Non-native Invasive Species

Non-native species or ***exotic species*** are organisms that have been introduced to regions outside their natural or historical home ranges. Typically, the term "exotic" or "non-native" brings to mind organisms from other countries or continents, however, exotic organisms can originate within the same country if they have historically not existed throughout that country (e.g. a species native to the west coast of the U.S. would be considered exotic on the east coast). Non-native species present a unique threat to forest health because they have the potential to become invasive. ***Invasive species*** are organisms that multiply and spread rapidly, displacing other organisms to the detriment of ecosystem health and stability. Invasives can be native (e.g. weeds) or non-native, but typically exotic invasives are much more damaging to forest health than native invasives, which are usually nuisances. ***Non-native invasive species*** include plants, animals, and microorganisms outside their native home range that cause significant injury to, displace, or kill native species. Throughout recent history, non-native invasives have wreaked havoc in our nation's forests. Chestnut blight, caused by a fungus that girdled and killed millions of American chestnuts throughout the eastern U.S. in the early 1900's, was one of the first major non-native invasives to attack our forests, and highlighted the threat posed by exotic organisms. Since that time, thousands of non-native organisms have been introduced to our country, many of which have or continue to threaten or exterminate native tree species and destroy our forest ecosystems.

Exotic species have the potential to become extremely invasive and destructive for a number of reasons. When introduced to a new area, exotic organisms are often freed from the predators, parasites, competition, and/or environmental constraints that kept their populations in check within their native home range, allowing rapid population growth and unimpeded spread through the landscape. New host/prey species are available in the invaded region that did not evolve along with these non-native invasives, and they may therefore lack the defense responses necessary to fend off an attack, or may be unable to sufficiently compete to avoid being displaced. The population size of newly introduced invasives is generally small, while the challenges faced in the new region may be substantial. This creates a genetic bottleneck, that when combined with significant selective pressure, can promote rapid adaptation in the pest population and results in new strains or subspecies of the invader that are optimized for their new environment.

Fortunately, although many exotic organisms may be introduced to the U.S. each year, not all of them become problematic. The process of invasion by exotic organisms involves several stages, each of which places a constraint on potential invaders and may prevent their development into a highly damaging invasive species.

1) ***Introduction*** is the first step in the invasion process, when an organism arrives in a new region. Introductions can occur naturally, as a result of gradually shifting home ranges due to climate change or continental shift for instance. But natural introductions can also occur more rapidly, due to sudden transport of the organism over long distances, for example in a storm or flood. Exotic organisms can also be carried, or ***vectored***, by other organisms that are capable of travelling long distances. Microorganisms and plant seeds ingested in one region can be carried in the digestive tract of migrating animals and released in new regions for instance. More commonly, exotic organisms are introduced through the action of humans, either accidentally or purposefully. With today's modern global economy, boats, airplanes, vehicles, and the goods they carry come from all corners of the globe. Exotic organisms frequently hitch rides on those vehicles or within the products being transported. Detection of these hitch hikers is often difficult or impossible. But there are also many instances where people knowingly introduce an exotic organism (often with good intentions), only to find that the organism is invasive and destructive. However, not all introductions are successful and many exotic organisms are unable to survive in their new environment.

2) ***Establishment*** occurs when an introduced non-native organism is able to survive and reproduce in its new environment. An established organism is generally already suited for its new environment, and is therefore likely to have originated in a place with a similar climate. To become established, the organism must be able to obtain everything it needs to survive, complete its life cycle, and reproduce (e.g. susceptible hosts must be available for exotic parasites), and must have a climate that the organism can tolerate. If either of these requirements is not met, the organism will not survive. Established organisms typically prey on, parasitize, or displace native organisms with potentially damaging side effects to a forest ecosystem. In some cases, non-natives may establish themselves in an unoccupied niche and cause little harm or alterations to the ecosystem.

3) ***Spread*** of non-native organisms occurs after establishment. If the organism is able to spread rapidly through the landscape, it has a high probability of becoming invasive. Resources must be available and the climate

must be suitable to sustain the spread. As the organisms range expands, the population will grow and increasing numbers of native organisms will be injured, killed, or displaced. The rate of spread is determined by many factors including the method or movement/spread, rate of reproduction, landscape characteristics, competition, predation, disease, and environmental constraints. Often, exotic organisms spread relatively slowly through the landscape, but with human assistance, they may spread more quickly. Many forest pests of concern today have spread rapidly and caused wide-spread damage because of a series of new human-assisted introductions that stem from a single, newly-established, localized population.

4) ***Impact*** of non-native invasives results from the interactions that occur when invading organisms prey on, parasitize, displace, or compete with native species. Occasionally native species form symbiotic relationships with exotic organisms that favor both populations (but are not always beneficial for the forest ecosystem as a whole). The long-term impact of non-native invasives is difficult to predict because of the complex interactions occurring within the forest ecosystem. The displacement or eradication of a single native species can set off a chain reaction of negative impacts on other organisms in that community. A cascade of changes in the biotic composition of a forest can impact abiotic components such as water quality and soil stability. Exotic organisms can even hybridize with native species, with potentially disastrous consequences. Even if serious ecological damage does not occur, exotic organisms can become a serious nuisance to humans and to forest management.

5) ***Naturalization*** is the eventual result when an organism spreads into a new region. At some point the organism will reach a natural equilibrium with the native biotic and abiotic components in its new environment; however, the ecosystem is usually significantly altered as a result. Over time, populations of non-native invasives that exploded during their initial spread through a new region, will begin to fall as resources run out, predator and parasite populations increase, and native species adapt to the presence and impact of the new organism. Exotic organisms must also adapt and evolve to their new environment; naturalized population frequently become significantly different from populations in their native range.

Management of non-native invasives is often difficult and presents unique challenges not posed by native pests. Because non-native invasives are freed from significant competition, predation, and parasitism, they often spread at a rate that exceeds our ability to manage or control them. The most effective means of control is to prevent introductions in the first place using quarantines and encourage the use of native plants. After exotic organisms are introduced and become established, eradication of the new organism is only possible when the population is localized and caught relatively early. Once the organism begins to spread through the environment, focus must be shifted to other methods of pest management such as protective and therapeutic treatments, resistance development, and avoidance. If natural barriers are available, or effective artificial barriers can be established, spread of the organism can be halted. In extreme situations where exotic organisms threaten the survival of a native species, seed conservation efforts or establishment of endangered populations in regions free from the invader may be the only way to save the species.

A potentially effective management tool used to control non-native invasives is biological control (also known as biocontrol). ***Biocontrol*** is the use of organisms that can prey on, parasitize, or displace the pest of concern. Although biocontrol options are usually incapable of completely eradicating a pest, they can significantly depress their populations and minimize their impact. When utilized properly, biocontrol options tend to be environmentally safe, have few non-target effects, and are relatively inexpensive once the bio-control organism becomes established. However, biocontrols are often times unavailable for non-native invasives because the invader is free from its native predators, parasites, and competitors. Therefore, biocontrol agents for non-native invasives need to be sought out in the native range of the exotic pests, imported, and released into the invaded area. Unfortunately, the importation and release of biocontrols presents its own challenges and difficulties. Care needs to be taken to ensure the biocontrol specifically attacks the exotic pest of concern, and cannot cause damage to native species. There is a significant risk that introduction of additional exotic species for biocontrol purposes can result in new non-native invasives.