Multidisciplinary Field Investigation: Using Shared Logistics to Increase Research Productivity

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In many ways, off-campus field studies are ideal learning opportunities. What could be better for students than a learning experience that offers excitement, adventure, travel, and immersion in a subject for weeks at a time in a setting away from everyday distractions, diversions, and responsibilities? The things that make fieldwork so memorable for students, however, raise unique challenges for faculty members. Beyond being responsible for supervising students' research activities, in a field research project the faculty member also becomes responsible for a majority of the everyday logistical decisions that students would normally make on their own, up to, and occasionally including, when and where to eat, sleep, and go to the bathroom. Meeting the basic needs of the field crew is obviously an indispensable part of fieldwork, but logistical demands can divert faculty time, attention, and energy away from the research that is the crew's primary purpose. One way to decrease a research project's logistical overhead is to share the load by having two or more faculty members supervise multiple research projects at a single field site.

We have taken this approach in a collaborative research project, "Paleoenvironmental Characterization of a Dinosaur Site in the Morrison Formation of the Bighorn Basin, Wyoming," funded by the National Science Foundation's Research Experiences for Undergraduates program. The field locality is near Shell, Wyoming (population 50) along the western slope of the Big Horn Mountains on property administered by the Bureau of Land Management (BLM). The site is located in deposits that have produced numerous fossils, including *Allosaurus, Camarasaurus, Torvosaurus,* and *Stegosaurus*. The project engages each participant in field and laboratory work directed toward our overarching goal - to develop a broad understanding of the ancient environments and fossils represented at the site. Participants, either individually or in pairs, collaborate with faculty to design research projects that focus on specific aspects of the fossils, sediments, or sedimentary rocks at the site.

One of us (BEB) is a paleontologist with interests in the interpretation of fossils at the site, whereas the other (TMD) is a sedimentologist with extensive experience in the stratigraphy and environmental interpretation of the Morrison Formation. Purists might refer to our collaboration as "multisubdisciplinary" rather than multidisciplinary since we share a common background in the discipline of geology, but our areas of expertise are complementary, allowing us to supervise a broader range of student projects than either could alone.

In June of 2004 we took 10 undergraduates into the field for 4 weeks of fieldwork. Both of us were in the field the entire time to supervise the students' projects, and Mark Uhen, from the Cranbrook Institute of Science, joined us for two weeks to provide additional expertise in dinosaur excavation. Besides dinosaur excavation, student projects included geologic mapping, constructing and describing stratigraphic sections, collecting and analyzing paleocurrent data, examining dinosaur bone geochemistry, screen washing for microvertebrates, collecting and describing fossil plants, and analyzing paleosols (ancient soils). Before traveling to the field we gave the students four days of orientation to introduce our research goals, potential projects, field methods, field and lab safety, and lab facilities the students could use for sample and data analysis during the 5 weeks of research following the field season. We used weekends for the bulk of our travel to and from the field to

REU participants examining Jurassic rocks in the Bighorn Basin, Wyoming. From left to right: Elisa Ramirez, Maureen Yonovitz, Eric Baar, Justin Scott (standing), Jennifer Murphy (bending), Brian Bodenbender (stooping), Erica Clites, and Cody Holbrook.

maximize the number of regular workdays available for student research. Students performed their lab work at Hope College, with occasional trips to other institutions in the region to use analytical equipment or examine museum collections.

Establishing Collaborations

Although developing productive collaborations often seems to involve a fair bit of serendipity, a good place to start searching for collaborators is within your own institution, looking first to faculty from other departments that typically engage in field study (e.g., biology, geology, forestry, or environmental science) or to faculty from more lab-based disciplines (e.g., chemistry or engineering) who have a desire to do applied studies. One way to explore the potential for research collaborations with colleagues from other disciplines is to teach a joint multidisciplinary field course. One of us (BEB) has taken this approach successfully in courses that introduce students to the biology and geology of the Great Plains and Rocky Mountains regions and the botany and carbonate geology of San Salvador Island, Bahamas. Such trial field courses can highlight areas of overlap in research interests and help narrow the choice of field areas that could be productive research sites for all collaborators. In fact, we secured our current field site through contacts made while teaching a field course.

In many cases, especially at smaller schools, you may have to look for collaborators beyond your institution. Our collaboration was the result of a suggestion in a grant proposal review, where the reviewer recognized that we had parallel interests that could dovetail at a single research site. Potential collaborators might also be found by way of networking opportunities such as CUR conferences, meetings of disciplinary societies, membership in groups like Project Kaleidoscope that promote faculty development, or institutional consortia. It can also be very helpful to meet researchers working on unrelated projects in the general region, as they can provide entree into the informal networks that often develop among field workers. Federal or state officials in charge of administering public lands near a prospective field site are also in the know concerning researchers who have expressed interest in the area. It was through a BLM scientist that we found a permanent repository, the Cincinnati Museum Center, for the vertebrate fossils collected over the course of the project.

While we have focused our comments on the sciences, much broader research collaborations are also possible (e.g., Pallant, 2000). We are interested in establishing more truly multidisciplinary collaborations, having tried to fund proposals to bring researchers in Communications to our site, but, despite the theoretical appeal this kind of collaboration has in the academy, we have not yet found a

funding source for a project that brings together such disparate disciplines.

Selecting a Field Site

Finding a suitable field site can be problematic. In our case, the site was a known source of fossil material, so we were relatively certain that we could develop paleontology projects. Furthermore, it is in a region that had previously received comparatively little attention from geologists, relative to other dinosaur-bearing parts of the Morrison Formation. Thus, the site offered many open questions concerning the interpretation of individual rock units, their extent and ordering at the site, the site's relationship to other nearby sites, and its position within the Jurassic stratigraphic column.

Logistical Keys

Preview the area

Preview the area – If possible, do some field study in the area on your own before bringing students along. This gives you the opportunity to evaluate the logistical considerations firsthand, as well as line up potential research questions that students can address.

Use available infrastructure

Remote camping with weekly trips to town for showers, supplies, and fresh water has a certain adventurous charm and makes for a memorable research experience. It also has clear advantages in terms of minimizing student mischief that might jeopardize relationships with the local populace.

Emily Swor (left), Cody Holbrook, and Carrie Thomason (right) excavating *Camarasaurus* bones.

However, as appealing as we may find the idea of a self-sufficient base camp right on the study area, it is probably better to rely on existing facilities (e.g., campgrounds, field stations, or nearby college dorms) at least for the first field season. Camping at a remote site requires that *everything,* from quantities of food, water, and gasoline to the longevity of ice blocks and the cargo capacity of vehicles, be planned beforehand and estimated accurately, with time-consuming and expensive re-supply trips as the penalty for miscalculation. Setting up a remote camp, therefore, presents a very significant logistical burden that can be avoided if established accommodations are available within convenient commuting range. Besides relieving faculty of the burden of providing some portion of the group's infrastructure, the availability of flush toilets, showers, and a telephone or internet connection will pay dividends in maintaining the long-term morale of all participants, especially the less venturesome ones.

Moreover, a research program is only sustainable if it works personally as well as professionally. Both of us have spouses and small children, so it was important to arrange for our families to stay with us at camp for at least a portion of the field season. Given the parameters of spousal good will, remote camping was not in the cards for either of us. We based our operations at a campground about 30 minutes from our field site so the students had the amenities of running water and flush toilets in camp, although these were not available at the study site. From a personal balance perspective having a camp site away from the field area worked well in allowing us to "go off to work" during the day and then have family time back at camp, and eliminated concerns about supervising children in potentially hazardous field settings. The need to meet at the vans each afternoon and drive to our campground also meant we did not have to worry about situations where students might be dispersed over a remote field site at night.

Plan meals ahead of time

We were able to delegate meal planning and preparation to a spouse who had some prior experience with catering for large groups and a penchant for exploring the limits of what can be prepared on a charcoal grill (pork loin, biscuits, baked potatoes, yes; cake, smoky but acceptable; two courses on one set of coals, not so hot), but we have been given to understand that this circumstance is exceptional. Other options for meal preparation with which we are familiar are to hire a field cook, assign pairs of students responsibility for planning and preparing particular meals, or, as we plan to do this summer, arrange for a local restaurant to cater simple fare.

Regardless of how you arrange to have the meals prepared, it's a good idea to plan the meals beforehand. We were able to bring our first two weeks worth of meals with us to the field by packing a cooler with frozen meat items and pur-

chasing bulk canned goods at a warehouse club. This helps stretch the meal budget and simplifies logistics by reducing shopping needs during the week to a few items such as milk, bread, and fresh vegetables that might not travel well and are likely to be stocked at small local stores. Simple is certainly preferable if you decide to dragoon novices into cooking duties, but, fortunately, much variety can be achieved with Hamburger, Tuna, or Canned Chicken Helper, and many canned meals need only be mixed and heated.

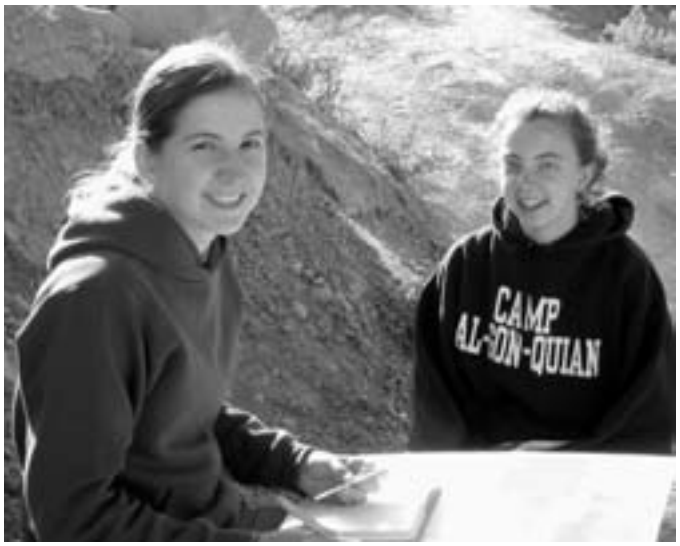
Organize lunch at breakfast

We made students responsible for preparing their own breakfast and eating it by a set time so that the day's clean-up crew could pack away all food items and do dishes. Students prepared lunch sandwiches at breakfast, supplemented with canned fruit, cookies, and chips packed into a communal lunch cooler. All students met at a single spot for lunch each day. This provided an opportunity to check in with each student, review progress, answer questions, replenish water supplies, and plan the afternoon's activities.

Be aware of, and minimize, alcohol

We consider a culture that equates fieldwork with prodigious evening beer consumption to be anachronistic, counterproductive, unprofessional, and, frankly, irresponsible. Even when we set aside a preachy statement of principles to consider the matter from a more practical viewpoint, alcohol can lead to a variety of logistical headaches we would much rather avoid. These range from minor but real inconveniences, such as disturbing the sleep of other crew members or neighbors, through progressively more vexing issues, such as how to clean a soiled sleeping bag or tent or having "beverage fatigue" impact research productivity, to truly serious situations that may involve legal intervention (e.g., one of our counseling centers notes alcohol as a factor in all but one of the campus sexual assault cases reported over the last 10 years).

Cody Holbrook, Maureen Yonovitz, Emily Swor, and Carrie Thomason (left to right) pedestaling out *Camarasaurus* bones.



Jennifer Murphy (left) and Erica Clites documenting sandstone features in the field.

We let our students know our expectations concerning alcohol use along with other research expectations in a Research Agreement that each one signs in order to be accepted into the program. We model those expectations in camp and minimize the role of alcohol as a part of camp life. We are assisted in this by Hope College policies, which prohibit alcohol on campus grounds and, more to the point, in campus vehicles. However, we try to put ourselves in a position to monitor the situation, providing an outlet for those students who want to drink on a special occasion rather than creating a situation where we might have students in our charge sneaking off to drink elsewhere. That is, we don't prohibit alcohol in camp for those willing to walk a mile to the nearest store and carry it back with them.

Take safety seriously

Much as our lawyers might cringe when we say it, safety is not the primary consideration in fieldwork (or for that matter in lab work or any other exploration of the unknown). If safety were the primary consideration, we would not venture to the field (or lab) in the first place. This isn't to say that one should disregard safety; rather, it's an acknowledgement that fieldwork is inherently hazardous (for examples, see Bentley, 2004). In remote locations the hazards can be compounded by factors such as weather, unfriendly biota, distance to emergency facilities, and limited communications. These create a working environment with a smaller margin for error than participants might expect under normal circumstances, and a less comprehensive safety infrastructure can magnify problems

that elsewhere would cause only moderate concern. Thus, we impress on our students that safety has to be an ever-present, overarching consideration as we go about the inherently hazardous task of fieldwork. Anyone planning a field project would do well to read *Planning for Field Safety* (American Geological Institute, 1992) for an extensive review of safety considerations.

The unfamiliar environment that surrounds students as they conduct their fieldwork may contribute to a heightened awareness of safety as they go about their research activities, but it may mask the fact that their greatest risk comes from an activity they will likely consider mundane – vehicular travel to and from the field site. We put special emphasis on travel safety by requiring passenger van driving checks, charging the co-pilot with maintaining driver alertness, and, if warranted, instructing students in off road driving skills.

Positives of multi-campus student collaborations

Institutions naturally have an interest in providing opportunities for their currently enrolled students. However, we have found many positives in accepting off-campus students, aside from fulfilling the expectations of the agency funding our project. Having an application process that involved writing a research statement, sending transcripts, and arranging for a letter of recommendation meant that, unlike the typical set of students one might find populating a course during the school year, participants in our program were self-selecting for motivation. They were also very enthusiastic, and viewed participation as a privilege since they knew they had competed with other applicants for a research spot. The letters of recommendation also could give us some insight into applicants' abilities to work with others. Compared with other field experiences involving students from a single school, having students who did not previously know each other appears to have had a positive effect on morale since they came to the program without a prior history that could generate interpersonal flare-ups; our field season, therefore, benefited from a honeymoon period of a week or so when everyone got along particularly well. Even after the first week, morale was better than we have experienced during long class field trips. We managed expectations by telling students up front that we expected to work six days a week, with the potential to substitute a day off and trip to town for a workday if weather dictated. We also ensured that students had the option to explore the region on their day off by arranging trips into the mountains or to town, as well as planning a larger sightseeing and regional geology field trip toward the end of the research time.

Elisa Ramirez (left) and Sara Kubarek expose a jumble of *Camarasaurus* vertebrae embedded in hard sandstone.

Maureen Yonovitz (left) and Eric Baar experiencing the glamour and excitement of fieldwork.

In cases where institutional realities dictate that you include students only from your own school, some of the benefits we attribute to selecting off-campus students might be simulated by a competitive application process that allows you to vet the participants, or by projects that involve widely separated departments on campus.

Results

Time in the field is time that cannot be spent in the lab or in the office writing up results. In anticipation that the 10 weeks of summer research would not allow enough time for students to complete a project with both a field and a lab

component, we planned for students to present their results at a meeting during the following school year, either at a regional or national meeting of the Geological Society of America or at Hope College's annual Celebration of Undergraduate Research and Creative Performance. We included partial funding for student travel in our REU, and supplemented this with a commitment from Hope College's Dean of Natural Sciences to fund Hope students' travel. Furthermore, we encouraged all off-campus students to seek travel funds from their own institutions and to apply for professional society travel grants. During our return travel from the field, all students collaborated in writing an abstract about our project for the Geological Society of America Annual Meeting (Demko et al., 2004). Eight of the 10 students attended the meeting and observed first hand what made successful (and unsuccessful) research posters. We then consulted with students by e-mail as they wrote their own research abstracts and prepared poster text. This approach extends student work on the project beyond the summer research experience, potentially serving as a basis for undergraduate theses or independent research at the student's home institution; but, it means that students may not get to see all of their peers' final results if not all students can attend the same meeting.

Although we began this discussion by introducing multidisciplinary field studies as a way to increase research productivity in the face of logistical challenges, we think the multidisciplinary approach also has clear benefits in terms of scholarship. Having faculty with complementary skills provides a richer background of expertise for students to draw from for their individual projects and gives them a greater context for interpreting the importance of their own results. Moreover, our multifaceted approach to exploring our research site should ultimately yield a more comprehensive analysis of the site and a richer understanding of its ancient environments and history.

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