Risks of introducing non-indigenous species by shellfish transfer

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Definitions

- **Species**: A group of organisms capable of interbreeding and producing fertile offspring. Described as species in taxonomical literature.

- **Indigenous**: A species living inside its indigenous or native distributional range.

- **Non-indigenous**: A species living outside its indigenous or native distributional range.

*Ensis siliqua*

*Ensis directus*
Definitions

- **Exotic species**: A species introduced by **human** intervention outside its native distribution range.

- **Settled exotic species**: An exotic species that reproduces sustainably within an area.
Definitions

- **Invasive exotic species**: a settled exotic species that expands outside its area of introduction and might impact biodiversity.

- **Problem species**: Species that, based on the state-of-the-art knowledge, might have a negative impact on the Natura-2000 goals.
Vectors of introduction exotic species

- Natural processes
  - Secondary introduction
  - Swimming/floating
- Ships hulls
  - Hard-substrate
  - Anti-fouling
- Ballast water
  - Planktonic organisms
- Shipping canals
- Shellfish transports
  - Intentional/unintentional
The Netherlands

- > 100 marine exotic species reported

**Most-likely vectors primary introduction**

**Most-likely vectors introduction into the Netherlands**

Shellfish culture in the Netherlands

- **European flat oyster** (*Ostrea edulis*)
  80 tons yr\(^{-1}\)

- **Pacific oyster** (*Crassostrea gigas*)
  2,500 tons yr\(^{-1}\)

- **Mussels** (*Mytilus edulis*)
  60,000 tons yr\(^{-1}\)
European flat oyster

- Traditional fishery Zuiderzee
- Culture in Zeeland since late 19\textsuperscript{th} century
- Import from France, UK
- Decline in winter 1962/1963
- Disease \textit{Bonamia ostrea}
- At present culture in Lake Grevelingen
- Import from Denmark, Ireland
- Export to France, Belgium
- Translocation between culture lots
Pacific oysters

- Since 1964 introduced in Oosterschelde
- Wild since 1970
- Culture plots in Oosterschelde and Lake Grevelingen
- Export to Belgium, France
- Translocation of oysters and hard substrate between culture lots
Mussel culture: Wild seed fishery in the Wadden Sea
Mussel culture: Seed Mussel Collectors (Oosterschelde and Wadden Sea)
Mussel culture: Mussel seed translocated to culture plots

Musselpercelen

Yerseke

Amsterdam
Mussel culture: seed translocated to culture plots

Aerial photograph of submerged culture plots
Mussel culture: After 2-3 years sold at auction in Yerseke
Registered production consumption mussels

![Graph showing total production of mussels over years. The x-axis represents the season, and the y-axis represents the total production in metric tons per year. The graph includes data for import and the Netherlands.](graph.png)
Average import 2002 – 2006: 24.5 million kg yr$^{-1}$
Risks of shellfish transfer

With the transfer of mussels also other (non-target) organisms could be transferred:

- Diseases
- Harmful algae
- Exotic (invasive) species

Bonamia ostrea (Marc Engelsma)
Exotic species in Dutch waters (Wolff 2005)

- 99 exotic species
- 55% in Oosterschelde (Wadden Sea 30%)
- 14% exclusively in Oosterschelde (Wadden Sea 4%)
- Relation with shellfish Aquaculture?

Number of species exclusive for that area
Introductions related to shellfish aquaculture

- **Direct introductions**
  - Pacific oysters
  - *Mercenaria mercenaria*

- **Indirect introductions**
  - Shellfish associated species
Crepidula fornicata

- Introduced several times in UK with American oysters UK (1872-1890)
- First record in NL 1926
- Competition with other shellfish
- In 1941 4 million kg of *Crepidula* from the Oosterschelde estuary were processed for human food
- Biomasses decreased
Bonamia ostreae

- Protist
- Introduced into Brittany at the end of the seventies
- Introduced in Oosterschelde with oysters from Brittany in 1980
- High mortalities Ostrea edulis
- Culture restricted to Bonamia-free zones (Lake Grevelingen)
Crasostrea gigas

- Introduction into Portugal as C. angulata
- Introduction into the Oosterschelde from British Columbia (1964)
- First wild record 1970.
- Expanded intertidal mudflats
- Competition for food and habitat
- Large-scale removal in 2006 (12.5 Mkg, Wijsman et al 2008)
**Ocenebrellus inornatus** and **Urosalpinx cinerea**

- **U. cinerea** introduced in UK 1920
- **O. inornatus** introduced Marenes Oléron 1995
- First record in the Netherlands in 2007
- Frequently found on oyster culture plots. Mortality reported
- Internal spreading due to shellfish transfer
Legislation

- Shellfish production areas Wadden Sea, Lake Grevelingen and Oosterschelde are Natura-2000
- No permit required
  - Mussel seed to culture plots
  - SMC to culture plots
  - Translocation within system
  - Wadden Sea to Oosterschelde
- Permit required
  - Import from other countries (Ireland, UK, Germany)
  - Oosterschelde to Wadden Sea
Risk assessment shellfish transfer

- Appropriate assessment is needed to apply for permit
- No significant effect on Natura-2000 goals
- Effect of Non-Indigenous Species (NIS) often quantified as risk
- Various risk assessment tools available for NIS.
  - ISEIA
  - Biopollution Index
  - FAO Organism risk assessment
  - ...

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Risk assessment shellfish transfer

Step 1. Identification target NIS

Step 2. Transfer Probability

Step 3. Establishment Probability

Step 4. Impact Score

Species specific

Risk

Exotic species export area

Exotic species import area
Risk assessment shellfish transfer

- Overview of exotic species that could potentially be introduced with shellfish transfer (target species)
- Quantification both on literature and expert judgment
- Focus on species with highest risks
- Mitigating measures
  - Exclusion of areas or periods
  - Monitoring
  - Treatment
Risk management shellfish transfer

- Shellfish Import Monitoring protocol (Gittenberger 2010).
  - Shellfish-Associated Species Inventory (SASI)
  - Sampling big-bags
    - Number of species
    - NW-European NIS
    - Number of exotic species
    - Number of problem species

- Measurements
  - Intensification Big-bag inventory
  - Repeated SASI
  - Quarantine and removal
Conclusions

- Shellfish industry is (was) an important vector for introduction of exotic species
- Translocations of shellfish within system increase spreading rate
- Risks cannot be excluded, but tools are available to manage and reduce risks
Thank you for your attention

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