

A practical guide for successful research expeditions at sea

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Introduction

One of the first large-scale oceanographic expeditions was aboard the *HMS Challenger* in the 1870s, lasting a heroic 1000 days and leading to major discoveries like The Mariana Trench (Bishop et al., 2003). Today, ocean expeditions continue to push the boundaries of scientific discovery and innovation, with hundreds of research vessels departing from ports all over the world to explore every corner of the sea (CSIROscope, 2015; POGO, 2022). Such expeditions can last days to months and can perform a wide array of measurements and experiments.

Sea-going research typically requires a collaborative effort by scientists, academic institutions, and ships' management teams, among others. Scientists initiate and/or join these expeditions, and participants vary from researchers with years of sea-going experience to inexperienced, early-career researchers and trainees. Expedition leaders (e.g., principal investigators and chief scientists) usually assume broader roles like securing funding, booking ship time, and coordinating routes and scientific programs. Together with other experienced scientists, expedition leaders also play a key role in mentoring and assisting newcomers in various activities such as packing equipment, troubleshooting, and conducting the science work onboard. However, even with ample support, stepping onto a research vessel for the first time can be intimidating, overwhelming, and downright confusing. These pressures can make it challenging for inexperienced participants to adjust to life at sea and to achieve their goals.

While others have discussed relevant topics such as planning field work in remote locations (Daniels and Lavalley, 2014) and provided some tips about going to sea (WHOI, 2022), a single collection of advice specific to inexperienced sea-going oceanographers is missing. As a heterogenous group of ocean scientists with diverse expedition experiences, we aim to provide newcomers with a practical guide to be used in the preparation for, and execution of, an expedition at sea. What follows is a set of general considerations, ordered by the potential timeline of events leading to the completion of an oceanographic research expedition lasting several weeks to months.

I. Before the Expedition

"At sea, I learned how little a person needs, not how much."

Robin Lee Graham, American Sailor

Oceanographic expeditions bring together international groups of people of varying ages, genders, and diverse cultural and scientific backgrounds. It is the responsibility of every participant to contribute to an inclusive, safe, and respectful atmosphere at every stage of an expedition, including the early planning phase (see Amon et al., 2022 for insightful discussion). As a newcomer, you should feel encouraged to ask questions freely, and request guidance and additional help as needed. Attending planning meetings will be essential for you learn about logistics like location (including port stops and cruise path) and timing, the type of vessel involved, and where your research fits within the broader aims of the expedition. A good understanding of these details is crucial for personal and science preparations.

Personal preparation – What you need to be comfortable at sea will be unique to you, but there are a few general considerations. Think about what your wellbeing requires, and how you can accommodate this without overpacking (Table 1). Ahead of time, get in touch with fellow participants and the science lead / your supervisor to ask questions. These might range from travel arrangements and dietary requirements to gender-specific and cultural concerns. Experienced teammates will also be happy to help, so try to find one or more people whom you feel comfortable approaching.

When packing apparel, consider the work environment and weather conditions you will encounter while on board – If you will be spending time in a temperature-controlled cold room, you might need some extra layers; if you will be cruising through Caribbean, a pair of sunshades will be useful. Salt and ships are not kind to fabrics, so durable and comfortable materials are ideal. Inquire about onboard laundry facilities as these will help reduce the amount of clothes you need to pack. Additionally, be cognisant of the expedition's duration when packing personal items; two weeks without nail clippers might be fine, but two months will get uncomfortable. You might also want ear plugs and a sleep mask if you are a light sleeper, and especially if you are next to the engine room or sharing a cabin. Bring enough personal medication (including

seasickness remedies) and toiletries for the trip and find out if you can purchase merchandize and other items from an onboard canteen – you should consider carrying some cash in the currency accepted on the ship.

It is also important to think about what you might need to de-stress and stay entertained during your down time. Larger ships typically have a gym, movies, and books. Internet access can be slow and limited however, so pre-download any music, podcasts, or shows you would like to access. For additional personal entertainment, pack something small and durable – a book, diary and camera will go a long way. Lastly, never underestimate the power of a candy bar after a few weeks at sea.

Table 1. List of generally useful personal and science-related items to consider while packing. We have also added this list to a shared document that any scientist may contribute to. Which additional items do YOU consider to be useful at sea? shorturl.at/KMOUX

Personal Items	Science Items
1. Personal medication, sea sickness pills	1. Strong tape – e.g. duct tape, masking tape
2. Printed copies of paperwork	2. Cable ties and straps
3. A hobby: book, diary, camera, music	3. Plug/power adapters if necessary
4. Cash of the currency used on vessel	4. Tools specific to your equipment
5. Leak /shatter proof thermos or mug	5. Absorbent cloths and anti-slip mats
6. Clothes for every occasion – e.g. foul weather gear, exercise clothes etc. *	6. Notebooks – waterproof recommended
7. Toiletries – e.g. tooth brush, nail clippers, shower shoes, ear-plugs, deodorant, shampoo, moisturizer **	7. Scissors / pocketknife / multi-tool
8. Wireless speaker	8. Permanent makers / pens / pencils
9. Comfort food / snacks (chocolate, candy)	9. Various sized bags and containers

* Some expeditions might have formal dinners or themed parties.

** Bedding and towels are usually provided. Inquire about what other toiletries are provided.

Packing for science – Equipment preparation and a packing list are vital to any oceanographic expedition. Start by evaluating your methodologies and carefully list every piece of equipment you will need, including appropriate personal protective equipment (PPE; inquire about what PPE is onboard, and what you need to provide), and other generally useful items (Table 1). When acquiring supplies, be mindful of delivery timelines, vessel compatibility (e.g., voltage and electrical socket type), and if you plan to use chemicals, what special considerations are needed. It is advisable to start acquiring, preparing, and packing equipment well in advance, as this step can be subject to delays out of your control. If you plan to collect samples, calculate the number of vials (or filters, bags, etc.) you will need, and add ~30% for spares. Bringing spares of sample vials and certain equipment can save your expedition in case of malfunctions and mistakes, and can facilitate opportunistic sampling. However, be careful to not overpack and consider sharing equipment and supplies with other groups if logistically feasible.

Keep an updated and comprehensive packing list as you prepare your equipment. This should include information that aids in packing and unpacking, as well as any details required for shipping and customs paperwork: the description, serial number, quantity, and status (e.g., packed, on-order) of each item, and the dimensions and weights of packing boxes, among other information. When possible, use durable, weather-proof containers for packing. See Table 2 for packing list example.

Table 2 – Example of a packing list of two boxes containing items with hypothetical information. It is advisable to consult with a customs broker and/or a shipping agent to determine what information is required for shipping.

	Item	Quantity	Unit Cost (CAD \$)	Brand and Serial #	Status
Box #1; Blue, 12 kg L: 54 cm, W: 39 cm, H: 31.5 cm	- Pump	1	500	PumPs; XYZ123	In-prep
	- Electric adapter	4	20	BestElec; QWE1	On-order
	- Filter	400	400	FilerZ; ABC	Packed
Box #2; Black, 20 kg L: 70 cm, W: 40 cm, H: 50 cm	- Adjustable straps	5	75	Strapz; ULI22X	Packed
	- Foul weather pants	1	66	BestGear; VIA400	Packed
	- 2mL vial	400	200	BestVial; HJJ488	On-order
	- Multi-colour tape	6	18	N/A	Will pack

Planning the science – Developing your research plan should be a collaborative effort between you, your supervisor, and other scientists. Consider if your question(s) can be answered using the available resources and in the timeframe of the expedition, and remember that the biological, chemical, and physical properties of the ocean change regularly. As such, be sure to familiarise yourself with the regions you will visit and be ready to adjust your research plans accordingly.

Onboard coordination will be essential, as oceanographic expeditions can be filled with different research activities from various projects. Communicate your needs to the chief scientist well in advance, and address your plans, requirements, and concerns during pre-expedition meetings. If you need seawater, make sure that the chief scientist is aware of your water budget (how much, what depths, which locations). Similarly, the time for instrument deployment at a station is typically limited and predetermined, so make sure that the chief scientist is aware of your needs to ensure that instrument use fits into the overall station plans. You should also inquire about what facilities are available onboard (e.g., fume hood, ultra-pure water, temperature-controlled space etc.), and be aware that they might be different than those in your home laboratory. Further, ship movement and limited space can inhibit your ability to work, so be sure to design robust experiments that can be carried out safely and properly under difficult conditions. If collecting samples, devise a consistent labelling and organization strategy, but avoid ‘pre-labelling’ too far in advance, as oceanographic expeditions can be highly dynamic. Bring plenty of appropriate adhesive labels and markers, and consider the conditions at which you will handle and store your samples.

Paperwork – While you should not be expected to deal with high-level bureaucracy as a newcomer, you may still be required to complete some amount of paperwork. Be cognizant of the additional time and effort this may require. Some common administrative work you may encounter includes finding out if you require visas – and what type – during your travels. If needed, apply for visas well in advance, as some may take several months to acquire. If you will be crossing international borders, ensure that your passport will be valid after the planned return date, and that you can legally enter your final return destination (e.g., ensure your study/work permit remains valid if applicable). Be sure to complete any necessary medical exams, training

courses and certifications, and be prepared to handle some additional paperwork such as customs and shipping forms.

Preparing for oceanographic expeditions can incur considerable expenses such as plane tickets, hotels, and visa costs. These should be covered by research funding, often administrated by a supervisor / chief scientist. It is becoming less common for participants to pay using personal funds and retroactively claim expenses, as this represents an inequitable burden. Nevertheless, be sure to have an open discussion about finances with your supervisor so they can help clarify costs and avoid you paying out of pocket.

II. During the Expedition

“First you need to worry about proper nutrition, rest, and hygiene. Then, you can worry about the science.”

RV Pelagia Captain, MetalGate2021 Expedition

You have done all the appropriate preparations and you find yourself standing in front of a research vessel. Now what? When you first get on board, follow the ship’s guidelines for onboarding: this often involves checking in with the chief scientist and first mate/captain, as it is their responsibility to oversee all aspects of the expedition. Acquaint yourself with other scientists, crew, mealtimes, and internet access. Shortly after everyone is settled, there will typically be a familiarization tour of the facilities (laundry, mess, laboratories, muster stations etc.), and an emergency drill will usually be held at the beginning of the expedition. If you have not done so before the expedition, we recommend that you find an approachable point of contact for awkward questions, and for safeguarding issues and serious complaints. There will usually be a designated person(s) for this, so be aware of who they are, and whether you may prefer to speak to someone else if the need arises. While anti-bullying and harassment training is becoming more common, this unfortunately does not guarantee that it will not happen on the vessel (Nash et al., 2019). If you experience or witness anything that makes you uncomfortable or worried, speak up immediately if you feel safe doing so, or talk to your point of contact as soon as you can.

Personal – Conducting science at sea can be cold, dirty, and physically and mentally demanding. Feeling seasick, grumpy, lonely, and tired are all common and nothing to be ashamed of. Be sure to recognise these feelings and practice self-care, and care for others. You will also likely have to work closely with people you do not know well, and who have different opinions and backgrounds. It is therefore important to be a team player and to be respectful of others. Ask permission before borrowing equipment or personal items and be careful not to disturb others who are trying to sleep or work. Be considerate of others, help where needed, avoid gossiping, and boost the morale as much as possible. Be considerate of the ship’s crew, as they experience their own set of stressors and challenges. At sea, the lines between working and living with others can become blurry, and making people feel comfortable will contribute to a supportive and happy team throughout the expedition.

Science – Use the time before you reach your first station to unpack and prepare. Set-up, secure (sea-proof) and test your equipment and workflow. Get acquainted with the scientific program and your shift times for the coming days, and remember to seek the advice and help of the crew and/or other scientists when needed.

The first few station deployments will test your equipment and procedures. Expect the operations to be bumpy and adjust your methods accordingly. After some practice however, you will get into a routine where sampling and data collection become more streamlined. Be sure to stay organized to sustain this routine. Label and store your samples in a meaningful manner, take detailed notes and keep a sample and station log. Be sure to also store and back-up any data you collect while on board. Nevertheless, unforeseen circumstances like bad weather and equipment malfunction are the norm, and may cause postponement or cancellation of some deployments. Be flexible and do the best you can with the resources and timelines available. Lastly, remember that good science is safe science. Be sure to follow ship’s safety guidelines and speak up if you have any safety concerns.

III. After the Expedition

Good preparation and organization before and during the expedition (see previous sections) will help you wrap up the work you did on board. Budget time for disassembly, repacking and shipping your equipment and samples. This may involve shipping and customs paperwork, as well as time for cleaning your onboard work and living spaces. You will also likely be expected to contribute to a report that is due before you depart the ship. Shortly after returning home, we advise you to revise your notes and sample logs, and inspect your samples/data while the expedition is still fresh in your mind. This will help you spot mistakes and inconsistencies that may become more difficult to rectify later.

Take time to reflect and debrief with fellow teammates. Note what did and did not go well, and what can be done to improve future expeditions. Lastly, it is our responsibility as scientists to share our work and should strive towards eliminating barriers in sea-going research. We therefore encourage you to share your experiences with fellow scientists and the community around you through outreach (e.g., blogs, presentations) and open-access publications and data sharing.

Conclusion

Sea-going research can provide invaluable experiences and often leads to exciting discoveries, collaborations, and new friendships. However, it comes with a set of challenges that are especially difficult to navigate without previous experience. In this article, we draw from our own experiences to outline general considerations for planning and executing oceanographic research expeditions. In doing this, we hope to give new ocean-going scientists some insight and the confidence to make the most of out of their expeditions.

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