ECO 101

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An Early-Career Scientist's Guide to Delving Into Data Synthesis

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This is a summary of a 1 November 2012 discussion in the Biodiversity Research Centre at the University of British Columbia. As early-career ecologists and evolutionary biologists, we provide our perspective on how other young researchers can embark on collaborative science.

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Collaboration and synthesis have become essential parts of research in the fields of ecology and evolution. Some of the most exciting and high-impact research currently being published is coming from working groups, meta analyses and shared data synthesis activities (Carpenter et al. 2009, Hampton and Parker 2011, Cadotte et al. 2012). If you are an early-career scientist, this type of collaboration will expand your research network, hopefully advance your career, and gives you the opportunity to do really "cool" science! But getting involved in successful synthesis projects takes some legwork.

Definitions of two commonly used terms in collaborative research

Working group.—A group working together to study a particular question, and in science, a form of collaborative research. Often refers to a face-to-face group of fewer than ~20 participants who meet for a period of a few days to a couple of weeks. We used a "mini" working group to develop and publish this blog post.

Data synthesis.—A method of scientific research that combines data from multiple sources to find a new or emerging answer that wouldn't be apparent by examining a single study alone (Hampton and Parker 2011). Data synthesis can be the analysis of raw, summarized data, previously published results, or an integration of results from many different types of studies (e.g., combining observation and experimentation). It is sometimes contrasted with meta-analysis, or the analysis of the analysis, which is the statistical synthesis of the results of separate studies (Gurevitch et al. 2001), and is not

necessarily conducted with raw data.

Synthesis sounds so great, but how do you get started? There are three basic ways:

1) **Work with others who do collaborative research**. Folks who are actively involved in collaborative research can provide great mentorship and can help you establish your own synthesis project.

2) **Form a research network of your own**. Connect with other researchers who are asking similar questions and collecting similar data to you. Research networks can begin through e-mail, social media, or an informal gathering at a meeting, and can lead to more established collaborations over time.

3) **Prepare for future collaboration**. You never know when a synthesis opportunity might present itself, so develop your own skills and be keen and ready for future collaborative research.

These sound like easy undertakings, but they are difficult to put into practice. For instance, you could come up with an idea, form a Facebook group with students and one or two prestigious professors, plan to collect data from a series of papers, and there you have it; your working group is formed, moving forward, and you could be on your way to a paper in *Nature* or *Science*. The problem is that collaborations often dissolve early on, stalled on the road of good intentions.

Golden rules of working group success

How do you prevent your working group from becoming a flop? As early-career scientists, we have some ideas and insights garnered from our own experiences participating in and leading working groups. Here are our simple rules to success.

Rule 1: Success depends on leadership

Successful collaborative science is a balance of group work and individually driven leadership. Leadership can come at different levels, with more established researchers often leading the working group or initiating the project, and an early-career researcher conducting the analyses and writing up the project. That being said, early-career researchers are well positioned to participate in and lead working groups and data syntheses, and the postdoctoral stage can be the ideal time to take on a leadership role. Postdocs have the skills and expertise to carry out the work and can devote more time to coordination, database management, analysis, and writing. However, synthesis projects can take years to establish, so you may need to start thinking about your synthesis project early. If you are thinking of doing a synthesis project for your postdoc, you may need to start organizing your collaboration during your Ph.D.

Rule 2: Think outside the box

NCEAS (http://www.nceas.ucsb.edu/), NESCent (http://www.nescent.org/), NIMBioS (http://www.nimbios.org/), SESYNC (http://www.sesync.org/), iDiv (http://www.idiv-biodiversity.de/), and other

synthesis centers provide the resources, facilities, and opportunities for highly successful collaborative research. Postdocs based at these institutions have gone on to have great success in their academic careers (Hampton and Parker 2011). However, successful synthesis can also be run without this institutional support. Workshop funding provided by research networks or regional thematic centers can be great sources of funding: EU (http://www.cost.eu/participate/open_call); Quebec (http://qcbs.ca/resources/research-funding/working-groups/); Arctic (http://www.iasc.info/home/groups/working-groups). Remember that as a group you don't all necessarily need to be based in the funding jurisdiction to be able to apply for the funding, but you may need to schedule the face-to-face meetings in the funding jurisdiction. Be creative when looking for sources of funding, begin collaborations remotely, and tie working group meetings with conferences to minimize the need for travel funding. And remember that some collaborative efforts can be conducted without any funding at all.

Rule 3: Establish trust

Issues of authorship, data ownership, and intellectual property can arise in collaborative projects, and any issues of this sort can have greater effects on the junior members of the group. As early-career scientists, we want to avoid being in a situation where we are doing the lion's share of the work, but not receiving the corresponding credit, the role of "the post-doctoral Sherpa." To prevent conflict, you want to establish the best possible practices for collaboration early on. One approach is to define specific tasks and time lines for each group member, so that not all the workload is lumped onto one person, and each person knows what they are expected to contribute. These guidelines should be refined and revisited as the project progresses. Some collaborations will be short-lived, others longer, but the contacts and networks that you build could last throughout your career; even if this working group flops, it is essential to establish positive working relationships.

Rule 4: Seek the skillz

Data synthesis provides an opportunity for large-scale, novel, and innovative research that has the potential to greatly advance our fields of research. It also allows you to develop skills and access data beyond what is available to you as an individual scientist (Carpenter et al. 2009), such as how to frame synthetic questions, work with large data sets (programming, database management, statistical analyses, GIS) and collaborate as a part of a team. You can begin by learning the best practices for open science (Wolkovich et al. 2012), including publicly cataloging your own data, code, and methods so that your data are freely available and ready to go when a potential synthesis opportunity arises.

Rule 5: Open science is the future

We believe that collaboration, data sharing, and open science are the way of the future (Wolkovich et al. 2012); as an early-career scientist, it is best to get on board sooner rather than later. Learning the process and procedures of transparent science and data sharing is important. It's often difficult to hand over hard-earned data, but trusting your collaborators enough to take those risks can provide untold success. When establishing a data synthesis, agreeing upon a data management plan is essential for establishing this trust, attracting data contributions, and securing funding. Many funding sources for syntheses promote or require public data sharing at the end of the proposed collaboration, so this is

something that should be incorporated into the time lines and work plan from the get go. Putting your data and code online will provide future opportunities and potentially stimulate future collaborations. For most of us, this data doesn't belong to us anyway, but rather to the public that has funded our research.

Rule 6: Be strategic

Academia is competitive by its very nature. With intense competition for postdoctoral fellowships and faculty positions (Bergman 2012), an early-career scientist needs something to make them stand out from the crowd. Based on ecology and evolution faculty interviews in 2012–2013 at major Canadian universities, committees are looking for ~10–20 publications from applicants who are 1–5 years out of their Ph.D., publication rates of three or more papers per year, candidates with a cohesive research program and ambitious, yet achievable, future goals. Carrying out synthetic and collaborative research can help to set you apart from the pack and can give you a broader outlook on your current research focus. However, some ideas are cheap, and time is always expensive, so try your best to limit your involvement to projects that are really interesting to you and that are going to result in papers and products, and not those that might be major time sinks with little career gains.

Rule 7: Don't force it

You can't create a data synthesis unless there is a topic ripe for synthesizing, and even with the great idea in place, your project may not take off for other reasons, such as data availability, commitment of participants, or time to do the work. If your synthesis efforts are not leading to a scientifically useful product, don't force it; shelve that idea and get ready for the next synthesis opportunity to arise.

Key steps to success

So now that you know the basic rules of a working group, how do you put them into practice? We all know that reading a textbook and actually doing science are not the same. Here is our annotated list of the steps we needed to get started on collaborative research. Keep in mind that these steps can occur in different orders: sometimes the funding comes before all the participants are chosen, or the plan of attack is developed during the first working group meeting.

1) Develop the idea. Start by reading and pondering hard and coming up with a great idea. Then talk through your idea with your friends and colleagues, first in small groups, than at a discussion group in your institution, and/or finally in conference breakout groups. Vet your idea, articulate it in a semi-formal setting, gauge reactions, and build support. Getting input and criticism early on while forming a small team of supporters for your synthesis endeavor prior to its launch will promote its success.

2) Beta development. Read the literature, talk to the experts, figure out if your idea has been tested before (or is currently being addressed) and whether the data needed actually exists, and perhaps run a preliminary analysis to see if the idea holds water.

3) Develop your plan of attack. Figure out exactly what data contributions you need, what

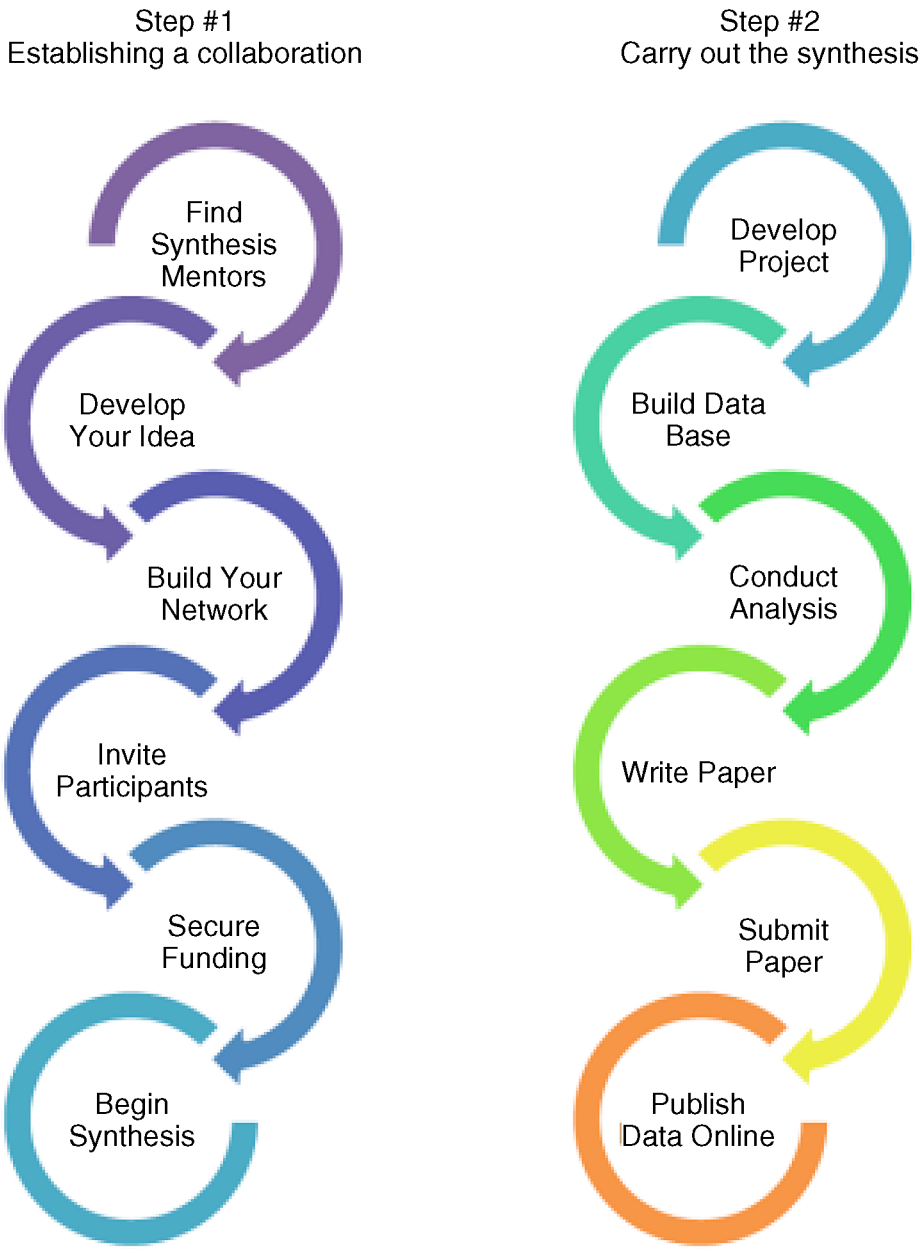

Fig. 1. Steps to establishing and carrying out a collaborative synthesis project.

collaborators you need to bring on board, and what specific steps need to occur to make your synthesis project happen.

4) The invitation e-mail. Since scientists are often reticent to take on new commitments, the first invitation e-mail is key to getting support for your idea and establishing trust. Make this formal invitation a good one, with an interesting question, clear objectives, potential contributions from the group, a sound scientific approach, and the products and outcomes clearly laid out. The group can alter this initial outline later, but be sure to give participants enough information to let them decide whether they want to contribute their valuable time. Think carefully about whom you invite to participate and what specific skill sets each participant will bring to the table. Each potential participant should have something unique and important to contribute.

5) Securing funding. Not all collaborations need large amounts of (or sometimes any) funding, but funding is often a prerequisite for successful collaborative research to get off the ground. This funding can take the form of a salary for a postdoctoral researcher leading the synthesis, working group funding to meet, design the project and synthesize the results, or simply travel funding for some or all individuals to attend working group meetings. Scientific collaborations usually progress while funding is in place, although friendships with your collaborators will last a lifetime.

6) The initial meeting. In a world of social media, conference calls, teleconferencing, and webinars, collaboration can be conducted remotely. However, face-to-face interaction is very hard to replace, particularly at the brainstorming stage. We are still human, and the process of establishing trust and group cohesion cannot be understated. Meet in a place that is friendly and welcoming, and will be memorable for the group. Establishing the meeting at the Airport hotel on the corner of Interstate 1 and Freeway 99 is not likely to be stimulating for a group of natural scientists. Also, spend time on developing positive group dynamics. A leisurely morning lunch or another type of meet-and-greet interaction can let people chat and get to know each other a little, and starting at a slower pace where everyone gets a chance to bring their ideas and perspective to the group can go a long way toward keeping the group together and producing a great product. Make sure that everyone feels a part of the group and that they feel they have something to add and gain. In the later stages of a working group, you will have ample opportunity to use social media, conferences calls, and teleconferencing.

7) Keeping things going. Make meeting agendas and goals, take detailed meeting minutes, and send regular updates to the group between meetings. Regular contact can go a long way to keeping a working or synthesis group alive. Meeting agendas should be planned and edited by the group up to two weeks previously, and agendas summarizing tasks achieved, contributions made, and future goals should be sent out after all working group meetings.

8) Building the database, writing up and submitting papers. Some aspects of collaborative research need to be spearheaded by the group leaders. You might feel like the "the post-doctoral Sherpa," but that same feeling might be the weight of leadership falling on your shoulders. In our experience it takes one or two committed individuals working together to assemble the initial database or a

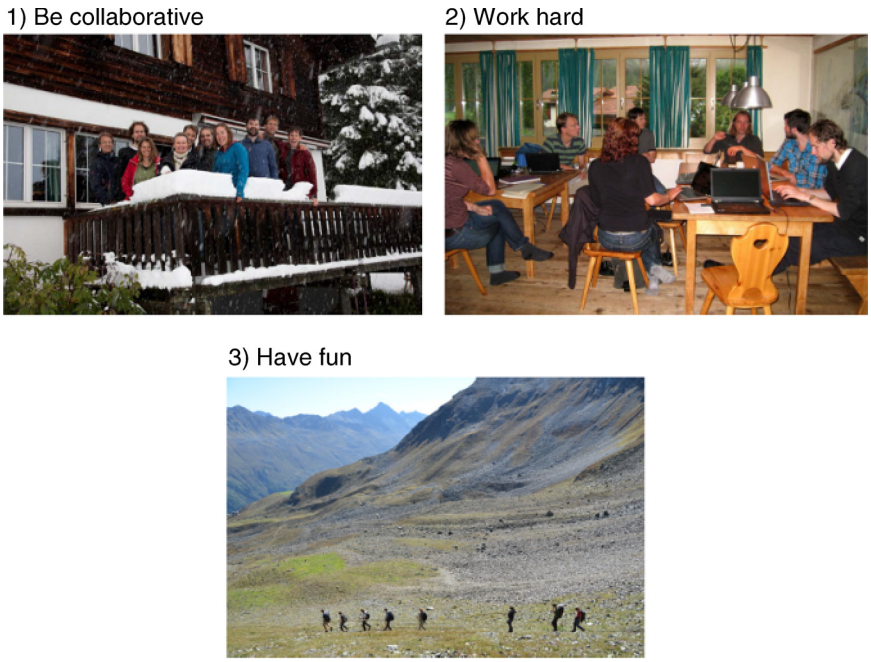

Fig. 2. Illustrating the "be collaborative, work hard, and have fun" components to the Shrub Ring synthesis working group in Davos, Switzerland in 2011.

first copy of the manuscript. Then these working products can be shared and edited with other group members. It also takes at least one dedicated person to compile and edit the drafts, and then work with a publisher on the final pieces. This often occurs long after the interest of most or all the working group members has subsided.

9) Follow through. Keep to timelines, send updates, share products as they are finished, and don't dither at the publication stage. Prioritizing and planning for follow-through will help to keep momentum going and promote successful synthesis!

Here are a few of the questions that we suggest you consider if you are interested in initiating a data synthesis.

Synthesis queries

1. What is the research question and what data are required? (meta-analysis, data contributions, etc.)

2. Who will be involved, how will participation be solicited, and who will lead the endeavor?

3. How will authorship, data ownership, and publication of papers/databases be managed?

4. What are the work plans and timeline, who will do what, and what will be the final products? (papers, databases, web sites, research networks, etc.)

5. Who will fund any working group meetings, salaries, publication costs, etc.?

You don't need to have all the answers to each of these questions before you decide to participate in or initiate a synthesis project, but asking and re-assessing these questions during the entire working groups process will really help you build and maintain effective collaborations while avoiding some of the time-sink black holes.

The bottom line

Collaborative research and data synthesis can provide truly inspiring scientific experiences and can lead to very high-impact products. There is a lot for an early-career researcher to gain by getting involved or even taking the helm of a newly launched synthesis project. There are some tricks to the trade, but by following some of the rules listed here and making the most of your mentorship networks, you too can delve into this growing domain of ecological research. Remember, for successful synthesis: be collaborative, work hard, and have fun!

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