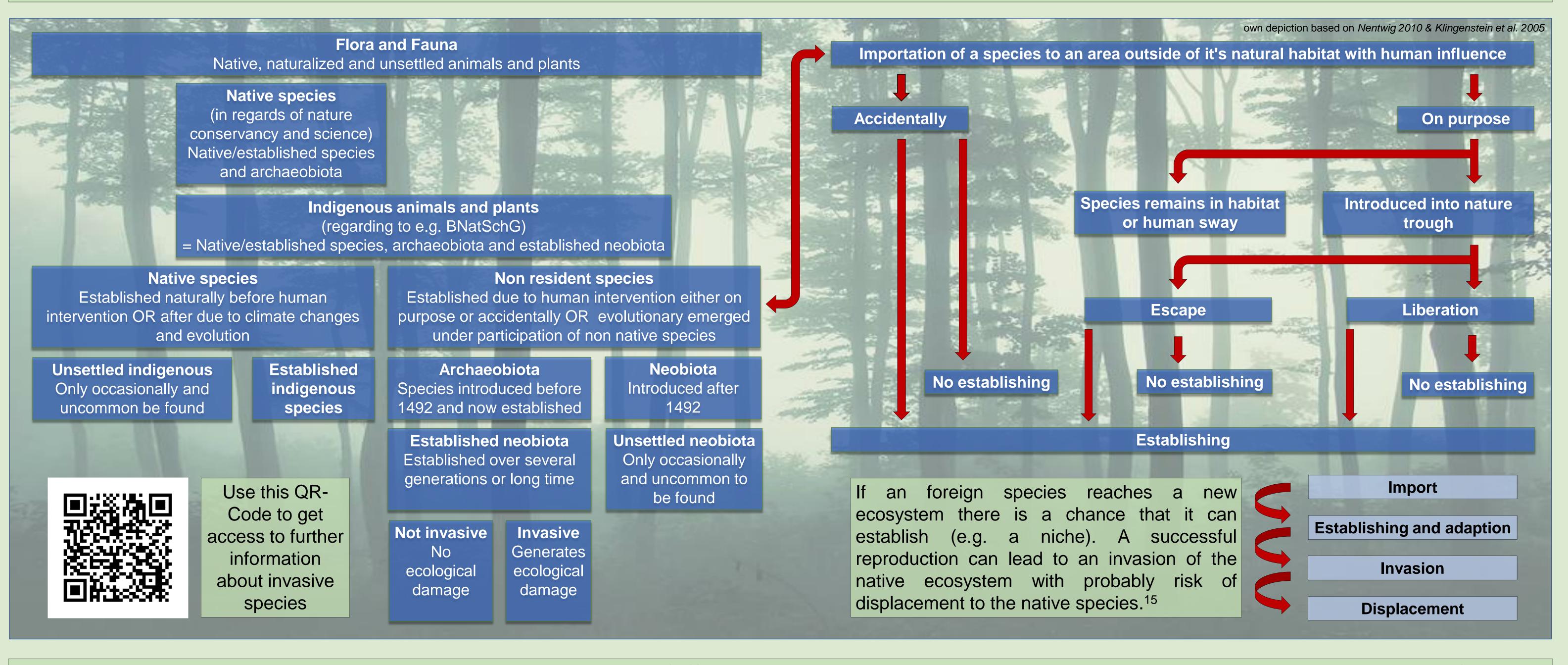
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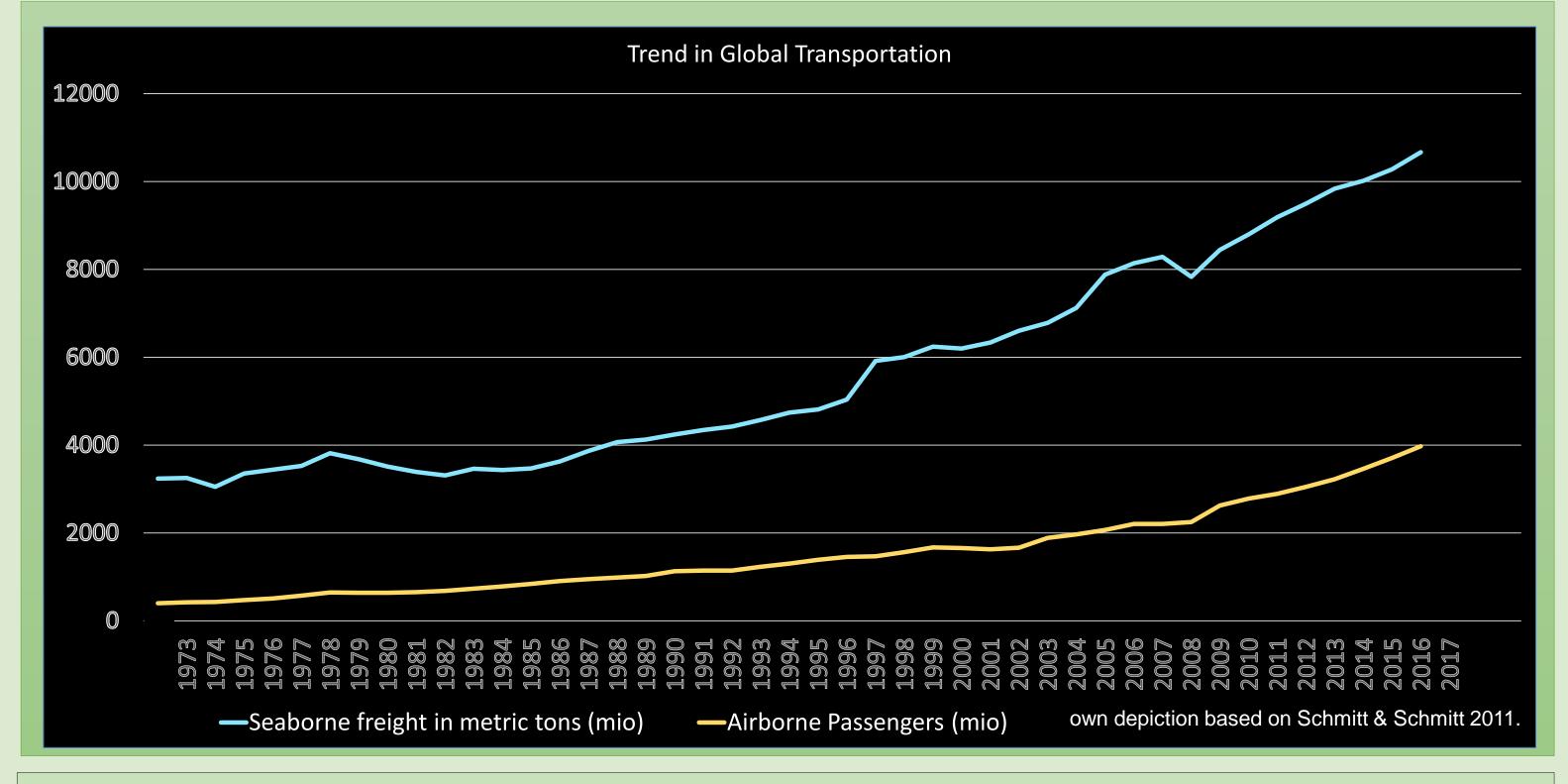
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Bioinvasion – Distribution Patterns for Invasive Species on a Global Scale

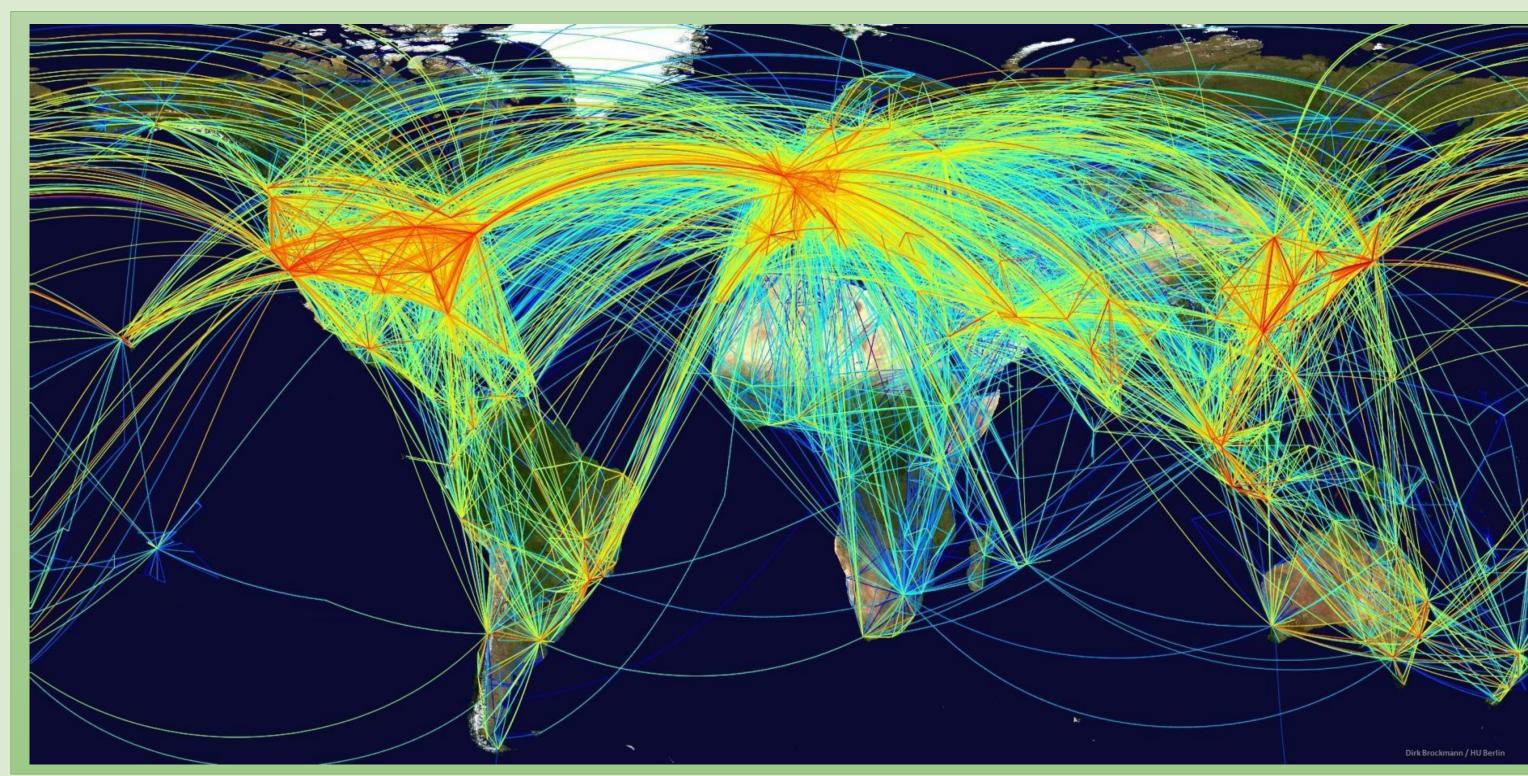
Definition | Species are classified as invasive when they appear outside of their natural habitat and harm their newly occupied habitat in manners of ecosystems, biotopes, species and human health.^{9,15} This can happen either intentionally or unintenionally caused mostly by human influence (e.g. trading).⁷ There are many different definitions for invasive species depending on science and administrative guildlines and can be very complex and contradictionary.⁹ In the following the focus lies on increasing human influrence by globalization.



Transport | Biological invasions strongly depend on human trade and transport. First indicators for trading between human settlements can be described since the Neolithic. The further development of trading in times of the Roman empire lead to an sufficient transportation system all over Europe. Three events linked the worlds floral and faunal realms like nothing before. The first impact took place in the year of 1492 with the end of the middle age in Europe which brought demographic changes and the discovery and colonization of the new world. From the 18th century onwards industrialization, the extension of infrastructure, higher mobility and emigration from europe linked areas which were never in touch before. The third big impact is the modern day globalization and flow of goods on a scale we do not fully understand yet. In 19



Development of Global Trading | Compared to 1970 the volume of seaborne transportation is five times higher and airborne passenger transportation has even increased by the factor of ten.^{22, 23} About 90% of total international transportation of goods is carried out by seaway⁵, while ballast water from cargo ships alone transfers high amounts of species alone.^{18, 4} The key to handle such massive amounts of goods is the invention of the standardized ship container and huge improvements in mechanical engineering.^{1, 10} While cargo transfer via plane takes a minor part for world economy, many invasive species are transfereed with luggage of passengers.^{5, 12}



Worldwide transportation | The increasing importance of transportation in terms of the globalization leads to wide international exchange of goods. Due to this global transportation networks the risk for Bioinvasions has dramatically risen in the past decades. The figure above shows the main directions of global trade. The intensity is represented by the density of the linies which displays that the trading intensity between Europe, Asia and North America are the most important. This leads to a significant penetration of natural barriers on a global scale (see figure below) which threatens ecosystems originally divided for long times of evolution .

Example | The Asian Longhorn Beatle

Pathway

- The Asian longhorn beetle is transported on infested fire wood, containers, pallets & dunage.
- Has reached the United States and other countries in wood packing materials headed from Asia.
- It is found frequently at ports and warehouses.
- So far the occurance is limited to urban areas.⁶

Nutrition

- Adult Asian longhorn beetles feed on leaves, petiole and twigs preferred on hardwood trees.
- They appear to attack healthy trees as well as stressed trees.
- Eggs are injected under the bark
- surface, where they hatch into larvae.
- The tunnels oft he larvaes destroy the structural integrety of the trees.⁶

North America Impacts

- 30-35% of trees in urban eastern states are susceptible to its attack.
- This could lead to a loss of 1.2 billion trees with an estimated value of \$669 billion.
- If the beetle reaches natural forests, the potential impact could reach to the elimination of 71 billion trees valued at over \$2 trillion dollars.
- In case of such an dramatic loss of trees, the whole forest ecosystems could be seriously damaged.^{17, 21}

Management

- Eradication programms were implemented by the US Animal and Plant Health Inspection Service (APHIS) by the use of insecticides.
- Intensive visual inspections when the beetle is reported.
- Trees at high risk are felled and chipped (400m from the edge of the known infestation).¹⁷

Review of Oceanography and Marine Biology, 43, 419-453.



Flora and Fauna Realms | The world can be divided in several floral and faunal realms which are seperated by natural barriers due to the continental dirft (oceans) and cilmatic borders like deserts. These realms contain ecosystems specialized for their environment.

23Worldbank (2019): World Bank Open Data. https://databank.worldbank.org/data/home.aspx

18 Streftaris, N., Zenetos, A. & Papathanassiou, E. (2005) Globalisation inmarine ecosystems: The story of non-indigenous marine species across European seas. Annual

²²UNCTAD (2019): United Nations Conference On Trade And Development – Database.<http://unctadstat.unctad.org/wds/ReportFolders/reportFolders.aspx?sCS_ChosenLang=en>

¹⁰Levinson, M. (---2006): The Box. How the Shipping Container Made the World Smaller and the World Economy Bigger. Princeton/Oxford.