

# Which factors influence the introduction and spreading of invasive plant-species in Switzerland and what impact do they have?

*[Marcel Scheiwiller, Noah Manohar, Niklas Gohm, Vincent Pas, Fabiana Chiriatti, Désirée Oberli]*

## Summary

Invasive plant species directly impact ecosystem functions and native plant and animal communities. Invasive species also indirectly impact ecosystems through transmission of diseases and parasites and through hybridization with native species<sup>1</sup>. There are 48 invasive plants listed by the Swiss Federal Office for the Environment<sup>2</sup>, a number of which have severe impacts on local species<sup>1</sup>, human healthcare, welfare, and economic costs<sup>3</sup>. To combat invasive species, educational programs and information are instrumental in raising public awareness and avoid potential conflicts concerning invasive species management<sup>4</sup>. Of primary concern, invasive species can out-compete valued trees in the forest and therefore reduce the yield. The management of these invasive plants are costly<sup>5</sup>.

The factors influencing the success of invasive species is discussed in the following part. The term invasibility implies that not all ecosystems are prone to biological invasions and that some are more „invasible“ than others. The invasibility of a habitat depends on the forest type, soil type and elevation<sup>6</sup>. Disturbances as well as disease and pest outbreaks can facilitate invasions by eliminating or reducing the cover or vigor of native competitors or by increasing resource levels<sup>7</sup>.

The establishment of invasive plants is strongly influenced by climatic variables and anthropogenic disturbance. Passive transportation for example, like by train or car and an increased host range, which are mostly influenced by humans<sup>8</sup>. The potential gain of neophyte species in settlements and urban landscapes are up to twice as high as in rural landscapes<sup>9</sup>. *Ailanthus altissima* is probably the most famous example for invasive tree species in Switzerland. It is favoured by rock coverage and high light availability<sup>10</sup>. In conclusion, invasive plants are very much influenced by their environment and can have a big impact on it as well.

## Research aspect A: What is the invasive species environmental impact?

[Marcel Scheiwiller]

### Short summary

Invasive species in forests cause various environmental impacts, such as direct impacts on plants and animals, indirect impacts on ecosystems and other species through transmission of diseases or parasites and through hybridization<sup>1</sup>. In the case of robinia pseudoacacia and impatiens glandulifera (two invasive plants in Switzerland) local species composition is influenced<sup>11</sup> respectively biomass of local species is decreased<sup>12</sup>. These are just two examples of 48 invasive plants in Switzerland listed by the Federal Office for the Environment<sup>13</sup>. Environmental impacts can be severe for local species and the introduction of new alien species will likely increase in the future<sup>1</sup>. Since there is still a lack of detailed knowledge and information, studies in this field should be emphasized<sup>14</sup>.

### Scoring environmental and socioeconomic impacts of alien plants invasive in Europe (1)

Scoring system, 128 alien plants in Europe; most spread/biggest impacts selected; competition with other species most frequent environ. impact, impact on human health most frequent socioec., significant correlation environ. and socioec. impacts; important step for prevention and control

### Black locust (Robinia pseudoacacia) beloved and despised: A story of an invasive tree in Central Europe (11)

Invasive robinia p. (tree) in Europe, ecological and socioeconomic impacts; literature review and unpublished results; spread in Ticino, pioneer species that disperses quickly, influences species composition; lots of economic benefits, environmental impacts should be more important

### The invasion of an annual exotic plant species affects the above- and belowground plant diversity in deciduous forests to a different extent (12)

Impact of Impatiens glandulifera on (above) and belowground diversity in forests; study sites in Switzerland, comparison of invaded and uninvaded sites; the root biomass of native plants was reduced for invaded areas, aboveground richness was lower in invaded plots but not belowground

## Invasive alien species in Switzerland (13)

overview of all invasive alien species in Switzerland; summary of reviewed literature; 48 invasive plant species are listed, the distribution in Switzerland is given and environmental impacts are described; a lot of information gaps, research needed

## A global assessment of invasive plant impacts on resident species, communities and ecosystems: The interaction of impact measures, invading species' traits and environment (14)

synthesis of global plant invasion impacts; review paper, 1551 cases analysed; significant impacts were highest on outcomes associated with plants; detailed knowledge on impacts is often missing.

## Research aspect B: What is the invasive species impact on the economy and on culture?

[Fabiana Chiriatti, Désirée Oberli]

### Short summary

[Fabiana]

The negative impacts from invasive plants in certain industries and ecological systems can be recognized by local inhabitants<sup>15</sup>.

The example of *Robinia pseudoacacia* shows, that invasive species can have a positive impact on economy due to their appeal in forestry use. The economic potential of Robinia, due to various properties like nitrogen fixation or fast growing, is huge in Europe, but only marginal in Switzerland. Those economically advantageous traits can also create big problems for nature protection and cause conflicts<sup>16</sup>.

Invasive species cause healthcare-, welfare- and economic costs. These alien species compete against valued plants, for example, and therefore reduce the yield. The management of these invasive plants are costly<sup>5</sup>.

There is also an impact on culture, because the aesthetic appeal of those invasive plants can influence the general opinion of the population, for example leading to management or reduction of those plants<sup>17</sup> The impact on native species, for example on butterfly diversity is negatively correlated with increasing richness of invasive plants. Biodiversity is threatened because of biological invasions<sup>18</sup>.

### Invasive plants threaten the least mobile butterflies in Switzerland (18):

Analyses the threat of biological invasions on biodiversity; modification by exotic plants, regarding ecosystem composition, structure, dynamics and competition with native species; extensive inventory of plants and butterfly, following a comparison of plants on butterfly richness; butterfly richness decreases with increasing numbers of invasive plants

### Invasive species policy and climate change: social perceptions of environmental change in the Mediterranean (15):

Perception of effects from invasive plants, compared to environmental issues; in-depth interviews, questionnaires and surveys; stakeholders raise concerns about specific impacts and ability of policies to respond to future risks; expression of need to have an integrative environmental policy for local management of invasive plants.

### Dangerous and useful at the same time: Management strategies for the invasive black locust (16):

Positive and negative properties of *Robinia pseudoacacia* and approaches of its management; various management models are examined.

### Benefits of Classical Biological Control for Managing Invasive Plants (5):

Examine the advantages of biological control for managing invasive plants, against conventional methods, which are using pesticides; threat of invasive plants for ecology and economy is looked at; strategies for managing problems with invasive plants and analyzing advantages and disadvantages of the latter.

### Beasts or beauties? Laypersons' perception of invasive alien plant species in Switzerland and attitudes towards their management (17):

Investigate laypersons' perception of invasive alien plant species (IAPS) and opinions on management of those; questionnaire in three cities in Switzerland; agreement on eliminating those plants that cause costs and problems; already established invasive plants are more tolerated and people are unwilling to remove those.

## Short summary

[*Désirée*]

The socio-economic impact of invasive species can be classified into 5 levels<sup>19</sup>.

Invasive plants are a big problem in the USA<sup>20</sup>. Educational programs and information in terms of invasive species are instruments to raise public awareness and a possibility to avoid conflicts concerning management of invasive species<sup>4</sup>.

Invasive plants can cause ecological and economical damages and costs in terms of invasive species- fighting<sup>3</sup>. There are impacts of invasive species on the economy that are influenced by personal opinions and preferences<sup>17</sup>.

## Socio- economic impact classification of alien taxa (SEICAT) (19)

This paper classifies different alien taxa by the magnitude of their impact on human well-being. According to semi-quantitative scenarios, there are 5 level of impacts, from minimal to massive concern.

## Environmental and Economic Costs of Nonindigenous Species in the United States (20)

There are approximately 50'000 nonindigenous species in the US. 5000 of these nonindigenous species are plants, compared to 17'000 native plants. The damage non native plants cause is very expensive. Sometimes an alien species can entirely overrun an ecosystem causing substantial long term impacts and significant costs.

## Invasive Alien Species in Switzerland: Awareness and Preferences of Experts and the Public (4)

The authors of the paper conducted a survey on public awareness and knowledge of IAS (Invasive Alien Species). This experiment was able to analyse preferences concerning intensity, priority, costs of interventions, Education programs or information campaigns are a promising instrument to raise public awareness. This public online survey had 1251 participants, it was conducted using an online panel sample which was sourced from a private provider. This Swiss panel consisted of more than 50,000 participants of the German, French- and Italian-speaking parts of the country.

## Ökonomische Folgen der Ausbreitung von Neobiota (3)

20 IAS, animals and plants, were sampled from different regions which were adversely affected by the alien species. These were processed. The costs have been investigated from 3 perspectives. These were the economical impact, the ecological impact and the costs incurred to fight the IAS. However, not all alien species cause economic damage.

## Beasts or beauties? Laypersons' perception of invasive alien plant species in Switzerland and attitudes towards their management (17)

The authors investigated laypersons' perceptions of IAPS (invasive alien plant species) and attitudes towards management with questionnaires in ZH, GE, Lugano. There were 720 participants, Knowledge of IAPS (ability to identify it) and desire to have it around were negatively correlated. Participants agreed mostly with the eradication of IAPS that caused serious costs and problems. Almost all plants were perceived as beautiful and wanted. The study location influenced characterizations.

## Research aspect C: How is the spread of invasive plants influenced by ecosystems?

*[Noah Manohar, Vincent Pas]*

### Short summary

*[Noah Manohar]*

The invasibility of a habitat depends on the forest type, soil type and elevation: Natural riparian and floodplain forests are among the forest types most vulnerable to biological invasions<sup>6</sup>. Disturbances as well as disease and pest outbreaks facilitate invasions by eliminating or reducing the cover or vigor of competitors or by increasing resource levels. Environments subject to pronounced fluctuations in resource supply are vulnerable as well<sup>7</sup>. Most of the important elements of global change (increased N deposition, rapid anthropogenic climate change, increased habitat fragmentation, altered disturbance regimes) are likely to increase the prevalence of biological invaders<sup>21</sup>.

The following plant species traits can make them become successful in new regions and invasive: Rapid germination, high biomass production, a higher likelihood of flowering during the first season, fast growth, self-compatibility, a short juvenile period, seeds that germinate without pretreatment, being pollinated by generalists, vegetative reproduction and having a wide geographic range in the native region<sup>22 23</sup>.

### Fluctuating resources in plant communities: A general theory of invasibility. (7)

They performed Experiments and long-term monitoring in the USA and UK to test the influence of fluctuating resources on invasibility of a habitat. Resource availability and disturbances are identified as key factors influencing invasibility.

### Does global change increase the success of biological invaders? (21)

This Review-Paper explains what elements of global change are advantageous to invasive plant species, by summarizing insights from many papers on this topic. They show, that most of these elements positively influence the spread of invasive species.

### Invasive alien plant species in unmanaged forest reserves, Austria. (6)

This study presents the results of a 15-year investigation into how invasive species occur within natural forest reserves. The results show, that certain forest-types are more susceptible to invasion than others.

### A multi-species experiment in their native range indicates pre-adaptation of invasive alien plant species. (22)

This study compares invasive with non-invasive plant species from Europe in the USA. They show which plant traits are beneficial outside the home-range and can potentially cause alien plants to become invasive.

### Plant invasion across space and time: Factors affecting nonindigenous species success during four stages of invasion. (23)

This paper aimed to find universal 'invader traits' and show how invasive species might benefit from climate change. The study was performed in the USA and considered four different spatio-temporal stages of invasion.

## Short Summary

[Vincent]

Alien plant distribution is affected by spatial heterogeneity, anthropogenic disturbance and climatic constraints, whereas the area seems to be the most important predictor<sup>24</sup>. For *A. altissima* there are several environmental factors like rock, litter coverage and high light availability which play major roles on its distribution<sup>10</sup> but *Ailanthus altissima* seems to grow under low light conditions as well<sup>25</sup>. Besides the light levels, seasonality seems to play a role as well, as it is very important for the establishment and distribution of the invasive rainforest tree *Maesopsis eminii* in Tanzania<sup>26</sup>. Additionally, anthropogenic nitrogen input seems to play a role for growth and competitive behaviour between native and invasive plant species such as *Bidens frondosa*<sup>27</sup>.

### Alien plant species distribution in the European Alps: influence of species' climatic requirements (24)

Question: What are the main abiotic and anthropogenic drivers for alien plant species richness and distribution in the European Alps?

Methods:

-study area: european alps

-specified species database from a study of Aeschmann et al. (2004)

- measuring of environmental data

statistical analyses for species richness: ordinary least squares regression

statistical analyses for species composition:

constrained analysis of principal coordinates, followed by forward selection of environmental variables

Results: austria and italy included higher number of species, alien species number discovered on more than half of the district was 59, species richness was significantly related to area, temperature, precipitation, urban elements and forest cover

### Low litter cover, high light availability and rock cover favour the establishment of *Ailanthus altissima* in forests in southern Switzerland (10)

Question: What factors have the biggest influence on the establishment of *Ailanthus altissima*?

Methods: two types of multiple regression models (LOG and NB)

Results: 243 saplings of *A. altissima* were recorded, establishment positively affected by rock cover, low litter cover and high light availability

### Shade tolerance of *Ailanthus altissima* revisited: novel insights from southern Switzerland (25)

Question: Can juvenile *A. altissima* grow and survive in sweet chestnut forests in southern Switzerland?

Methods: hemispherical photography to assess light conditions of samples

Results: vegetative regeneration grew in significantly lower light conditions than generative individuals, median age of juvenile *A. altissima*: 3 years



### Effect of seasonality and light levels on seed germination of the invasive tree *Maesopsis eminii* in Amani Nature Forest Reserve, Tanzania (26)

Question: Do seasonality and light levels have an impact on germination of *Maesopsis eminii*?

Methods: dry and wet season, 4 different shade levels

Measuring of 5 parameters: final germination percentage, mean germination time, germination index, Coefficient of velocity of germination, germination rate index  
growth parameters: shoot height, stem diameter, total fresh biomass, total dry biomass, total leaf chlorophyll content, morphological indicators

Results: wet season: number of germinated *M.eminii* seeds did not differ significantly across shade levels, Final Germination percentage 1.5 times higher at 0% shade level than at 85%, growth parameters during wet season indicated significant differences in diameter shoot height, fresh biomass and chlorophyll content but not in total dry biomass across different shade levels, during the dry season germinated seeds differed significantly across all shade levels

### Effects of Global Risks – Nitrogen Additions on Growth and Competitive Relations among Invasive and Native Congeneric Species – *Bidens frondosa* (27)

Question: Do increased levels of nitrogen increase the risk of *Bidens frondosa* invasion?

Methods: common garden experiment, measuring increase in biomass, relative interaction intensity for competitive effects

Results: nitrogen additions significantly increased biomass, differences in total biomass among *B.frondosa* and btw the two native congeners, mean total biomass did not differ between *B. frondosa* and the native congeners, enhanced the mean growth of *B.frondosa*, *B. frondosa* growth was favoured over the native congeners, increased competitive interaction of *B. frondosa*, decreased of the two congeners

## Research aspect D: How is the spread of invasive plants influenced by economy and culture?

[Niklas Gohm]

### Short summary

The distribution of invasive species depends, amongst other things, on passive transportation and an increased host range<sup>8</sup>, which are mostly influenced by humans. Control measures are more effective if they are spatially prioritized and applied at early stages<sup>28</sup>.

The BAFU says that humans affect the distribution of invasive species through passive and active transportation<sup>29</sup>.

Researchers came to the conclusion, that global warming has a much higher impact on shifts in neophyte biodiversity than urban sprawl. The potential gain of neophyte species is up to twice as high in settlements and urban landscapes than in rural landscapes<sup>9</sup>.

### Citizen science and early detection of invasive species: phenology of first occurrences of *Halyomorpha halys* in Southern Europe (8)

Question: How did the distribution of *Halyomorpha halys* take place in southern Switzerland and northern Italy?

Methods: Combining active research and multimedia citizen science survey.

Results: depends on factors such as voltinism, type and range of host plants, biotic potential and possibility to overcome geographical barriers. BMSB has established breeding populations that can rapidly spread due to bivoltinism, passive transportation and an increased host range

### Strategie der Schweiz zu invasiven gebietsfremden Arten (29)

Question: The report is about the strategy of Switzerland on how to fight invasive species.

Methods: There are no methods mentioned.

Results: Different ways of distribution are mentioned. For example by passive transport (through human activity) or active transport.

### Space matters when defining effective management for invasive plants (28)

Question: How does spatial prioritization improve the management planning of invasive species?

Methods: They used a dynamic simulation model.

Results: Control actions are more effective if they are spatially prioritized. Most effective spatial treatments generally prioritized small populations in the case of the annual species and large populations in the case of the perennial species. Further, applying intensive control at early stages generally increased effectiveness of control.

### Neophyte species richness at the landscape scale under urban sprawl and climate warming (9)

Question: What implications for the future dynamics of neophyte species richness can be inferred from environmental scenarios with a focus on land-use and climate change?

Methods: They used different data sets and combined them with urban sprawl and climate scenarios.

Results: Climate warming had a much higher impact on shifts in neophyte biodiversity (up to 191% increase in mean species richness by 2050) than urban sprawl (up to 10%). The potential gain in neophyte species in settlements and urban landscapes are up to twice as high as in rural landscapes.

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