NOBANIS
European Network on Invasive Alien Species
Gateway to information on Invasive Alien Specis in North and Central Europe

# Invasive Alien Species

## Pathway Analysis and Horizon Scanning for Countries in Northern Europe

**The report offers knowledge on alien introductions and recommendations for prioritising future management of Invasive Alien Species**

Photo: *Arion lusitanicus*, Hans Erik Svart

One of the main drivers of biodiversity loss is Invasive Alien Species (IAS). In order to plan cost-effective measures to prevent the introduction of harmful IAS, we need to know the pathways of introduction.
Until now, the measures to prevent harm to native environments and biodiversity by IAS have mainly been reactive methods based on knowledge of the IAS already present. This approach has proven to be a costly and ineffective way to manage IAS.
Therefore, early warning of new IAS, in order to implement preventive measures as early as possible, may be a cost-effective way to safeguard our environment and save money.

**Acknowledgement**
This report was made possible by financial contribution from the Terrestrial Ecosystem Group (TEG) of the Nordic Council of Ministers.

**Purpose**
The aim of this project was to contribute to the fulfilment of obligations in the Aichi target 9 under the Convention on Biological Diversity (CBD) and the EU Biodiversity Strategy 2020 target 5. This was done by conducting a pathway analysis and horizon scanning. The pathway analysis was carried out to identify and prioritise pathways of introduction by which alien species were introduced in the Nordic and Baltic region, along with Iceland and the Faroe Islands. In order to examine which new alien species may be introduced and established in the countries in the future, a number of potential *door knocker species* were assessed by experts.

**Regions**
10 countries and territories have participated in this project: Denmark (DK), Estonia (EE), the Faroe Islands (FO), Finland (FI), Iceland (IS), Latvia (LV), Lithuania (LT), Norway (NO) (including Svalbard (SJ)) and Sweden (SE). The national data from the NOBANIS database from each participating country and territory has formed the basis for the pathway analysis.

The pathway analysis and the horizon scanning were conducted on a regional level in three regions:

- a Nordic region (DK, FI, NO, SE and for the pathway analysis SJ separately)
- a Baltic region (EE, LV, LT)
- a region consisting of the islands in the North Atlantic Ocean (FO, IS)

**Pathway analysis**

The pathway analysis explores the pathways used for alien introductions until now, and contains the following subanalyses:

- Pathways of introduced species
- Invasiveness of introduced species
- Taxonomic groups of introduced species
- Temporal development of pathways
- Species origin and the pathway of introduction

The pathway analysis revealed that the main pathway of introduction for alien species in the three regions was horticulture, followed by agriculture & transport, but also that there were variations between the regions (See figure 1 & Figure 2). The analysis also revealed that the majority of species introduced had an unidentified pathway of introduction. This reflects that it is a challenging task to identify pathways of introduction for alien species that are unintentionally introduced, but also that the method and degree of data collection varies between countries and regions.

The pathway analysis also showed that the main pathway of introduction varies between the different taxonomic groups, but that angiosperms and arthropods are the groups with the highest number of introductions in all three regions. The high number of introductions of angiosperms are primarily by horticulture, while arthropods mainly are introduced by horticulture and transport. The high number of introduced arthropods may reflect the high diversity of the group giving a wide range of pathways for dispersal. This means that prioritising pathways of concern can be challenging and costly, and further studies of arthropods (specific subgroups) and their pathways of introduction are needed.

The part of the pathway analysis regarding invasiveness of alien species revealed that the groups with the highest number of invasive or potentially invasive alien species were angiosperms and arthropods. Although, when looking at the percentage distribution, the group with the highest degree of invasive or potentially invasive species varies between the three regions.

For the Nordic region the groups with the highest percentage of invasive or potentially invasive alien species were microorganisms, flatworms and fungi, while for the Baltic region annelids and fish had the highest number, and for islands in the North Atlantic Ocean it was birds and mammals.
Looking at the pathways where most introductions of species with high invasiveness occured, horticulture once again was the main pathway of concern.

The development of pathways over time reveled that the number of introductions and the importance of different pathways varies over time, but also that the introduction of alien species with horticulture has increased over time in all three regions. The overall increase in registered introductions may reflect both the increase in globalisation, but also the global awareness about invasive alien species may effect the overall increase in registered introductions.

Most of the alien species registered in the participating countries and territories originates from Europe, Asia or North America, reflecting the similarities in the biogeographic zones in those areas and the participating countries and territories in this project.

**Figure 1: Pathway of introduction for alien species in the three regions. The graph shows the number of species introduced by each pathway in the different regions.**

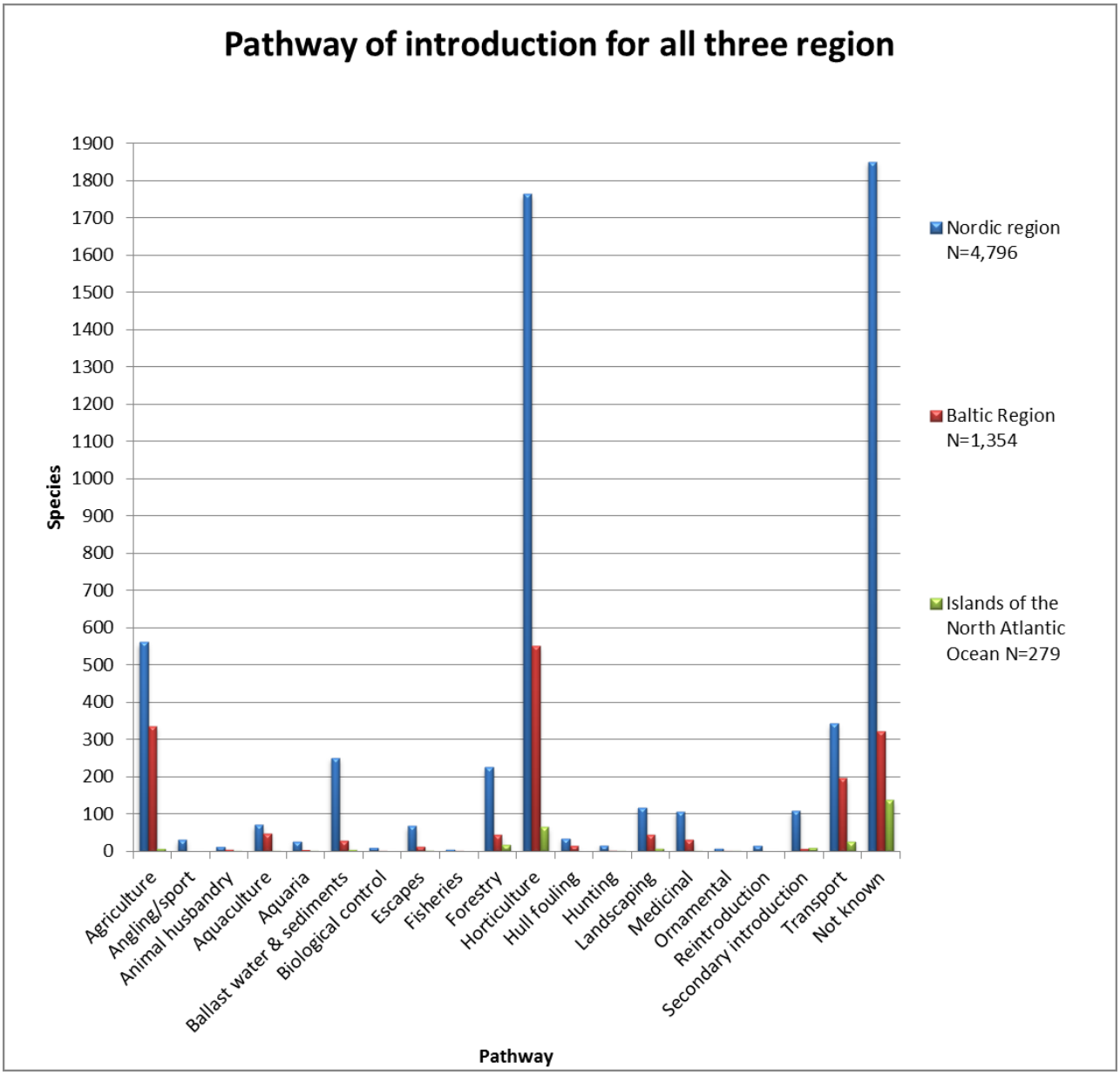
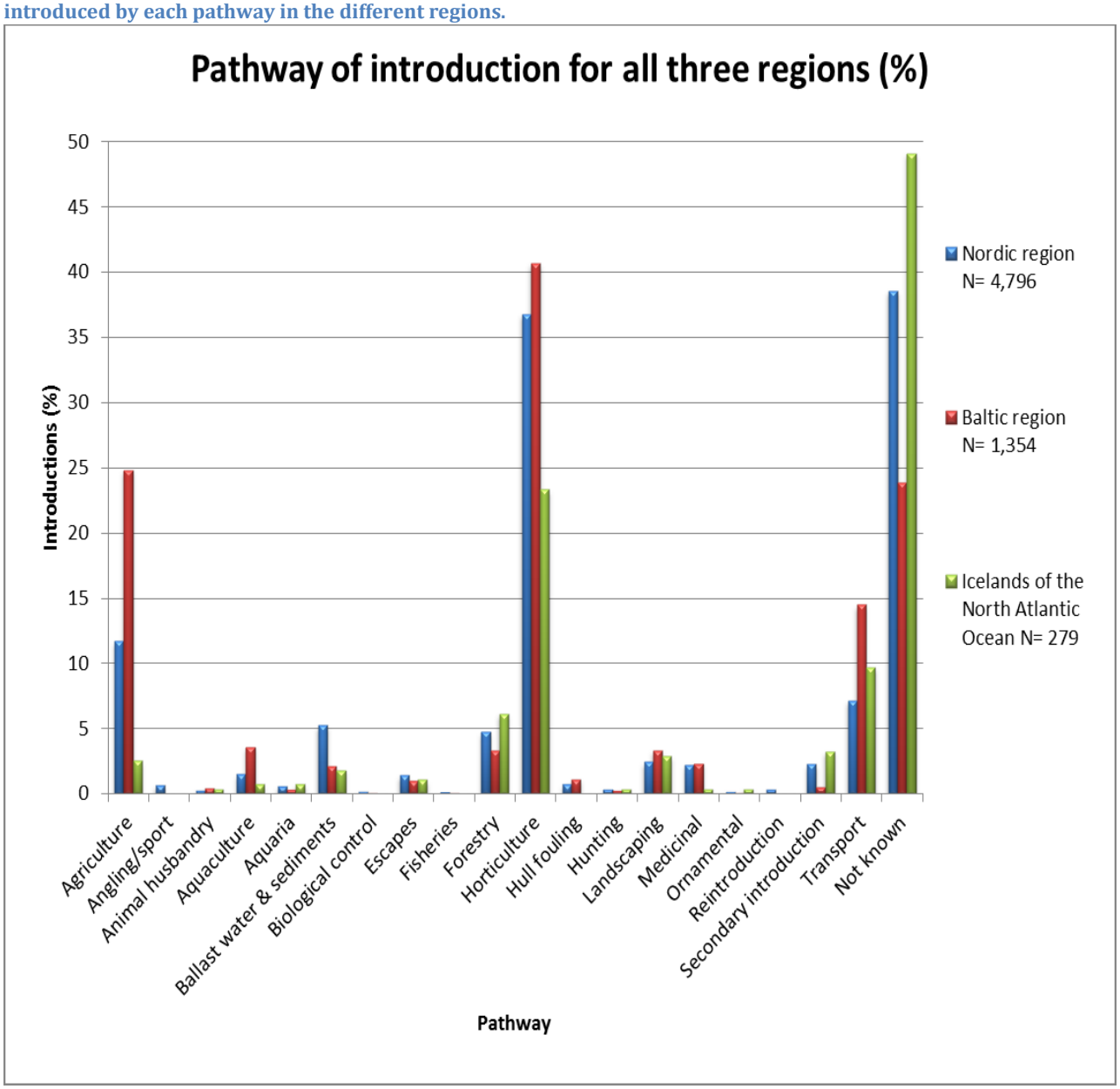


**Figure 2: Pathway of introduction for alien species in the three regions. The graph shows the percentage of species introduced by each pathway in the different regions.**



**Horizon scanning**

The horizon scanning analyses the risk of future introductions of invasive alien species, by looking at so called *door knocker species* that can potentially be introduced in the near or distant future. For the horizon scanning a list of 414 potential *door knocker species* was assembled using:

- The NOBANIS database: To search and list invasive or potentially invasive species established in non-participating countries that are part of the NOBANIS network (Austria, Belarus, Belgium, Czech Republic, Germany, Greenland, Ireland, the Netherlands, Poland, Slovakia and the European part of Russia).
- Data from alert lists from Denmark (Pathway for non-native species in Denmark, 2014), Norway (Alien Species in Norway, 2012), Germany (Warnliste, 2013) and Ireland (Risk analysis and prioritisation, 2013).

The list was then assessed by experts across the regions and territories based on:

- Arrival
    - What is the possibility that the species will arrive?
- Establishment
    - What is the possibility that the species will become established?
- Impact assessment
    - Does the species pose a threat to biodiversity?
    - Does the species pose a risk to human health?
    - Does the species pose a risk regarding socio-economic concerns?

Of the 414 potential *door knocker species*, 43 were evaluated as high risk species and 78 as medium risk species for the regions combined. For the species assessed as being high risk species, arthropods were the largest group represented, while the medium risk species largely were angiosperms and arthropods.

In the analysis horticulture, secondary introduction and transport were assessed as being the most likely pathways of introduction for species of high risk and medium risk.

**Door knocker species**

D*oor knocker species* are defined as an alien species which has not yet arrived and established in any of the participating countries and territories (DK, EE, FI, FO, IS, LT, LV, NO & SE), but can be expected to be introduced in the near future.

This might be an alien species which is already established in a neighbouring country, and which unaided can manage to cross national boundaries into any of the participating countries and territories. This is called secondary introduction (Gederaas et al. 2012). It could also be a species with a natural range in other geographical areas that can potentially spread to the participating countries and territories by using a pathway of introduction e.g. by horticulture, transport, forestry etc.

In this report a *door knocker species* can also include alien species already present but not established in the wild with a sustainable population, in any of the participating countries and territories. This can apply to species which initially only survive indoors, in greenhouses or in compost heaps (Gederaas et al. 2012).

**Prioritisations and recommendations**

Based on the results from the pathway analysis and horizon scanning, the different pathways of introduction were prioritised and recommendations were presented (See figure 3).

The prioritised list of pathways is to be seen as guidelines for future management, and the prioritisation was based on:

- Number of introduced invasive species by the individual pathway
- Number of introductions overall by the individual pathway

Subsequently, other parameters from the pathway analysis and the horizon scanning were taken into account to make adjustments to the prioritisation of the pathways:

- Invasive introductions (%)
- Number of high risk (A) door knocker species that is assigned to the individual pathway
- Number of medium risk (B) door knocker species that is assigned to the individual pathway
- Number of potentially invasive introductions
- Temporal development of the pathways

**Figure 3: An overview of the prioritised pathways for all three regions.**

| Pathways of concern | | | | | |
|---|---|---|---|---|---|
| **Nordic region** | | **Baltic region** | | **Islands of the North Atlantic Ocean** | |
| **1** | Horticulture | 1 | Horticulture | 1 | Horticulture |
| **2** | Transport | 2 | Transport | 2 | Transport |
| **3** | Ballast water & sediments | 3 | Forestry | 3 | Secondary introduction |
| **4** | Agriculture | 4 | Agriculture | 4 | Escapes |
| **5** | Secondary introduction | 5 | Aquaculture | 5 | Ornamental |
| **6** | Forestry | 6 | Landscaping | | |
| **7** | Landscaping | 7 | Ballast water & sediments | | |
| **8** | Aquaculture | 8 | Secondary introduction | | |
| **9** | Escapes | 9 | Escapes | | |
| **10** | Hull fouling | | | | |

| | | | |
|---|---|---|---|
| **11** | Aquaria | | |
| **12** | Angling/sport | | |

**General recommendations**

The pathway analysis showed that horticulture was the main pathway of concern in all three regions, and that many alien species from different taxonomic groups use horticulture as a pathway of introduction - either intentionally or unintentionally.

Since intentional and unintentional introductions need different management approaches, general recommendations based on the type of introductions, and not related to specific pathways, was made to manage pathways on a broader scale. Only secondary introduction and pathways linked to the marine ecosystem are presented with more specific recommendations, since these pathways have challenges that varies from the other pathways (see figure 4).

**Figure 4: An overview of the presented recommendations**

| Recommendations | |
|---|---|
| **Challenges** | **Recommendations** |
| **All** | Gathering of new knowledge |
| | Early warning system |
| | Horizon scanning on a regular basis |
| **Intentional introductions** | Restrictions on import and trade |
| | Restrictions on release |
| | Information campaigns |
| **Unintentional introductions** | Obligations to importers or exporters |
| | Restrictions on import |
| | Sample control or screening |
| | Quarantines |
| | Treatments |
| **Secondary introduction** | Early warning system |
| | Reduction of introductions in general |
| | Reduction of individuals introduced by other pathways |
| **Marine ecosystems** | Prevention of introduction by ballast water & sediments |
| | Reduction of introductions by angling/sport and aquaculture. |

Additional studies and scientifically validated data are needed in order to identify pathways of introduction, as well as to clarify the invasive status of some alien species registered in the regions. Further study of those particular species may increase the amount of information, and give us a more comprehensive understanding of invasive alien species to help prevent introduction, and to manage and eradicate the species.

## References

Gederaas, L., Moen, T. L., Skjelseth, S. & Larsen, L. K. (2012): Alien species in Norway – with the Norwegian Black List 2012. The Norwegian Biodiversity Information Centre, Norway.

Kelly, J., O'Flynn, C., & Maguire, C. (2013): Risk analysis and prioritisation for invasive and non-native species in Ireland and Northern Ireland. A report prepared for the Northern Ireland Environment Agency and National Parks and Wildlife Services as a part of Invasive Species Ireland.

Madsen, C. L., Dahl, C. M., Thirslund, K. B., Grousset, F., Johannsen, V. K. and Ravn, H. P. (2014): Pathways for non-native species in Denmark. Department of Geosciences and Natural Resource Management, University of Copenhagen, Frederiksberg, pp. 131.

Rabitsch, W., Gollasch, S., Isermann, M., Starfinger, U., and Nehring, S. (2013): Erstelling einer Warliste in Deutschland noch nicht vork-ommendee invasiver Tiere und Pflanzen. BfN-Skripten 331.

## Full report

NOBANIS: Invasive Alien Species – Pathway Analysis and Horizon Scanning for Countries in Northern Europe
TemaNord 2015:517
http://dx.doi.org/10.6027/TN2015-517