

Eco-engineering with quagga mussels: risk assessment and environmental permit

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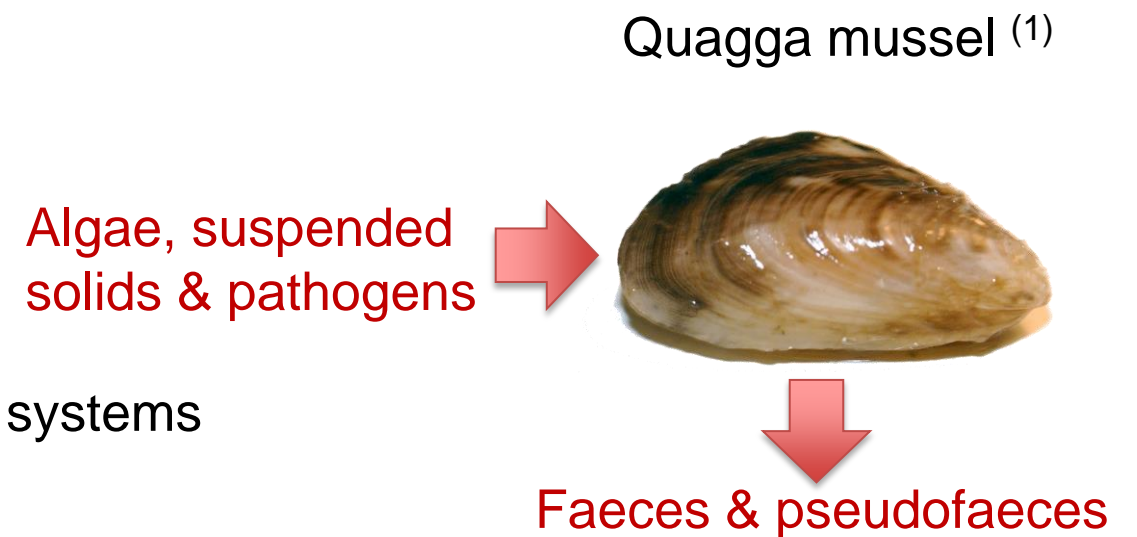


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Introduction

- Ponto-Caspian species
- Filter feeder → Eco-engineer
 - turbid, eutrophic or chemically polluted water systems



Multiple approaches for using the mussel

1. Purification plants
2. Isolated surface waters (e.g., ponds, pools)

¹ © Michigan Sea Grant

Issues

1. Negative and positive ecological and socio-economic effects

✗ No risk assessment available for quagga mussel

2. Exemption of legislation nature conservation
 - Ban on release in nature
 - Ban on disturbing protected species

✗ No criteria available to assess granting of exemptions for quagga mussel release

**Goal 1
Risk assessment**



**Goal 2
Criteria and protocol**



**Goal 3
Expert consensus**

1. Risk assessment - Methods

A. Risk inventory

- Literature study

Species description
Introduction
Establishment
Secondary spread

Effects: environment, human
health, infrastructure,
ecosystem services

B. Effect assessment and risk classification

- Harmonia⁺ protocol ⁽²⁾
 - Modules
 - Negative & positive effects
 - EU regulation

C. Expert consensus

- Risk scores and confidence levels
- Risk classification

² D'hondt et al. 2015. Harmonia+ and Pandora+: risk screening tools for potentially invasive plants, animals and their pathogens. Biological Invasions 17:1869-1883. Online protocol: <http://ias.biodiversity.be/protocols/>

1. Risk assessment – Risk inventory

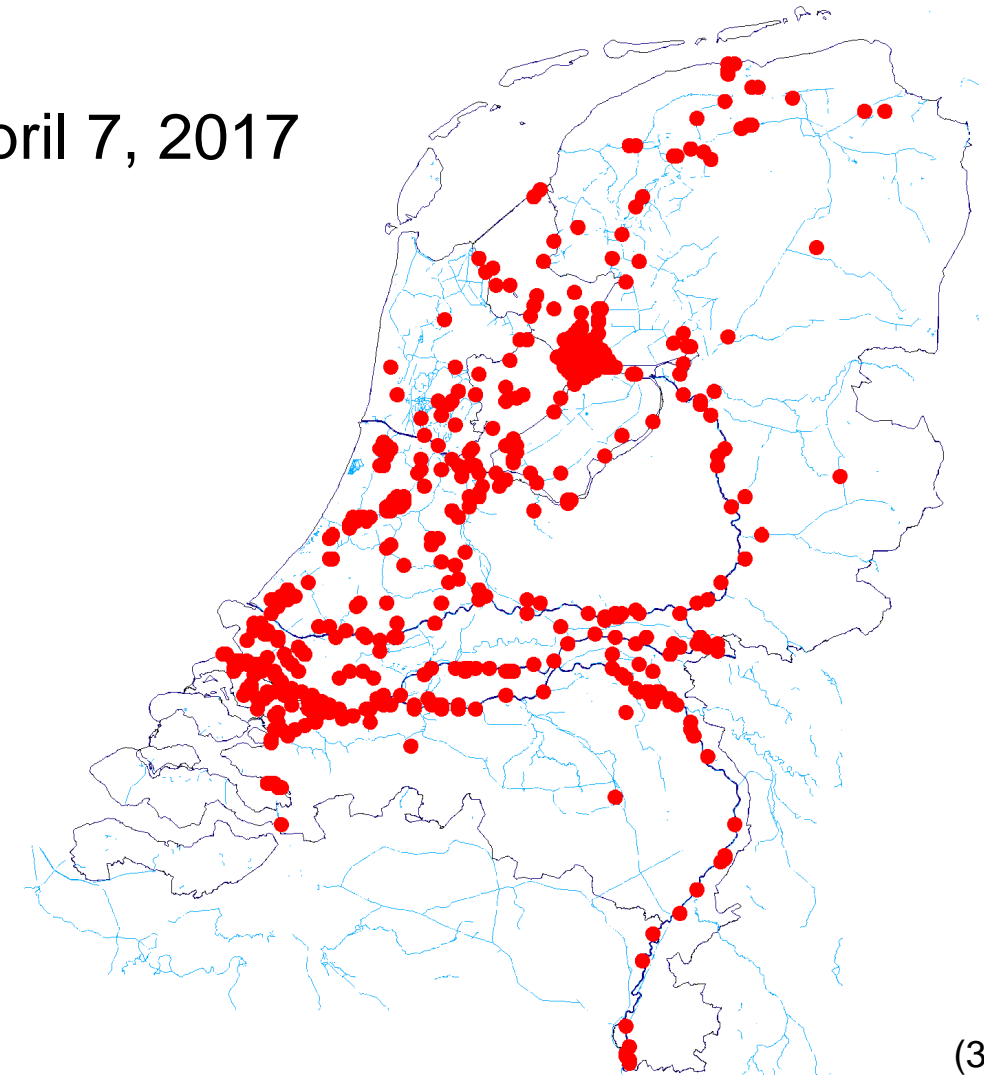
- **Introduction**

- First observation in 2004
- Shipping

April 7, 2017

- **Establishment**

- Widespread
 - large rivers, channels and lakes
- Expected increase in water systems
 - suitable habitat conditions (e.g. hard substrate)
 - no desiccation



(3, 4)

³ Collas, F.P.L., De Hoop, L., Koopman, K.R., Le, T.T.Y., Matthews, J., Bij de Vaate, A., Van der Velde, G., Leuven, R.S.E.W. (2017) Database on the distribution of the Quagga mussel (*Dreissena rostriformis bugensis*) in the Netherlands and Europe.

⁴ Matthews, J., Van der Velde, G., Bij de Vaate, A., Collas, F.P.L., Koopman, K.R., Leuven, R.S.E.W. (2014) Rapid range expansion of the invasive quagga mussel in relation to zebra mussel presence in the Netherlands and Western Europe. *Biological Invasions* 16: 23-42.

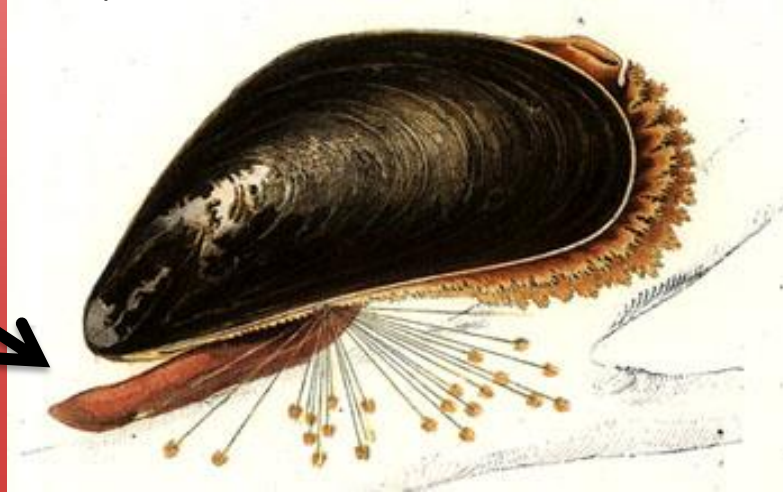
1. Risk assessment – Risk inventory

- **Secondary spread** ⁽⁵⁾

Active or passive



Example: blue mussel



Vector mediated



⁵ Matthews et al. 2012. Key factors for spread, impact and management of Quagga mussels in the Netherlands. Reports Environmental Science nr. 404. Radboud University & Waterfauna Hydrobiologisch Adviesbureau, Lelystad, Nijmegen, the Netherlands, p. 123.

1. Risk assessment – Risk inventory

- **Environmental effects**

Abiotic

- ↑ Hard substrate & mat formation
- ↑ Water clarity
- Nutrient mobilization and pollution following mass extinction ⁽⁶⁾

Biotic

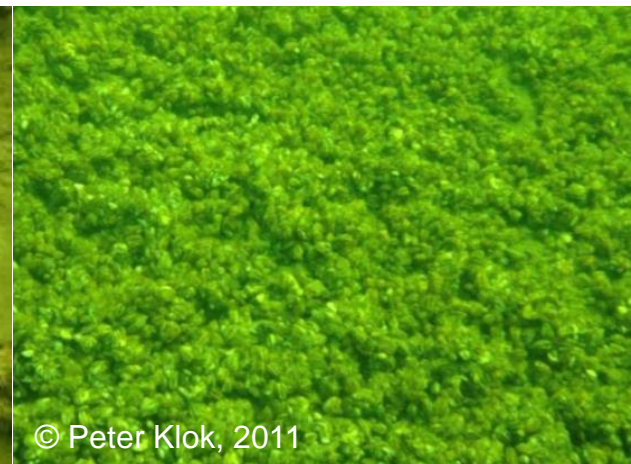
- ↓ Native freshwater mussels
- Plankton composition & density change
- ↑ Water plants

- **Public health**

- Toxic blue algae

- **Infrastructure and economy**


- Pipes, pumping-engines, fishing nets, hulls



⁶ Leuven, R.S.E.W., Collas, F.P.L., Koopman, K.R., Matthews, J. & Van der Velde, G. 2014. Mass mortality of invasive zebra and quagga mussels by desiccation during severe winter conditions. *Aquatic Invasions*, 9 (3): 243-252.

1. Risk assessment – Risk scores and classification

- **Harmonia+ protocol** ⁽⁷⁾

Risk category		Risk classification	Score	Confidence	Score ³
Invasion	Introduction ¹	High	1.00	High	1.00
	Establishment ¹	High	1.00	High	1.00
	Spread ¹	High	1.00	High	1.00
Effect	Environment ¹	High	1.00	High	1.00
	Cultivated plants ¹	Low	0.00	High	1.00
	Domesticated animals ¹	Low	0.25	High	1.00
	Human health ¹	Medium	0.50	High	1.00
	Others (e.g. infrastructure) ¹	High	0.75	High	1.00
Invasion score ²		High	1.00	NA	NA
Effect score		High	1.00	NA	NA
 Overall risk score ⁴		High	1.00	NA	NA

NA: not applicable, ¹ Maximum effect score per category, ² Introduction x establishment x spread, ³ Arithmetic mean per category, ⁴ Invasion score x effect score

- Consistent with other risk assessments

⁷ De Hoop et al. 2015. Risicobeoordeling en uitzetcriteria voor de uitheemse quaggamossel (*Dreissena rostriformis bugensis*) in Nederland. Radboud Universiteit Nijmegen, DNV GL, Deltares, Bureau Waardenburg, GiMaRIS, Stichting Bargerveen, Universiteit van Amsterdam. 87 pp.

2. Permit criteria - Methods

Risk assessment &
independent review by experts



Proposal for protocol

- Evaluation criteria
- Exemption nature conservation legislation
- Eco-engineering



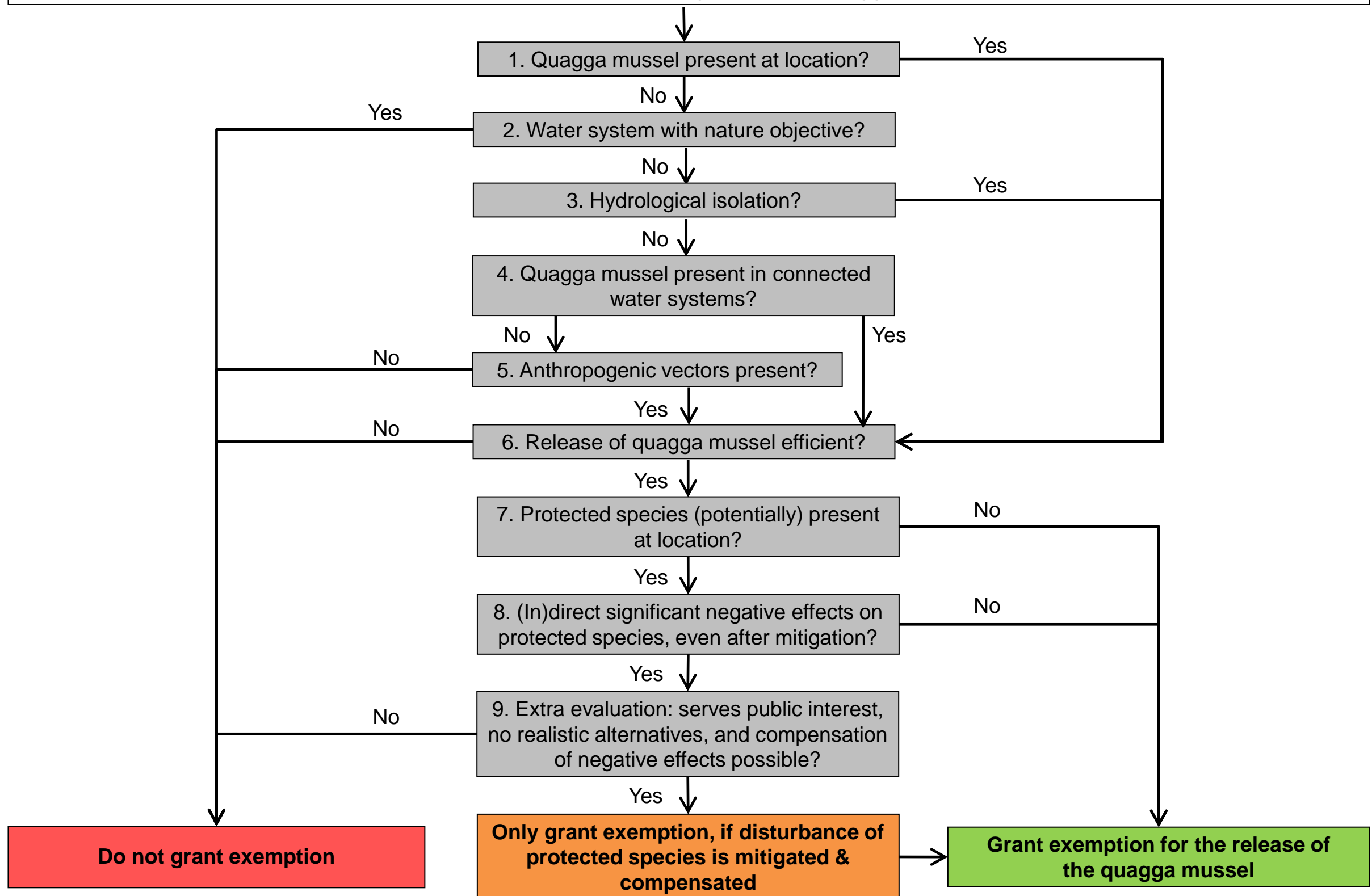
Decision tree

- Widely supported proposal
- Useful for
 1. Applicants: which information needed?
 2. Competent authorities: assess application
- Natural and artificial water systems

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2. Permit criteria – Decision tree

Application for exemption from nature conservation legislation for quagga mussel release in water systems



Conclusions

- High risk species → effects on environment and socio-economy
- Decision tree → quick insight in success of application for exemption
- Consensus → precautionary position

Recommendations

- Develop quantitative method for weighing positive and negative effects
- Consider potential effects on infrastructure and (fire) safety
- Remove nutrients from system

Acknowledgements

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- Netherlands Food and Consumer Product Safety Authority





Questions?

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