

# Invasion by alien species and size and location of nature reserves

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Petr PYŠEK<sup>1</sup>, Tomáš KUČERA<sup>1</sup> and Vojtěch JAROŠÍK<sup>2</sup>

<sup>1</sup>Institute of Botany  
Academy of Sciences of the Czech Republic  
CZ-252 43 Průhonice, Czech Republic  
e-mail: pysek@ibot.cas.cz

<sup>2</sup>Department of Zoology  
Faculty of Science, Charles University  
Viničná 7  
CZ-128 01 Praha 2, Czech Republic

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**SUMMARY:** Studies of alien species in 302 nature reserves located in the Czech Republic, central Europe, have shown that the degree to which a reserve is invaded, depends on the altitude, type of protected vegetation, interactions with native species, and propagule pressure manifested through density of human population in the region. A complex statistical analysis was needed to entangle the net effects of many correlated environmental variables. Besides scientific problems we attempted to analyse in our study, we also focussed on practical aspects of knowledge, which can be useful for managers and nature conservationists involved in design and establishment of nature reserves. Our study was driven by three basic questions: Is there a difference between (1) small and large, and (2) old and young reserves in a degree to which they are invaded, and (3) does the position of a nature reserve in the landscape affect the probability that it will be exposed to invasion by alien species?

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One of the most frequently debated theories in conservation biology has been whether several small reserves will contain more species than would a single reserve of equal total area (the SLOSS model). Arguments have been accumulated for support of both views but the debate is taxonomically biased and does not have a definitive solution: large reserves are more suitable for protection of large animals, while small areas seem to be more convenient in the case of invertebrates and plants (Primack 2000). However, the question of whether or not small-scale nature reserves are more vulnerable to invasions than large ones has not been rigorously studied for plants. Our results do not support the hypothesis that small reserves are more invaded than large ones; we found a weak significant relationship between the occurrence of aliens and reserve area only when the effect of native species was removed. This does not justify implementation into practice: removing the effect of native richness is irrelevant from the practical point of view of nature conservation because the decision about how large a reserve should be cannot disregard the native species it will harbour. Clearly, for reserve invasibility in temperate zone, the size of area does not play an important role (Pyšek *et al.* 2002).

However, our results have shown that reserves surrounded by protected landscape have significantly fewer alien species than those not located inside national parks or protected landscape areas. This finding has a practical relevance for issues associated with reserve establishment and design. While natural factors such as climate and composition of native flora are beyond control in the process of establishment of nature reserves, and reserve area is not important in terms of reserve invasibility, positioning the reserve within large protected sections of landscape significantly decreases probability of it being invaded by alien species. Such landscapes, subjected to a special conservation regime, act as effective barriers to invasive species. For an alien species, it is easier to invade reserves located in a countryside with diverse land uses, which is more heavily affected by various human activities creating opportunities for their dispersal. On the basis of these results, we

suggested a new model called Several Small Inside Single Large (SSISL) that seems to be an appropriate solution to maximize the species richness of nature reserves with regard to plant invasions.

By measuring the rate of inclusion of both alien and native species into the system of nature reserves in the Czech Republic on an historical time scale since 1838, we showed that natural vegetation in nature reserves is an effective barrier against the establishment of alien species (not only that old nature reserves have fewer aliens because less of them were present at the time of establishment, but also that it is more difficult for alien species to penetrate into protected areas). This implies another important issue, i.e. that on an historical time scale, the early establishment of nature reserves in a given country decreases the probability that reserve will be invaded by alien plants (Pyšek *et al.* 2003).

## REFERENCES

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