

Chapter 2

Dynamics of Biological Invasions

Abstract We provide an overview of mathematical tools and approaches for modeling the population dynamics of invasive species. We begin with a brief qualitative analysis of biological invasion to show how it can be split into different stages, each stage having its own determinants in terms of invasive species management. We then introduce the modeling framework that will be used in the rest of the book. A detailed description of relevant nonspatial population models is followed by a discussion of the spatial dynamics. We will show that a variety of mathematical techniques may be used to describe different aspects of invasion dynamics at different invasion stages.

2.1 Stages of Invasion

In the previous chapter, we showed that biological invasion is a complex phenomenon that can be driven by a variety of different mechanisms and can follow different scenarios. Biological invasion has a number of clearly distinguishable stages; see Table 2.1. Generally speaking, the biological processes involved at each stage of the invasion are different from those involved at the other stages; each stage has its own issues to address in terms of the management and control of the invading species [3,36]. For instance, at the establishment stage, adaptation and phenotypic evolution can be important, but they are unlikely to be important at the stage of introduction. Environmental heterogeneity can greatly affect the rate and pattern of invasive spread, but it will have less effect on establishment.

Biological invasion obviously starts with introduction. Indeed, nothing can possibly happen until an alien species is brought in. A comment on terminology seems to be necessary here. By *introduction* we mean the transport of a given species¹ to a new geographical location that would be inaccessible for this species because of natural reasons. Therefore, introduction is usually a result of human activity rather than of the action of natural mechanisms.

¹More precisely, of a number of individuals of a given species that are able to reproduce.

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