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Neophytes in the NP Thayatal - distribution mapping and evaluation of management

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Abstract

In the year 2000, the Nationalpark Thayatal-Podyji had comissioned a project to map the distribution of several invasive alien plant species, which also provided the background for subsequent management of these species. After a 10 years period, the distribution of the invasive alien species were re-mapped, the changes in distribution and the management efficiency were assessed. These results provide the basis for adjusting future alien species management.

The three neophytes of main concern were *Robinia pseudacacia, Impatiens glandulifera* and *Fallopia x bohemica*. Our survey showed that the management of *I. glandulifera* was successful, albeit the costs incured were substantial. As a result of substantial management efforts, population densities of *R. pseudacacia* have been strongly reduced, whereas its distribution has relatively little changed, mainly as a result of the formation of root-suckers. For this species, management efforts have to be continued. The third main target species*, F. x bohemica*, is rare in the Nationalpark Thayatal-Podyji, but notoriousely difficult to eradicate. The managed sites show lower densities than in 2001 but few new occurrences in near-natural habitats have been recorded.

For each occurrence a management goal has been proposed. The need for action was estimated and concrete suggestions for management measures were given where possible and most needed.

This study provides insights into adaptive management of invasive alien plants in national parks and thus is valuable for a wide range of protected areas, which have increasingly to cope with invasions.

Keywords

Fallopia x bohemica, *Impatiens glandulifera,* invasive species, management efficiency, neophytes *Robinia pseudacacia*

Introduction

The continuing progression of globalization increasingly affects the distribution of biota. Besides many benefits intentional and unintentional transfer of organisms among regions that were previously separated, increases. (PERRINGS et al. 2010, KELLER et al. 2011). Some of those introduced species actually become invasive and have negative impacts (KOLAR & LODGE 2001, ESSL & RABITSCH 2002). Because of frequent time lags between introduction and establishment of species the process of future invasions is likely to have been set in motion already (KOWARIK 1995, ESSL et al. 2011) and the magnitude of impacts of invasive species in Europe is expected to grow in the next future (PYŠEK et al. 2013). Therefore the need for action is high, especially in national parks which are bound in law to conserve the typical flora, fauna as well as habitats (PYŠEK et al. 2013).

In the year 2000 a first assessment of several invasive neophytes in the Nationalpark Thayatal was conducted, including species descriptions, dispersal and frequency, their habitat preferences, assessment of probable spread and issues for conservation (ESSL & HAUSER 2001). A first management plan and long term monitoring were developed. In 2010 a reassessment was conducted by the authors of this paper. The goal were i) to assess the current distribution of *Robinia pseudacacia*, *Fallopia x bohemica* and *Impatiens glandulifera*, ii) to aassess changes in distribution within the two mapping periods, iii) to record further potentially invasive neophytes, iv) to evaluate the efficiency of management measures undertaken since 2001 and v) to provide recommendation for adjusting management measures.

Study species

Fallopia x bohemica (Polygonaceae) is a hybrid of *F. sacchalinensis* and *F. japonica* (TIÉBRÉ et al. 2008), which are native to northeastern Asia (i.e. Sakhalin and northern Japan respectively Japan, China and Korea) (BMLFUW 2005). Both were introduced to Europe in the 19th century and in particularly *F. japonica* has become widespread in Austria. *F. x bohemica* is only documented more frequently since a few years, maybe due to earlier misrecognition of the species (WALTER et al. 2002, BMLFUW 2005). Considered aggressive invaders all three *Fallopia* species reproduce by clonal, rhizomatous growth and can quickly form monodominant stands (Aguilera et al. 2010). They preferably colonize shaded riparian habitats (BMLFUW 2005), disturbed sites demonstrate enhanced recruitment, colonization and spread of *Fallopia* species (TIÉBRÉ et al. 2008). *Fallopia* spp. can cause

large changes to the communities and ecosystems they invade and reduce biodiversity (GERBER et al. 2008, AGUILERA et al. 2010).

Impatiens gandulifera (Balsaminaceae) is an annual forb originating from Himalaya, that favours wet and nutrient-rich riparian habitats (PYŠEK & PRACH 1995). Although in Austria the invasion history of *I. glandulifera* started as early as 1898 it has only in recent decades become one of the most widespread invasive species in Europe (BEERLING & PERRINS 1993, ESSL & RABITSCH 2006). Himalayan balsam is able to form monospecific stands, albeit the extant of negative impact on native flora and fauna is controversial (DRESCHER & PROTS 1996, TICKNER et al. 2001, HEJDA & PYŠEK 2006). HEJDA & PYŠEK (2006) implicate that control measures may even give way to invasions of other alien species.

Robinia pseudacacia (Fabaceae) is one of the most problematic alien plants in Europe (CHYTRY et al. 2005, HULME 2009,). It is native to southeastern North America and has been introduced to Europe during the 17th century (BMLFUW 2005). Black locust is a pioneer tree, able to colonize a wide array of different habitats in its secondary range (KLEINBAUER et al. 2009). However in Europe it particularly invades nutrient poor dry and semi-dry habitats, increases productivity due to nitrogen fixation and modifies nutrient cycles (KOWARIK 2003).

Methods

The field survey of the second distribution mapping period was conducted during the vegetation period 2010, mainly in July and August. All stands recorded in the first mapping period (2000) have been visitied, as well as all sites of the study species which have been found in the intermittent period. In addition, other potentially invasive neophytes were recorded and their population sizes and the invaded vegetation type were recorded.

The stands were mapped on aerial photographs in 1:10000 scale. To document the sites' size and density, all stands have been assigned to size classes (0-10m²; 10-100m²; 100-1000m²; 1000-10000m²; >10000m²), and the study species density measure was assessed based on BRAUN-BLANQUET (1964). Population trends between 2000 and 2010 were classified for each site (unknown, declining, spreading, stable).

The monitoring net installed in 2001 consists of 20 observation squares, measuring 3 x 3meters each. Eight lie within *R. pseudacacia* stands, eight within *I. glandulifera* stands and four within *F. x bohemica* stands. Within those continuous observation squares species cover of all vascular plants was estimated in percent and general data (date of assessment, verbal description of the site, localization via GPS, etc.) were surveyed.

The sites were digitalised, using ArcMap, an overview of the sites as well as 17 distribution maps were compiled. The non-graphic data were integrated into the existing ACCESS-data base from 2001.

The management evaluation is based on data from the years 2001, 2008, 2009 and 2010 provided from the national park management. Between 2002 and 2007, no data was available concerning duration and costs of management. Missing data was interpolated for this period by decreasing a steady percentage of 5,27% each year, based on data from 2001 for costs and calculating duration out of costs from 2001, thereof decreasing a steady percentage of 6,96% each year.

Results

In the year 2010, *Fallopia x bohemica* was present on 2699m² equalizing 2% of all neophyte stands (Table 1). Most stands in the national park are located in the proximity of anthropogenic settlements. Two sites were located in near-natural area of the stream Kaja. All stands are located in shadowed and wet habitats.

Management was implemented on six of the seven sites registered in 2001. Four sites were managed by mowing once a year, the date varied from May to September in the years 2008 to 2010. One site was eradicated manually by managers of the national park, two further sites were removed manually by the community. One site was not included into the management.

However, we found that *F. x bohemica* has been spreading in the National Park Thayatal since 2001. The number of polygones and sites increased from 8 polygones (7 sites) to 13 polygones (8 sites) in the year 2010, despite three sites registered in 2001 were eradicated completely. The total colonized area increased by 2028m². Regarding the four sites present in both survey periods we found an increase of the colonized area by 319m² (54%).

Average stand densities were very highy (>75%) in most sites existent in both survey periods. Only three of the four newly registered sites showed low densities (< 5%). The overall „area-density-index", which is calculated by multiplying area (m²) by density categories (r=1, +=2, 1=3, 2=4, 3=5, 4=6, 5=7), increased by 658 points (+16%) between both survey periods. The average management effort (15 hours and 225 € per year) was rather low.

Impatiens glandulifera colonized 10.391m² (6%) in 2010 in the national park (Table 1). All 18 sites are located directly at the riverbank or within 25 meters to the Thaya river. *I. glandulifera* is found primarily in open and wet habitats (e.g. tall herb communities), the stands are small and densities are low.

The management of *I. glandulifera* included all sites registered in 2001. Large sites were mowed once a year in July (before seed set) smaller sites were removed manually. During August and September the sites were controlled and overlooked individuals were removed.

All *I. glandulifera* stands decreased in extent since 2001. The number of polygones and sites decreased from 45 (15 sites) in 2001 to 18 (11 sites) in 2010. Nine sites were eradicated completely, four sites were newly registered in 2010. The total area colonized decreased by 34,165m² (-77%), and sites which had been already colonized in 2001 and 2010 decreased even stronger (-84%, -31,159m²).

Interestingly, average population densities did only change little between 2001 and 2010. Most stands are sparse with average population densites <5%. The „area-density-index“ showed a substantial decline (-81,263 points, 85%) between 2001 and 2010. Management effort was high with average annual costs of 1600€ and 113 hours.

Robinia pseudacacia is present on 13,7 ha (137,358m²), thus contributing 85% to total stand sized of of the three study species combined (Table 1). The stands are mainly located ni forests and forest edges close to settlements.

Five of the 19 *R. pseudacacia* sites were subjected to management. They were girdled in 2001 leaving a small part of cambium to reduce resprouting. In subsequent years the root suckers were chopped and mowed several times during the vegetation period.

Overall, *R. pseudacacia* stands increased in area. The number of sites and polygones has increased from 28 (19 sites) in 2001 to 32 (26 sites) polygones in 2010. Two sites were eradicated since 2001, but six new sites were registered in 2010. Sites which were already existent in 2001 increased by 15,376m² (26%) until 2010.

Most stands with dense *R. pseudacacia* canopies (>50%) in 2001 decreased substantially. The newly registered sites show Black locust densities between 25% and 75% and are located mainly outside the borders of the national park. The „area density index“ increased by 12,302 points from 2001 to 2010. Management effort of *R. pseudacacia* was the most expensive (3800€ and 243 hours annually) of the study species.

Table 1: Change in number of polygones and sites and area invaded (m²) of studied neophytes in 2001 and 2010

	Fallopia x bohemica			***Impatiens glandulifera***			***Robinia pseudacacia***		
	polygones	sites	area m²	polygones	sites	area m²	polygones	sites	area m²
2001	8	7	671	45	15	44556	28	19	57541
2010	13	8	2699	18	11	10391	32	26	137358

Discussion

Although species composition changes fundamentally under dense *F. x bohemica* stands, the overall impacts in the National Park Thayatal are currently moderate due to the small extent of the infestations. However, the species is spreading since 2001 and it is expected to continue to spread and invade further near-natural habitats. In addition, *F. x bohemica* is difficult to manage, thus substantial negative effects are probable in the future. The management measures carried out since 2001 seem to have lowered the rate of spread, but even more dedicated management is needed. Especially sites close to along water courses should be eradicated to prevent further spread by rhizome fragments which are often transported by floods (PYŠEK & PRACH 1994, HEJDA et al. 2009). Small stands should be managed manually by cutting and removing shoots and rhizomes. Large stands situated in less valuable habitats can be mowen once to twice a year to prevent further spread.

The invasion of *I. glandulifera* has been strongly reduced since 2001 due to dedicated mnagement efforts, and thus the negetaive impacts caused by this species are minor. To avoid re-invasion, management should continue. Remaining small stands should be eradicated manually, larger stands can be mowen annually just before seed set. Inspection of the sites in August is recommended to remove missed and later developed individuals. Management measures should be carried out until complete eradication of the species in the national park will be achieved.

R. pseudacacia ist the most wide-spread of the study species and it causes strong impacts on biodiversity in invaded habitats (KLEINBAUER et al. 2009), .So far, management has been able to reduce stand densities, but further infestations have been recorded since 2010, and the overall extent of invaded sites has increased .

However, it has to be noted that improved quality of aerial photographs in 2010 facilitated exact mapping of the Black locust infestations. Thus, recording bias migth in part account for the increase in area invaded.

Within management sites older individuals should be girdled in early summer, in chest height leaving 1/10 of the bark to minimize the number of root suckers. To prevent resprouting from the stem the sapwood should not be harmed (SKEW 2006). Some of the ring barked individuals of 2001 still resprouted in 2010. In dry grassland root suckers should be removed once to twice a year, within other sites the upcoming individuals should also be removed manually. Consequent management is important until the stands are eradicated completely.

Conclusion

This study shows that management of neophytes in national parks is possible, but requires substantial and continuous ressources. The extent of the invasion and consequences for species composition and structure in the national park, the biology of the alien species, the complexity of control measures and their probable effect on the species, conservation value of habitats invaded and distribution of the study species outside the national park, which may function as source for (re-)establishment as well as the costs of management measures are some of the factors to be considered when undertaking neophyte management in national parks. Overall, the management measures taken until now show satisfying results also because of strong cooperation with the Czech Národní park Podyjí. However, invasive alien species are not perceived as a pressing problem by the public and there is a need for more education of visitors to protected areas. Education and public involvement are part of prevention which is the most effective and cheapest measure controlling IAS (PYŠEK et al 2013).

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