



* *The impact of biological invasions on the food web of the Wadden Sea (INFOWEB) - an introduction and outlook*

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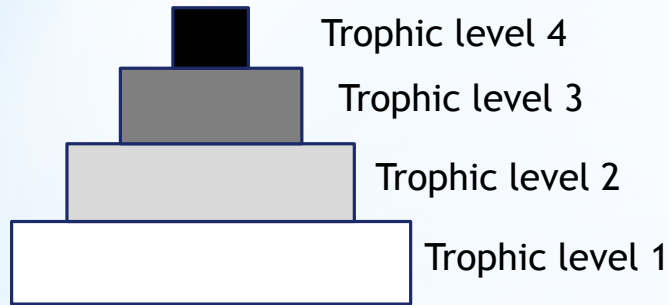
University of Groningen, the Netherlands

Senckenberg Institut, Wilhelmshaven, Germany

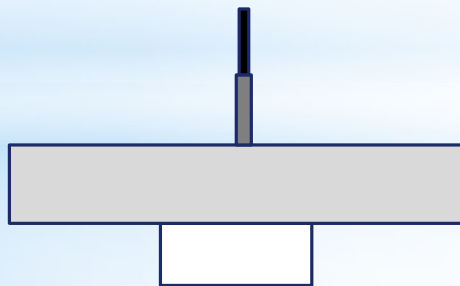
Wattenmeerstation Sylt, Alfred- Wegener- Institut (AWI), Helmholtz- Zentrum für Polar und Meeresforschung, Sylt, Germany

Fiskeri- og Søfartsmuseet, Saltvandsakvariet, Esbjerg, Denmark

* Invasions occur mainly at lower trophic levels



Trophic distribution of a pristine ecosystem



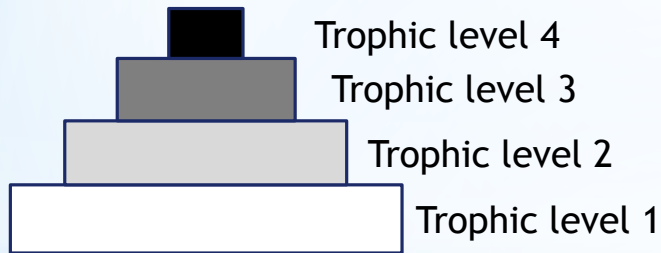
invaders trophic distribution



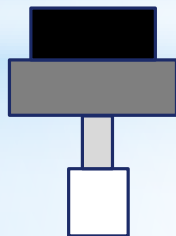
After Byrnes et al. 2007

* *The impact of biological invasions on the food web of the Wadden Sea (INFOWEB)*
- an introduction and outlook

- * Invasions occur mainly at lower trophic levels
- * In the Wadden Sea extinctions in the past occur on top of the food web



Trophic distribution of a pristine Wadden Sea



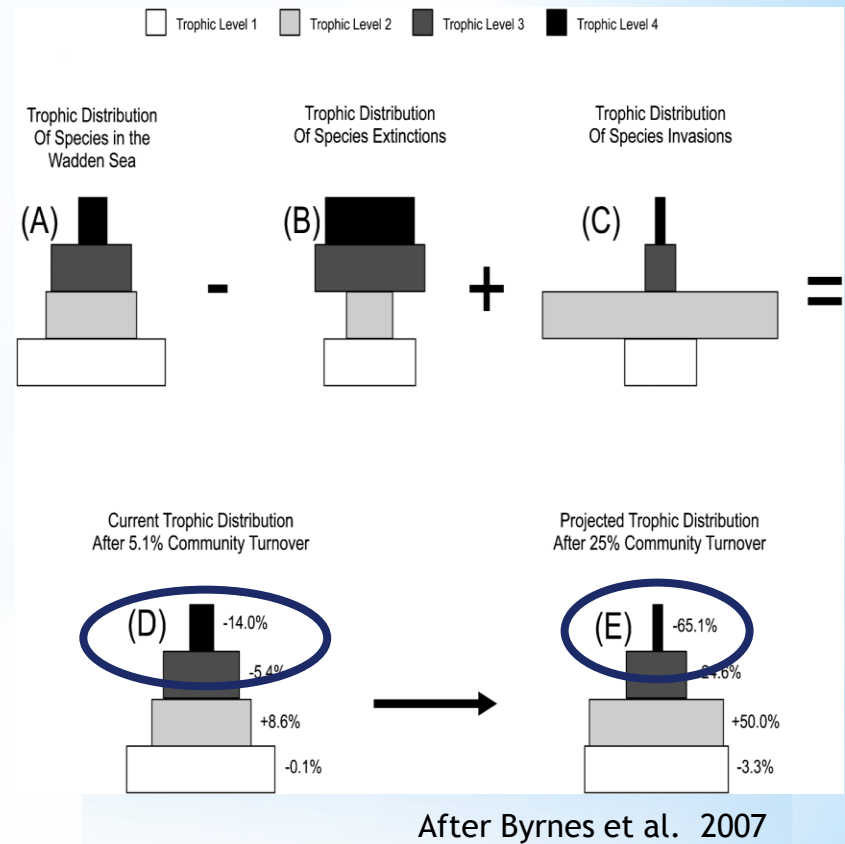
Extinct species trophic distribution



After Byrnes et al. 2007

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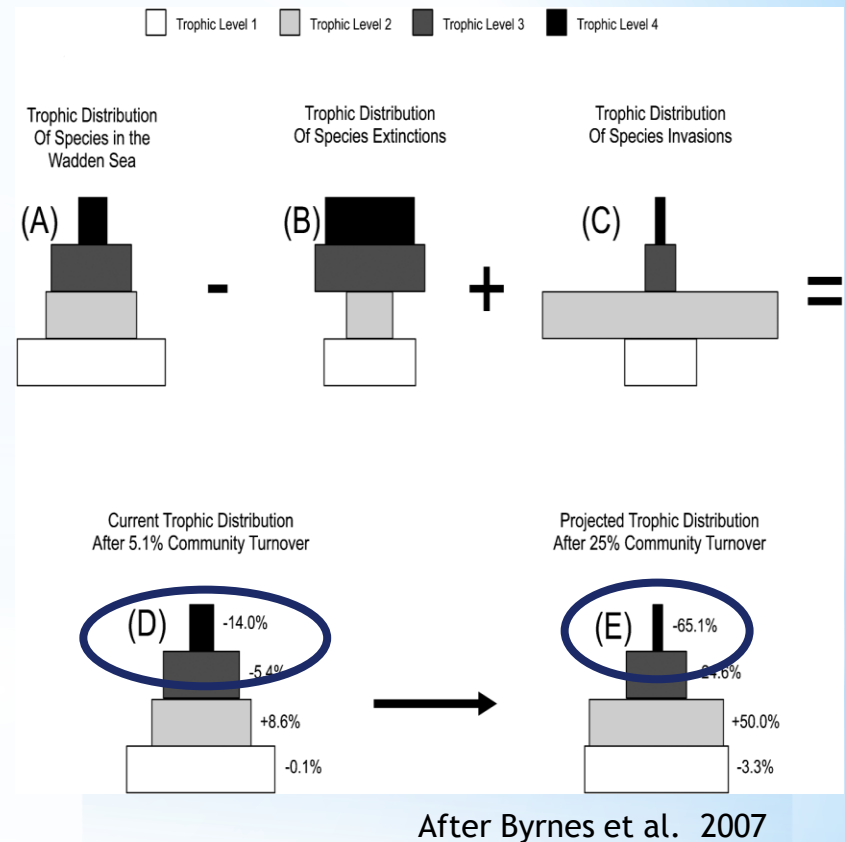
- * In the Wadden Sea extinctions in the past occur on top of the food web
- * Invasions occur at lower trophic levels
- * The consequence is a disproportion in the trophic pyramid with a dominance of primary consumers and a reduction of predators and top predators



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* What does this mean for the stability and the functioning of the food web ?



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Comparing the food web of a certain Wadden Sea region with and without invasive species

and assessing the consequences

* of the dominance of invasive primary consumers



* for the role of predators and top predators



* *The impact of biological invasions on the food web of the Wadden Sea (INFOWEB)*
- *aim of the project*

- * Food web model of the Sylt- Rømø Bight, before major alterations in the system occur due to invasions of species.
- * It takes into consideration the different habitats of the system (eg. seagrass beds, mussel beds, sand flats and mud flats).

* *The impact of biological invasions on the food web of the Wadden Sea (INFOWEB)*
 - *our starting point*

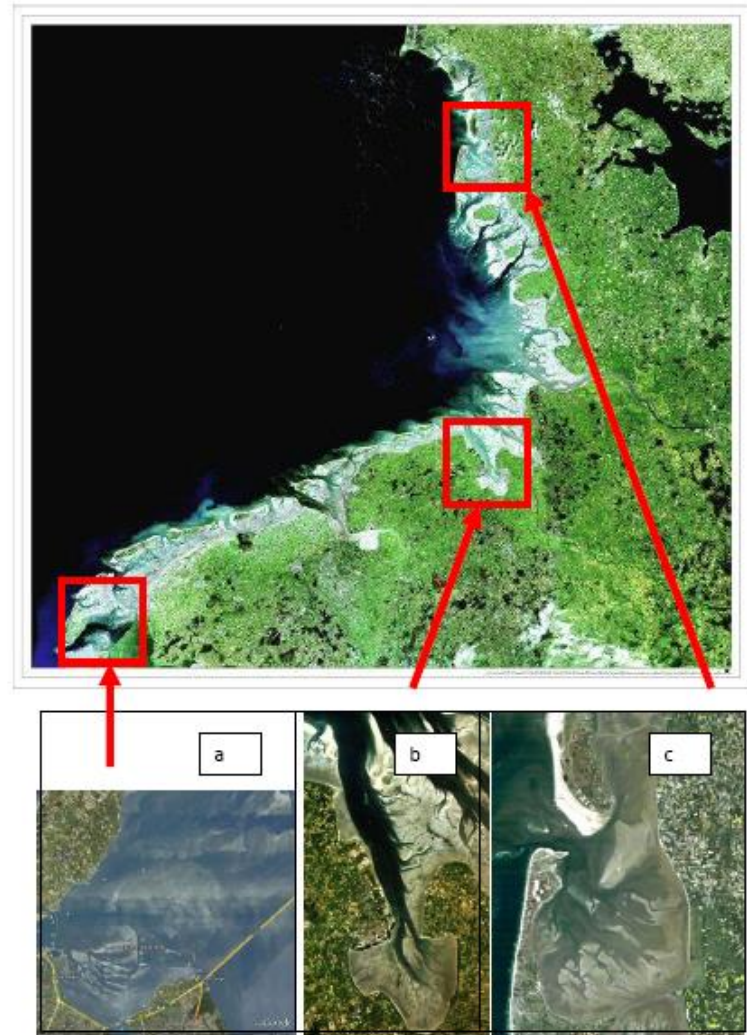
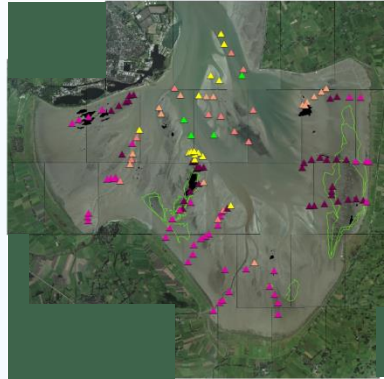


Fig. 1: Satellite Image of the Wadden Sea showing the 3 prospected areas for food web analysis (a.: Balgzand at the Southern Wadden Sea; b. Jade Bay in the Central Wadden Sea c. Sylt-Rømø Bight in the Northern Wadden Sea)

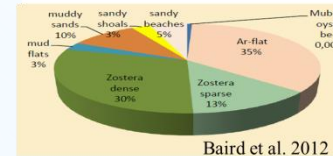
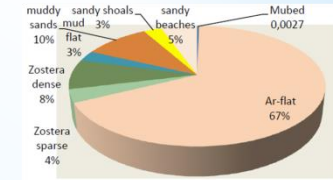
Balgzand



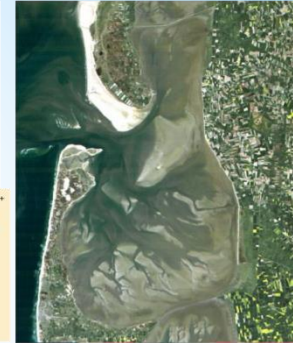
Jade Bay



Sylt-Rømø Bight



Baird et al. 2012



Tidal range	mesotidal, 1.4 m	macrotidal, 3.8 m	mesotidal, 2 m
Total surface area	60 km ²	158 km ²	404 km ²
Intertidal area	50 km ²	114 km ²	135 km ²
Habitat characteristics:			
<i>Arenicola</i> sandflats	35 %	30 %	35 %
Mudflats	15 %	43 %	3 %
Seagrass beds	<1 %	8 %	20 %
Important invasive species:	<i>Crassostrea gigas</i> (2003), <i>Ensis americanus</i> (1982), <i>Marenzelleria viridis</i> (1989), <i>Mediopyxis helysia</i> (2004), <i>Mnemiopsis leidyi</i> (2006)	<i>Crassostrea gigas</i> (1998), <i>Ensis americanus</i> (1979), <i>Caprella mutica</i> (2009)	<i>Crassostrea gigas</i> (1986), <i>Crepidula fornicata</i> (1870), <i>Ensis americanus</i> (1978), <i>Marenzelleria viridis</i> (1983), <i>Sargassum muticum</i> (1993), <i>Spartina anglica</i> (1920), <i>Mnemiopsis leidyi</i> (2006).

The impact of biological invasions on the food web of the Wadden Sea (INFOWEB)

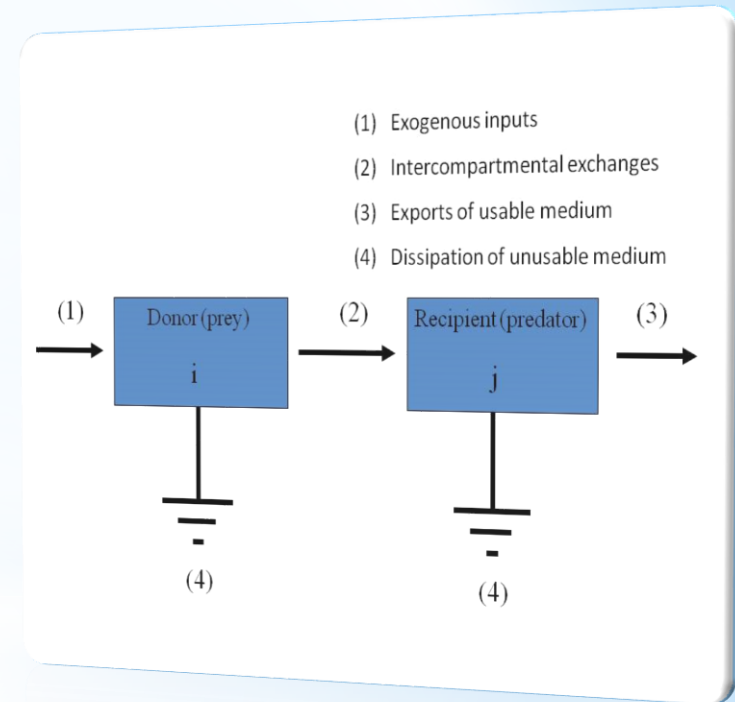
- ***our project***



The impact of biological invasions on the food web of the Wadden Sea (INFOWEB)

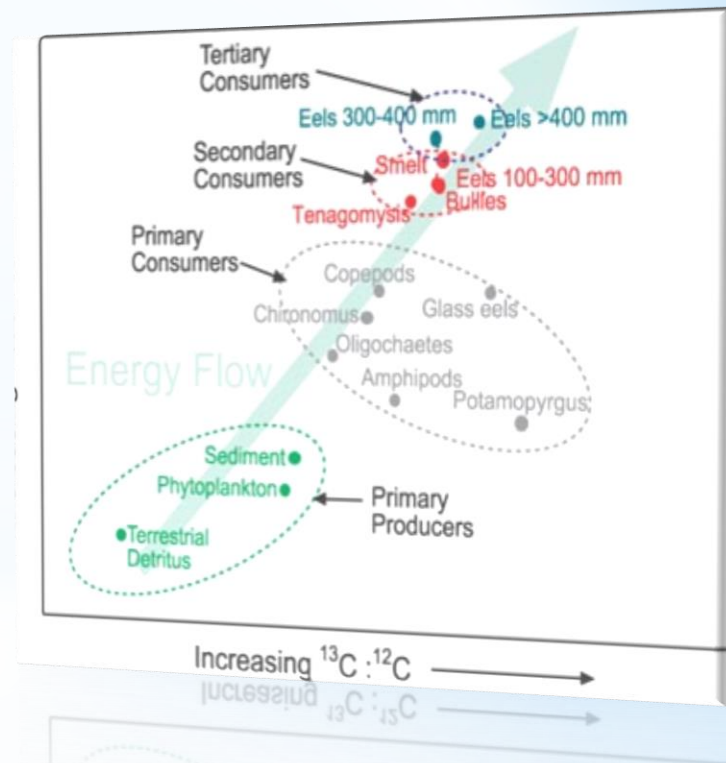
- our team

- * Biomass and production data, respiration and egestion/excretion data to formulate energy budgets of the dominant species



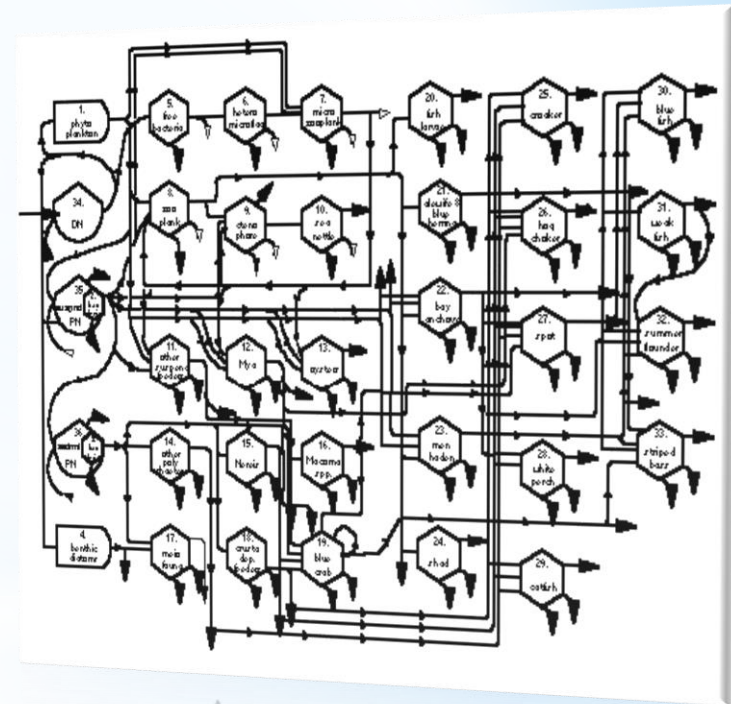
- * *The impact of biological invasions on the food web of the Wadden Sea (INFOWEB)*
- *our tools*

- * Biomass and production data, respiration and egestion data to formulate energy budgets of the dominant species
- * Stable isotope analysis to compute diet spectra



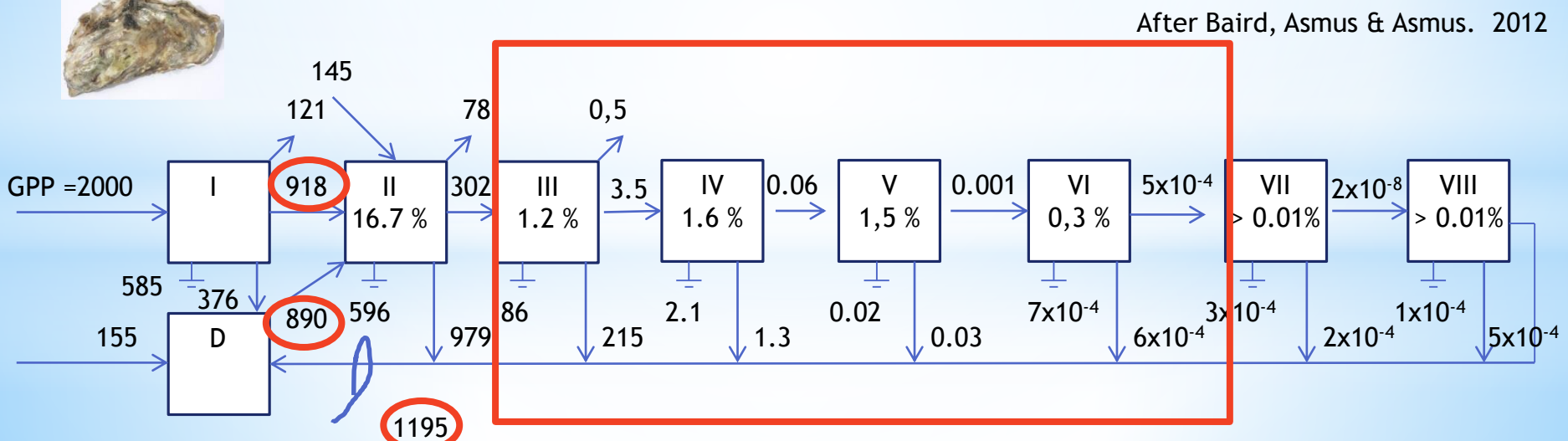
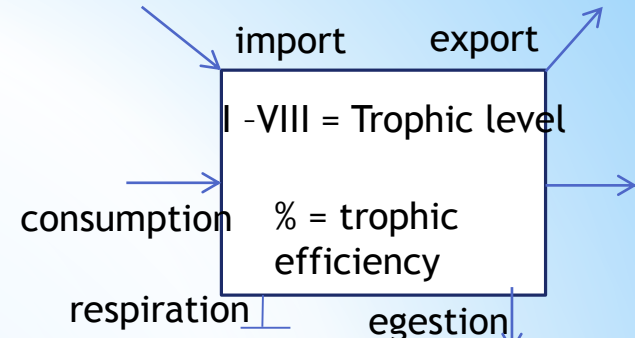
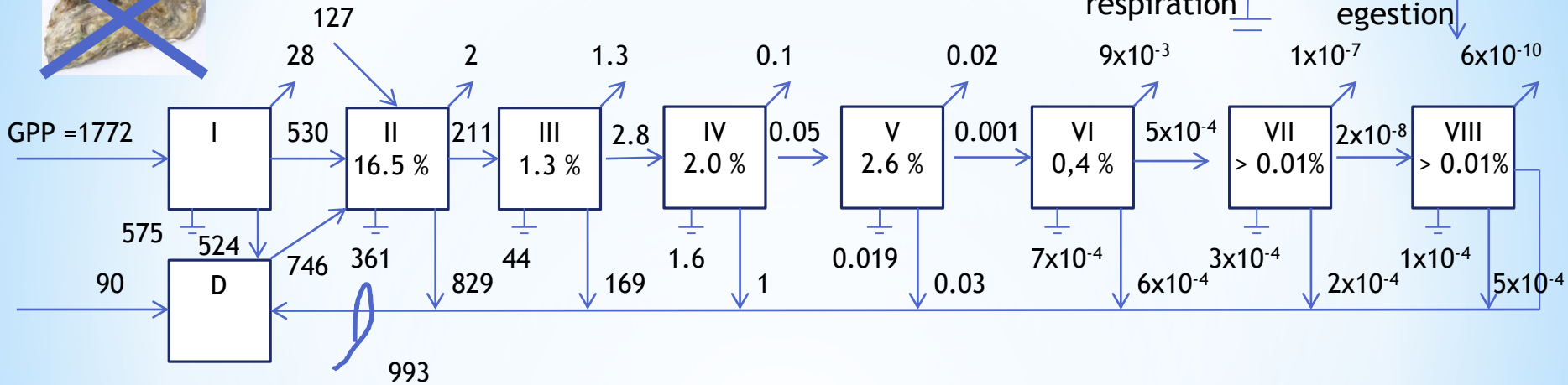
- * *The impact of biological invasions on the food web of the Wadden Sea (INFOWEB)*
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- * Biomass and production data, respiration and egestion data to formulate energy budgets of the dominant species
- * Stable Isotope analysis to compute diet spectra
- * Ecological network analysis to describe food web characteristics



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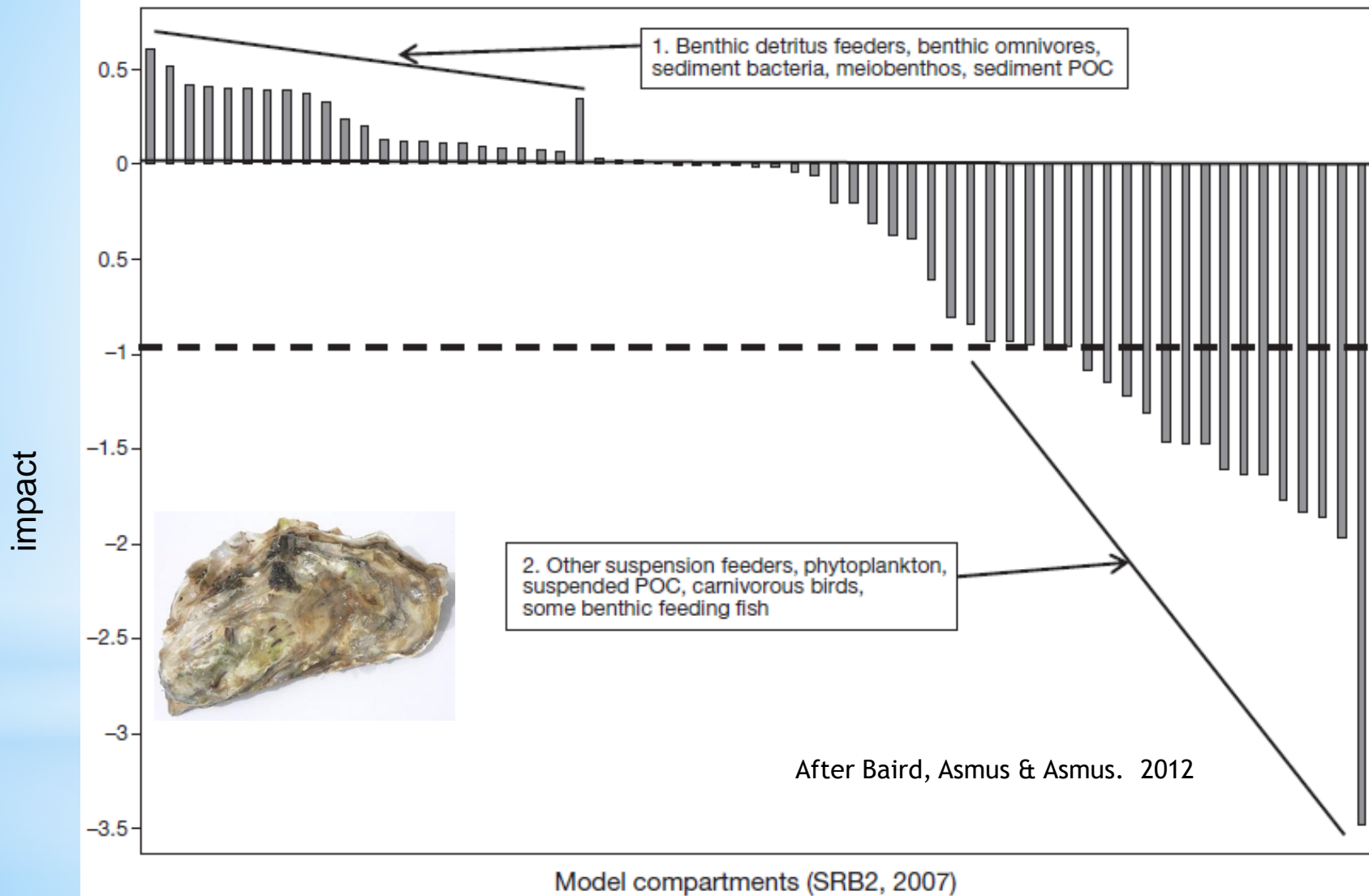
dominance of invasive primary consumers consequences on the food web



After Baird, Asmus & Asmus. 2012

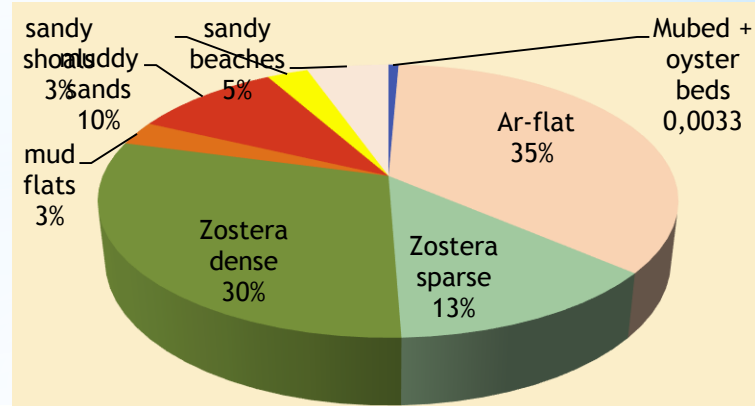
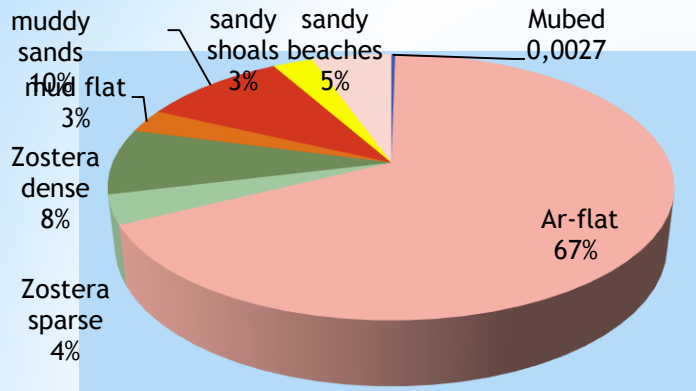
The impact of biological invasions on the food web of the Wadden Sea (INFOWEB)
 - our results

dominance of invasive primary consumers consequences on the food web



The impact of biological invasions on the food web of the Wadden Sea (INFOWEB)
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Shift in energy networks of the Sylt Bight between 1990/1995 and 2007



2 Energy Network Models (food webs) based on data from 2 different time periods:

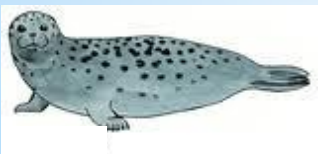
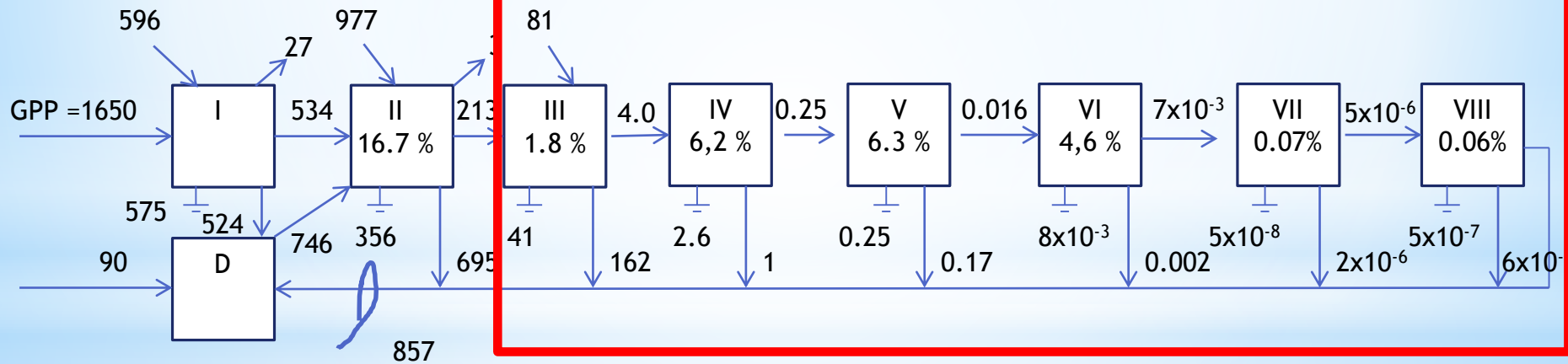
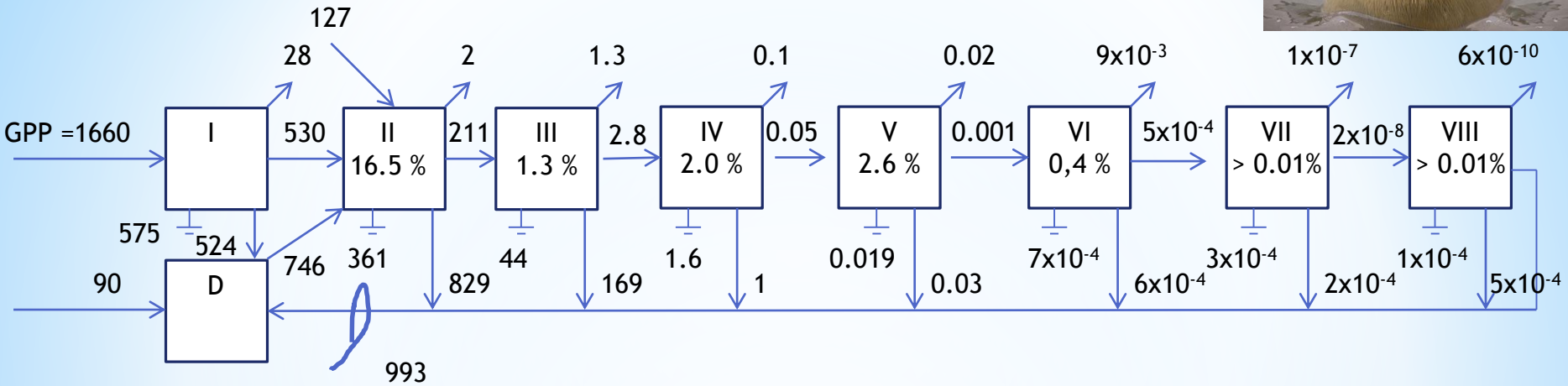
	Before seagrass and oysters	oyster abundance	
Model compartments	59	63	
Total biomass (gC m ⁻²)	35	45	↑ 28
Average system P/B(day ⁻¹)	0.043	0.026	↓ -40
Number of cycles	1197	829	↓ -31
Finn cycling index (FCI, %)	17.21	16.47	↓ -4.3
Total systems throughput (mgCm ⁻² d ⁻¹)	6752	6462	↓ -4.3
Relative Ascendency ratio (A/DC;%)	38.8	36.6	↓ -5.7
Relative redundancy (R/DC;%)	33.7	31.3	↓ -7.3

The impact of biological invasions on the food web of the Wadden Sea (INFOWEB)

- our results

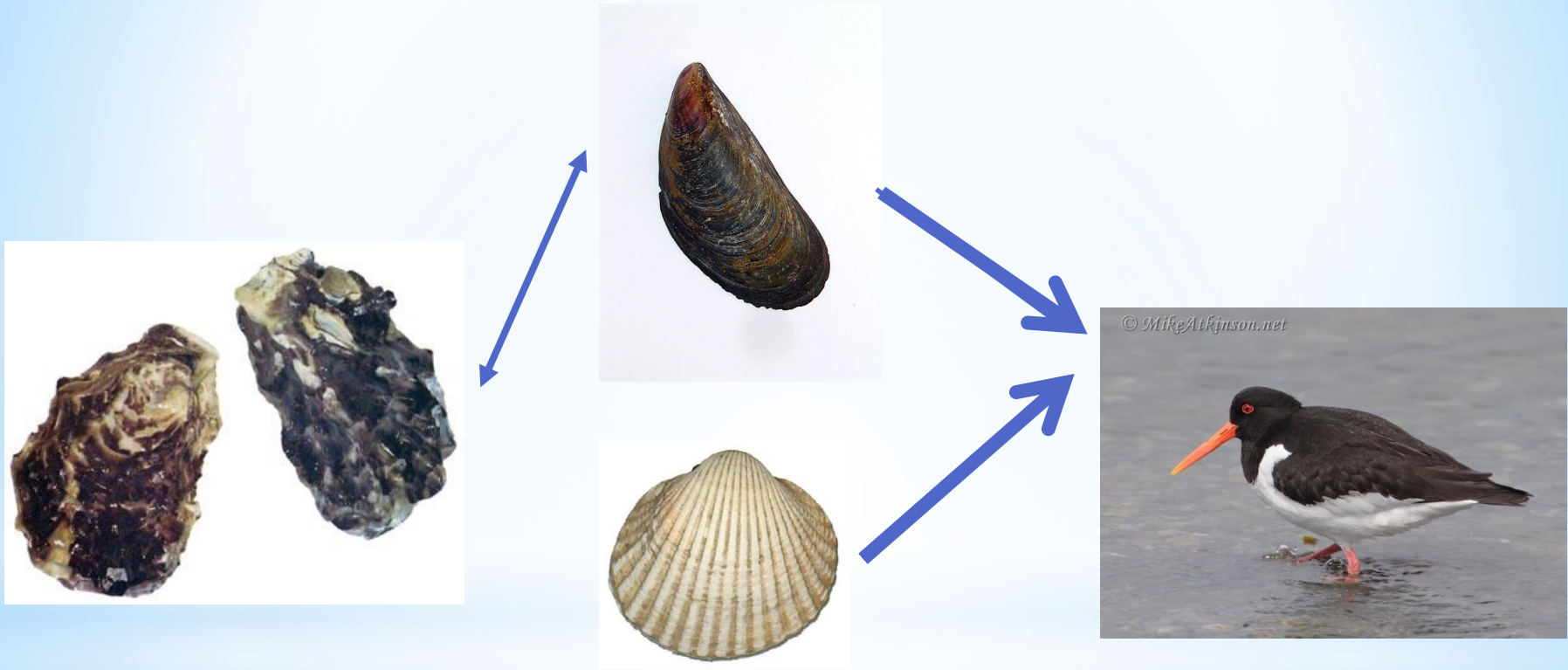


role of predators and top predators consequences on the food web



The impact of biological invasions on the food web of the Wadden Sea (INFOWEB)
- our results

diet shifts and indirect effects



The impact of biological invasions on the food web of the Wadden Sea (INFOWEB)

- still gaps

Ensis directus:

- high biomass per m², comparable to mussel beds (about 1000 g dw m⁻²)
- Important new food resource for birds and fish



- Still gaps in knowledge on energy budget of *Ensis* was filled this year

The impact of biological invasions on the food web of the Wadden Sea (INFOWEB)

- *our gaps*

- * A dominance in invasive species results in
 - * A positive impact in benthic detritus feeders, benthic omnivores, sediment bacteria, meiobenthos and sediment POC.
 - * decrease of trophic efficiencies and export to the sea in higher trophic levels
 - * A negative impact on other suspension feeders, phytoplankton, suspended POC, carnivorous birds and some ebenthic feeding fish
- * Inclusion of top predators into a food web changes
 - * characteristics , increases imports, decreases exports and improves transfer efficiency

* *The impact of biological invasions on the food web of the Wadden Sea (INFOWEB)*
- *our conclusions*

- **Project: Effects of invasive species on native predator-prey and pathogen –host webs (NL/D)**
- Project: From sediments to top – predators – influence of seabed characteristics on benthos and benthivorous birds (STopP, D)
- Project: Temporal development of the invasion of Pacific oysters by contrasting the physiological response of Pacific oysters and Blue mussels to physical and chemical conditions in the Wadden Sea and the Limfjord (Musclin DK)
- Projekt: NOAH (national FONA, D)
- Project: Waddensleutels (national NL)
- Project: BEFMATE (artificial islands, terrestrial and marine food webs, D)

* Cooperation with similar projects

- * We need a trilateral approach
- * We need a new aspect in food web research in the Wadden Sea
 - * We agreed to use our network models to explore scenarios on future change of the Wadden Sea (eg. CO₂ and temperature at ecosystem level).
 - * focus on habitat models that could be used to show the influence of single habitats or of habitat diversity itself on ecosystem level.
 - * quantitative investigations on the interactions between habitats for incorporation into the model, but also on qualitative changes within the habitat (such as diversity changes)
 - * We need to integrate parasites into our food web (common synthesis between both biorisk projects)

* *The impact of biological invasions on the food web of the Wadden Sea (INFOWEB)*
- *our perspectives*

Mange tak !

Herzlichen
Dank !

Dank u wel!

