For certain invasive species, catching infestation early pays off

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Based on their assessment of impacts across different habitats -- marine, freshwater or terrestrial - and for invasive animals vs. invasive plants, the authors led by Bethany Bradley of UMass Amherst found that 'increasing the abundance of invasive alien species has pronounced negative impacts on native species populations and communities.' Credit: CJB Sorte/UC Irvine

An international research team led by invasion ecologist Bethany Bradley at the University of Massachusetts Amherst has conducted the first global meta-analysis of the characteristics and size of invasive alien species' impacts on native species as invaders become more abundant.

For example, as alien garlic mustard (*Alliaria petiolata*) invades forest understory in New England, the number of native sugar maple seedlings declines, and invasive purple loosestrife (*Lythrum salicaria*) in New England wetlands is linked to a decline in the abundance of native red-winged blackbirds and song sparrows, Bradley says. Elsewhere, predatory invasive lionfish (*Pterois volitans*) introduced in Caribbean waters leads to a rapid decline in the abundance of native coral reef fish, and invading Burmese python (Python bivittatus) in the Everglades has caused dramatic losses of natives such as opossum, fox and bobcats.

Bradley says, "What surprised me most was the magnitude of some of these effects. Invasive animal pests, like Emerald Ash Borer or lionfish, cause nearly a 50 percent decline in native populations. That's the average case—on average, invasive pests will cut the populations of native species in half if we don't prevent or control those invasions."

The associate professor of environmental conservation adds, "Our principal finding is that if the invasive species is at a higher trophic level, that is, they are likely eating the native species, then just a few invasive individuals can cause a sharp decline in native populations. Once those invaders reach higher abundance, the damage has long ago been done. This has big implications for management," she says. "Early detection becomes critical."

They report that impacts depend strongly on the invasives' position in the food chain, known as trophic level. Invasive species at higher trophic levels have a strongly non-linear effect on native species with the greatest impacts occurring early in the invasion, while invasive species at

the same trophic level have a negative, linear effect on native species.

Reporting in "Latest Articles" in the current online issue of *Proceedings of the National Academy of Sciences*, Bradley and colleagues analyzed findings from 1,258 case studies from 201 research papers. One goal was to understand generally how impacts accumulate during an invasion in order to support evidence-based management, Bradley says.

"We know that invasive species have negative impacts, but past meta-analyses have only looked at studies where invaders were absent vs. present," Bradley says. Without information on the slope and magnitude of the impacts, she adds, "we don't know the slope of the relationship, whether it's linear or non-linear, or if there's a sharp decline of native species early or late in the infestation. These are the questions we looked at."

For native species faced with an invader at the same trophic level, where the two are likely competing for resources, Bradley says, "We see a strong negative linear response," but no sharp initial decline. She adds, "As you increase invasive species' abundance, the native species decline in abundance and in community diversity. The management implications are that if you control the invasion at any point, it's a win for ecosystems."

In the situation where an invader enters at a lower trophic level than the native species, results were unclear, Bradley says. "It could be creating new resources or it could compete against resources that the natives need. It's not clear whether the effects will be positive or negative, unless you're talking about terrestrial plants. Invasive plants are likely to have negative effects on native insects."

Based on these and their additional assessment of impacts across different habitats—marine, freshwater or terrestrial—and for invasive

animals vs. invasive plants, the authors found that "increasing the abundance of invasive alien species has pronounced negative impacts on native species populations and communities."

Further, the fact that rapid declines in native species' populations can occur at initial stages of the invasion process, they say, "highlights the increasing need for early detection and rapid response (EDRR) to new invasive alien species," especially for animal pests. They point out that EDRR is cost-effective and "the only point at which eradication is feasible."

"Avoiding the ecological impacts of invasive species will require a much stronger commitment to proactive policies designed to prevent novel introductions as well as increased management targeting the early stages of invasion."

Bradley points out that adopting EDRR requires that natural resource managers spend more time monitoring for new invasive species. But, "our manager colleagues are telling us that they are only able to spend about 10% of their time monitoring for new species because they don't have enough resources to monitor and still manage existing invasions," Bradley says. "That's simply not enough."

She adds, "Now that we know that impact and abundance are so closely related, we can use abundance as a proxy for impact. If I observe a large infestation of an invasive species, I can make a pretty good guess as to the magnitude of the ecological impact on native species."

More information: Bethany A. Bradley el al., "Disentangling the abundance–impact relationship for invasive species," *PNAS* (2019). www.pnas.org/cgi/doi/10.1073/pnas.1818081116

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