



The William Floyd Estate once belonged to an original signer of the Declaration of Independence and the land also serves as important habitat for box turtles. Photo credit: Nancy Karraker.

## Can box turtles help control invasive fruiting plants?

If you're looking for a box turtle in autumn, try searching under the fruit trees. So says University of Rhode Island researcher Nancy Karraker who, with her graduate student Margarete Walden, launched a new study at the William Floyd Estate at Fire Island National Seashore. The study will reveal how the abundant box turtles at this important historic site help or hinder the germination and establishment of fruiting plants. Dr. Karraker wonders if these animals could be an important form of invasive species control.

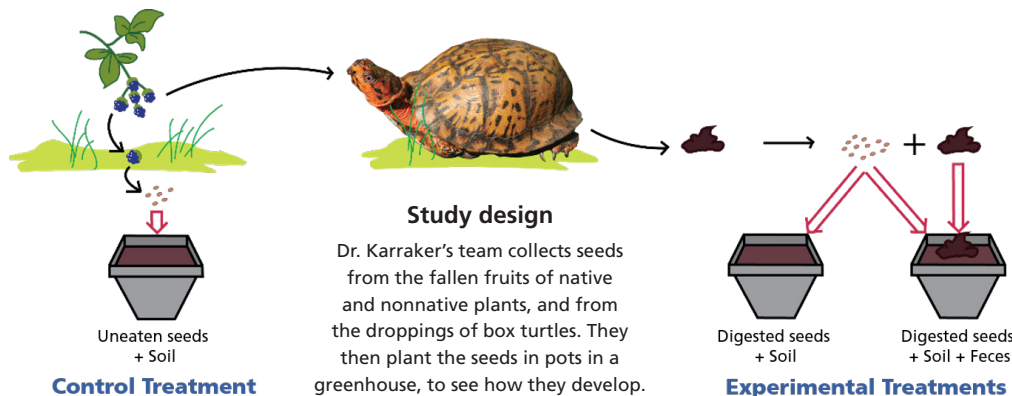
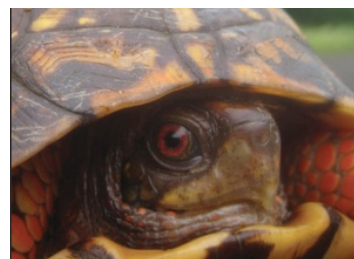
Many wild fruits—both native, like black cherry (*Prunus serotina*), and nonnative, like autumn olive (*Eleagnus umbellata*)—are targeted foods of the Eastern box turtle (*Terrapene carolina*), a species of Special Concern in New York State. Birds and small mammals eat wild fruits, too, but turtles may be particularly effective at helping to spread, or control, the plants they eat—given how they uniquely digest and disperse the seeds.

Reptiles digest food more slowly than other animals, allowing more time for them to carry seeds far from the parent plant and to chemically break down the tough seed coat that seedlings

must push through to germinate and grow. Turtles also keep seeds in one piece as they digest (rather than chew them like a mammal), and they provide defecated seeds with a natural fertilizer that is less acidic than the feces of a bird.

Native plants that evolved alongside the box turtle may therefore receive a substantial boost when their seeds pass through this animal's gut. Nonnative species that did not evolve with the box turtle, meanwhile, might benefit less, perhaps by being chemically processed too much as the turtle digests.

Remarkably, box turtles have been surveyed at the 613-acre William Floyd Estate since 1915, making the site an ideal place to study them. Maintenance of the property has also benefited the box turtles, which favor the forest-field mix managed there since the estate was donated to the National Park Service in 1976. After taking over long-term survey efforts in 2010, Dr. Karraker and her team began examining box turtle population trends and movement patterns at the site. Now she collects and grows seeds from fallen fruits and droppings to see how



Above: When a box turtle is found, it is placed in a plastic bucket on a mesh platform for two hours and droppings are then collected, stored on ice, transported to the lab, and are dissected for seeds. While most droppings contain an average of 10 seeds from one to two species of fruit, 452 seeds were found in the feces of one turtle, mostly blackberry and cherry. Photo credit: Nancy Karraker and Megan Skrip

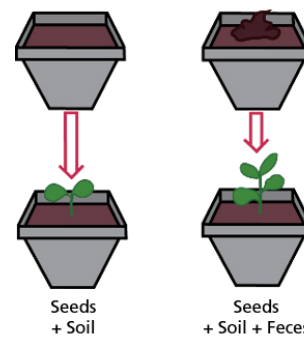
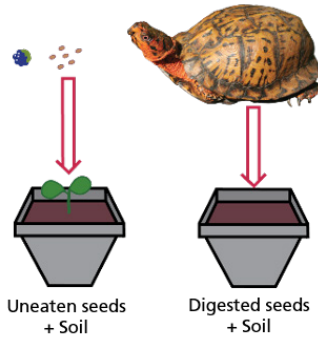
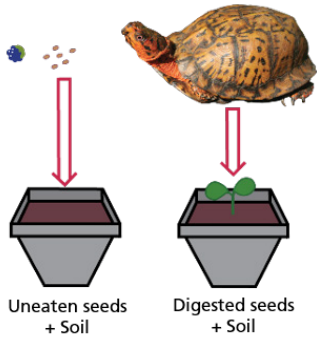
## Native Plants

## Nonnative Plants

Researchers hypothesize that box turtle digestion helps native plants germinate, but does not help—and might even hinder—the germination of nonnative plants. For both native and nonnative plants, and both uneaten and digested seeds, scientists measure overall germination success and time to germination.

## All Plants

The research team further predicts that box turtle droppings fertilize soil and help digested seeds grow faster and taller than seeds separated from the droppings. For all digested seeds that successfully germinate in the study, the scientists measure the height of seedlings every week.



turtle digestion affects native vs. nonnative plants.

As shown in the figures above, the research team is performing a controlled experiment in a greenhouse, with the expectation that box turtle digestion helps the seeds of native plants germinate and box turtle droppings help them grow. Specifically, digestion should disrupt the seed coat enough to allow faster and more successful germination, when compared with uneaten seeds. Dr. Karraker predicts that disruption of the seed coat will have a negative effect on nonnative plant seeds, given that they did not evolve with box turtles.

If box turtles can indeed play a role in controlling nonnative fruiting plants by preventing germination, they could contribute to an invasive species management strategy that is already sensitive to the turtles' needs at the William Floyd Estate: annual mowing. Mowing the fields on the property is important for keeping a consistent composition of native plants over time, controlling nonnative plants, and maintaining habitat for meadow-nesting birds. Site managers are aware of the danger that mowing poses to the slow-moving box turtles, and so fields are mowed only between November 1st and March 31st, as the turtles hibernate. When the turtles are active, they may be

helping to keep nonnative plants in check themselves by feeding on the fruits.

The team plans to collect samples until they have at least 30 samples for each of the two experimental treatments, to match with at least 30 control treatments. Although it will take several years before conclusive results are obtained from the greenhouse experiments, scientists are already learning important facets of box turtle biology as they perform the study:

- The seed composition of turtle droppings depends on the mix of foods available. After periods of rain, box turtles shift from eating fruits to eating the protein-rich slugs and snails that emerge when the ground is moist. During this time, the percentage of droppings that contain seeds can fall from 50% to 0%. Plant species represented in the turtles' diet also change through the season, following natural transitions in which fruits are ripe.
- An average number of seeds per dropping is 10, from one to two species of fruit. When turtles have been eating seed-filled blackberries, however, the typical number of seeds per dropping jumps to about 250.
- Observations during dissection of turtle droppings and whole fruits in the lab suggest that seeds eaten by turtles are less likely to get moldy, given that the seed is cleaned of all fruit pulp during digestion.

The box turtle study at the William Floyd Estate adds to a growing body of science revealing how animals affect seed germination, and might help control invasive species.

### Native plants tested for turtle impacts:

| Common name        | Scientific name                    |
|--------------------|------------------------------------|
| Northern spicebush | <i>Lindera benzoin</i>             |
| Black gum          | <i>Nyssa sylvatica</i>             |
| Virginia creeper * | <i>Parthenocissus quinquefolia</i> |
| Wild black cherry  | <i>Prunus serotina</i>             |
| Bristly blackberry | <i>Rubus hispida</i>               |
| Greenbrier *       | <i>Smilax rotundifolia</i>         |
| Riverbank grape    | <i>Vitis riparia</i>               |
| Fox grape          | <i>Vitis labrusca</i>              |

### Nonnative plants tested for turtle impacts:

| Common name         | Scientific name            |
|---------------------|----------------------------|
| Japanese barberry * | <i>Berberis thunbergii</i> |
| Autumn olive        | <i>Eleagnus umbellata</i>  |

\* hasn't yet been found in turtle droppings



Dr. Karraker and her team have created "seed libraries" to help identify seeds found in turtle droppings. Seeds vary in size, color, and shape, and the reference images—with a ruler for scale—help maintain accuracy during dissection of droppings. For samples with a lot of seeds, counting and identification can take up to three hours.

### What makes a plant nonnative?

A nonnative species has been introduced to an area (typically by people) where it previously never occurred.



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