

Identifying the gap between the rivers and the sea

Sander Wijnhoven

Monitor Taskforce,
Royal Netherlands Institute for Sea Research
(NIOZ - Yerseke)

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'Bridging the Gap: Working together to tackle invasive non-native species in Europe'

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Definitions

- Non-native, non-indigenous, exotic or alien species:**
 Species living beyond their natural range of potential dispersal (i.e. due to human activities).
 Nuances in definitions can be that:
 a historic native range is considered,
 whether climate-change induced dispersal is natural,
 or that national borders or territories are considered.
- Invasive species:**
 A species whose introduction causes significant economic or environmental/ecological harm or harm to human health.

F. enigmaticus
Tube worm



(DAISIE)

C. gigas
Pacific oyster



(Aquatic aliens)

H. takanoi
Brush-clawed shore crab



(WoRMS)

C. fornicata
Slipper limpet



(WoRMS)

S. clava
Leathery sea squirt



(BCSGA)

The estuary as a potential habitat (for non-native species)

● What is an estuary?

- The transitional zone from land to sea or
- transition from freshwater to the marine environment
- Definition according to Pritchard (1967):

‘An estuary is a semi-enclosed coastal body of water which has a free connection with the open sea and within which sea water is measurably diluted with freshwater derived from land drainage’

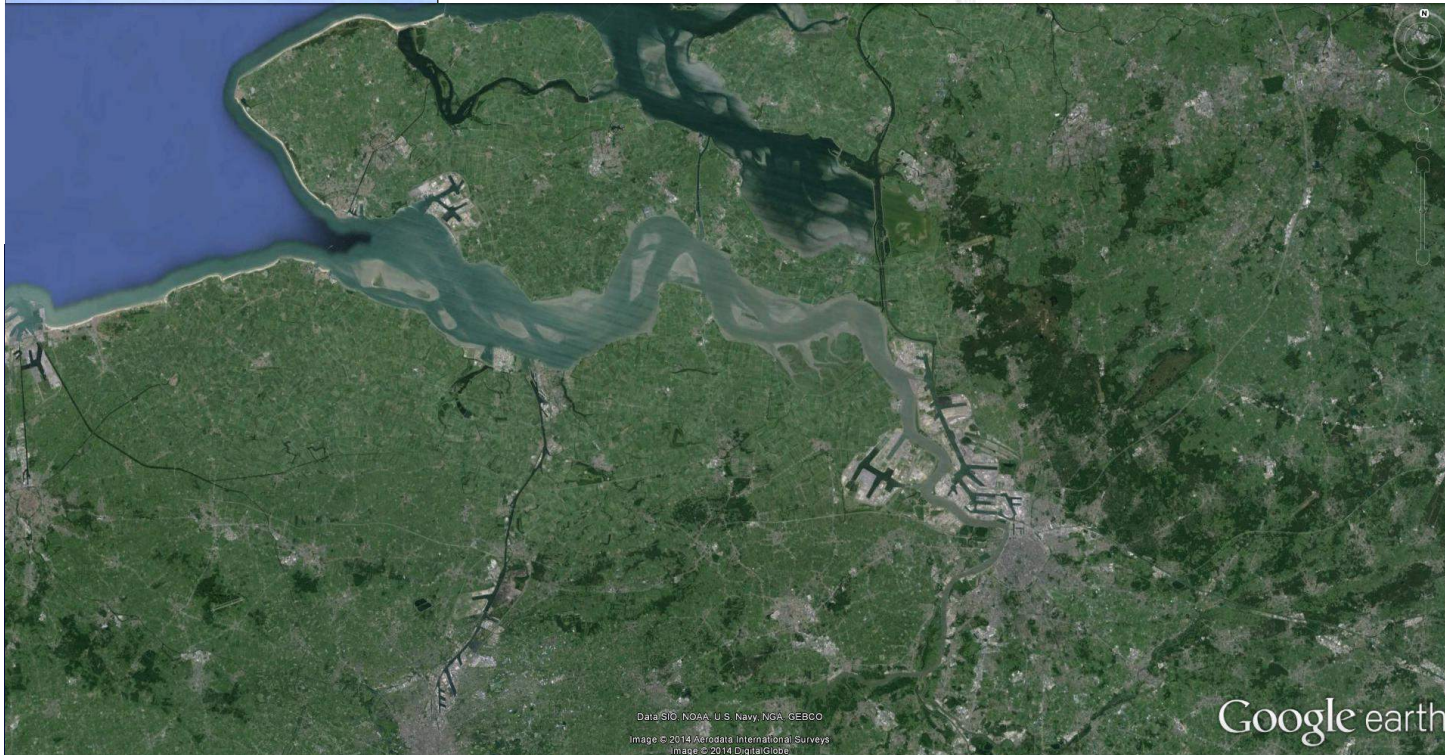
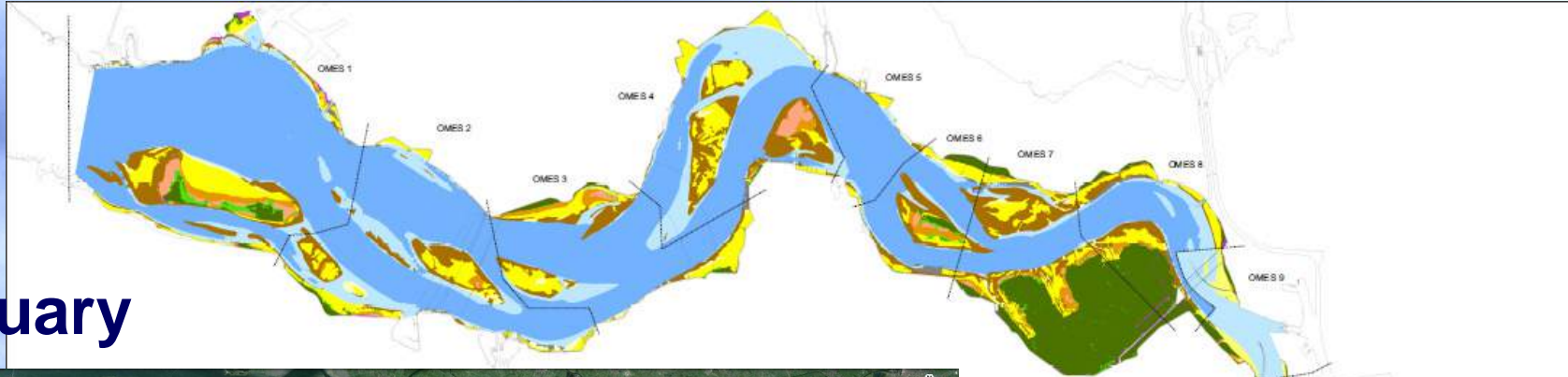
Definition can be extended by including systems with temporal connections to the sea, but all estuaries have at least some salinity differences and there is some tidal influence

This results in a variety of systems that can be identified as an estuary: e.g. river mouths, lagoons, fjords, drowned river valleys, embayment's, delta's, ria's, inlets, fjards, coastal plains; names based on aspects as shape, origin, geomorphology, topography.

The estuary as a potential habitat (for non-native species)

- In the 2 Seas region estuaries are generally shallow, open and dynamic,
- from an ecological point of view important that they are characterized by
 - a salinity gradient
 - salinity fluctuations (large and on a daily basis at reasonable tidal differences)
 - often supplied with large quantities of nutrients and sediments
 - in an environment with natural fluctuations in hydrodynamics
 - leading to temporal and spatial alternations in sedimentation and erosion
- The recipe for a diverse landscape with plenty of niches in various developmental (successional) stages

Scheldt estuary



Data: SIC, NOAA, U.S. Navy, NOAA, GEBCO
 Image © 2014 Aerodata International Surveys
 Image © 2014 DigitalGlobe



T2009 Rapportage Schelde Estuarium

Eindopen 2010 versnelvoudigde legende	
Zeezandklei	Wadenzandklei
000	000
als heel vrij oppervlakt	als heel vrij oppervlakt
als heel nat oppervlakt	als heel nat oppervlakt
als heel verzand	als heel verzand
hoog wateroppervlakt	hoog wateroppervlakt
zandklei zandvulling	zandklei zandvulling
zand	zand
aanvullend heel oppervlakt	aanvullend heel oppervlakt
0	0

0 1 2 3 4 kilometers



Scheldt estuary



The estuary as a potential habitat (for non-native species)

- Shallow nature and good mixing of water layers results in efficient nutrient and element recycling which potentially leads to high productivity
- Therefore estuaries important habitats for a variety of very specific species
- but also important (temporal) feeding grounds
- or nursery grounds
- and important transition zones (e.g. diadromous fish and visiting species entering from either the rivers or the sea)

The estuary as a potential habitat (for non-native species)



M. intestinalis



(M. Faasse)

M. viridis



(WoRMS)

E. directus
American Jack
knife clam



(WoRMS)

H. takanoi
Brush-clawed shore crab



(WoRMS)

C. fornicata
Slipper limpet

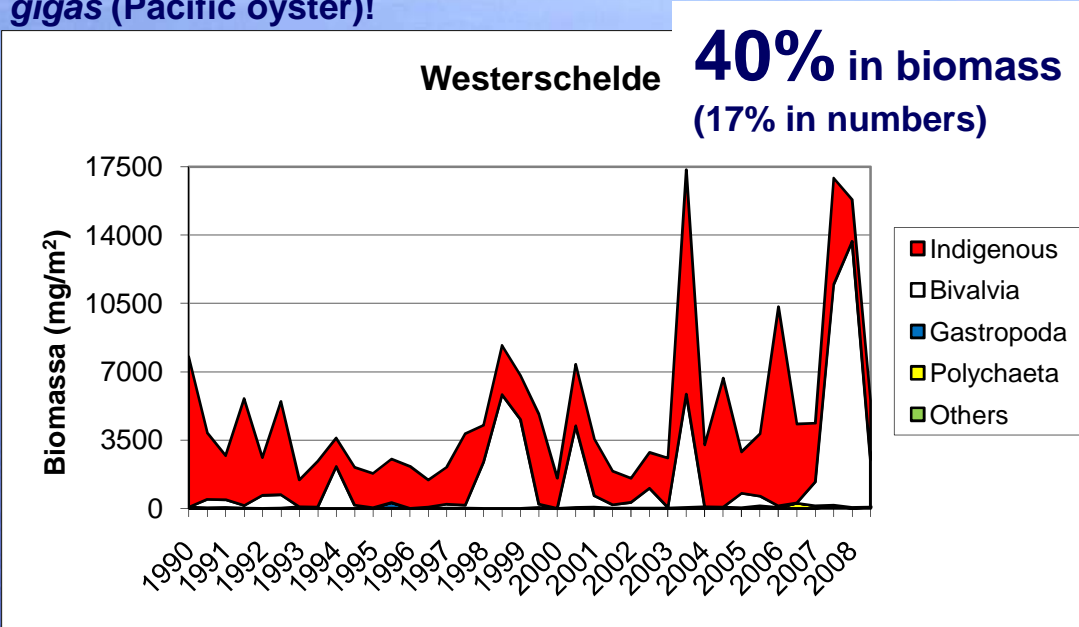


(WoRMS)

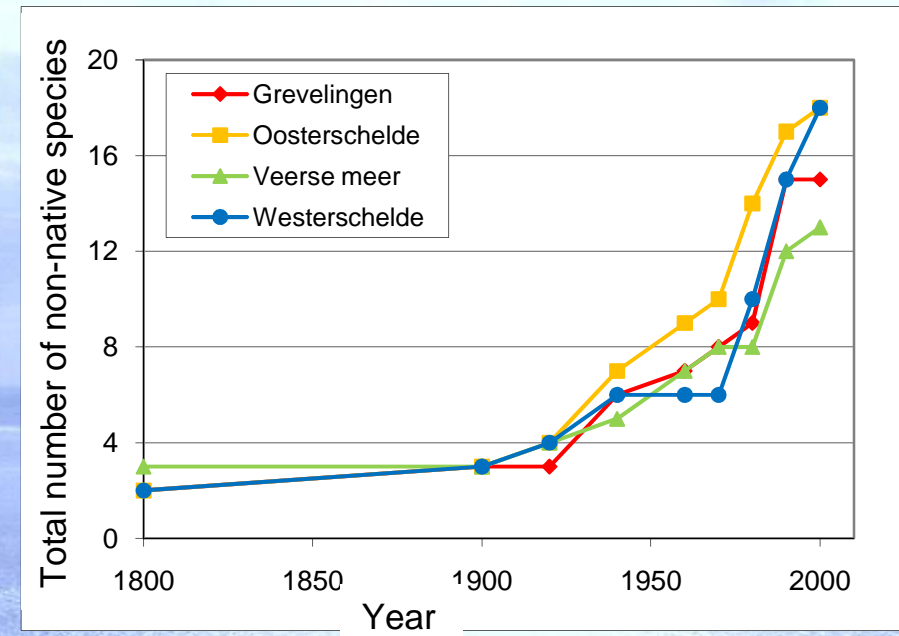
The estuary as a potential habitat (for non-native species)

The role of non-native species in the macrozoobenthic communities of the Western Scheldt

Mainly *Ensis directus* (American jack knife clam) & *Crassostrea gigas* (Pacific oyster)!



E. directus is nowadays dominant; before 2006 only locally present in low numbers!

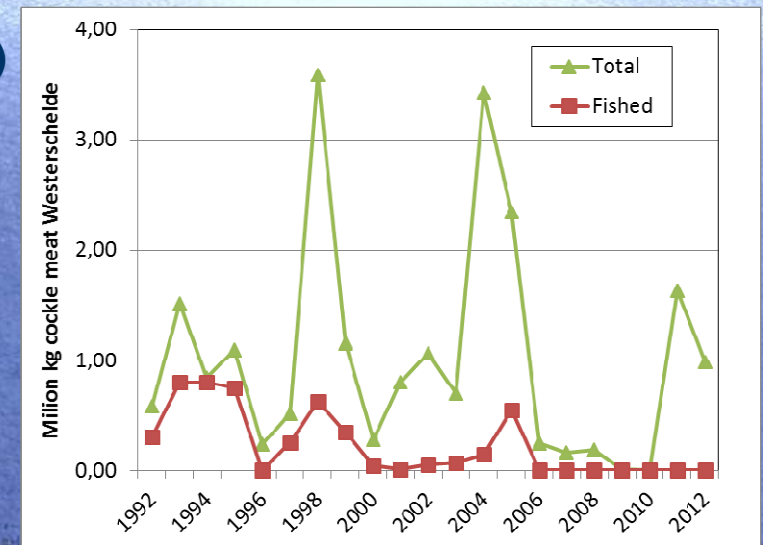
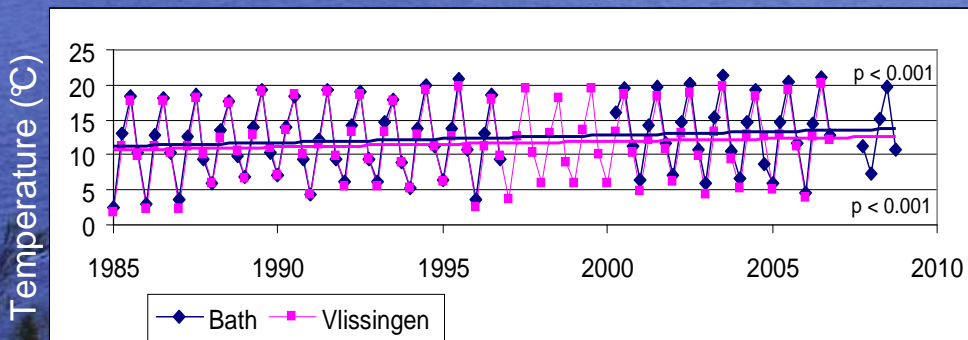
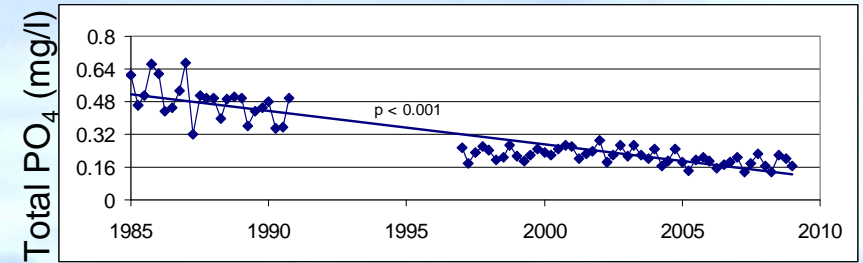


These are results of a standardised monitoring program with its limitations (not specifically focussed on non-native species), only showing trends for (already) common species in a certain habitat!

Human activities in estuaries

- Estuaries are also where anthropogenic impacts and activities accumulate:
 - excessive inputs of nutrients, sediments or pollutants (incl. thermal)
 - resources exploitation (harvesting and fisheries)
 - activities like industries and aquaculture
 - important transportation and recreational functions (incl. infrastructures)

- Because of
 - relative easy access and central positioning (rel. to land, sea and urbanized areas)
 - abundantly available resources (e.g. water, nutrients, biomass, energy)



Human activities in estuaries

Southampton Water & Portsmouth Harbour

Southampton

Portsmouth

Human activities in estuaries



Estuaries potential hotspots for non-native species

- Numerous ways for non-native species to enter estuaries; introduction of large numbers of specimens on a daily basis, e.g. via
 - ballast water
 - ship hull fouling
 - accidental and non-accidental introduction
- and regions with similar conditions are globally connected
- Non-native species settling successfully can be typical estuarine or relative tolerant freshwater or marine species



High risks of successful settlement

- **Large nutrient inputs and turn-over ideal for high production (i.e. population expansion)**
- **Numerous potential niches due to large natural heterogeneity of environment and natural succession/rejuvenation**
- **Abundantly present new substrates (i.e. artificial constructions)**
- **Estuarine communities often already vulnerable or deteriorated**

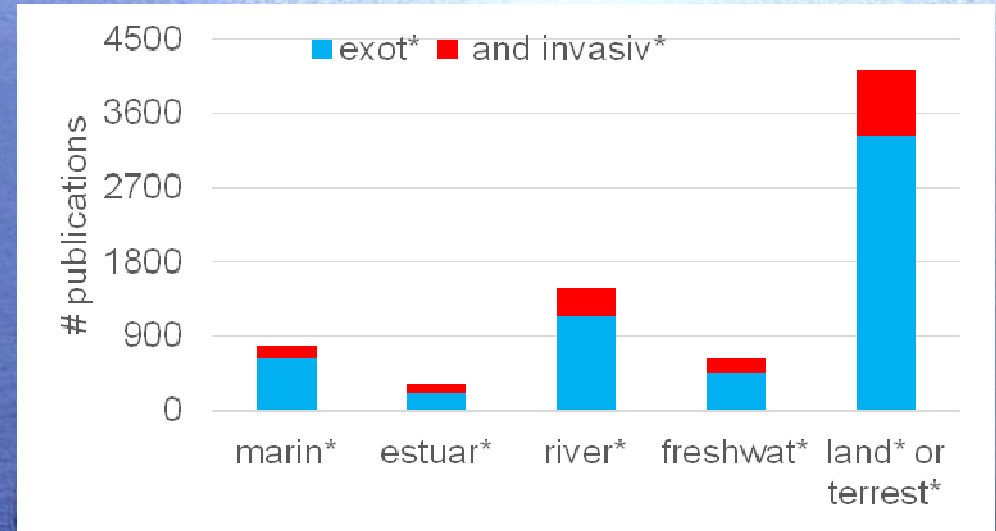
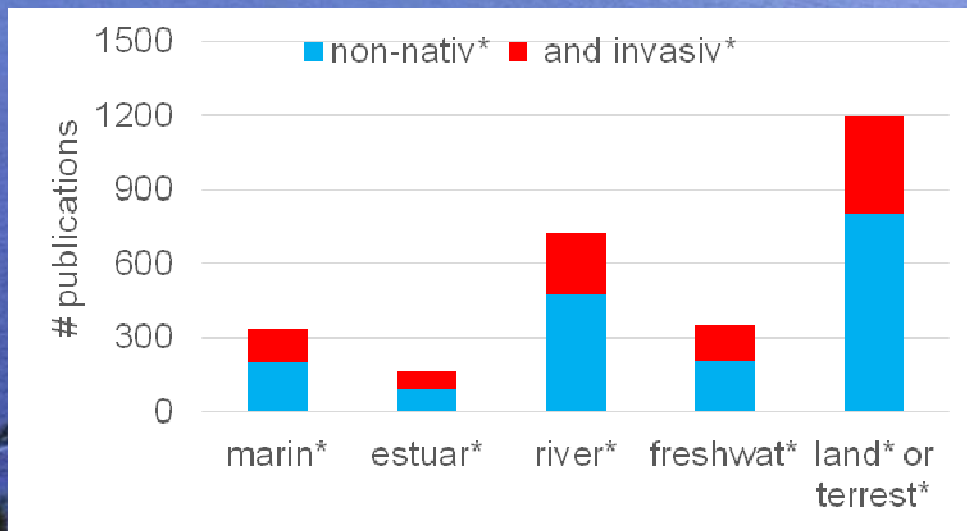
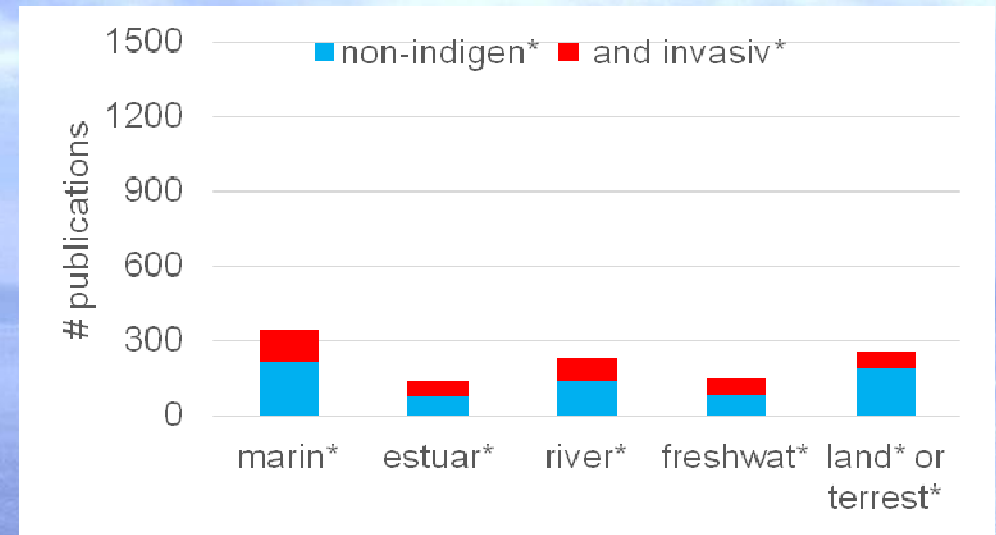
- **Additionally, improving environmental quality as the result of management regulations might exactly support non-native potential invasive species.**

- **Communities of natural dynamic environments might be less susceptible for non-native species dominance. Although this could reduce the risk of non-native species getting invasive in estuaries; the estuaries could act as a secondary source of invasions.**

Is there an estuarine gap in non-native species research?

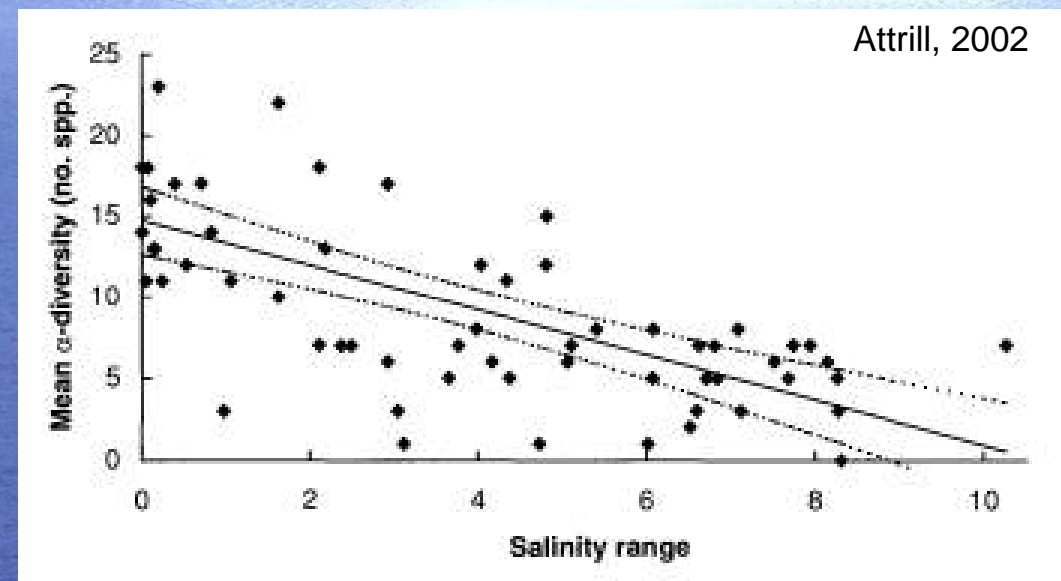
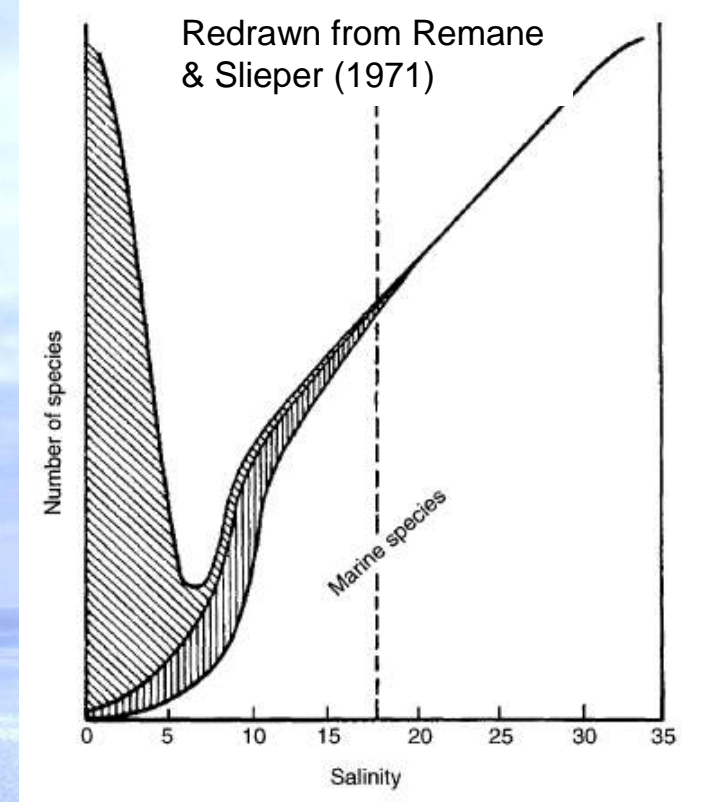
- An analysis of the number of publications in Web of Science with terms in the topic

(also brack* and salt wat* were analysed)



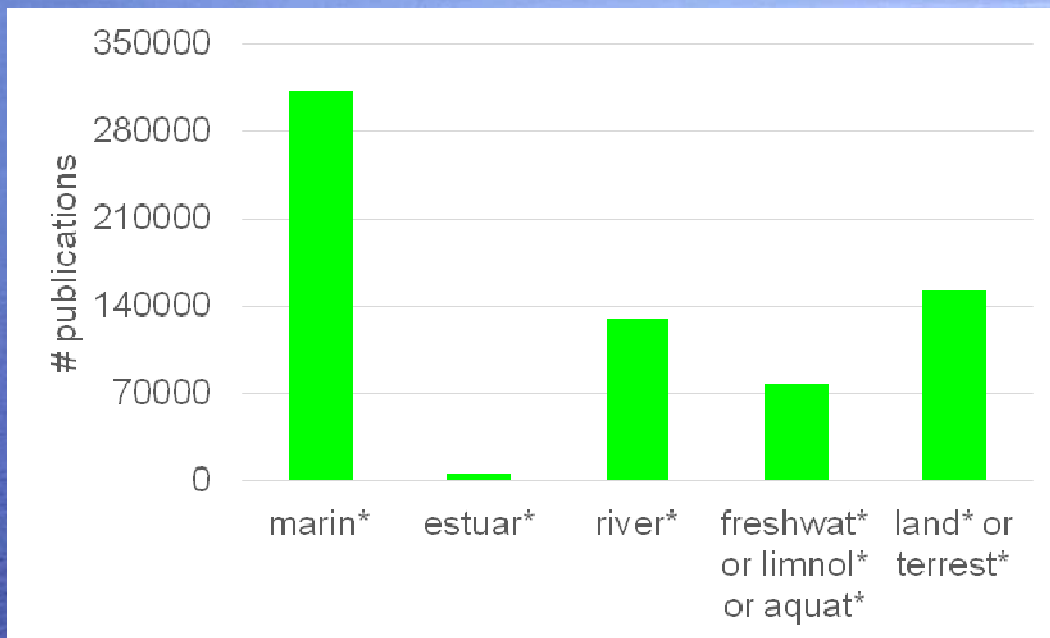
Is there an estuarine gap in non-native species research?

- Although there are less brackish water - than freshwater - or marine species, and α -diversity or local species richness is lower in estuaries than in freshwater or marine environments, total species richness is high in estuaries; the number of potential invasive non-native species could be similar high.



Why is there less attention for non-native species in estuaries?

- There is less attention for estuarine research in general, which might have to do with the traditional separation in a freshwater and a marine world (with less knowledge exchange and collaboration than would be desirable)



- An analysis of the number of publications in Web of Science with terms in the addresses of authors
- It has to be noticed that freshwater – and marine specialists have a different perspective of what is brackish!

- This separation exists in both science and management

A freshwater and a marine world

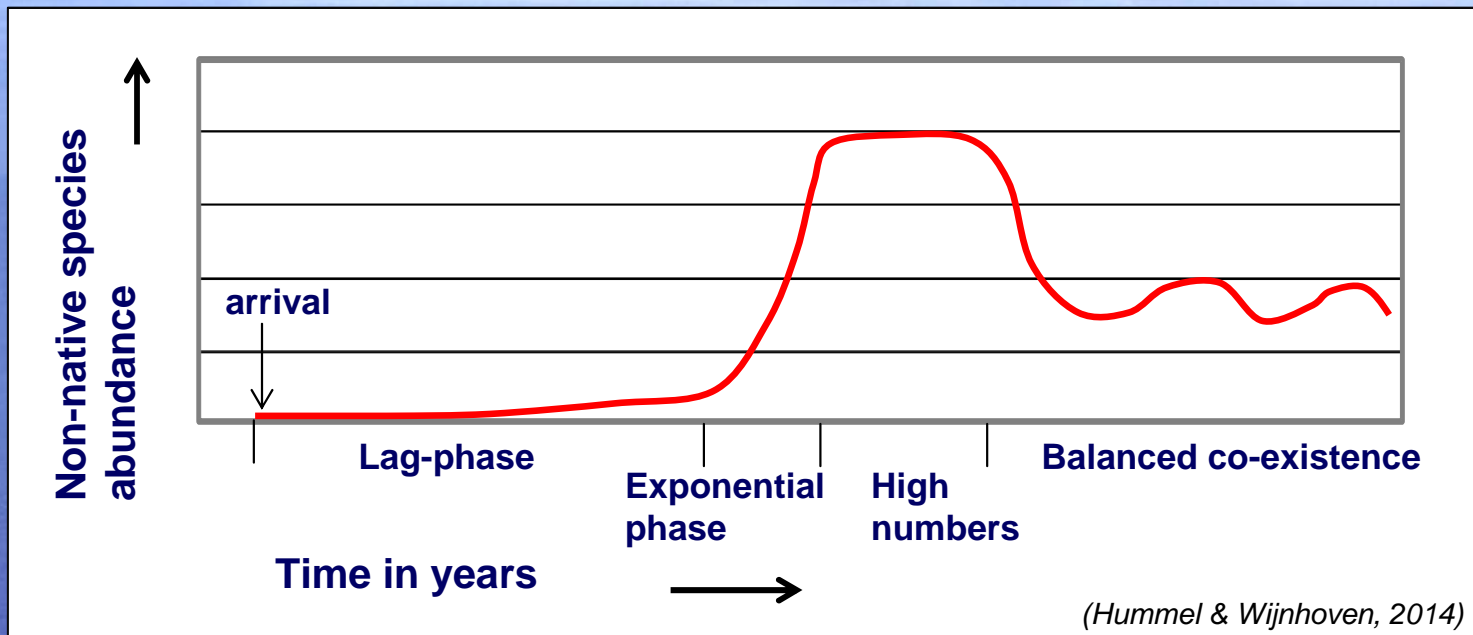
- E.g. European legislation works with a WFD and a MSFD with different instruments and methodologies
 - Estuaries are partly indicated as transitional waters in the WFD whereas estuary mouths/coastal zones are part of the MSFD

Another aspects that might lead to an estuarine gap

- Traditionally ecological research focused on natural habitats and nature areas, nowadays that (estuarine) environments are heavily modified and artificial environments common, *in situ* monitoring programs have been reduced, taxonomy gets less attention and the focus is on general indicators and processes
- Therefore we miss valuable information about the ecology of non-indigenous potential invasive species in their new environments.

Early detection of non-native species essential!

- Programs to detect and study non-native species in estuaries during an early stage are largely lacking



- Early-warning nowadays highly dependents on the work of a few specialists or hobbyists with special interest for a certain group of species or certain habitats

Thank you for your attention