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# **Economics of controlling invasive species: optimal control and stability of ecological-economic system**

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# Economics of controlling invasive species: optimal control and stability of ecological-economic system

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## Introduction:

Biological control agents that are introduced to agriculture can spill over to the environment and cause negative externalities (e.g. Chalak et al. 2010).

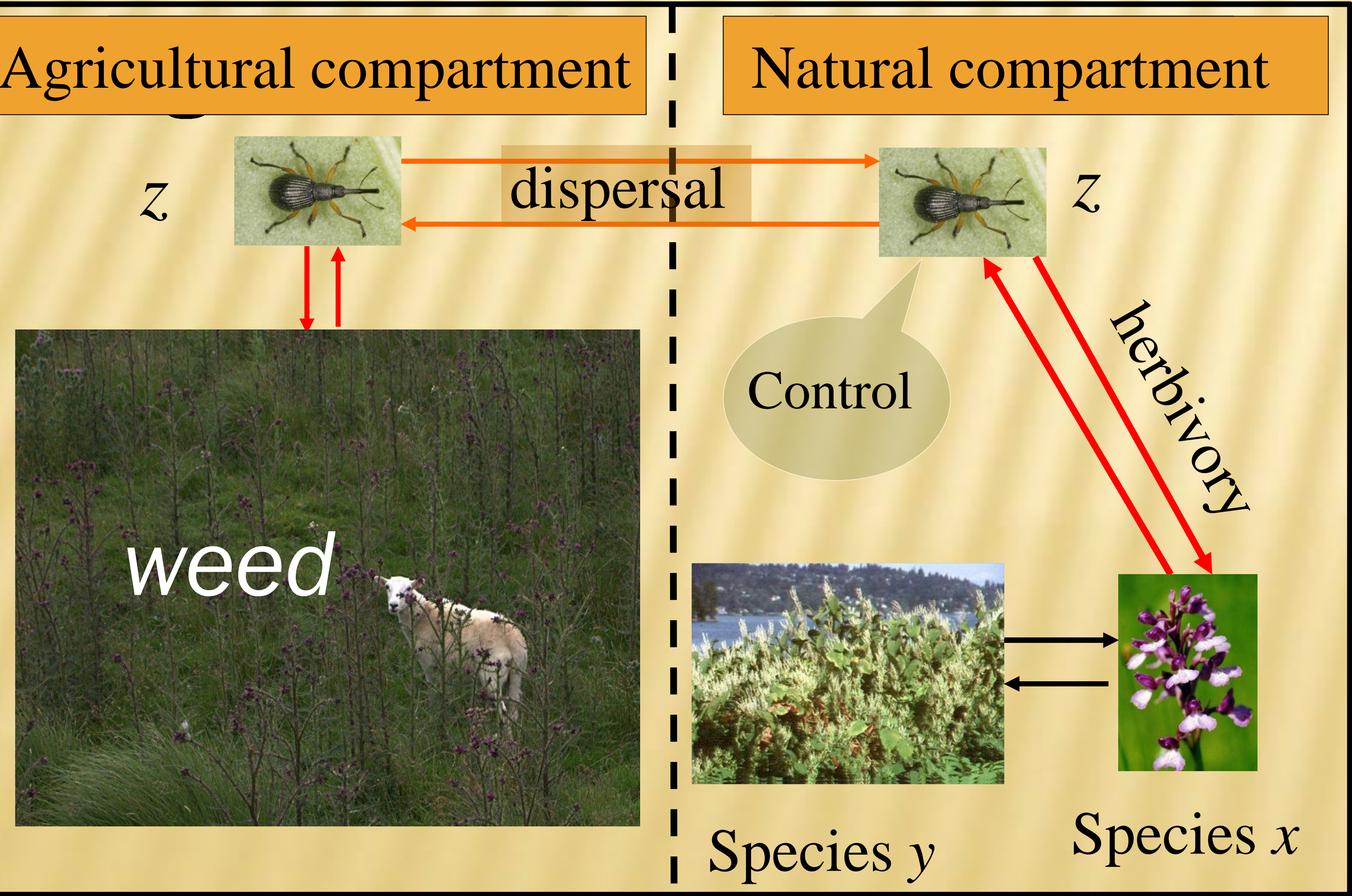
This study analyses a herbivore which:

- was introduced to agriculture to decrease weeds but...
- spilled over to the environment and attacked an endemic species.

## System:

We consider a two-compartments ecosystem where:

- herbivore ( $z_m$ ) is introduced to control weeds in agriculture,
- herbivore disperses to a neighbouring natural area,
- the herbivore attacks endemic species  $x$ .



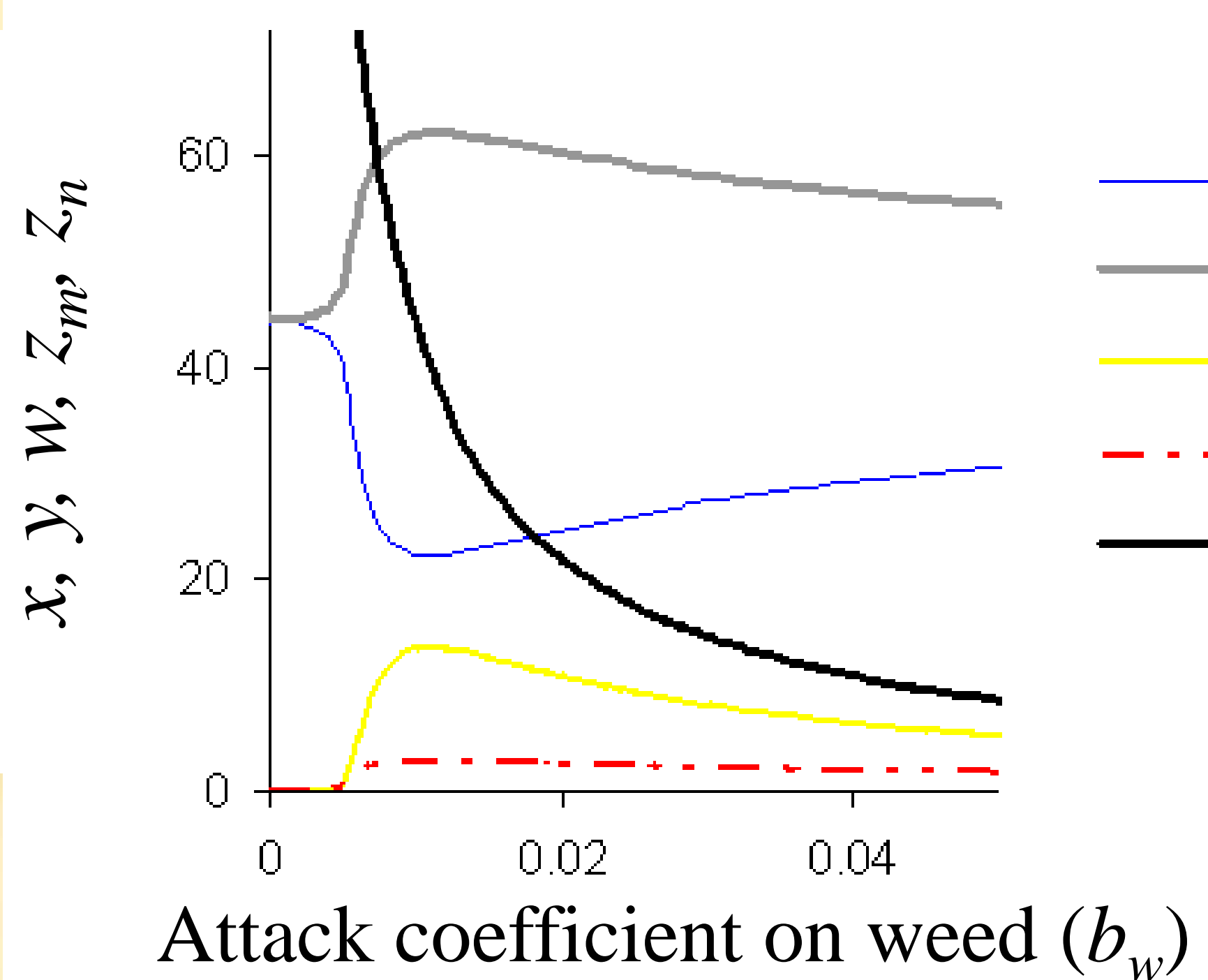
## Research questions:

A) Under what conditions do introduced herbivore drive endemic species  $x$  to extinction?

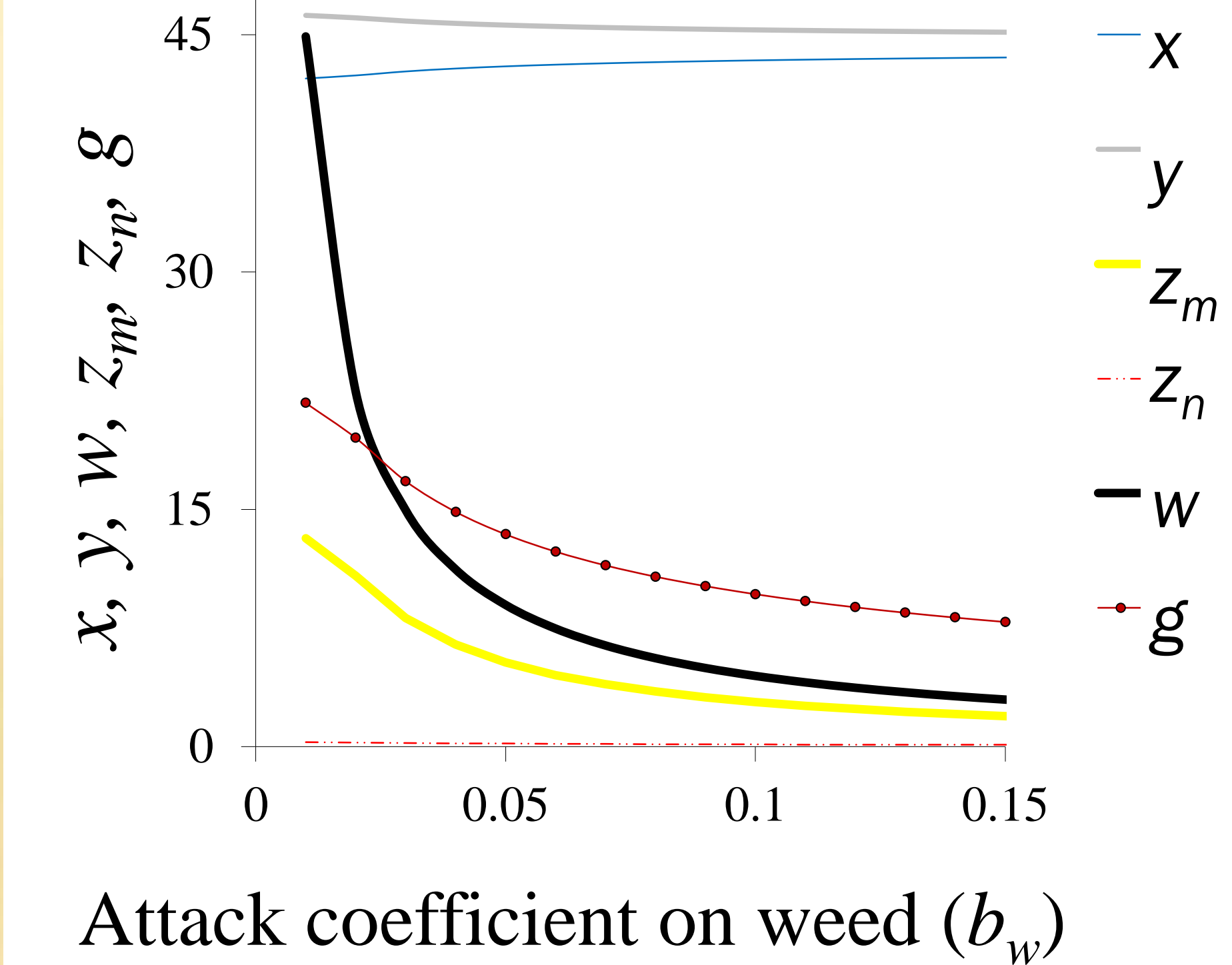
B) What are optimal levels for control of the herbivore for different:

- species values,
- attack rates of the herbivore,
- densities of non-target species  $x$ ?

Species densities without control



Species densities under optimal control

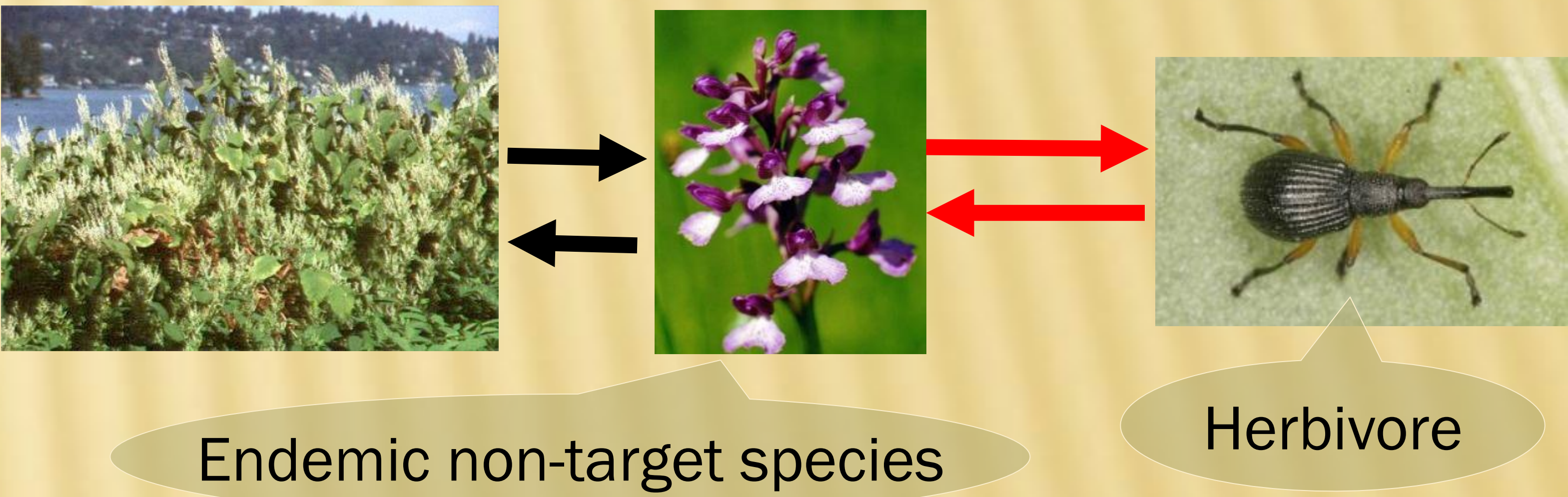


## Results and conclusions

A) Extinction risks can be higher when the herbivore has a lower attack rate.

B) Control must increase when:

- the non-target host has a higher biodiversity value than does its competitor,
- the herbivore has a relatively low attack rate on the target species (i.e. the weed),
- the non-target species has a low density.



## References:

Begon, M., Harper, J.L., Townsend, C.R., 1996. Ecology: individuals, populations and communities. Blackwell Scientific, Boston, Massachusetts, USA.

Chalak M, Hemerik, L., van der Werf, W., Ruijs, A., van Ierland, E.C., 2010. On the risk of extinction of a wild plant species through spillover of a biological control agent: analysis of an ecosystem compartment model. Ecological Modelling, 221, 1934-1943.

## Model:

- A complex economic optimisation model is developed that includes processes such as: plant competition, dispersal, herbivory and control.
- Stability of the ecological economic system is tested to find conditions under which the system becomes unstable and endemic species  $x$  goes to extinction.