Can we trust that they will bust? - Boom-bust dynamics in biological invasions

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1. Introduction and aims

Invasive alien species (IAS) - species that have been introduced accidentally or deliberately by humans into a natural environment outside their native distribution and are causing or are likely to cause environmental or socio-economic harm - are one of the greatest threats to global biodiversity [1].

Prevention and management of IAS are therefore of the utmost importance. However, populations of some IAS have shown boom-bust dynamics - a drastic decrease after having risen to outbreak levels [2, 3] - giving rise to scepticism among some stakeholders regarding the necessity of management.

As boom-bust population dynamics are of fundamental importance to understanding, interpreting, and managing biological invasions, we conducted a Web of Science analysis to investigate the prevalence of such dynamics, as well as their underlying trends and mechanisms.

2. Methods

An initial Web of Science® search revealed 836 papers that went through a screening process to uncover "true" boom-bust papers, defined as papers describing original data documenting a boom-bust population dynamics in an alien species or providing original assessments of existing datasets (Fig. 1). Details on search criteria and the review process can be found in Appendix 1 in "*Boom-bust dynamics in biological invasions: towards an improved application of the concept*" [3].

3. Results and discussion

We found 56 papers on IAS describing population dynamics that might be classified as boom-bust (Fig. 1). Enemy release followed by enemy accumulation was the main mechanism given in boom-bust papers, as predator-prey, diseases/parasites and competition were among the top-ranking mechanisms. Other important mechanisms included changes in inorganic factors, human influence and resource depletion (Fig. 2). IAS that showed boom-bust dynamics were of many taxa (Fig. 3), and occupied a variety of habitats (Fig. 4).

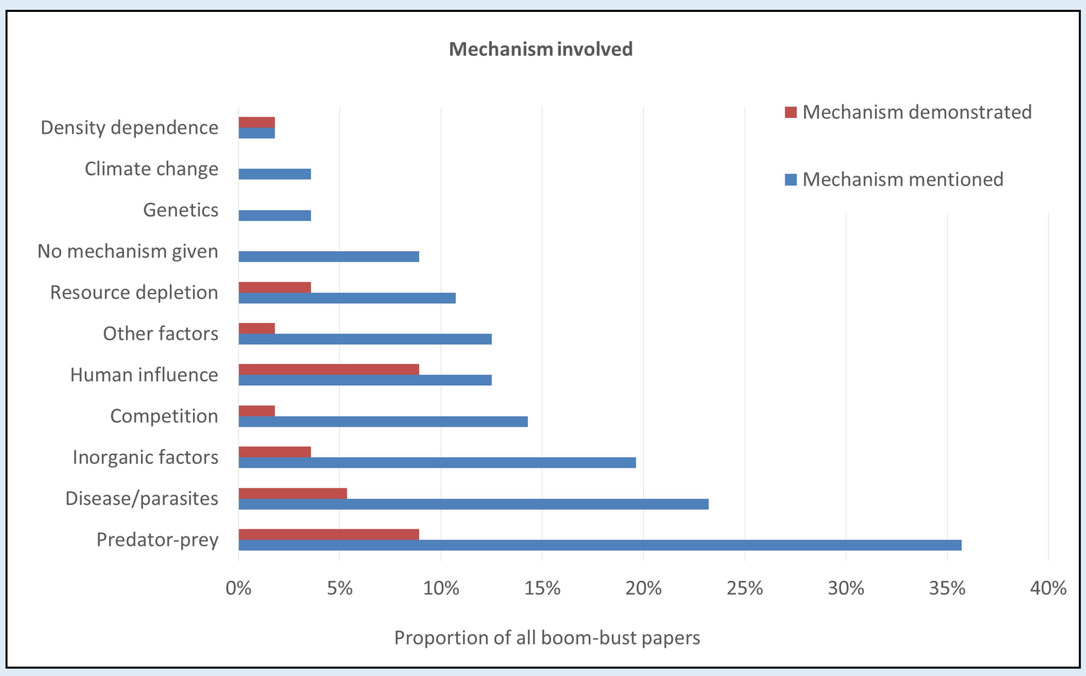
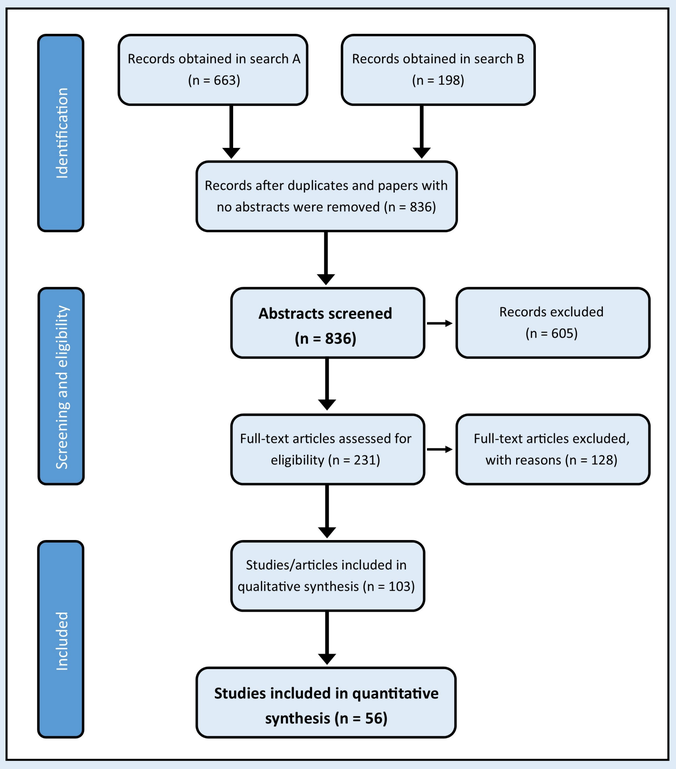


Fig 2. *Causes offered for population busts in "true" boom-bust papers (n=56) (blue bars). Enemy release of some variety followed by enemy accumulation was the most prominent mechanism. In some cases, the mechanisms were actually demonstrated (red bars). Studies in which a cause was hypothesized but not demonstrated are represented as the difference between the blue and red bars. In general, causes were rarely directly demonstrated except (perhaps unsurprisingly) in the case of human influence (direct management, habitat change due to human influences etc.). Because some studies suggested that busts were the result of multiple causes, the number of causes offered sums to more than the number of studies.*

Fig. 1. *PRISMA flow diagram providing overview of the review protocol. All full-text papers that described boom-bust dynamics and thereby potentially shedding some light on the phenomenon in general were included in the qualitative synthesis. Only "true" boom-bust papers, defined as papers describing original data documenting a boom-bust population dynamics in an alien species or providing original assessments of existing datasets, were included in the quantitative analysis. Papers that covered boom-bust dynamics but were for example reviews or described models or experiments were included in the qualitative synthesis but excluded from the quantitative analysis.*



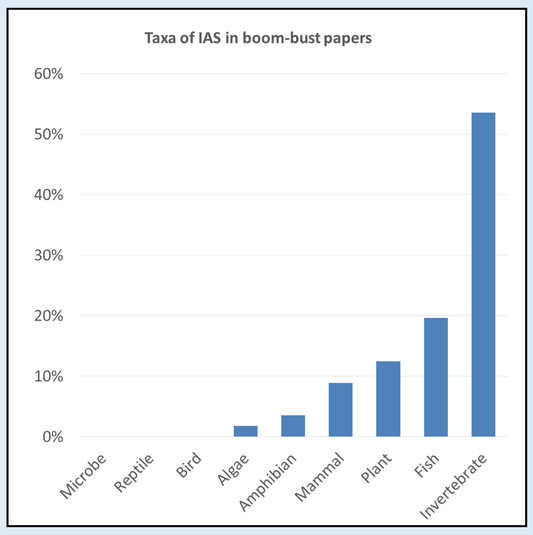


Fig. 3. *IAS of many different taxa show boom-bust population dynamics (n=56 studies). Interestingly invertebrates were most common in boom-bust papers, perhaps reflecting their short generation time and therefore a higher likelihood of documenting a boom-bust within the timespan of a scientific study (the average study duration in boom-bust papers was 26 years), although many other factors might also explain this.*

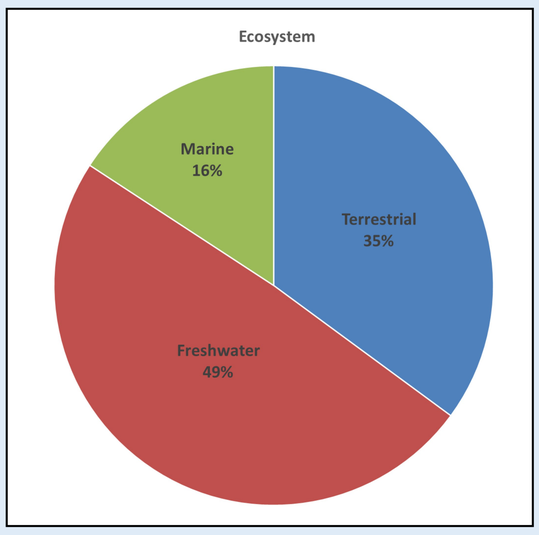


Fig. 4. *IAS showing boom-bust dynamics (n=56) occupy a variety of habitats. Approximately half of the documented cases involved freshwater ecosystems, perhaps reflecting that these often represent small or "closed" systems, raising the question if such systems are more likely to experience boom-busts of IAS than other systems.*

4. Conclusion

As thousands of populations of IAS are established worldwide, and hundreds of scientific IAS papers are published every year, the boom-bust phenomenon appears to be rather rare. It does occur in some important cases and can have many different causes, but exceptional cases of boom-bust should not be used as an excuse for not managing IAS.

References

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