

## = Invasive species =

An invasive species is a plant, fungus, or animal species that is not native to a specific location (an introduced species), and which has a tendency to spread to a degree believed to cause damage to the environment, human economy or human health.

One study pointed out widely divergent perceptions of the criteria for invasive species among researchers (p. 135) and concerns with the subjectivity of the term "invasive" (p. 136). Some of the alternate usages of the term are below:

The term as most often used applies to introduced species (also called "non-indigenous" or "non-native") that adversely affect the habitats and bioregions they invade economically, environmentally, or ecologically. Such invasive species may be either plants or animals and may disrupt by dominating a region, wilderness areas, particular habitats, or wildland-urban interface land from loss of natural controls (such as predators or herbivores). This includes non-native invasive plant species labeled as exotic pest plants and invasive exotics growing in native plant communities. It has been used in this sense by government organizations as well as conservation groups such as the International Union for Conservation of Nature (IUCN) and the California Native Plant Society. The European Union defines "Invasive Alien Species" as those that are, firstly, outside their natural distribution area, and secondly, threaten biological diversity. It is also used by land managers, botanists, researchers, horticulturalists, conservationists, and the public for noxious weeds. The kudzu vine (*Pueraria lobata*), Andean Pampas grass (*Cortaderia jubata*), and yellow starthistle (*Centaurea solstitialis*) are examples.

An alternate usage broadens the term to include indigenous or "native" species along with non-native species, that have colonized natural areas (p. 136). Deer are an example, considered to be overpopulating their native zones and adjacent suburban gardens, by some in the Northeastern and Pacific Coast regions of the United States.

Sometimes the term is used to describe a non-native or introduced species that has become widespread (p. 136). However, not every introduced species has adverse effects on the environment. A nonadverse example is the common goldfish (*Carassius auratus*), which is found throughout the United States, but rarely achieves high densities (p. 136).

## = Causes =

Scientists include species- and ecosystem factors among the mechanisms that when combined, establish invasiveness in a newly introduced species.

## = Species-based mechanisms =

While all species compete to survive, invasive species appear to have specific traits or specific combinations of traits that allow them to outcompete native species. In some cases, the competition is about rates of growth and reproduction. In other cases, species interact with each other more directly.

Researchers disagree about the usefulness of traits as invasiveness markers. One study found that of a list of invasive and noninvasive species, 86% of the invasive species could be identified from the traits alone. Another study found invasive species tended to have only a small subset of the presumed traits and that many similar traits were found in noninvasive species, requiring other explanations. Common invasive species traits include the following:

Fast growth

Rapid reproduction

High dispersal ability

Phenotypic plasticity (the ability to alter growth form to suit current conditions)

Tolerance of a wide range of environmental conditions (Ecological competence)

Ability to live off of a wide range of food types (generalist)

Association with humans

## Prior successful invasions

Typically, an introduced species must survive at low population densities before it becomes invasive in a new location. At low population densities, it can be difficult for the introduced species to reproduce and maintain itself in a new location, so a species might reach a location multiple times before it becomes established. Repeated patterns of human movement, such as ships sailing to and from ports or cars driving up and down highways offer repeated opportunities for establishment (also known as a high propagule pressure).

An introduced species might become invasive if it can outcompete native species for resources such as nutrients, light, physical space, water, or food. If these species evolved under great competition or predation, then the new environment may host fewer able competitors, allowing the invader to proliferate quickly. Ecosystems in which are being used to their fullest capacity by native species can be modeled as zero-sum systems in which any gain for the invader is a loss for the native. However, such unilateral competitive superiority (and extinction of native species with increased populations of the invader) is not the rule. Invasive species often coexist with native species for an extended time, and gradually, the superior competitive ability of an invasive species becomes apparent as its population grows larger and denser and it adapts to its new location.

An invasive species might be able to use resources that were previously unavailable to native species, such as deep water sources accessed by a long taproot, or an ability to live on previously uninhabited soil types. For example, barbed goatgrass (*Aegilops triuncialis*) was introduced to California on serpentine soils, which have low water retention, low nutrient levels, a high magnesium / calcium ratio, and possible heavy metal toxicity. Plant populations on these soils tend to show low density, but goatgrass can form dense stands on these soils and crowd out native species that have adapted poorly to serpentine soils.

Invasive species might alter its environment by releasing chemical compounds, modifying abiotic factors, or affecting the behaviour of herbivores, creating a positive or negative impact on other species. Some species, like *Kalanchoe daigremontana*, produce allelopathic compounds, that might have an inhibitory effect on competing species. Other species like *Stapelia gigantea* facilitates the recruitment of seedlings of other species in arid environments by providing appropriate microclimatic conditions and preventing herbivory in early stages of development.

Another examples are *Centaurea solstitialis* (yellow starthistle) and *Centaurea diffusa* (diffuse knapweed). These Eastern European noxious weeds have spread through the western and West Coast states. Experiments show that 8-hydroxyquinoline, a chemical produced at the root of *C. diffusa*, has a negative effect only on plants that have not co-evolved with it. Such co-evolved native plants have also evolved defenses. *C. diffusa* and *C. solstitialis* do not appear in their native habitats to be overwhelmingly successful competitors. Success or lack of success in one habitat does not necessarily imply success in others. Conversely, examining habitats in which a species is less successful can reveal novel weapons to defeat invasiveness.

Changes in fire regimens are another form of facilitation. *Bromus tectorum*, originally from Eurasia, is highly fire-adapted. It not only spreads rapidly after burning but also increases the frequency and intensity (heat) of fires by providing large amounts of dry detritus during the fire season in western North America. In areas where it is widespread, it has altered the local fire regimen so much that native plants cannot survive the frequent fires, allowing *B. tectorum* to further extend and maintain dominance in its introduced range.

Facilitation also occurs where one species physically modifies a habitat in ways that are advantageous to other species. For example, zebra mussels increase habitat complexity on lake floors, providing crevices in which invertebrates live. This increase in complexity, together with the nutrition provided by the waste products of mussel filter-feeding, increases the density and diversity of benthic invertebrate communities.

=== Ecosystem based mechanisms ===

In ecosystems, the amount of available resources and the extent to which those resources are used by organisms determines the effects of additional species on the ecosystem. In stable

ecosystems , equilibrium exists in the use of available resources . These mechanisms describe a situation in which the ecosystem has suffered a disturbance , which changes the fundamental nature of the ecosystem .

When changes such as a forest fire occur , normal succession favors native grasses and forbs . An introduced species that can spread faster than natives can use resources that would have been available to native species , squeezing them out . Nitrogen and phosphorus are often the limiting factors in these situations .

Every species occupies a niche in its native ecosystem ; some species fill large and varied roles , while others are highly specialized . Some invading species fill niches that are not used by native species , and they also can create new niches . An example of this type can be found within the *Lampropholis delicata* species of skink .

Ecosystem changes can alter species ' distributions . For example , edge effects describe what happens when part of an ecosystem is disturbed as when land is cleared for agriculture . The boundary between remaining undisturbed habitat and the newly cleared land itself forms a distinct habitat , creating new winners and losers and possibly hosting species that would not thrive outside the boundary habitat .

One interesting finding in studies of invasive species has shown that introduced populations have great potential for rapid adaptation and this is used to explain how so many introduced species are able to establish and become invasive in new environments . When bottlenecks and founder effects cause a great decrease in the population size , the individuals begin to show additive variance as opposed to epistatic variance . This conversion can actually lead to increased variance in the founding populations which then allows for rapid adaptive evolution . Following invasion events , selection may initially act on the capacity to disperse as well as physiological tolerance to the new stressors in the environment . Adaptation then proceeds to respond to the selective pressures of the new environment . These responses would most likely be due to temperature and climate change , or the presence of native species whether it be predator or prey . Adaptations include changes in morphology , physiology , phenology , and plasticity .

Rapid adaptive evolution in these species leads to offspring that have higher fitness and are better suited for their environment . Intraspecific phenotypic plasticity , pre @-@ adaptation and post @-@ introduction evolution are all major factors in adaptive evolution . Plasticity in populations allows room for changes to better suit the individual in its environment . This is key in adaptive evolution because the main goal is how to best be suited to the ecosystem that the species has been introduced . The ability to accomplish this as quickly as possible will lead to a population with a very high fitness . Pre @-@ adaptations and evolution after the initial introduction also play a role in the success of the introduced species . If the species has adapted to a similar ecosystem or contains traits that happen to be well suited to the area that it is introduced , it is more likely to fare better in the new environment . This , in addition to evolution that takes place after introduction , all determine if the species will be able to become established in the new ecosystem and if it will reproduce and thrive .

= = Ecology = =

= = = Traits of invaded ecosystems = = =

In 1958 , Charles S. Elton claimed that ecosystems with higher species diversity were less subject to invasive species because of fewer available niches . Other ecologists later pointed to highly diverse , but heavily invaded ecosystems and argued that ecosystems with high species diversity were more susceptible to invasion .

This debate hinged on the spatial scale at which invasion studies were performed , and the issue of how diversity affects susceptibility remained unresolved as of 2011 . Small @-@ scale studies tended to show a negative relationship between diversity and invasion , while large @-@ scale studies tended to show the reverse . The latter result may be a side @-@ effect of invasives ' ability

to capitalize on increased resource availability and weaker species interactions that are more common when larger samples are considered .

Invasion was more likely in ecosystems that were similar to the one in which the potential invader evolved . Island ecosystems may be more prone to invasion because their species faced few strong competitors and predators , or because their distance from colonizing species populations makes them more likely to have " open " niches . An example of this phenomenon was the decimation of native bird populations on Guam by the invasive brown tree snake . Conversely , invaded ecosystems may lack the natural competitors and predators that check invasives ' growth in their native ecosystems .

Invaded ecosystems may have experienced disturbance , typically human @-@ induced . Such a disturbance may give invasive species a chance to establish themselves with less competition from natives less able to adapt to a disturbed ecosystem .

= = = Vectors = = =

Non @-@ native species have many vectors , including biogenic vectors , but most invasions are associated with human activity . Natural range extensions are common in many species , but the rate and magnitude of human @-@ mediated extensions in these species tend to be much larger than natural extensions , and humans typically carry specimens greater distances than natural forces .

An early human vector occurred when prehistoric humans introduced the Pacific rat ( *Rattus exulans* ) to Polynesia .

Vectors include plants or seeds imported for horticulture . The pet trade moves animals across borders , where they can escape and become invasive . Organisms stow away on transport vehicles . Ballast water taken up at sea and released in port by transoceanic vessels is the largest vector for non @-@ native aquatic species invasions . Around the world on the average day , more than 3 @,@ 000 different species of aquatic life may be transported on these vessels . For example , freshwater zebra mussels , native to the Black , Caspian and Azov seas , probably reached the Great Lakes via ballast water from a transoceanic vessel . Although the zebra mussel invasion was first noted in 1988 , and a mitigation plan was successfully implemented shortly thereafter , the plan had ( and continued to have as of 2005 ) a serious flaw or loophole , whereby ships that are loaded with cargo when they reach the Seaway need not be tested , but all the same they transfer ballast ' puddles ' between Seaway ports .

The arrival of invasive propagules to a new site is a function of the site 's invasibility .

Species have also been introduced intentionally . For example , to feel more " at home , " American colonists formed " Acclimation Societies " that repeatedly imported birds that were native to Europe to North America and other distant lands . In 2008 , U.S. postal workers in Pennsylvania noticed noises coming from inside a box from Taiwan ; the box contained more than two dozen live beetles . Agricultural Research Service entomologists identified them as rhinoceros beetle , hercules beetle , and king stag beetle . Because these species were not native to the U.S. , they could have threatened native ecosystems . To prevent exotic species from becoming a problem in the U.S. , special handling and permits are required when living materials are shipped from foreign countries . USDA programs such as Smuggling Interdiction and Trade Compliance ( SITC ) attempt to prevent exotic species outbreaks in America .

Economics plays a major role in exotic species introduction . High demand for the valuable Chinese mitten crab is one explanation for the possible intentional release of the species in foreign waters .

= = = Impacts of wildfire = = =

Invasive species often exploit disturbances to an ecosystem ( wildfires , roads , foot trails ) to colonize an area . Large wildfires can sterilize soils , while adding a variety of nutrients . In the resulting free @-@ for @-@ all , formerly entrenched species lose their advantage , leaving more room for invasives . In such circumstances plants that can regenerate from their roots have an

advantage . Non @-@ natives with this ability can benefit from a low intensity fire burns that removes surface vegetation , leaving natives that rely on seeds for propagation to find their niches occupied when their seeds finally sprout .

= = = Impact of wildfire suppression on spreading = = =

Wildfires often occur in remote areas , needing fire suppression crews to travel through pristine forest to reach the site . The crews can bring invasive seeds with them . If any of these stowaway seeds become established , a thriving colony of invasives can erupt in as few as six weeks , after which controlling the outbreak can need years of continued attention to prevent further spread . Also , disturbing the soil surface , such as cutting firebreaks , destroys native cover , exposes soil , and can accelerate invasions . In suburban and wildland @-@ urban interface areas , the vegetation clearance and brush removal ordinances of municipalities for defensible space can result in excessive removal of native shrubs and perennials that exposes the soil to more light and less competition for invasive plant species .

Fire suppression vehicles are often major culprits in such outbreaks , as the vehicles are often driven on back roads often overgrown with invasive plant species . The undercarriage of the vehicle becomes a prime vessel of transport . In response , on large fires , washing stations " decontaminate " vehicles before engaging in suppression activities . Large wildfires attract firefighters from remote places , further increasing the potential for seed transport .

= = Effects = =

= = Ecological = =

Land clearing and human habitation put significant pressure on local species . Disturbed habitats are prone to invasions that can have adverse effects on local ecosystems , changing ecosystem functions . A species of wetland plant known as ?ae?ae in Hawaii ( the indigenous *Bacopa monnieri* ) is regarded as a pest species in artificially manipulated water bird refuges because it quickly covers shallow mudflats established for endangered Hawaiian stilt ( *Himantopus mexicanus knudseni* ) , making these undesirable feeding areas for the birds .

Multiple successive introductions of different non @-@ native species can have interactive effects ; the introduction of a second non @-@ native species can enable the first invasive species to flourish . Examples of this are the introductions of the amethyst gem clam ( *Gemma gemma* ) and the European green crab ( *Carcinus maenas* ) . The gem clam was introduced into California 's Bodega Harbor from the East Coast of the United States a century ago . It had been found in small quantities in the harbor but had never displaced the native clam species ( *Nutricula* spp . ) . In the mid @-@ 1990s , the introduction of the European green crab , found to prey preferentially on the native clams , resulted in a decline of the native clams and an increase of the introduced clam populations .

In the Waterberg region of South Africa , cattle grazing over the past six centuries has allowed invasive scrub and small trees to displace much of the original grassland , resulting in a massive reduction in forage for native bovids and other grazers . Since the 1970s , large scale efforts have been underway to reduce invasive species ; partial success has led to re @-@ establishment of many species that had dwindled or left the region . Examples of these species are giraffe , blue wildebeest , impala , kudu and white rhino .

Invasive species can change the functions of ecosystems . For example , invasive plants can alter the fire regimen ( cheatgrass , *Bromus tectorum* ) , nutrient cycling ( smooth cordgrass *Spartina alterniflora* ) , and hydrology ( *Tamarix* ) in native ecosystems . Invasive species that are closely related to rare native species have the potential to hybridize with the native species . Harmful effects of hybridization have led to a decline and even extinction of native species . For example , hybridization with introduced cordgrass , *Spartina alterniflora* , threatens the existence of California

cordgrass ( *Spartina foliosa* ) in San Francisco Bay . Invasive species cause competition for native species and because of this 400 of the 958 endangered species under the Endangered Species Act are at risk

== Geomorphological ==

Primary geomorphological effects of invasive plants are bioconstruction and bioprotection . For example , Kudzu *Pueraria montana* , a vine native to Asia was widely introduced in the southeastern USA in the early 20th century to control soil erosion . While primary effects of invasive animals are bioturbation , bioerosion , and bioconstruction . For example , invasion of Chinese mitten crab *Eriocheir sinensis* have resulted in higher bioturbation and bioerosion rates .

== Economic ==

==== Benefits ====

Non @-@ native species can have benefits . Asian oysters , for example , filter water pollutants better than native oysters . They also grow faster and withstand disease better than natives . Biologists are currently considering releasing this mollusk in the Chesapeake Bay to help restore oyster stocks and remove pollution . A recent study by the Johns Hopkins School of Public Health found the Asian oyster could significantly benefit the bay 's deteriorating water quality . Additionally , some species have invaded an area so long ago that they have found their own beneficial niche in the environment . For example , *L. leucozonium* , shown by population genetic analysis to be an invasive species in North America , has become an important pollinator of caneberry as well as cucurbit , apple trees , and blueberry bushes .

==== Costs ====

Economic costs from invasive species can be separated into direct costs through production loss in agriculture and forestry , and management costs . Estimated damage and control cost of invasive species in the U.S. alone amount to more than \$ 138 billion annually . Economic losses can also occur through loss of recreational and tourism revenues . When economic costs of invasions are calculated as production loss and management costs , they are low because they do not consider environmental damage ; if monetary values were assigned to the extinction of species , loss in biodiversity , and loss of ecosystem services , costs from impacts of invasive species would drastically increase . The following examples from different sectors of the economy demonstrate the impact of biological invasions .

==== Economic opportunities ====

Some invasions offer potential commercial benefits . For instance , silver carp and common carp can be harvested for human food and exported to markets already familiar with the product , or processed into pet foods , or mink feed . Vegetative invasives such as water hyacinth can be turned into fuel by methane digesters .

==== Invasivorism ====

Invasive species are flora and fauna whose introduction into a habitat disrupts the native eco @-@ system . In response , Invasivorism is a movement that explores the idea of eating invasive species in order to control , reduce , or eliminate their populations . Chefs from around the world have begun seeking out and using invasive species as alternative ingredients . Miya 's of New Haven , Connecticut created the first invasive species menu in the world . Skeptics point out that once a

foreign species has entrenched itself in a new place ? such as the Indo @-@ Pacific lionfish that has now virtually taken over the waters of the Western Atlantic , Caribbean and Gulf of Mexico ? eradication is almost impossible . Critics argue that encouraging consumption might have the unintended effect of spreading harmful species even more widely .

Proponents of invasivorism argue that humans have the ability to eat away any species that it has an appetite for , pointing to the many animals which humans have been able to hunt to extinction - such as the Dodo bird , the Caribbean monk seal , and the Passenger pigeon . Proponents of invasivorism also point to the success that Jamaica has had in significantly decreasing the population of lionfish by encouraging the consumption of the fish .

= = = = Plant industry = = = =

Weeds reduce yield in agriculture , though they may provide essential nutrients . Some deep @-@ rooted weeds can " mine " nutrients ( see dynamic accumulator ) from the subsoil and deposit them on the topsoil , while others provide habitat for beneficial insects or provide foods for pest species . Many weed species are accidental introductions that accompany seeds and imported plant material . Many introduced weeds in pastures compete with native forage plants , threaten young cattle ( e.g. , leafy spurge , *Euphorbia esula* ) or are unpalatable because of thorns and spines ( e.g. , yellow starthistle ) . Forage loss from invasive weeds on pastures amounts to nearly US \$ 1 billion in the U.S. alone . A decline in pollinator services and loss of fruit production has been caused by honey bees infected by the invasive varroa mite . Introduced rats ( *Rattus rattus* and *R. norvegicus* ) have become serious pests on farms , destroying stored grains .

Invasive plant pathogens and insect vectors for plant diseases can also suppress agricultural yields and nursery stock . Citrus greening is a bacterial disease vectored by the invasive Asian citrus psyllid ( ACP ) . Because of the impacts of this disease on citrus crops , citrus is under quarantine and highly regulated in areas where ACP has been found .

= = = = Aquaculture = = = =

Aquaculture is a very common vector of species introductions ? mainly of species with economic potential ( e.g. , *Oreochromis niloticus* )

= = = = Forestry = = = =

The unintentional introduction of forest pest species and plant pathogens can change forest ecology and damage the timber industry . Overall , forest ecosystems in the U.S. are widely invaded by exotic pests , plants , and pathogens .

The Asian long @-@ horned beetle ( *Anoplophora glabripennis* ) was first introduced into the U.S. in 1996 , and was expected to infect and damage millions of acres of hardwood trees . As of 2005 thirty million dollars had been spent in attempts to eradicate this pest and protect millions of trees in the affected regions . The woolly adelgid has inflicted damage on old @-@ growth spruce , fir and hemlock forests and damages the Christmas tree industry . And the chestnut blight fungus ( *Cryphonectria parasitica* ) and Dutch elm disease ( *Ophiostoma novo @-@ ulmi* ) are two plant pathogens with serious impacts on these two species , and forest health . Garlic mustard , *Alliaria petiolata* , is one of the most problematic invasive plant species in eastern North American forests . The characteristics of garlic mustard are slightly different from those of the surrounding native plants , which results in a highly successful species that is altering the composition and function of the native communities it invades . When garlic mustard invades the understory of a forest , it affects the growth rate of tree seedlings , which is likely to alter forest regeneration of impact forest composition in the future .

= = = = Tourism and recreation = = = =

Invasive species can impact outdoor recreation , such as fishing , hunting , hiking , wildlife viewing , and water @-@ based activities . They can damage a wide array of environmental services that are important to recreation , including , but not limited to , water quality and quantity , plant and animal diversity , and species abundance . Eiswerth states , " very little research has been performed to estimate the corresponding economic losses at spatial scales such as regions , states , and watersheds . " Eurasian watermilfoil ( *Myriophyllum spicatum* ) in parts of the US , fill lakes with plants complicating fishing and boating . The very loud call of the introduced common coqui depresses real estate values in affected neighborhoods of Hawaii .

= = = Health = = =

Encroachment of humans into previously remote ecosystems has exposed exotic diseases such as HIV to the wider population . Introduced birds ( e.g. pigeons ) , rodents and insects ( e.g. mosquito , flea , louse and tsetse fly pests ) can serve as vectors and reservoirs of human afflictions . The introduced Chinese mitten crabs are carriers of Asian lung fluke . Throughout recorded history , epidemics of human diseases , such as malaria , yellow fever , typhus , and bubonic plague , spread via these vectors . A recent example of an introduced disease is the spread of the West Nile virus , which killed humans , birds , mammals , and reptiles . Waterborne disease agents , such as cholera bacteria ( *Vibrio cholerae* ) , and causative agents of harmful algal blooms are often transported via ballast water . Invasive species and accompanying control efforts can have long term public health implications . For instance , pesticides applied to treat a particular pest species could pollute soil and surface water .

= = = Biodiversity = = =

Biotic invasion is considered one of the five top drivers for global biodiversity loss and is increasing because of tourism and globalization . This may be particularly true in inadequately regulated fresh water systems , though quarantines and ballast water rules have improved the situation .

Invasive species may drive local native species to extinction via competitive exclusion , niche displacement , or hybridisation with related native species . Therefore , besides their economic ramifications , alien invasions may result in extensive changes in the structure , composition and global distribution of the biota of sites of introduction , leading ultimately to the homogenisation of the world ' s fauna and flora and the loss of biodiversity . Nevertheless , it is difficult to unequivocally attribute extinctions to a species invasion , and the few scientific studies that have done so have been with animal taxa . Concern over the impacts of invasive species on biodiversity must therefore consider the actual evidence ( either ecological or economic ) , in relation to the potential risk .

= = = Genetic pollution = = =

Native species can be threatened with extinction through the process of genetic pollution . Genetic pollution is unintentional hybridization and introgression , which leads to homogenization or replacement of local genotypes as a result of either a numerical or fitness advantage of the introduced species . Genetic pollution can operate either through introduction or through habitat modification , bringing previously isolated species into contact . Hybrids resulting from rare species that interbreed with abundant species can swamp the rarer species ' gene pool . This is not always apparent from morphological observations alone . Some degree of gene flow is normal , and preserves constellations of genes and genotypes . An example of this is the interbreeding of migrating coyotes with the red wolf , in areas of eastern North Carolina where the red wolf was reintroduced .

= = Study = =



While the study of invasive species can be done within many subfields of biology , the majority of research on invasive organisms has been within the field of ecology and geography where the issue of biological invasions is especially important . Much of the study of invasive species has been influenced by Charles Elton 's 1958 book *The Ecology of Invasion by Animals and Plants* which drew upon the limited amount of research done within disparate fields to create a generalized picture of biological invasions . Studies on invasive species remained sparse until the 1990s when research in the field experienced a large amount of growth which continues to this day . This research , which has largely consisted of field observational studies , has disproportionately been concerned with terrestrial plants . The rapid growth of the field has driven a need to standardize the language used to describe invasive species and events . Despite this , little standard terminology exists within the study of invasive species which itself lacks any official designation but is commonly referred to as " Invasion ecology " or more generally " Invasion biology " . This lack of standard terminology is a significant problem , and has largely arisen due to the interdisciplinary nature of the field which borrows terms from numerous disciplines such as agriculture , zoology , and pathology , as well as due to studies on invasive species being commonly performed in isolation of one another .

In an attempt to avoid the ambiguous , subjective , and pejorative vocabulary that so often accompanies discussion of invasive species even in scientific papers , Colautti and MacIsaac proposed a new nomenclature system based on biogeography rather than on taxa .

By discarding taxonomy , human health , and economic factors , this model focused only on ecological factors . The model evaluated individual populations rather than entire species . It classified each population based on its success in that environment . This model applied equally to indigenous and to introduced species , and did not automatically categorize successful introductions as harmful .