Exotic effects of capital accumulation

Charles Perrings
School of Life Sciences, Arizona State University, Tempe, AZ 85287

The accumulation of capital in Europe is strongly and positively associated with the accumulation of alien invasive species. In a study of the drivers behind biological invasions in Europe, Pyšek et al. (1) use European macroecological, economic, and demographic data to explain the variation in alien species richness of bryophytes, fungi, vascular plants, terrestrial insects, aquatic invertebrates, fish, amphibians, reptiles, birds, and mammals. They find only two significant explanatory variables of the stock of alien species: national wealth and human population density. They interpret these as proxies for the direct drivers behind invasions—propagule pressure along new pathways of introduction, along with the disturbance of both freshwater and terrestrial habitats.

The study is a timely and important contribution to our growing understanding of the role of economic activity in the dispersal of species beyond their natural range. It provides fresh evidence for the cumulative effects of anthropogenic stress along two axes. One is the role of trade in opening up new pathways and in developing the propagule pressure along existing pathways. The other is the role of the production of goods and services in native habitat disturbance and hence in the vulnerability of ecological systems to invasion. Just as interestingly, it also provides evidence of a less alarming kind—evidence that, where the threats posed by invasive species are high enough, they have been excluded.

The stock of wealth in any country is the cumulative effect of past investments and so is the best measure of a process that, in many countries, has deep historical roots. In Europe, current wealth reflects 2,000 y (and more) of efforts to build productive capacity—through pilage and plunder as often as through trade and investment. The net effect is a legacy of assets that bears the imprint of many sources, reflecting not just the ebb and flow of empires but the progressive integration of the global economic system. The latter process has been far from smooth, but it has been sure. Globalization means that few places have been untouched by world trade, and the European legacy carries the stamp of much of the rest of the world. As Pyšek et al. (1) show, that stamp includes an unrivaled collection of invasive species.

Recent analysis of the link between trade and biological invasions includes a number of economic studies on the relationship between the opening of new markets or trade routes and the introduction of new species and between the growth in trade volumes (the frequency of introduction) and the probability that introduced species will establish and spread (2–4). It has been shown that the volume and direction of trade are good empirical predictors of which introduced species are likely to become invasive (5, 6) and which countries are the most likely sources of particular species (7, 8). The second axis of anthropogenic stress, disturbance, is also well understood. Pyšek et al. (1) have elsewhere observed that, although some ecosystems are fundamentally more vulnerable to invasion than others, the vulnerability of all systems increases with fragmentation and disturbance (9). Direct habitat loss through land use change also affects the vulnerability of ecosystems to invasion (10).

There is, however, an important dimension of the problem that is not identified by analyzing what species are there. It is the effectiveness of efforts to exclude or eradicate harmful pests and pathogens. The movement of both goods and people is as strongly implicated in the spread of harmful species as it is in the spread of benign species. It is, for example, directly implicated in the emergence both of human diseases, such as H5NI (11), West Nile virus (12), and sudden acute respiratory syndrome (13), and a series of livestock diseases (14, 15). In all cases of this kind, however, the potential harm posed by the pest or pathogen has induced a response aimed at changing the likelihood of its introduction, establishment, and spread. The risk depends on both the likelihood of establishment and the resulting damage. Governments have undertaken measures to detect, intercept, eradicate, or control pests or pathogens, depending on their expectations of the harm they will cause. The risk reflects these measures (16).

Historically, Europe has been confronted by a long list of extremely harmful organisms. The bubonic plague introduced in the 14th century, for example, caused
human populations to decline for more than 100 y, and for 300 y it was “normal” for outbreaks to kill up to half the pop-
ulation of infected cities. Although measures to limit the spread of the plague were of limited effectiveness, it is worth noting
that this was the pathogen that led to the development of quarantine as a risk-
minimizing measure (17). Pathogens that affect the production of crops or livestock
have also had a significant and long-lasting effect. Rinderpest (cattle plague), for
example, has historically been especially destructive. Three epidemics in the 18th
century severely affected meat production in Europe, with mortality approaching
100% in immunologically naive pop-
ulations. Bringing rinderpest under control has been a protracted process. Only now,
more than a century later, has the disease been finally eradicated (18).

Williamson’s “tens rule” reflects the fact that only a small proportion of es-
tablished invasive species are harmful (19). However, observations based on the in-
vasive species that remain after years of control are necessarily biased in favor of
those species that have attracted the least attention. Because the effort that coun-
tries put into inspection, interception, eradication, and control depends on the
potential value at risk and the resources available for these efforts, we would ex-
pect this effect to be greater in high-in-
come countries than in low-income
countries. In fact, harmful species intro-
ductions are frequently inversely related to income. Consider, for example, the
animal diseases reported to the World Organization for Animal Health. Until

**Biological invasions are frequently the unintended consequence of trade.**

recently, these were reported in two categ-
ories, with list A being more harmful and list B being less harmful (Fig. 1). Be-
cause animal diseases are dispersed through trade in animal products, out-
breaks would be expected to be increasing in trade volumes. However, the number of
introduced species that are undetected, established, and spread is reduced by the
sanitary and phytosanitary efforts un-
taken by countries. It has been found
that, whereas list B diseases were increasing in imports of risk materials during the period 1996–2004, list A species were
decreasing (20). Sanitary and phytosani-
tary controls outweighed the effect of
increasing imports.

What accumulates with capital is a set of
introduced species whose eradication is either infeasible or undesirable. In some
cases these impose net costs, in others net benefits. In all cases, it is the residual
after efforts to control the introduction, establishment, and spread of the most
harmful species. The economic problem associated with the findings of Pyšek et al.
(1) is not that the accumulation of capital in a globalizing world is, at the same
time, the accumulation of exotic species. It is that the level of control exercised by
both individuals and governments is less than it should be if all costs and benefits
were taken into account. Biological in-
vasions are frequently the unintended
consequence of trade. The costs they im-
pose are generally born by people other
than those responsible for their in-
troduction or spread, and the optimal level
of control should ideally take those costs
into account. Indeed, finding ways to
reduce the burden of biological invasions
associated with the closer integration of
the global system is among the most
pressing environmental problems we
face today.

1. Pyšek P, et al. (2010) Disentangling the role of environ-
mental and human pressures on biological invasions across
2. Casey P, Blackburn TM, Rusel GJ, Jones KE, Lockwood JL
(2004) Influences on the transport and establishment of
exotic bird species: An analysis of the parrots (Pittaci-
3. Semmens BK, Buhle ER, Salomon AK, Pattengill-
fishes: Evidence for the aquarium trade as an invasion
 correlates of plant invasions in European and North
5. Levine JM, D’antonio CM (2003) Forecasting biological
 invasions with increasing international trade. Conserv
Biol 17:322–326.
Unintended biological invasions: Does risk vary by trading
ating zoonotic diseases through wildlife trade, United
Globalization: Ecology, Economics, Management and
Policy, eds Perrings C, Mooney HA, Williamson M (Ox-
ford Univ Press, Oxford).
spread of H5N1 avian influenza. Proc Natl Acad Sci
USA 103:19368–19373.
responsible for an outbreak of encephalitis in the north-
pathogens of probable SARS coronavirus from animals in
Wildlife trade and global disease emergence. Emerg
Infect Dis 11:1000–1002.
15. Rwemamu MM, Astudillo VM (2002) Global perspec-
tive for foot and mouth disease control. Rev Sci Tech
17. McNeill WH (1977) Plagues and People (Anchor Books,
New York).
ence 319:1606–1609.
and Hall, New York).
and Bioinvasions: Ecology, Economics, Management
and Policy, eds Perrings C, Mooney HA, Williamson M
(Oxford Univ Press, Oxford).