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ORIGINAL ARTICLE

# Self-guided field trips take invertebrate zoology students away from their screens and into the environment for hands-on learning

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## Abstract

There is a great importance for undergraduate biology students to study organisms in their natural context. Safety concerns surrounding the global COVID-19 pandemic prevented Marine Invertebrate Zoology students at the University of Tampa from participating in traditional faculty-led field trips during the Fall of 2020. Instead, students were assigned to conduct a diversity-focused field trip on their own and report their findings. Here we describe considerations and methods for creating a safe and valuable self-guided field trip assignment for upper-level invertebrate zoology students. These methods are adaptable for a variety of different habitat types and can be conducted with little to no special equipment or training. Students were successful in completing this assignment and found it highly enriching.

**KEYWORDS**
field trip, Florida, pedagogy, teaching invertebrate zoology

## 1 | INTRODUCTION AND RATIONALE

For zoologists, there is tremendous value in spending time outdoors observing animals in the wild. There is something intrinsically fascinating about seeing all the pieces of an ecosystem in action, and many of our best ideas for experiments come from observation of an organism in its natural habitat. The benefits of learning outdoors range from an increased motivation to read and write about experiences in the field (Schaal et al., 2012) to an enhanced appreciation and attitude toward the environment and science (Ayotte-Beaudet et al., 2017). Participants in outdoor education programs reported an increased connection to nature and comfort in the outdoors, leading to a desire to protect nature (D'Amato & Krasny, 2011). Learning while outdoors can be even more important for undergraduate biology students. For example, inquiry-based learning in combination with outdoor field activities and participatory learning methods improved retention and understanding of biodiversity (Ramadoss & Poyya Moli, 2011; Schaal et al., 2012). Time spent outside observing and collecting specimens can be formative for undergraduates; it sparks their curiosity for nature, opens their eyes to the sheer magnitude of biodiversity, and ignites the passion we need in the next generation of biologists. Invertebrate zoology courses, with their inherent focus on biodiversity, are an excellent vehicle for exploring and discovering the wonders of nature in concert with course objectives. Both authors of this essay attribute their careers as educators and invertebrate zoologists to their experiences in nature as children, exploring local estuaries, snorkeling and diving, and participating in field courses during their degree programs.

Taking a science course to the outdoors offers an authentic learning environment that provides hands-on learning experiences, including technical skills (Fuller, 2012), that nurture students' curiosity of nature (Subramaniam, 2019). In a typical fall semester at the University of Tampa (UT), students enrolled in MAR 226 Marine Invertebrate Zoology course (taught by M. Middlebrooks) participate in at least five field trips as part of the lab coursework. Interested students have the opportunity to participate in additional optional field trips on the weekends. Each of these field trips gives students an opportunity to explore marine invertebrates in their

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natural habitats, providing an important context that is difficult to appreciate when organisms are only studied in a classroom or laboratory setting. Evidence suggests that theoretical and conceptual principles are better understood when students are able to associate them with specific experiences and ongoing practices (Auer, 2008; Schaal et al., 2012). The goal of each field trip is to expose students to the invertebrate communities within different habitats, which often include seagrass, mudflats, oyster reefs, mangroves, and high energy beaches (or as high energy as you can find on the west coast of Florida), depending on conditions and time of year. In each habitat, students learn new sampling techniques, find invertebrates that they have never seen before, practice identification and taxonomy, and have an opportunity to explore and ask questions. Many semesters may include a visit to the sponge docks in Tarpon Springs, FL, to learn about the intersection of human culture and invertebrate biology in the largest sponge fishery in the United States. All of these field trips leave a lasting impression on the students, and often are their favorite part of the course. From the standpoint of a professor, incorporating field trips can also keep labs feeling fresh because you never know what organisms might turn up. For example, nonnative species have been discovered on invertebrate zoology field trips (Williams & McDermott, 1990). During a pandemic, when most learning is happening in front of a screen, creating opportunities for students to learn invertebrate zoology *in situ* is more valuable than ever.

The UT was open in Fall 2020 for in person classes; however, the regular off-campus field trips were not possible. During this semester, Marine Invertebrate Zoology was run as a hybrid course. Lectures were run remotely as prerecorded videos for ~40 students and shortened in-person lab sessions were held for groups of no more than seven students, facemasks required. Meeting in small groups was important for reducing coronavirus risks, but it also reduced the time available for field trips. Fortunately, UT is adjacent to Plant Park along the Hillsborough River. This gave us some opportunities to do a little bit of field sampling within walking distance. Students took water samples from a stream to search for protozoans and microscopic invertebrates. They also spent one lab hunting for terrestrial and semi-terrestrial arthropods (which are everywhere, so this can be done on any college campus), and another sampling oysters from the seawall. Although these are valuable and useful opportunities, they still do not quite capture the full field-biologist experience we wanted students to get from these field trips. With that in mind we created an assignment for students to visit a local field site on their own to explore, sample, and identify the invertebrate community. UT Marine Invertebrate Zoology students were tasked with heading to a local field site to document the diversity of invertebrates found in the community. To assist, they were provided with a written explanation of the assignment (see Appendix S1), an orientation video of the field site (UT Slug Life, November 7, 2020, Self-Guided Field Trip Orientation Video, https://youtu.be/P-xwItCLNu4), a few simple sampling tools, and resources to help them identify invertebrates common to the area. Students were required to photograph each invertebrate animal, label each photograph with their field notes, and provide taxonomic and trophic information about the organism.

## 2 | DESIGNING THE ASSIGNMENT

### 2.1 | Safety and logistical considerations

Creating a successful assignment where students head off into the wilds without direct supervision has many considerations, the first of which should be safety. It is important to pick a field site in a location that balances opportunities for a good field experience with minimal risk for student injury. Sites with serious hazards such as powerful rip currents, violent wave action, high crime rates, or unstable terrain should be avoided. No location is going to be without hazards, but it is important to identify likely hazards and make sure that students are aware of them.

One important tool for identifying and alerting students to hazards is a safety disclosure. Although disclosures are often used as a means of limiting liability, which is important, their primary purpose should be to inform students of potential risks they are taking by engaging in these course activities. In the chosen location for this assignment, a city park in Tampa Bay called Picnic Island Park (27°50′59.4″N, 82°33′13.7″W), there was easy access to a few shallow-water habitats but no dramatic wave or tidal fluctuations. The primary concern for potential injury at this location was unseen submerged hazards (oysters, beer bottles, other debris). However, potential injury caused by marine life, for example, a sting ray, is also something about which students should be informed. As part of the safety disclosure, on the first day of lab students were treated to a slide show graphically illustrating stingray and oyster wounds and the resulting infection that occurs if they are not attended to properly. A discussion took place about how to avoid these situations (protective foot coverings and the classic "sting ray shuffle," e.g., Greensborough Science Center, 2019) and what to do if an injury does occur (seek medical attention). Potential hazards were later reemphasized to students during the orientation video and in the instructions for their assignment. Before participating, students were required to sign a disclosure stating that they understood these risks and chose to participate willingly. Students who were not comfortable with this assignment had an option of an alternative assignment to complete (details in Section 2.2).

Solo field work is another hazard and should never be encouraged. Students were required to have someone with them onsite while completing their self-guided field trip assignment. This could be another classmate, friend, roommate, or other person who was willing to meet them at the field site. Students were required to email their contact information, the name of the person(s) with them on site, and emergency contact information before heading into the field, and were required to check back in via email once they returned. During a pandemic, travel and working with others creates some unique concerns; although students were required to be with

someone at the site, they were encouraged to travel separately (although it does feel a little wrong to discourage carpooling) and wear face masks when working in close quarters. Once on site, however, students had plenty of room to spread out, so risk of COVID exposure during this field trip was lower than in traditional in-person classes.

Another consideration when choosing a field trip site is how accessible it is to students. Something close to campus is ideal; however, sending students further out is worth considering if campus is not near a suitable location. Our field site, Picnic Island Park, was about a 20-min drive from campus and provided access to several habitats including seagrass beds, saltmarsh, mangroves, and sandy mudflats. The mix of habitats was great for increasing the diversity of organisms students could expect to find, but less diverse habitats could also make for a great experience. Monetary costs are another factor to consider when picking a site, because even small fees will deter some student participation. We used a city park with free parking and no access fee.

Before students head out into the field it is a good practice to give them an idea about what to expect. We did this by creating an orientation video to show students where to park, the best spots to look for organisms, and methods they could use to collect specimens. The best videos for this should be short (we made one ~6.5 min in length), informative, interesting, and fun. We used a mix of narrative voice-overs to explain sampling methods and to tell students a little about the organisms that live there, shots of scenery, sometimes accompanied by music, and a montage of commonly encountered invertebrates (https://youtu.be/P-xwItCLNu4).

For our assignment, students were provided with a shallow plastic tray, a small aquarium net, and a piece of waterproof paper. Supplies in hand, students were instructed to go the field site on their own time to collect, photograph, and then release the invertebrates they found. Photographing organisms rather than collecting them provides many advantages. UT has a collection permit from the state of Florida for educational purposes. We could have kept specimens, but because we have many commonly found invertebrates preserved in our specimen collection, we decided to keep this project catch and release. One advantage of photographs over preserved specimens is that you also remove the safety concern of working with preservative chemicals. If, however, you decide to have students collect specimens, make sure you are aware of local laws and that students have copies of any necessary collecting permits and additional personal protective equipment. Other reasons for only photographing the organisms is that cell phones are now ubiquitous, and it allows for a digital submission of the assignment. We are trying to avoid paper submissions of anything during the pandemic to avoid potential virus spread from surfaces and hope that this will offset some of the carbon footprint for not carpooling.

For any student assignment, plagiarism can always be a concern, and in the digital age it is easy enough to find photographs of many organisms. To help eliminate this temptation, students were required to either photograph the organism next to themselves (#invertselfie) or next to a piece of waterproof paper with their name on it. They were also required to include a photo of themselves at the field site to prove they were there.

### 2.2 | Pedagogical considerations

Once students found and photographed their organisms, they needed to identify their invertebrates to the lowest taxonomic level they could manage. For most students this was a rather challenging part, as undergraduate students typically do not yet possess the required skills. To help with this, students were provided with a pdf photo guide of organisms common at the field site (many of which were photos by M. Middlebrooks from past field trips, e.g., Figures 1 and 2) and some dichotomous keys for invertebrates local to the area. The instructor also offered to help students with any organisms they had difficulty identifying.

For each organism, students labeled their photograph with taxonomic information (ideally phylum, class, order, and then the lowest taxonomic level they could identify). Photograph labels needed to include the habitat where they found the organism, its trophic role or feeding method, and any notes they observed on its behavior. All of this information was then compiled into a document and submitted by the students. Students were provided with several examples of what a well-labeled photograph looks like. We suggest that you do the same because, otherwise, you will end up with very odd format choices, which can make grading the assignment more taxing than it needs to be. Students were not given a minimum number of organisms to find but were instead given a maximum number of species for which they could turn in photographs and accounts. We found that for most students a maximum limit would drive them to spend more time exploring and looking for specimens but would also keep the highest performing students from spending all of their time on this one project. Students were assigned this project on the first day of lab and given 8 weeks to complete the assignment. They were periodically reminded of the assignment during weekly lab meetings. The assignment was worth ~5% of the total course grade. Students who were uncomfortable with the assignment or unable to complete it were given the option of writing a short life history paper on the invertebrate of their choice.

## 3 | COMPLETED ASSIGNMENTS

In the end, this assignment went extremely well. Because it fulfills a requirement for their degree, most of the students in this course were Marine Science–Biology majors, and as such they were enthusiastic about visiting a local marine habitat. Students mostly followed instructions, and all of them were able to complete their assignment safely. On average they found 12 distinct species on their field trip, but several students included the maximum 20

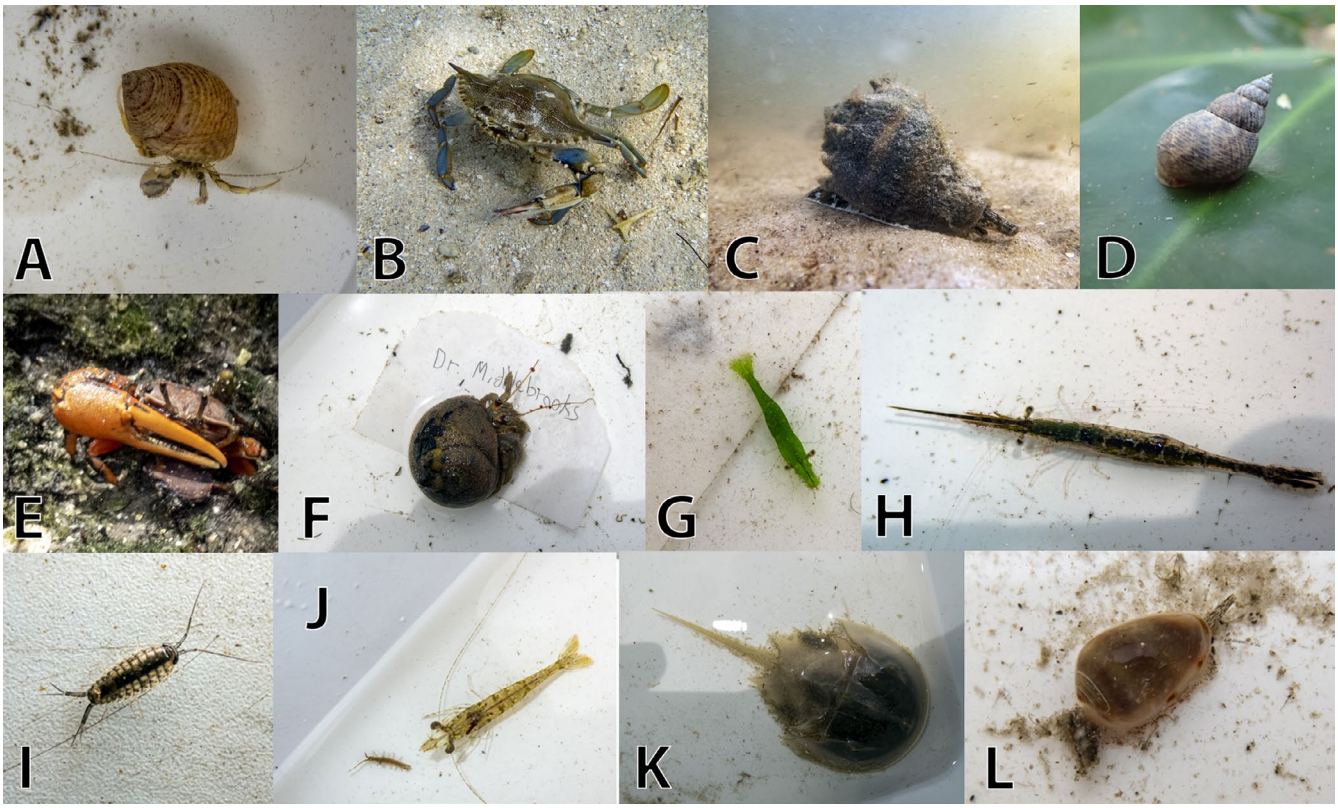


**FIGURE 1** Examples of commonly encountered motile invertebrates included in the photo guide provided to students to assist with identification. **A**. The hermit crab *Pagurus longicarpus*. **B**. The blue crab *Callinectes sapidus*. **C.** The crown conch *Melongena corona*. **D**. The mangrove tree snail *Littoraria angulifera*. **E**. The fiddler crab *Uca* sp. **F.** The hermit crab *Pagurus pollicaris*, with the hydrozoan *Hydractinia* sp. growing on the shell. This is also an example for an organism photographed next to a name tag as required for this assignment. **G**. The caridean shrimp *Hippolyte zostericola*. **H**. The caridean shrimp *Tozeuma carolinense*. **I**. The non-native isopod *Ligia exotica*. **J**. The penaeid shrimp *Penaeus duorarum* and the isopod *Erichsonella attenuata*. **K.** The horseshoe crab *Limulus polyphemus*. **L.** The marginellid snail *Prunum apicinum*

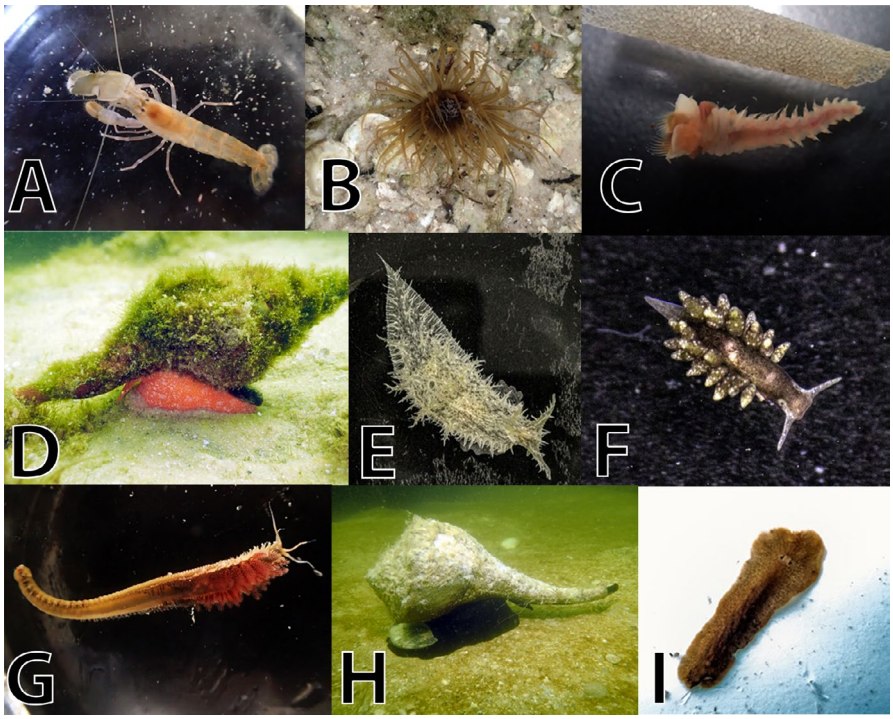


**FIGURE 2** Examples of less commonly encountered motile invertebrates included in the photo guide provided to students to assist with identification. **A**. The caridean shrimp *Alpheus heterochaelis*. **B**. The tube anemone *Ceriantheopsis americana*. **C**. The terebellid polychaete *Pectinaria gouldii*, removed from and photographed next to its tube. **D**. The horse conch *Triplofusus giganteus*. **E**. The sea hare *Bursatella leachii*. **F**. The sacoglossan sea slug *Ercolania fuscata*. **G**. The tube-dwelling polychaete *Diopatra cuprea* shown removed from the tube. **H.** The lightning whelk *Sinistrofulgur sinistrum*. **I**. The oyster flatworm *Stylochus* sp.

different species. Taxonomically they reported a fair range of different phyla including Arthropoda (mostly crustaceans, but also horseshoe crabs and one swimming beetle), Mollusca (all gastropods and bivalves), Annelida, Ctenophora, Porifera, and Cnidaria. Students reported that they enjoyed the experience greatly and most did a good job identifying their specimens. Some students reported going back multiple times so they could find even more invertebrates! Students learned not only to sample for marine invertebrates in the field effectively, but their learning continued during the time spent identifying their finds. Providing feedback on their work allowed students to learn even more. For example, many students found what they thought were jellyfish, which were in fact gelatinous egg masses from burrowing polychaete worms. Students were not penalized in grading for mistakes such as these, but rather we used them as opportunities to teach students further about the diversity and natural history of invertebrates in our local habitats. Students were also not graded on photography skills, but rather on turning in a complete, organized, and well-labeled assignment. Scores were lowered if students turned in assignments with missing information (for example including the phylum and order and omitting the class of an organism) or improperly formatted scientific names.

## 4 | INSTRUCTORS' REFLECTIONS ON THE ASSIGNMENT

Although we are all looking forward to the day when normal field trips can resume, self-guided field trips are a great opportunity for students to get out in the field and learn the natural history of invertebrates firsthand. Further, students' eagerness to be outdoors was observed in courses across disciplines prior to the COVID-19 pandemic (Fedesco et al., 2020), and it seems to be even more appreciated after periods of quarantine. In teaching a biodiversity-centered course, we learned that being more available to students via email or extended virtual office hours facilitated students' eagerness and willingness to perform well on assignments, as in-person assistance was not available. The instructor greatly enjoyed helping students identify invertebrates and discussing their most exciting finds. Students who completed their field work earlier tended to do a better job on identification and organizing their assignment than students who completed their field work closer to the due date. With that in mind, we suggest giving students a due date for completing the field work that precedes the final assignment due date by a week or two. Other than that, this project was successful enough that it is being run again in the Spring 2021 semester without any major modifications.

## 5 | PRESCRIPTIVE ADVICE FOR OTHER INSTRUCTORS

If possible, we highly encourage you to incorporate some aspect of field work into invertebrate zoology courses, even while teaching during the pandemic. The students at UT were eager to engage in field work, and we suspect that many of your students will appreciate a break from on-screen learning. If you decide to create a similar assignment, the first step is to select an appropriate field site in your area. Students can still find lots of great invertebrates in forests, streams, fields, and even in well-landscaped city parks (Lei, 2010), so it's not necessary to abandon the idea of invertebrate sampling just because your campus is not next to the ocean. If possible, it is best to choose a site where there are no fees for access; if this is not an option, see if student lab fees can be used to offset the costs of entry. Ideally you also want to pick a location that has decent cell phone coverage in case there is an emergency.

Once a site has been identified and selected you will then want to create the assignment and supporting materials. While we prefer a deep dive into the diversity of a single field site, this type of assignment could also work as a semester-long project, with students documenting and comparing invertebrates they find in a number of habitats. Make sure that your introductory materials alert students to any hazards in the area and any temporal concerns such as major tidal fluctuations. NOAA provides accessible information for tidal predictions in the United States (https://tidesandcurrents.noaa.gov). If the site you pick is a particularly sensitive ecosystem, you should also include practices to minimize impact to the habitat. If you decide to make a video, we highly recommend that you appear in it to make it more personal for your students. Featuring some of the more charismatic invertebrates from the area can also help keep student interest. Hermit crabs, active snails, and horseshoe crabs make great video subjects and are often very popular with students.

Depending on the types of invertebrates you want students to find, they may need some equipment. If you are meeting in person, you might be able to supply the equipment; however, a supply list could easily be included in the syllabus for students to acquire supplies on their own, as long as the cost is kept minimal (aquarium or dip nets are probably fine, yabby pumps might be a bit over the top). Sunscreen, bug spray, clothing with sun protection, appropriate footwear, and other safety measures are all additional items you might add to this list. If available, a local field guide could also make a good addition to their required materials. If appropriate field guides are not available for your area, online resources such as iNaturalist (inaturalist.org) can also be useful. You might even consider having students contribute to iNaturalist as part of the assignment. We recommend having students use the World Register of Marine Species (WoRMS, marinespecies.org) to help with taxonomy, and local state departments may have accessible taxonomic keys available (e.g., Florida Department of Environmental Protection: https://floridadep.gov/dear/bioassessment/content/macroinvertebrate-taxonomic-keys).

Even if you pick the perfect site and educate your students about potential hazards and sensitive species or habitats, you will likely still have students who cannot participate for a variety of reasons. For those students, we suggest having an alternative assignment ready, especially during a pandemic, because any student could end up in quarantine and unable to complete a field

assignment at any time. We suggest presenting both options to your students concurrently, rather than waiting for students to approach you about transportation or other issues. The alternative assignment used in Fall 2020 was a short literature-based life history paper on a selected marine invertebrate, but any assignment that works towards achieving your course objectives could fulfill this role. Upon further reflection, an assignment based on a virtual field trip might make an even better choice. Whatever you choose, ideally the alternative assignment should be a similar amount of work for students to complete and address at least some of the same goals as the field trip assignment. Although most students were excited to participate in the self-guided field trip it was useful to have the alternative assignment ready to go for the few who were not able to participate.

Finally, with some modification, a self-guided field trip could even work for courses taught entirely online. Remote courses taught to far-flung students can still take advantage of this methodology by sending students into their backyards, neighborhoods, and local parks to see what they can find. Most of them will be able to get outside somewhere and, at the very least, find some arthropods. In any case, the students will enjoy this assignment and their appreciation for the study of invertebrates will grow as a result. The invertebrates are out there; let's teach our students to find them!

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## SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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