POPULATION ECOLOGY

When a new problem species, such as the zebra mussel or Asian longhorned beetle, is introduced to North America, scientists are concerned with how fast its populations might grow. They are also concerned about where they might spread. Questions about changes in the size and location of populations of organisms and why these changes occur are central to the branch of ecology called *population ecology*. Population ecologists ask

***Population ecology* is the study of how populations of organisms change in size and location and why these changes occur.**

- How many individuals of the species are there?
- How fast is the population growing or declining and why?
- Where are the individuals located?

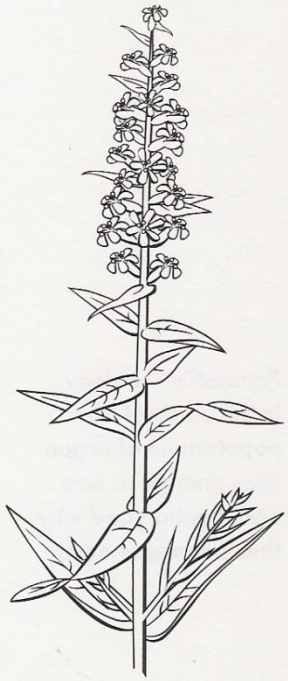
THE PURPLE LOOSESTRIFE STORY

If you live in the continental U.S., you may have admired purple loosestrife in bloom along roadside ditches in late summer. Huge expanses of purple loosestrife add beauty to North American wetlands during their summer flowering season. Purple loosestrife is also a source of nectar and pollen for bees and it is popular as an ornamental plant in gardens. So why has purple loosestrife been cited by Congress as one of the most destructive introduced plants in North America? And why is it listed as one of "The Dirty Dozen—America's Least Wanted Species" by the prominent conservation organization, The Nature Conservancy?

A group of individuals of a particular species in one area is referred to as a *population.*

Purple loosestrife, also known as the "purple plague," rapidly invades all types of wetlands across the continental U.S. and southern Canada. There, it outcompetes cattails and other native plants. Because animals depend on native plants for food, nesting areas, and shelter, purple loosestrife invasions indirectly harm wildlife. Muskrats, bog turtles, and ducks are some of the species that suffer when purple loosestrife takes over.

FIGURE 1.5
Purple Loosestrife



How did purple loosestrife first arrive in North America?

Purple loosestrife first arrived in North America from Europe in the early 1800s. Similar to many introduced species, it was brought in both accidentally and on purpose. It arrived accidentally as a contaminant of ballast water on ships (similar to how zebra mussels arrived). Gardeners also brought in purple loosestrife as an ornamental plant, and herbalists purposefully introduced it as a treatment for diarrhea, ulcers, and sores.

How did purple loosestrife populations expand over time?

By the 1830s, purple loosestrife was well established along the New England seaboard. The construction of the Erie and other canals in the 1880s allowed purple loosestrife to spread into interior New York and the St. Lawrence River valley. As railroads and roads expanded, purple loosestrife followed. In addition, purple loosestrife plants that were sold as ornamentals and as a source of nectar for honeybees spread into natural wetlands. Over the last two centuries, the "purple plague" has spread to wetlands throughout all the lower 48 states except Florida.

What characteristics of purple loosestrife allow it to expand its populations?

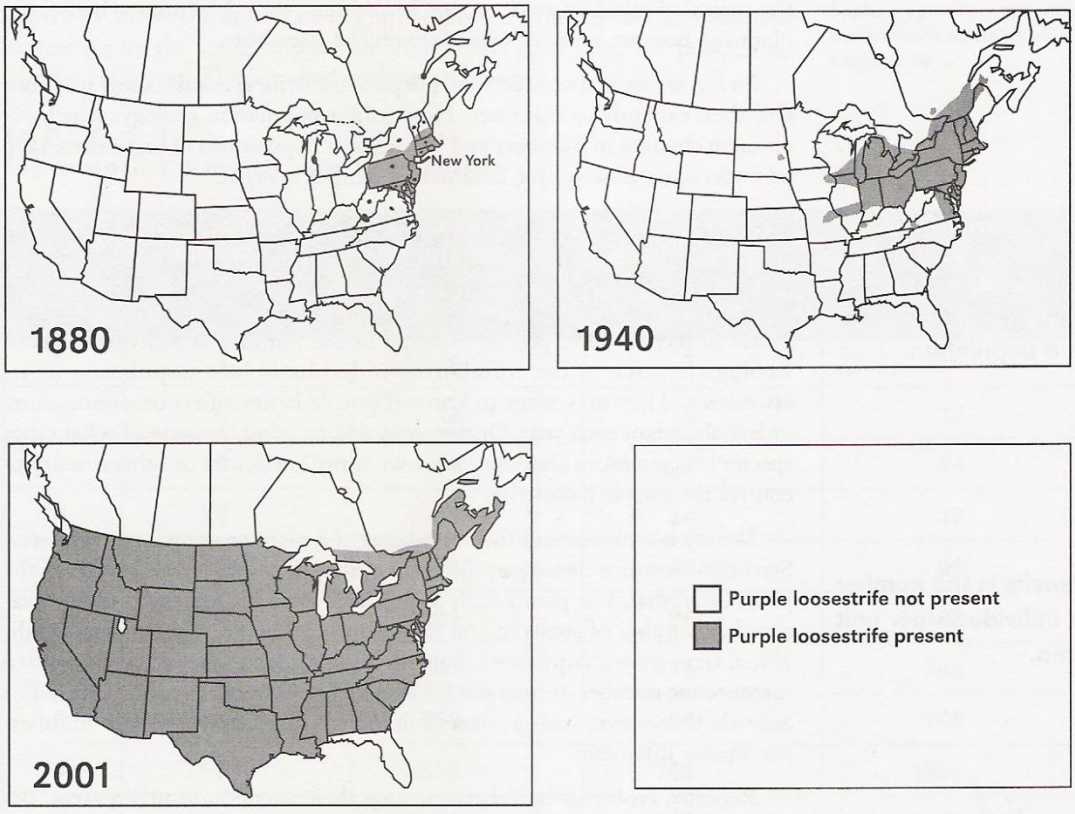
In its native Europe, purple loosestrife is not an invasive plant. It normally makes up only about 5% of the plants in a wetland. Yet, somehow purple loosestrife has been able to expand its populations in North America, outcompeting native plants (Figure 1.6). Species that are successful invaders usually have several of these characteristics:

- They grow rapidly and compete with other plants or animals
- They produce large numbers of seeds at a young age
- Their seeds can survive a long time before sprouting
- Their seeds travel long distances
- They can spread by sprouting from the roots or stems
- They have few predators
- Their native region has a climate similar to that of the U.S.

In North America, purple loosestrife has many of the characteristics typical of an invasive species.

- **Growth.** In the U.S., purple loosestrife grows rapidly, sometimes faster than 1 cm per day. It can grow to 2 m in height. A single plant has 30–50 stems, which shade out other plants. Even though the stems die back in the winter, new stems grow again in the spring from its large root system. Stems also grow back quickly after they are killed by mowing, herbicides, or fire.

FIGURE 1.6
Expansion of Purple Loosestrife in North America



- **Seeds.** Purple loosestrife produces seeds in its first year. A single plant can produce more than 2.5 million seeds annually. The seeds are long lived. They spread easily by floating on water and in mud that sticks to wildlife, livestock, and people's boots. Within a single square meter plot, ecologists have counted up to 20,000 purple loosestrife seedlings.
- **Sprouting.** Purple loosestrife develops a large root system that sends up new stems. If a piece of root gets broken off and washed downstream, stems can sprout in a new location.
- **Predators.** None of the insects that feed on purple loosestrife in its native Europe occur naturally in North America. Few North American insects feed on purple loosestrife and none are able to control it.
- **Native region.** Purple loosestrife is native to Europe and Asia. It occupies regions on these continents that have a climate similar to the regions it occupies in North America.

Ecologists think that these factors have allowed purple loosestrife to expand rapidly across the U.S. Today when scientists help make decisions about whether to introduce a new species, they first ask whether it has characteristics typical of other invasive species. In addition, they determine whether the plant has become invasive when introduced elsewhere.

So far, we have discussed how purple loosestrife spreads to new locations and then expands its numbers. How might population ecology, which focuses on changes in numbers and locations of populations of organisms, help us understand how purple loosestrife becomes invasive?

HOW MANY? ABUNDANCE

***Abundance* is the number of individuals in a population.**

Purple loosestrife becomes a problem when its populations expand in wetlands. We can simply observe that there are a lot of plants, but sometimes it is useful to have a more precise measure of the number of individual stems. Ecologists refer to the number of individuals in a population as its *abundance*. They may want to know if purple loosestrife is becoming more or less abundant each year. Or they may want a good measure of what other species become more abundant after we spray herbicides or otherwise try to control the purple loosestrife.

***Density* is the number of individuals per unit area.**

Density is a measure of the abundance of a plant or animal per unit area. Scientists measure density at different scales, depending on the size of the plant or animal. For plants such as purple loosestrife, density is often measured as number of stems in one square meter. But what about trees? Individual trees may occupy more than one square meter. Forest scientists often measure the number of trees per 0.1 hectare (a hectare is about 2.5 acres). For animals that move, such as deer, wildlife scientists may measure numbers per square kilometer.

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Recently, ecologists have been turning their attention to urban areas. Because most of their past work has been in more "natural" settings, ecologists often are ill-prepared to conduct research in highly developed areas like cities. How would you measure plant density in a city? Would you limit your sample to parks and yards or would you include built-up areas? Scientists are trying to answer these questions as they define goals for their research in urban areas.