This talk is intended for a general physics audience, and concerns the application of concepts from mathematical physics to the spatiotemporal dynamics of animal populations. Many animal populations undergo intrinsic multi-year cycles in abundance, and recent field data indicates that the resulting spatiotemporal behaviour consists of plane waves and/or chaos. I will discuss the way in which this behaviour can be understood using techniques originally developed in mathematical physics. I will focus on the particular case of the invasion of a prey population by predators. In applications, a key question is whether one expects the behaviour behind the invasion to be dominated by regular or irregular oscillations, or to involve a significant proportion of both. I will outline a new method for determining this, which uses the concepts of front propagation into unstable states in amplitude equations, and of convective and absolute stability of plane waves. The results raise a range of new challenges for mathematical physicists, which I will summarise. From an ecological viewpoint, I will show how the sensitivity of the predicted behaviour to parameter changes implies that climate change may induce dramatic shifts in population dynamics, with profound effects across a wide range of ecosystems.