Rijkswaterstaat
Ministerie van Infrastructuur en Milieu

Sediment…….
Home of the unknown…..

Wadden Sea Day 2018

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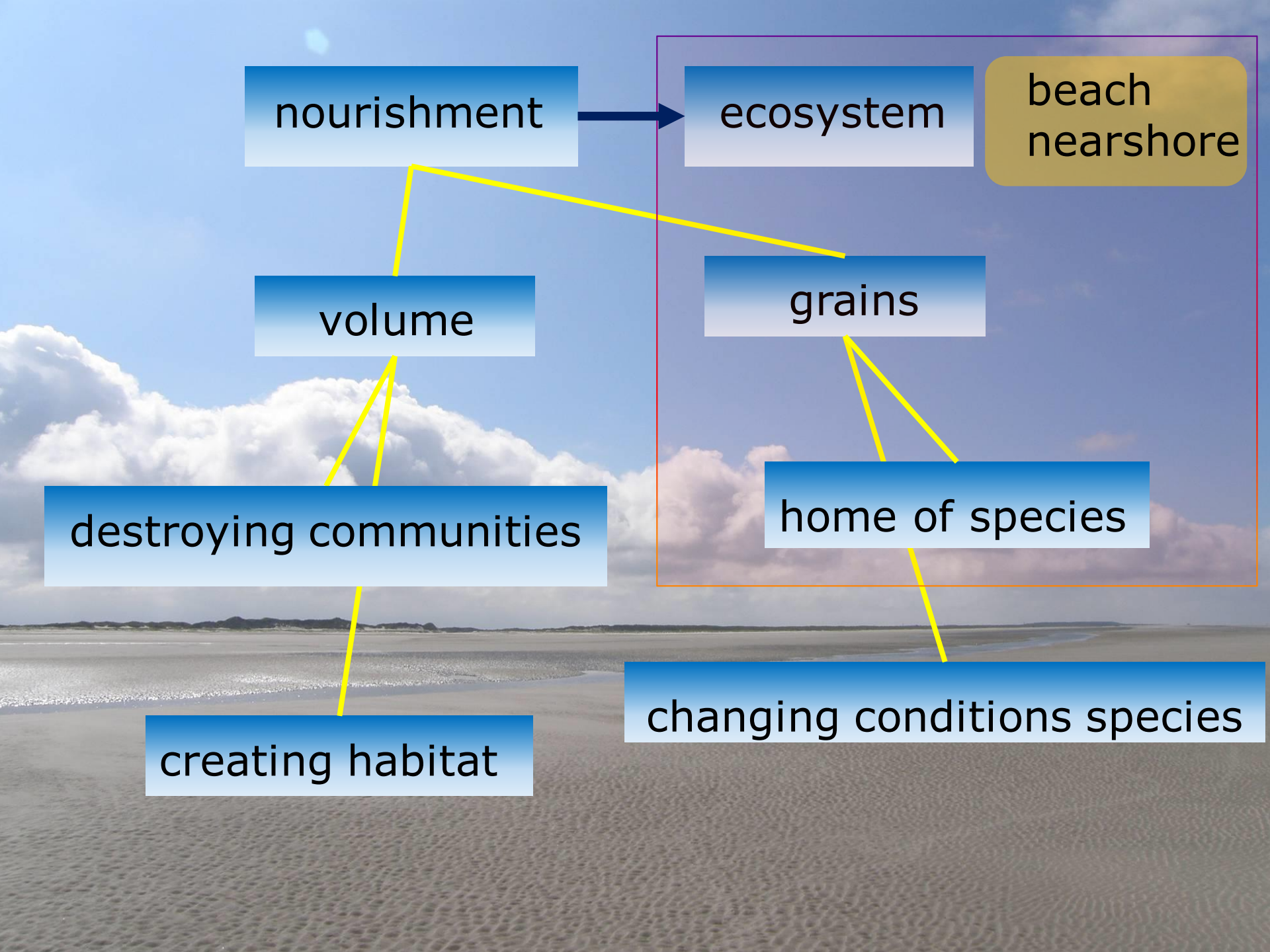
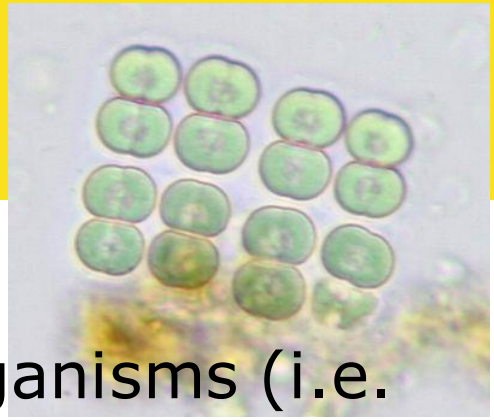
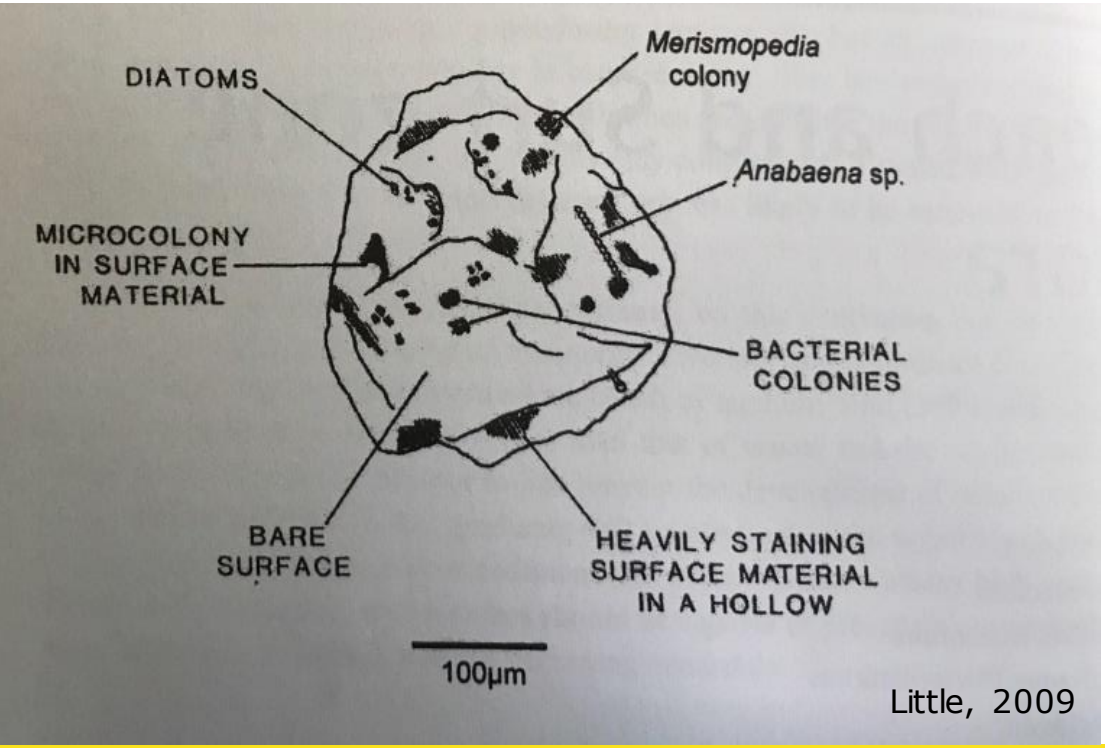
Ministry of Infrastructure and Water / Rijkswaterstaat
The Netherlands


nourishment
ecosystem
beach
nearshore
volume
grains
destroying communities
home of species
creating habitat
changing conditions species

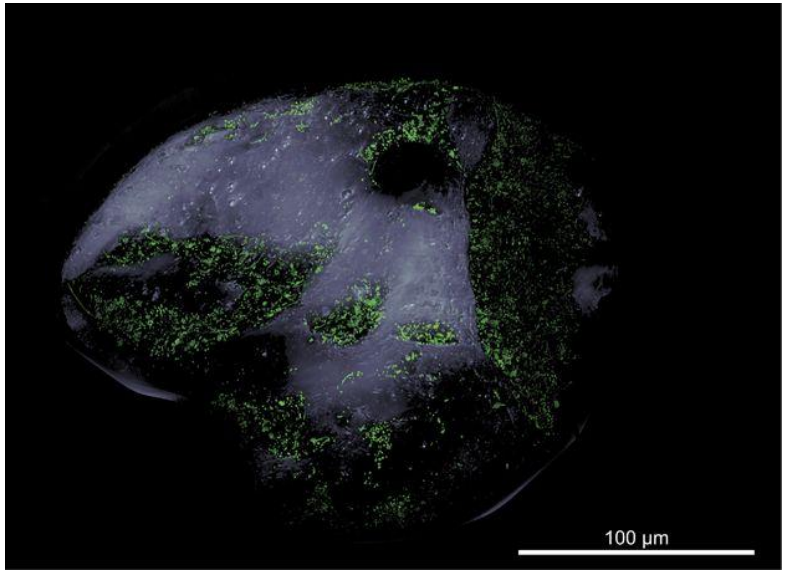
2-dimensional



Between 10,000 and 100,000 microorganisms (i.e. bacteria, diatoms) live on each single sand grain



Little, 2009



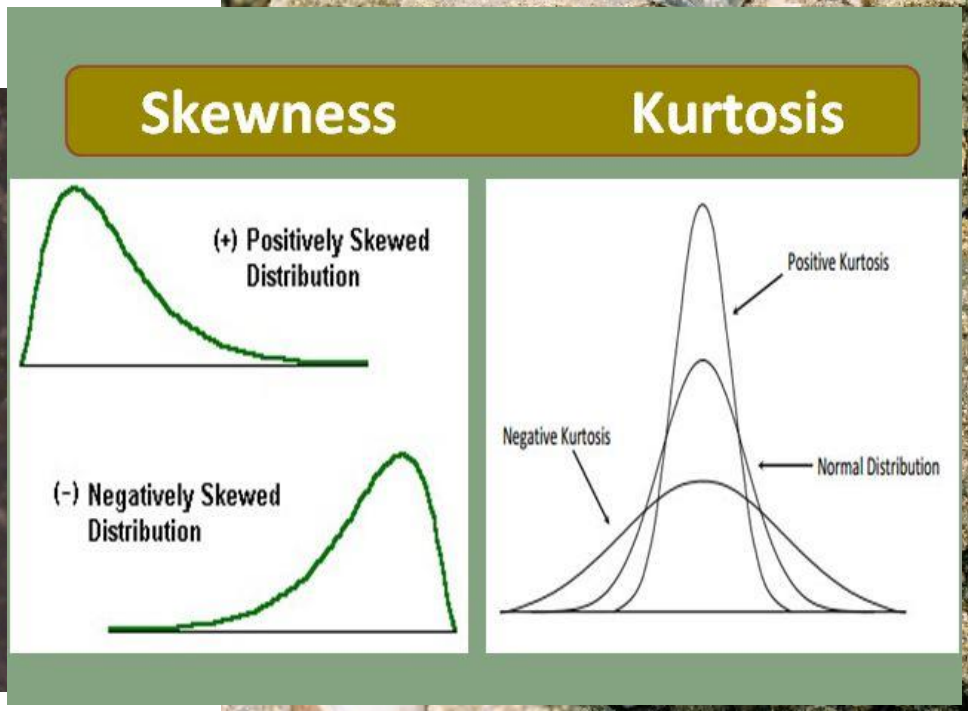
Probandt et al 2018

3-dimensional:

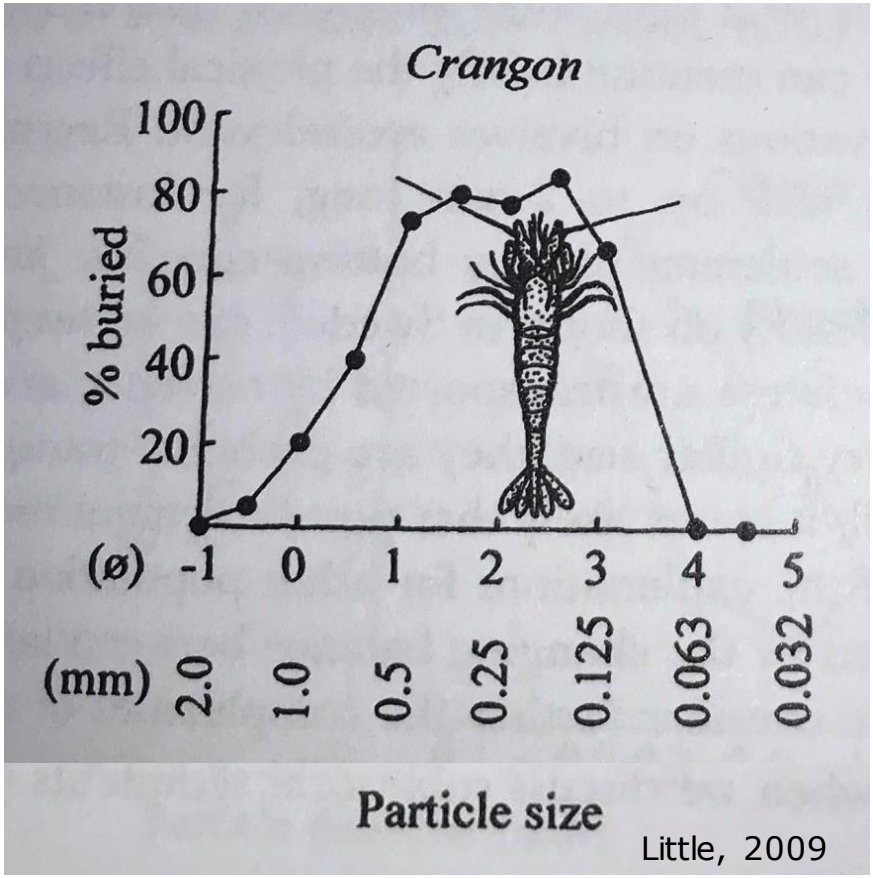
living between the grains

Porosity, pore space


Scolelepis squamata



Sorting / grain size distribution / mean / skewness / kurtosis / permeability / penetrability

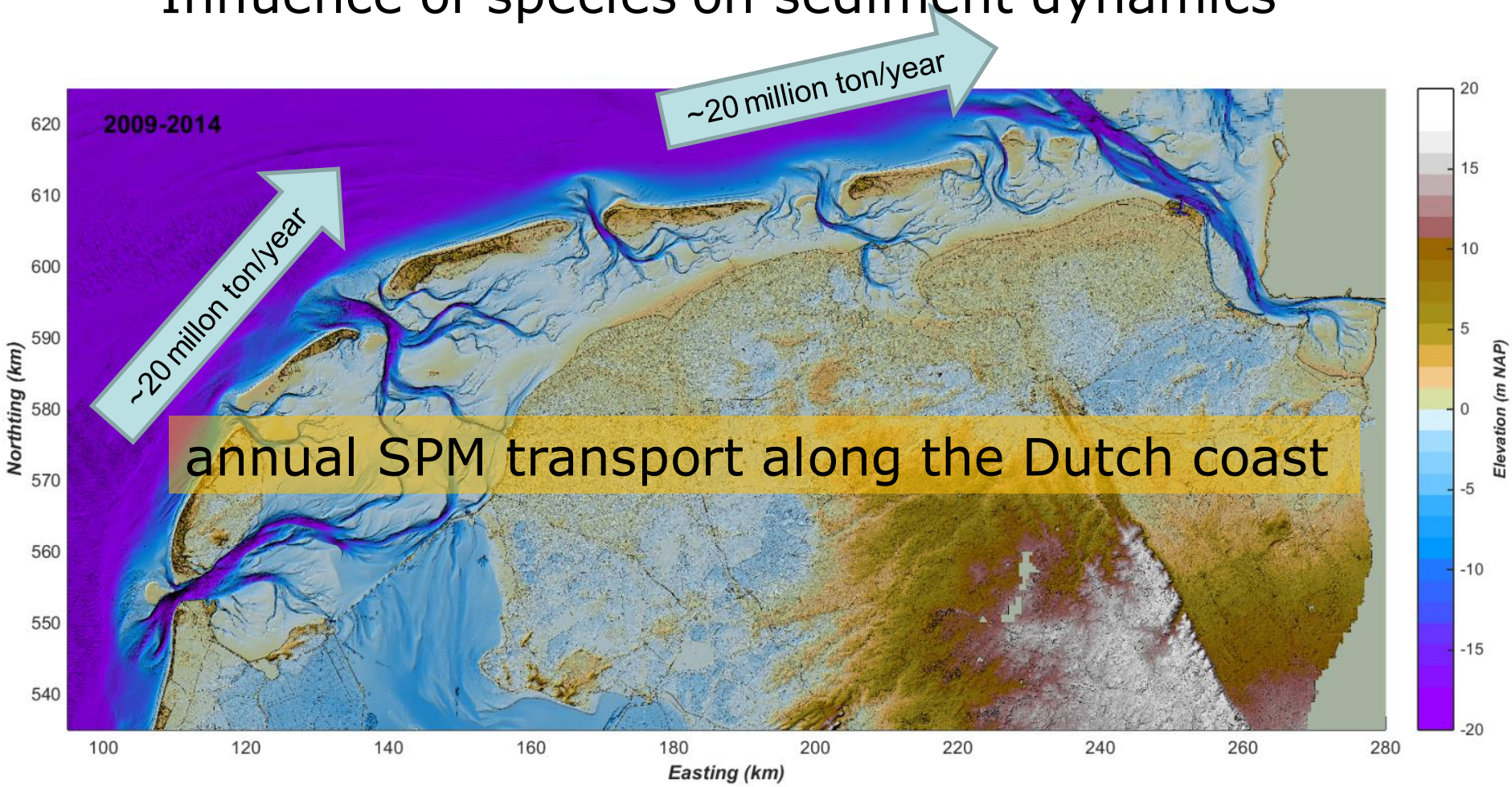


Little, 2009

Behaviour depending on sediment composition

The effect of particle size on the burying ability of a "substratum specialist" (after Pinn and Ansell, 1993)

Influence of species on sediment dynamics



after Bas van Maaren / Deltares

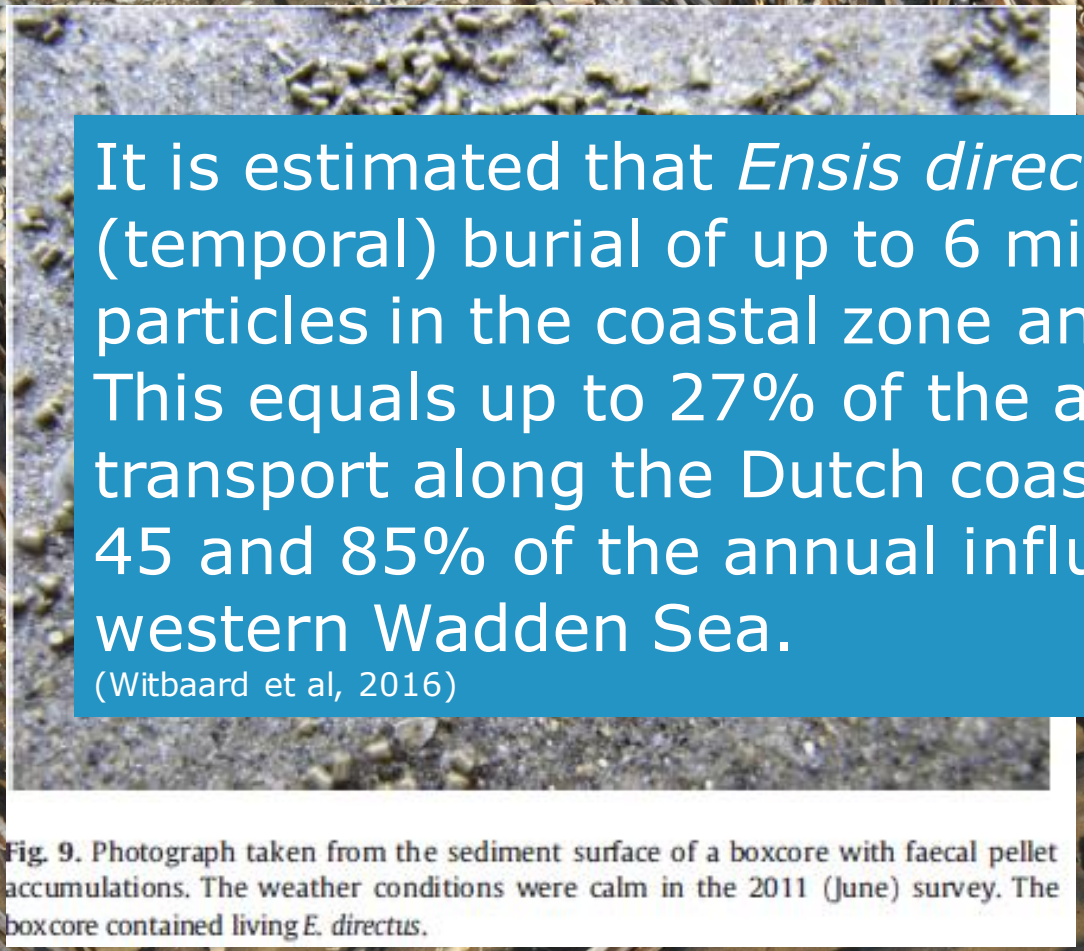


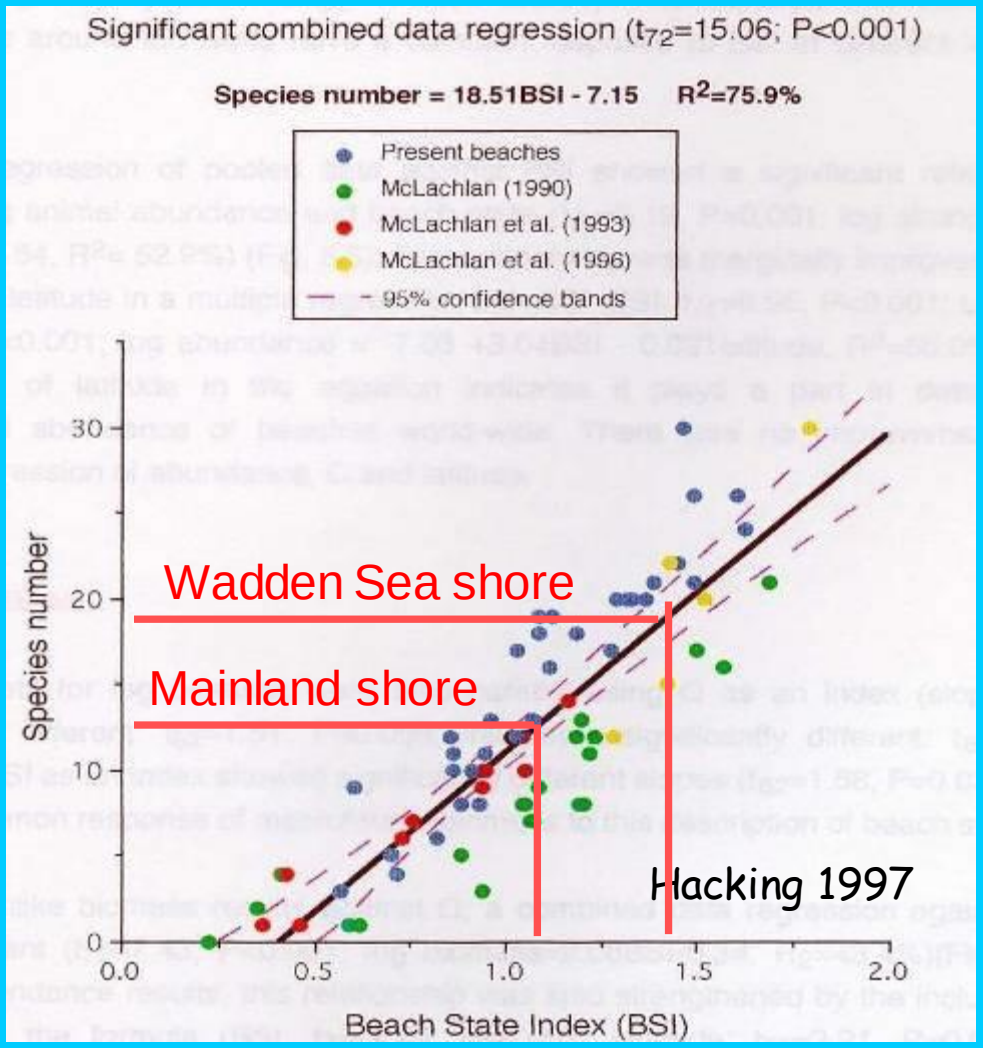
Fig. 9. Photograph taken from the sediment surface of a boxcore with faecal pellet accumulations. The weather conditions were calm in the 2011 (June) survey. The boxcore contained living *E. directus*.

It is estimated that *Ensis directus* facilitates the (temporal) burial of up to 6 million ton of fine particles in the coastal zone annually.
This equals up to 27% of the annual SPM transport along the Dutch coast and is between 45 and 85% of the annual influx into the western Wadden Sea.
(Witbaard et al, 2016)

American razor clam *Ensis directus*

Ecomare/Salko de Wolf

Species Richness



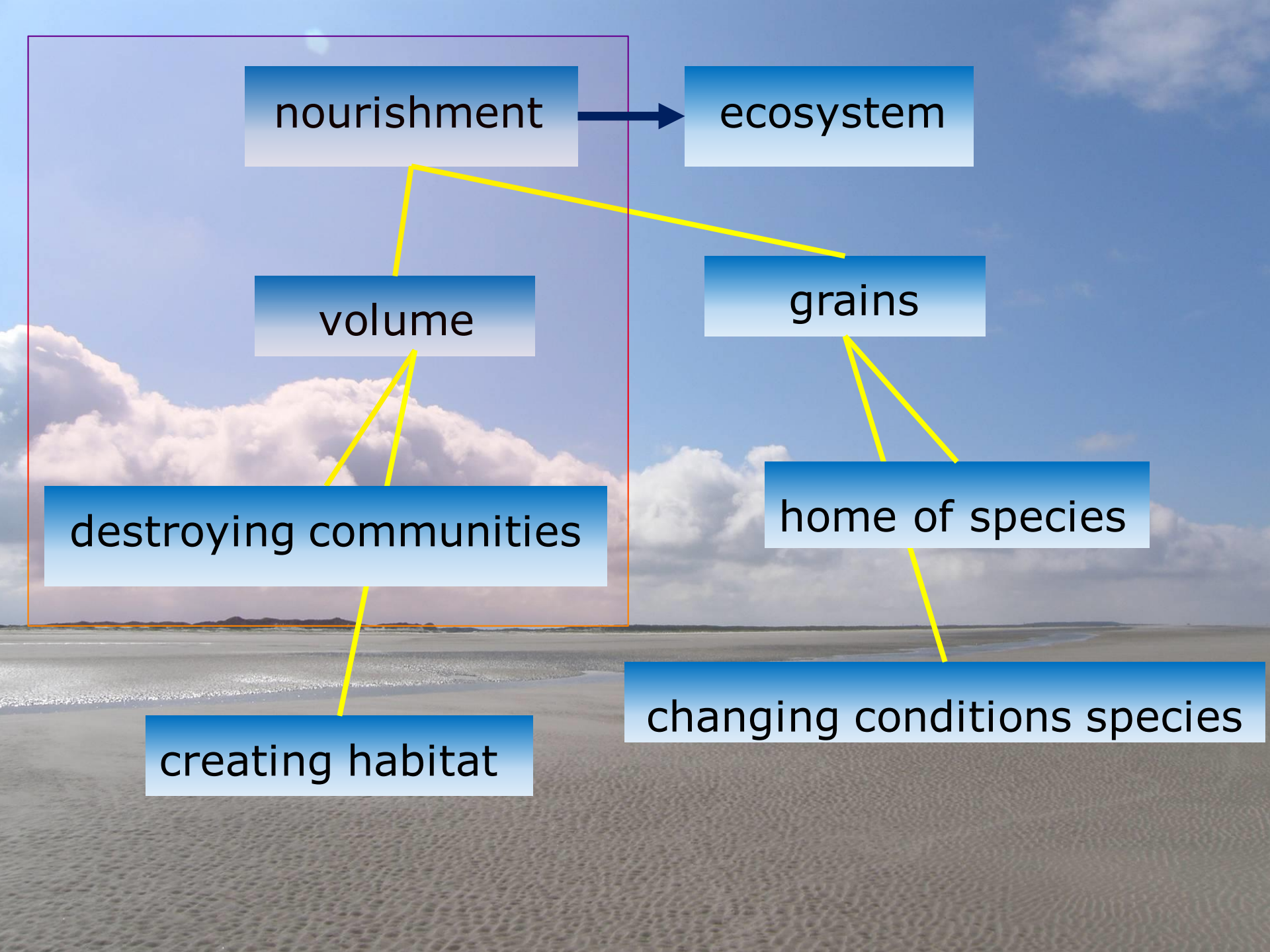
based on Janssen & Mulder, 2005

steep — flat

coarse — fine

BSI: beach morphodynamic conditions
(tidal range and grain size)

species number
Wadden Sea = ~ 2 x Mainland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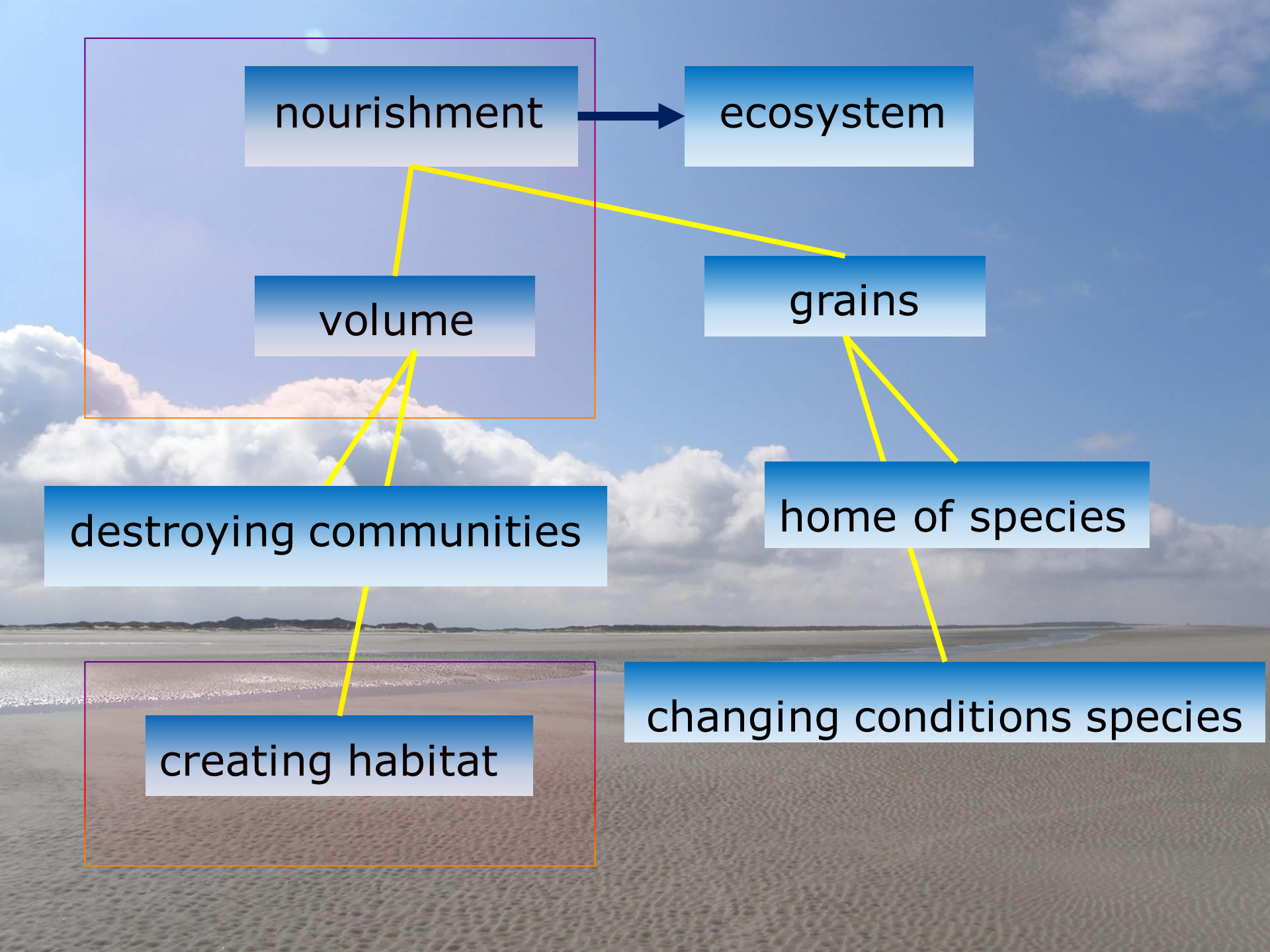
Most macroinvertebrate fauna is unlikely to survive a burial of sand of more than 1 m., let alone the more regularly used layers of 3 to 4 m.

(a.o. Speybroeck et al., 2006; Janssen et al., 2011Leewis et al., 2012).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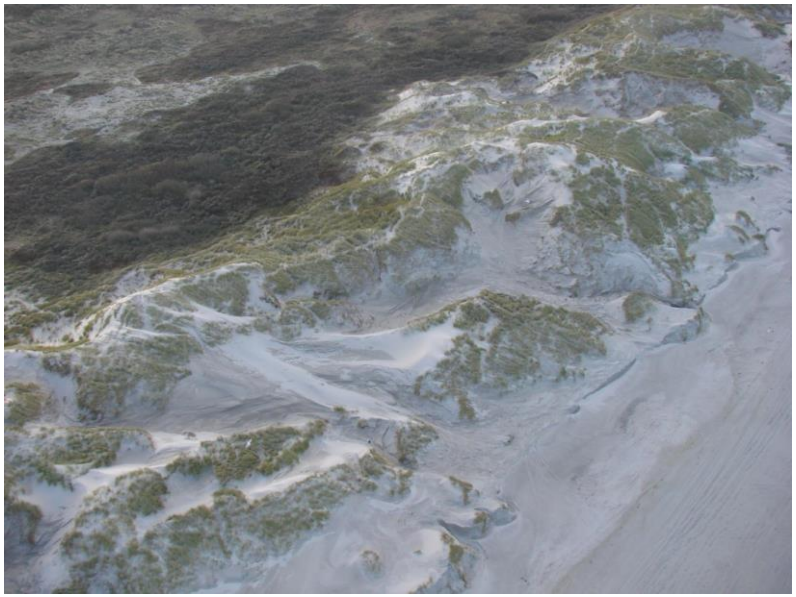
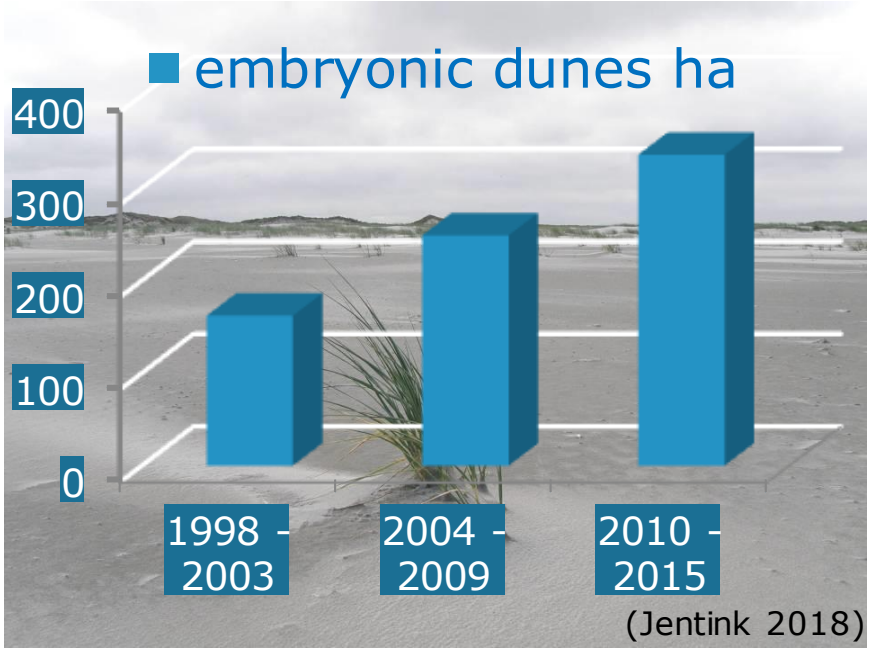
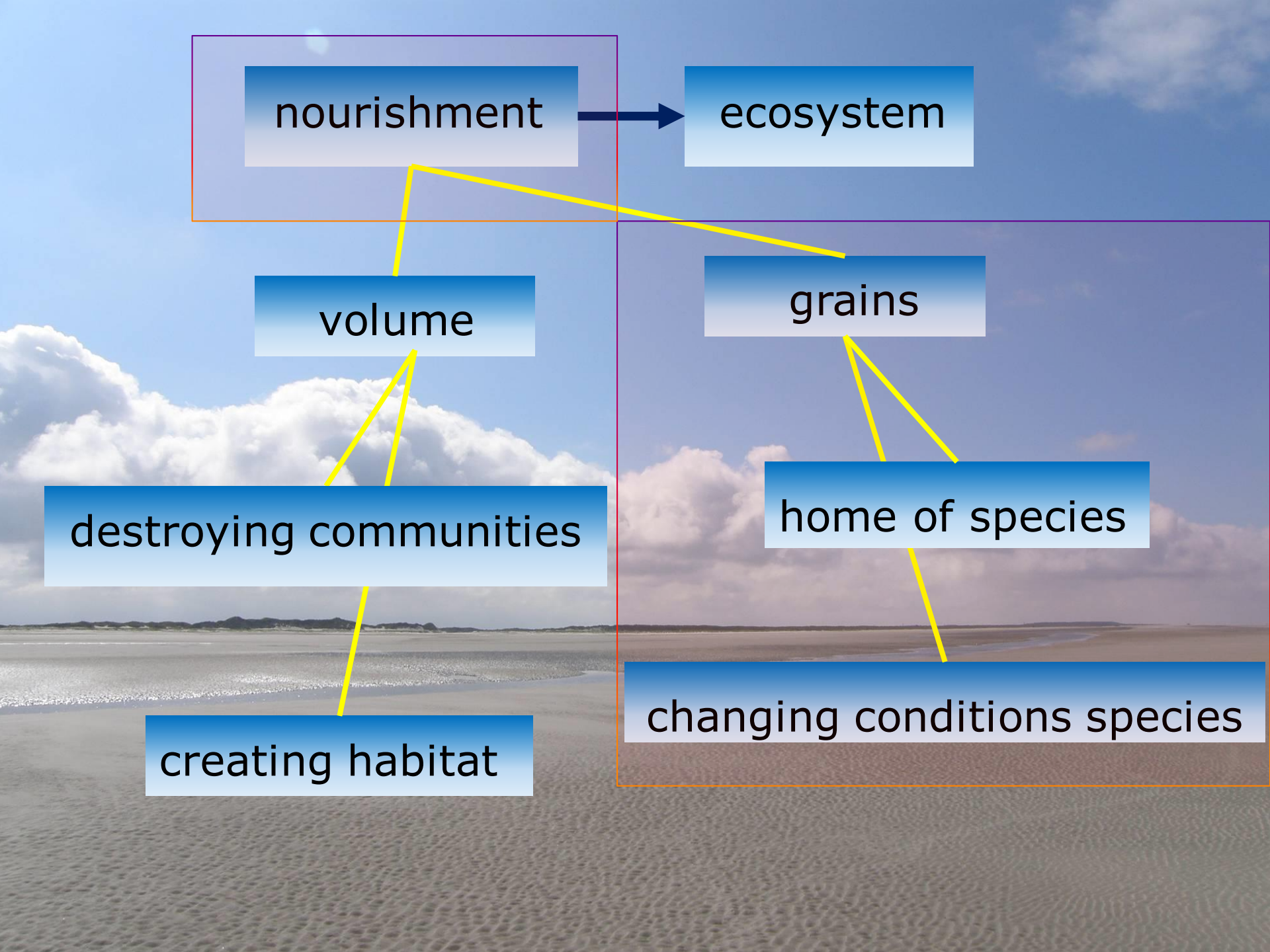
30 % of the nourished sand is transported into the dunes by wind. On larger temporal and spatial scales (decades / regions), nourishments contribute to the formation of terrestrial coastal habitats. (after Arens & Janssen, 2009).

Area embryonic dunes in Dutch Wadden Sea increased.



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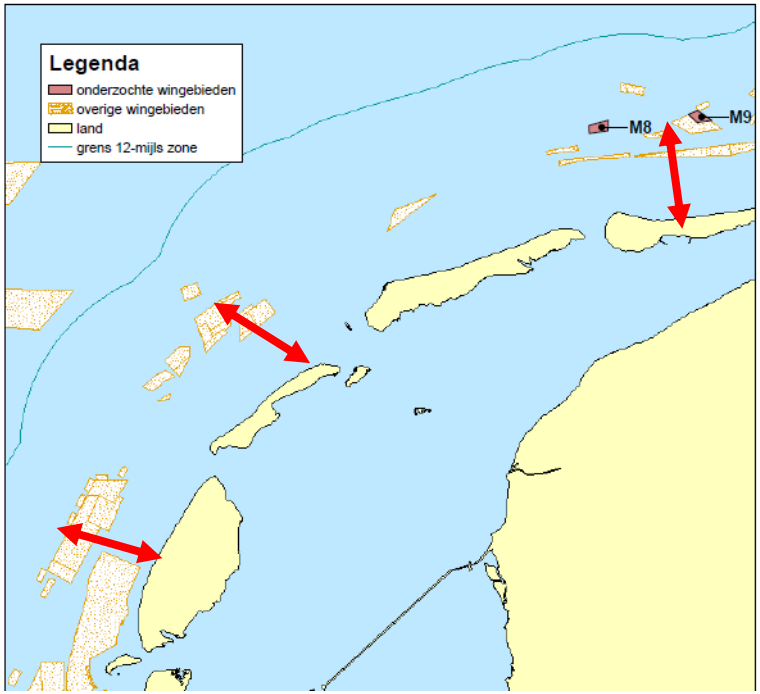
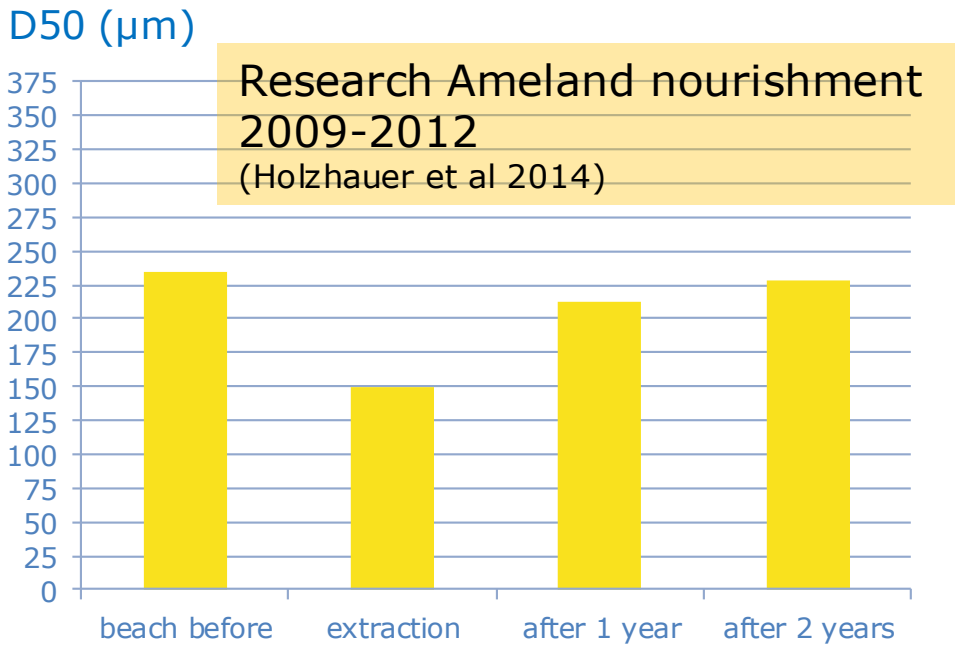




the pattern in the grain size characteristics in the extraction areas along the Dutch coast match the pattern of the grain size on beach and dune

(Cleveringa 2014)

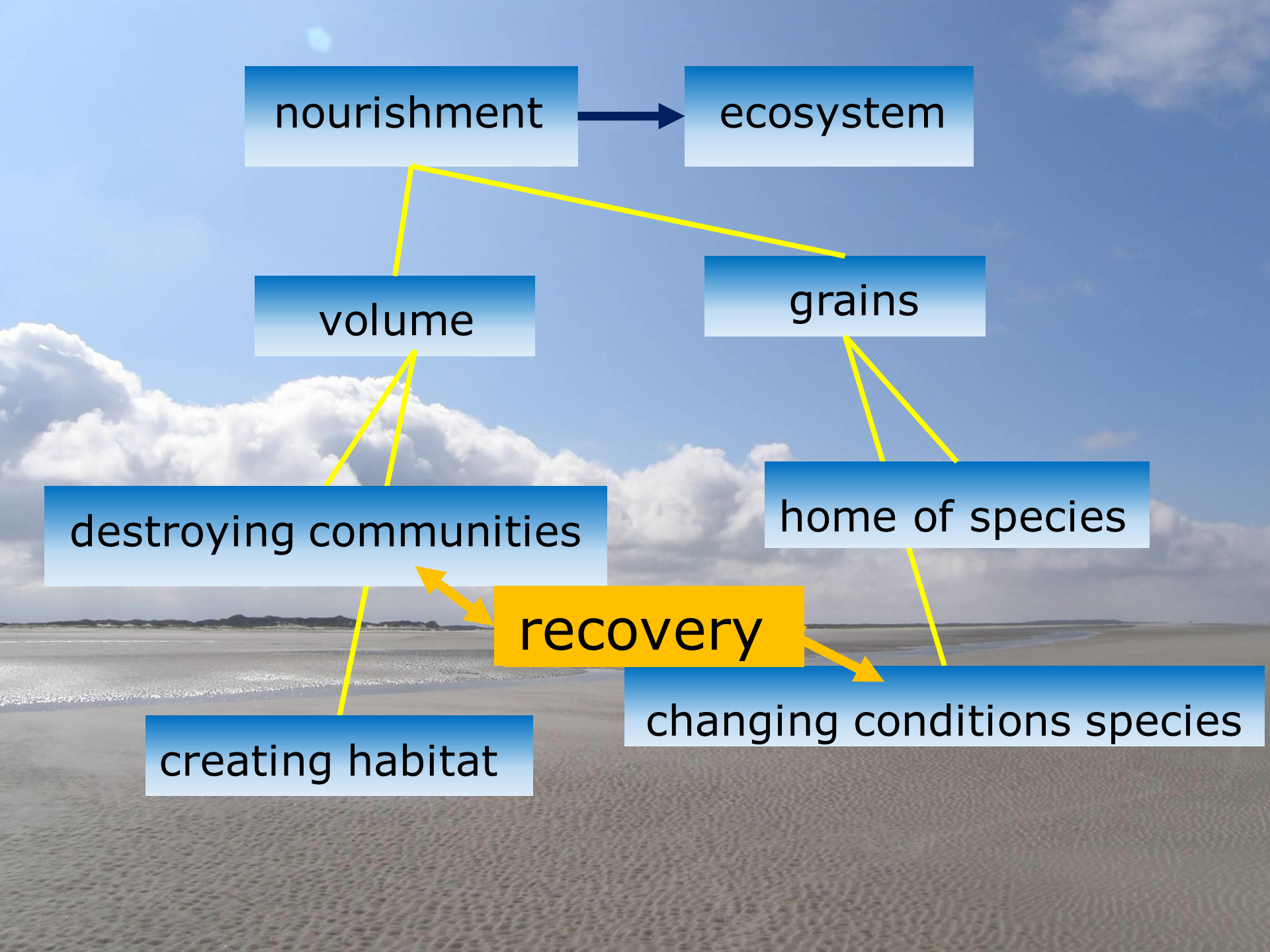
Despite several nourishments since 1990, no permanent effect of nourishment on beach characteristics was shown, in average **grain size** (1982-2002 /Janssen en Mulder, 2004), nor in other environmental variables (**sorting, skewness, slope, CaCO3** (1994-2007 /Leewis et al., 2012) along the Dutch coast over periods of 14 - 20 years

But….

Nevertheless, it is suspected that decades of sand nourishment will change mean grain size of the Dutch beaches (based on Valk 2014)

Will sand nourishments on the beaches, foreshore and ebb-tidal delta change sediment composition in the Wadden Sea?

The intertidal flats in the Dutch Wadden Sea have become sandier in the period 2009-2015. Particularly median grain size of the sediment has increased (0.89 µm per year) and the mud fraction has decreased (0.24% per year)…
……changes in the benthos community are to be expected in the long term... (Folmer et al 2017).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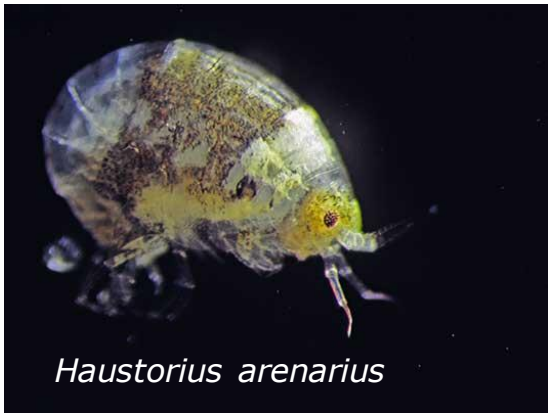
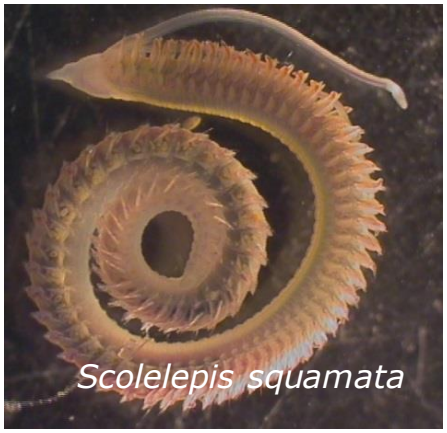
Some sediment related environmental variables explain macrobenthos abundance.





mean grain size, skewness and beach slope

mean grain size

Recovery ?

no environmental variable explained its abundance

within 1 year

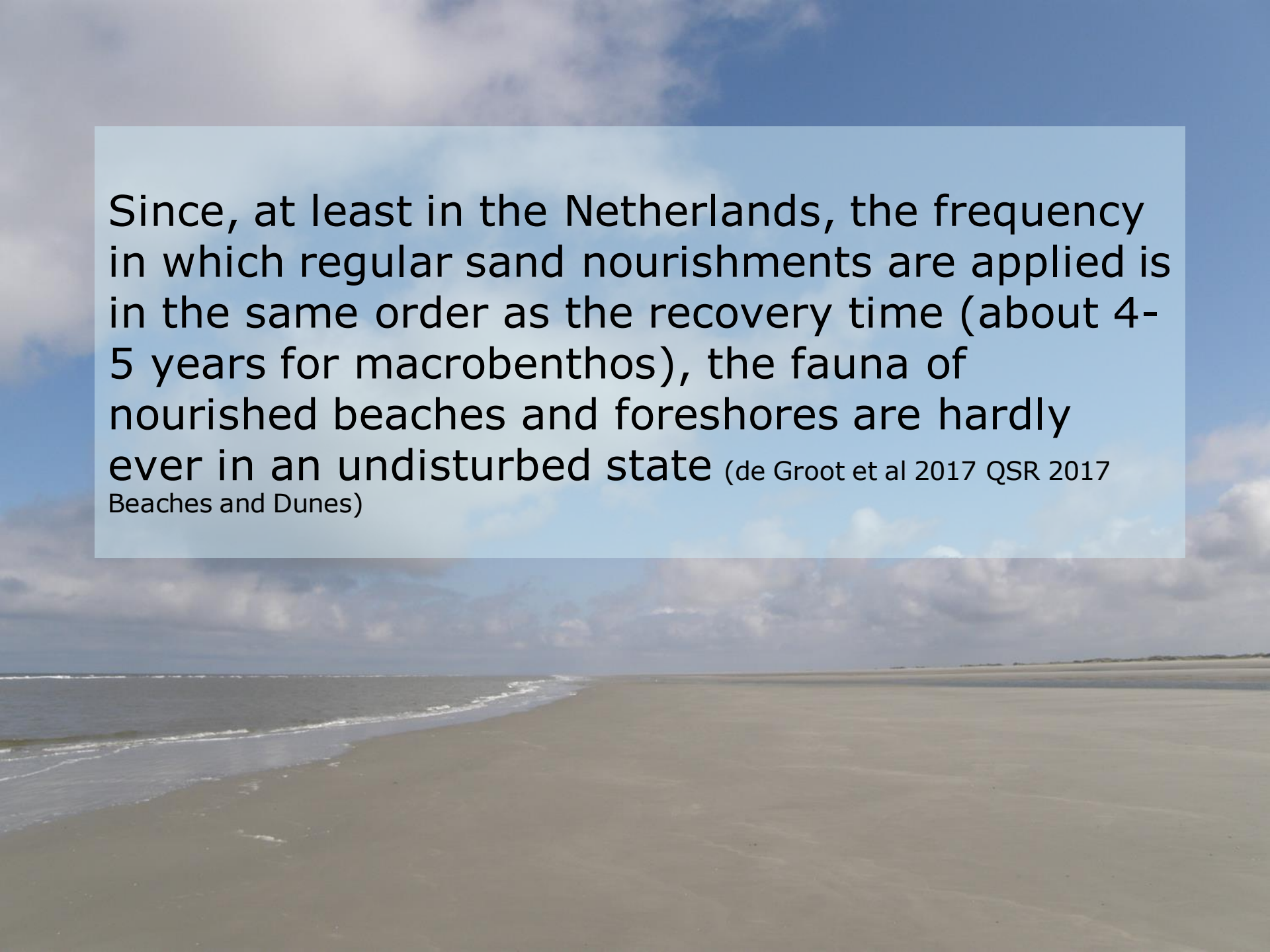
'over' recolonization

within 1 year

(Leewis et al., 2012)

The responses of the most abundant invertebrates following beach nourishment are ***species specific***.

This shows the importance of knowing the autecology of the sandy beach macroinvertebrate fauna in order to be able to mitigate the effects of beach nourishment and other environmental impacts (Leewis et al., 2012)



Since, at least in the Netherlands, the frequency in which regular sand nourishments are applied is in the same order as the recovery time (about 4-5 years for macrobenthos), the fauna of nourished beaches and foreshores are hardly ever in an undisturbed state (de Groot et al 2017 QSR 2017 Beaches and Dunes)

Conclusions

General conceptual models on the relation between sediment properties and ecological aspects of sandy shores apply to the Wadden Sea shores.

Nourishments alter sediment characteristics and morphodynamic conditions on the short term and ecological effects will appear, even though recovery in some (macrobenthic) species occur within a few years. In the long term it creates habitat but might alter sediment composition and ecosystem quality definitely.

But……

Incomplete knowledge, unpredictability and ambiquity about the coastal ecosystem

- We have scarce information on most species living on and in between the sand (bacteria, microbenthos, insects, fungi, fish etc etc)
  - *Species specific effects / home of the unknown*
- A few locations studied in a defined period
- Almost no information on effects on Wadden Sea
- Low statistical power / limited budget in a dynamic environment
- No experimental setup / real nourishments
- No long history of nourishment: Cumulating effects in time?

Careful drawing conclusions about the ecological effects of sand nourishment

foto: Mart Smit