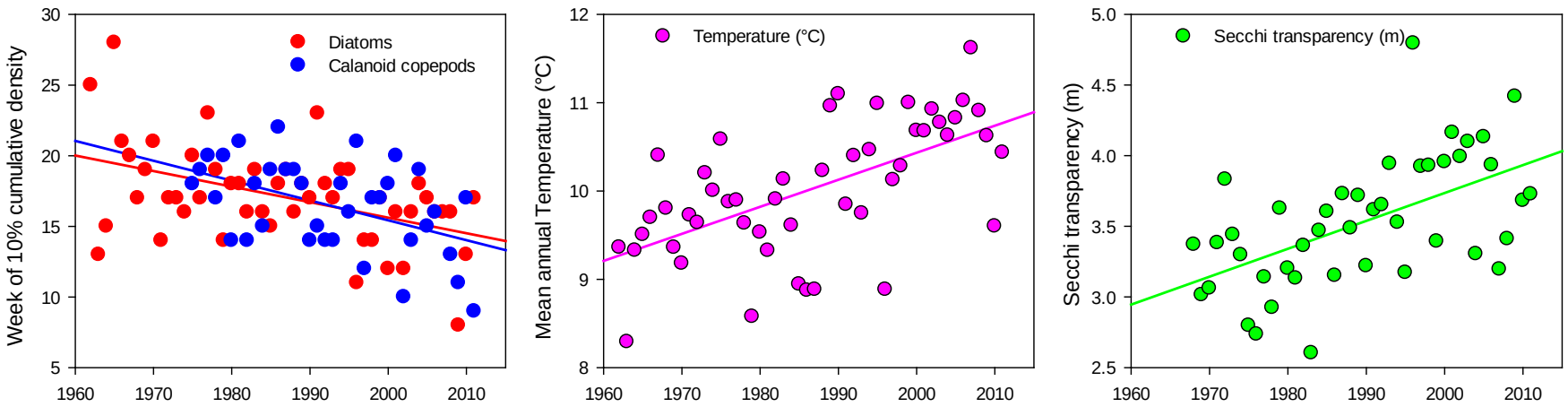
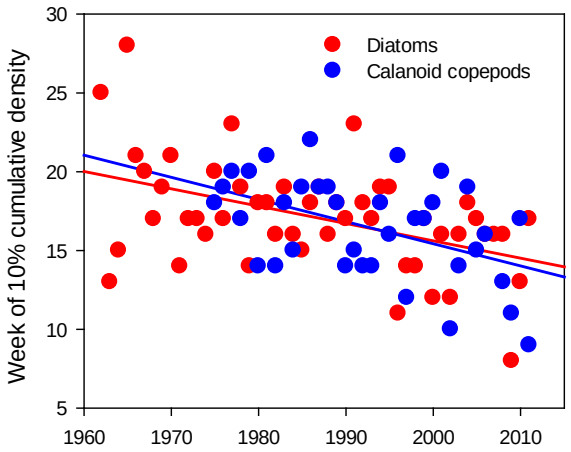
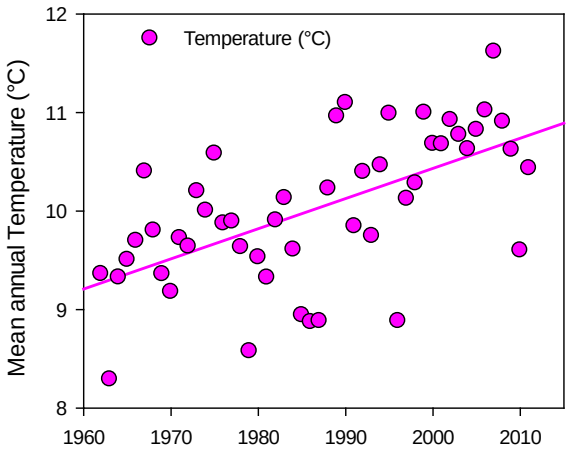
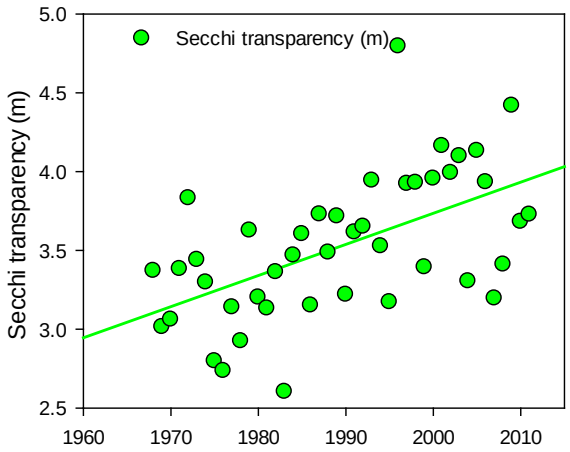


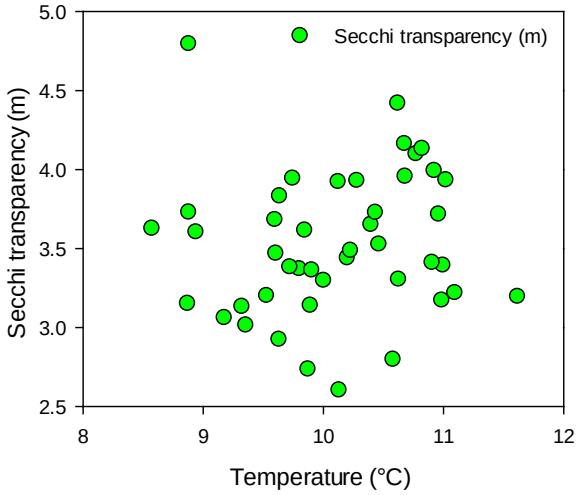
Ursachen:

Wasser klarer und wärmer



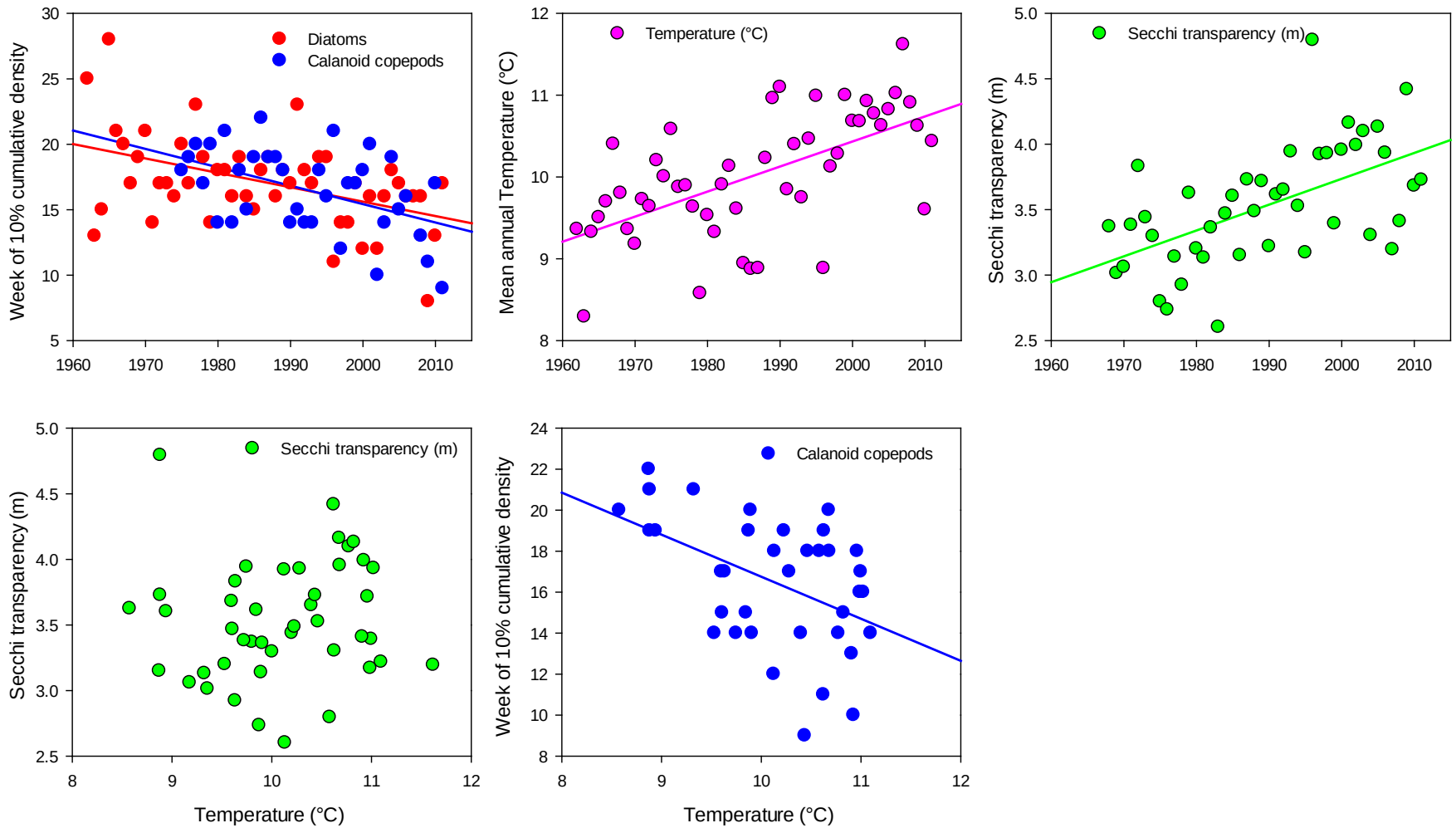




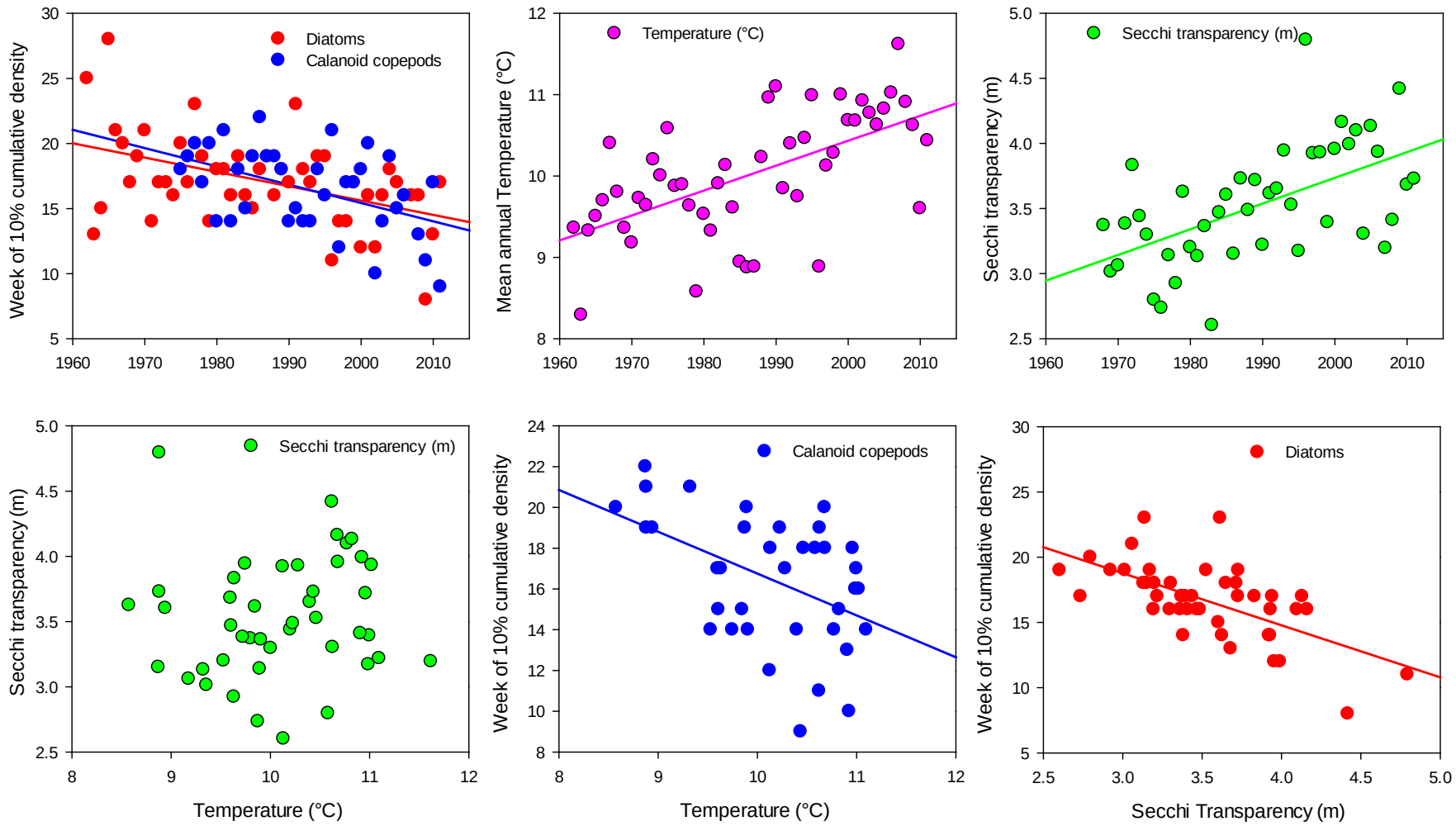


Ursachen:
Wasser klarer und wärmer

Aber:
Die beiden Faktoren sind nicht korreliert



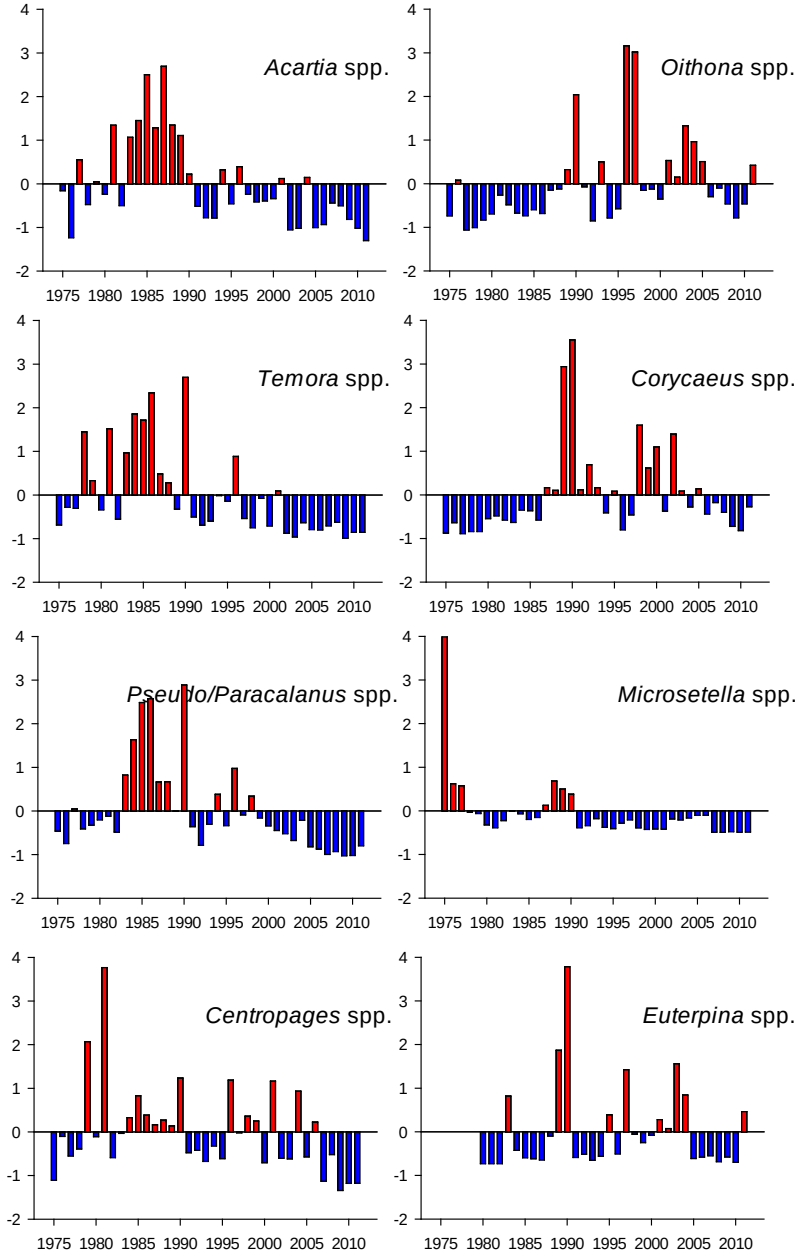
Temperatur korelliert nur mit Saisonanfang der **Copepoden** und nicht Diatomeen

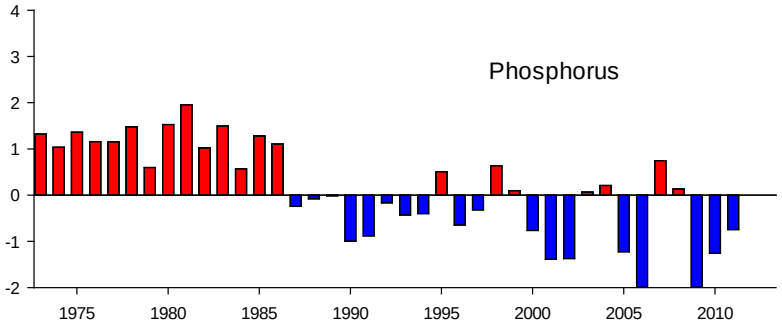


Secchi korreliert nur mit **Diatomeen** und nicht Copepoden

Wiltshire & Boersma 2016

Und vieles mehr:

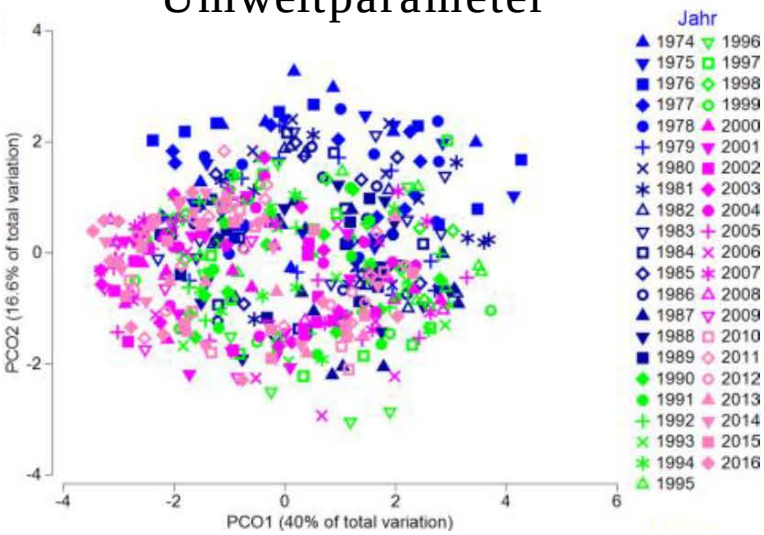




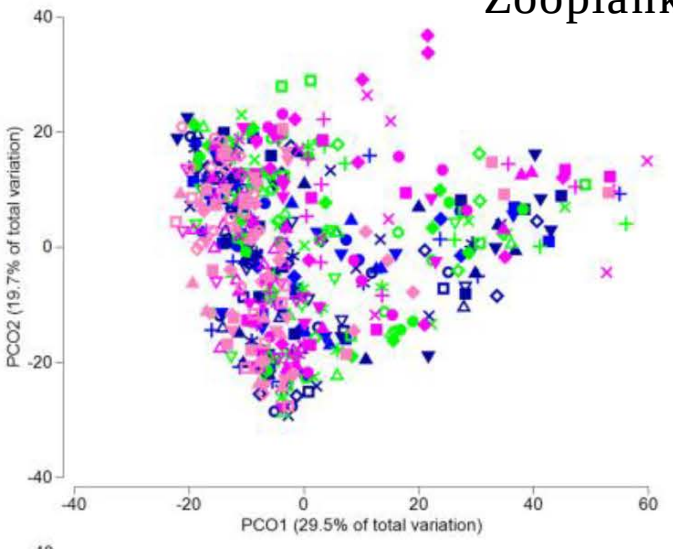
Boersma et al. 2015

Zooplanktongemeinschaftsänderung

Umweltparameter



Zooplankton

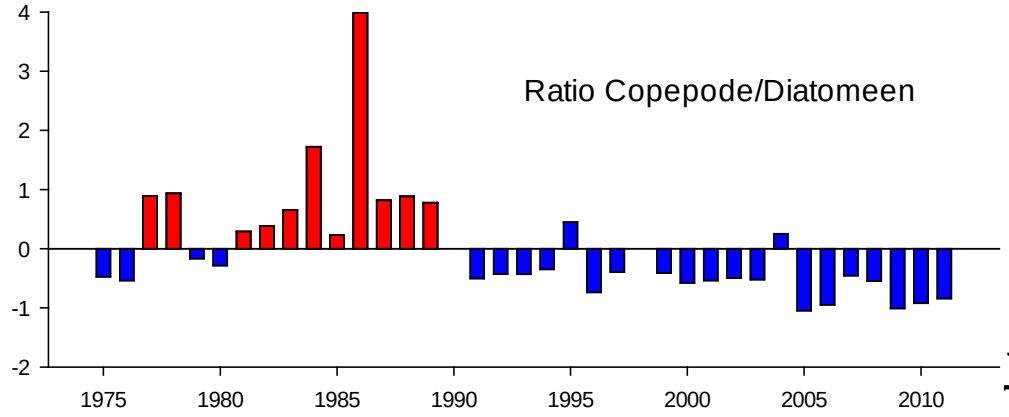


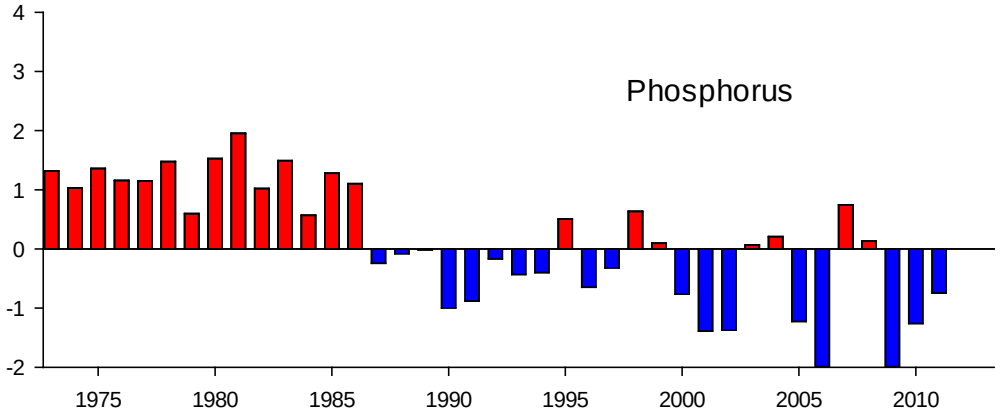
Aber Zooplanktonparameter korrelieren mit Umweltparameter

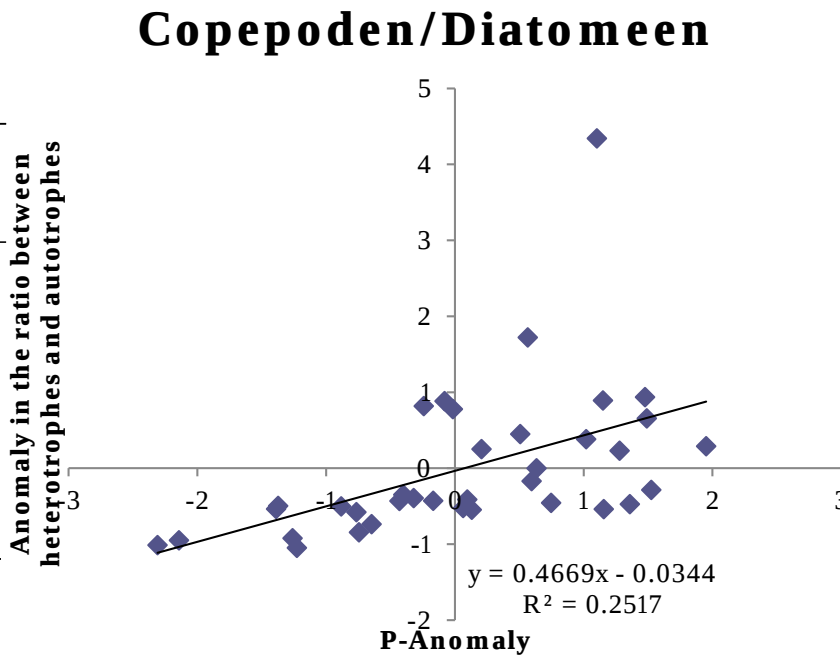
	Secchi	Temperatur	Salzgehalt	SiO_4	PO_4	DIN
Oithona:Acartia	**-0,087**	**-0,010**	**0,158**	**0,234**	**0,062**	**-0,143**
Temora:Acartia	**-0,137**	**-0,449**	**-0,106**	**0,124**	0,020	**0,392**
Cirripedia:Acartia	**0,251**	0,006	**-0,181**	**-0,086**	**-0,342**	**0,059**
Calanus:Acartia	**-0,105**	**-0,136**	**0,134**	**0,141**	**0,131**	**0,085**
Calanoida:Cyclopoida	**0,079**	0,015	-0,006	**-0,074**	**-0,032**	0,021
MZA	**0,404**	**0,548**	**-0,362**	**-0,391**	**-0,388**	**-0,136**
MCA	**0,310**	**0,496**	**-0,316**	**-0,326**	**-0,275**	**-0,105**
Shannon-Diversität	**0,209**	**0,314**	**-0,034**	**-0,070**	**-0,271**	**-0,231**

- Allerdings immer nur <5% erklärter Varianz

So einfach wie möglich:







Boersma et al. 2015

Also….

- Zooplanktonparameter korrelieren mit Umweltbedingen, allerdings in der Regel nur schwach
- Damit ist bis jetzt unklar, was Zooplanktonindikatoren zusätzlich beitragen können
- Allerdings, brauchen wir sie für eine komplette Beschreibung des Systems

Deswegen ist noch einiges zu tun:

- Was sind Referenzzustände?
  - Kompletter Satz CPR-Daten, historische Daten
- Was bedeuten Life-form pairs genau?
  - Nutzung von *a priori* festgelegten Indikatoren
- Fokus nur auf Eutrophierung und Fischerei?
  - Analyse der anderen Stressoren (Temp, pH, O_2)
- Wie Gebietspezifisch sind die Deskriptoren?
  - ???
- Benutzt man Anzahl oder Biomasse
  - Biomassebestimmungen von Zooplankton