
Invasion Meltdown: a lesson meltdown saved by invasion-wise elementary students

By Meredith A. Zettlemoyer (Kellogg Biological Station; zettlem2@msu.edu)

INTRODUCTION

Invasive species represent a serious threat to the health of our native ecosystems and our daily lives. These non-native plants and animals disrupt food production, agriculture, natural resources, waterways, recreation...the list is endless, and the damage caused can cost billions in time, money, and resources (Padilla and Williams 2004, Pimentel 2009). The impacts reach national scales, but local consequences are already recognized by land managers and educators (Hakam 2016). It is the next generation that will have to take care of our damaged ecosystems, so their decisions, actions, and knowledge will play into the establishment and prevention of invasive species' spread in the future.

Despite this, many students can neither name an invasive plant or animal in their home state nor the extent of the problem (Hakam 2016). There are hundreds of research articles floating around in the nether of scientific literature, but how can we translate this into secondary school classrooms? McGuire's (2015) identity-based environmental education model addresses this: we can help students generate environmental identity, and hopefully stewardship, through public education and outreach programs.

The K-12 Partnership at the W.K. Kellogg Biological Station hosts three annual professional development workshops for K-12 STEM educators from across Michigan, where researchers develop classroom activities based on their own work and hot topics in ecology and environmental science. In the evaluation form from one of these workshops, invasive species came up as a suggestion for a future session theme. During the following workshop, I took on an invasive species session, which played out in a tale of the folly of candy, exploding pom-poms, and the power of the Bee Gees' 'Stayin' Alive'.

Our first run at an invasion lesson: chaos ensued

In this lesson, we decided to teach about the role invasive species play in native ecosystems, focusing on Michigan's invasive species, and developed a game where students, playing as invasive and native insects, would compete for resources. After learning about basic invasion biology and seeing some "Most Wanted" profiles of our most prolific local invaders, students would be introduced to some of the adaptations and effects of invasive species, including resource limitation and biodiversity decline. Our goal: drive every single native species extinct.

The first time I presented this lesson was to mostly middle-and high-school science teachers. The teachers split into groups: one person at each table was the emerald ash borer, a voracious wood-eating insect that has decimated ash trees across North

America. Everyone else was assigned a native bug of a particular color. They had to compete for food resources in their habitat: M&Ms. We set some basic rules of invasive species' biology: they are more competitive (could use two hands to collect more 'food resources' at a time) and are generalist feeders (can collect any color M&M). Meanwhile, the native species specialized on a particular color M&M and could only collect one at a time. We played in rounds, so everyone had 20 seconds to collect the food they needed to survive. Eventually, your species wouldn't have any more food available to it and would be "extinct". Once that happened, you transformed into an emerald ash borer (think of this as rapidly reproducing invasive populations) and played as one of the invaders. After a few rounds, we threw in some jellybeans to represent polluted food resources: native species couldn't recognize the threat, so if they accidentally collected too many toxic resources, they died. We set everything up with our one goal in mind.

What a disaster.

Error #1: candy. We had candy going into people's mouths, onto the floor, halfway across the room. I was yelling out "Time's up!" after every round over the resulting hyperactivity.

Error #2: letting people choose whatever native bug most appealed to them. We had so many cute green caterpillars, all the green M&Ms vanished and the caterpillars died within minutes. Meanwhile, our native brown insects survived just fine.

Error #3: not having a minimum amount of food resources needed to survive. Some native insects elected to starve themselves instead of attempt to collect polluted jellybeans. A wise strategy? Yes. A biological suicide mission in a real ecosystem? Definitely.

Needless to say, the feedback from this activity was mixed:

- "Fun and locally relevant." Check - studies have shown that an understanding of invasive species in people's own communities are more likely to promote engagement (Hashitomo-Martell and Mcneill 2012).
- "Neat game... not with M&Ms though." Our opinion too!
- And my personal favorite: a "hot mess."

Take two: the knowledge of some incredible fourth-graders

A few months later we had the opportunity to present at Women in Engineering's Girls' STEM Day at Michigan State University. We needed a quick lesson, doable in 20-minute shifts. The most rapid-fire lesson plan we had available was the invasion game. But there was no way we could go into a classroom full of 1st-4th grade girls with the chaos that had ensued last time.

We ended up developing the game for groups of 5 students: 1 emerald ash borer and 4 native species of red, yellow, green, and blue. We bought pom-poms in matching colors and made player cards for each student. In order to make it through a round, you had to collect at least 3 pom-poms: if you were an insect and you were out of food, wouldn't you at least try to eat something else? Finally, to top it off (and entertain the parents in the back of the classroom) in a nod to musical chairs, we blasted "Stayin' Alive" through each 20-second round so that the girls would freeze as soon as the

music stopped. Anyone who was out of food raised their hands so that we could tally who'd died and needed to switch to the ever-growing population of emerald ash borers.

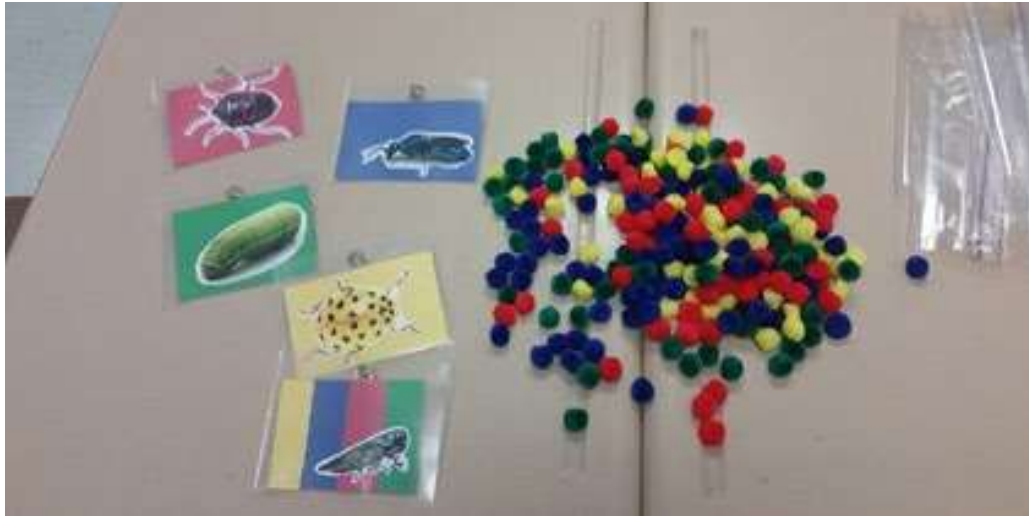
This was without a doubt one of the most successful K-12 lessons I have participated in. The girls were collecting as quickly as possible, scavenging any pom-poms that fell to the floor in an attempt to survive, and carefully tracked their food intake as food got scarcer and scarcer.

We then tossed in some glittery pom-poms as a poisonous little twist. If you accidentally collect this food, you have to keep it: this was the new rule. If you're out of your healthy food source, what are you going to eat? Different strategies popped up: some collected much slower, avoiding the poison but sometimes not collecting their minimum food requirement as time wore on. Some girls took the dangerous approach and even closed their eyes ("Would they know it was poison?") and took their chances. By the end of a few rounds, when we asked who was still alive, not a hand raised. When we asked who was playing as an emerald ash borer, two dozen hands with emerald ash borer cards popped up - they'd taken over!

The most rewarding part of this was the follow-up discussion. We didn't have time to do walk through a complete lesson plan, but we wanted the girls to understand why invasive species are so damaging and link this to species in their own neighborhoods. We started off by having the students name as many invasive species as they could, not expecting more than a vague "ivy" or "snails." Instead, we got stink-bugs, zebra mussels, Asian carp, emerald ash borers, spotted knapweed, purple loosestrife...all invasive species that have been particularly damaging to Michigan's native habitats. The highlight was when one girl, in responding to my questions about what an invasive species is and what adaptations make them competitive, proceeded to give me a more thorough answer than some undergraduates would give: "A species that is foreign to an environment and has damaging effects, that can eat anything and grow quickly and has lots of babies." She even threw in the enemy-release hypothesis, an idea in invasion biology that predicts that invaders spread because they no longer have natural predators or enemies to keep their populations in check, and allelopathy, a plant's ability to release chemicals that inhibit any nearby germination. These students engaged with a local environmental issue, and actively acquired information through both past knowledge and the game.



M. Zettlemoyer adding toxic plants to the insects' food supplies at the Girls' STEM Day (2018 17 November).



Sample pieces for the Invasion Meltdown game, including food resources and playing cards. Each native insect feeds on only one color pom-pom, while the invasive emerald ash borer can feed on yellow, blue, red, or green pom-poms.

CONCLUSIONS

When every single student in the room raised an emerald ash borer at the end of the game, it clicked: invasive species cause the extinction of our native species. We were able to discuss human-caused changes to the environment when they recognized that pollution caused extinction to happen even more rapidly. This lesson addressed the NGSS standards relating to environmental change (3-LS4-1, LS2.C), cause and effect (3-LS4-2-3), and constructing explanations (3-LS4-2-3). Beyond that, it demonstrated the mechanisms by which invasive species are so competitive and problematic and how humans compound that threat, and engaged the students in how their own homes might be impacted. This last lesson, hopefully, will be the link to place that helps them grow into the environmental stewards of tomorrow.

REFERENCES

1. Padilla, D. K. and Williams, S. L. (2004). Beyond ballast water: aquarium and ornamental trades as sources of invasive species in aquatic ecosystems. *Frontiers in Ecology and the Environment*, 2: 131–138
2. Pimentel, D. (2009). Invasive plants: their role in species extinctions and economic losses to agriculture in the USA. *Management of Invasive Weeds* 5: 1-7.
3. Hakam, L. (2016). Invasive species: public awareness and education. *University of Washington*. Web.
4. McGuire, N.M (2015). Environmental education and behavioral change: an identity-based environmental education model. *International Journal of Environmental & Science Education* 10: 695-715.
5. Hashimoto-Martell, E.A. and Mcneill, K.L. (2012). Connecting urban youth with their environment: the impact of an urban ecology course on student content knowledge, environmental attitudes and responsible behaviors. *Research in Science Education* 42: 1007-1026.

SUPPLEMENTARY MATERIALS

The resources for the "Invasion Meltdown!" lesson (lesson plan, PowerPoint, and insects for the game) can be found in the folder at: https://drive.google.com/open?id=1IBJ0ro1wHxaM5MqLI7I5_ou-MdFcy3Ut