

ALL ABOARD!

PROVIDING SHIPBOARD TECHNICAL SKILLS WHILE BUILDING CAPACITY IN OCEAN OBSERVATIONS

By Lilian A. Krug, Fiona Beckman, Andrew P. Rees, Angelika Dummermuth, Cassandre Stygiest, Eva-Maria Brodte, Karen H. Wiltshire, Peter Croot, and Sophie Seeyave

ABSTRACT. Shipboard training equips early career ocean professionals (ECOPs) with the skills, knowledge, and confidence to tackle the challenges of marine research. Such training helps develop a workforce essential for implementing a truly global ocean observation system and advancing understanding of the ocean and its sustainable use. Working with other organizations and individuals, the Partnership for Observation of the Global Ocean (POGO) offers opportunities to ECOPs, mainly from developing countries, to join research cruises and acquire hands-on experience with real-world oceanographic work. These learning experiences can be organized either as one-on-one training on research cruises with spare berths or collective training on dedicated expeditions designed for larger groups of international students. This article introduces POGO's shipboard training program by presenting examples from each of the modalities, and it explores the program's long-term impacts and future directions.

THE POGO SHIPBOARD TRAINING PROGRAM

Observing the ocean is critical not only for understanding its natural cycles but also for monitoring the impacts of human activities, predicting changes, and providing evidence to support management strategies that protect and restore marine ecosystems and resources (GOOS Strategy, 2019). Nonetheless, opportunities to observe the ocean are limited by scientific, technological, and financial resources, particularly for those from developing nations (IOC-UNESCO, 2020). The Partnership for Observation of the Global Ocean (POGO, <https://www.pogo-ocean.org/>) is committed to addressing this imbalance by providing training, networking, and technology transfer opportunities for scientists and institutions in developing countries in order to enable development of new self-sustaining ocean science and observational communities (e.g., Krug

et al., 2021). The variety of approaches taken include supporting development of low-cost instruments (e.g., Marcelli et al., 2021), citizen science initiatives (e.g., Catarino et al., 2023), and outreach and advocacy.

As highlighted by the Global Ocean Science Report (IOC-UNESCO, 2020), the greatest need remains in increasing human capacity. Over the last 25 years, POGO has built a capacity development program that focuses on new generations of experts and leaders in ocean science and observations. It includes visits to state-of-the-art laboratories in advanced oceanographic institutions (e.g., Krieger et al., 2025, and Seeyave et al., 2025, both in this issue), regional training adapted to local resources and conditions (Urban and Seeyave, 2021), and training onboard research vessels.

The POGO shipboard training program is primarily aimed at early-career scientists, technicians, postgraduate (PhD

or MSc) students, and postdoctoral fellows who are nationals of and working in developing countries or countries with economies in transition. However, a limited number of opportunities are also available for individuals from developed countries. The program is designed to equip participants with essential at-sea technical skills that should benefit development of their careers. Trainees gain valuable knowledge by working onboard state-of-the-art research vessels with advanced equipment under the guidance of experienced researchers, often collaborating within interdisciplinary teams. Furthermore, the program prepares participants to address real-world challenges encountered in the field by fostering a deeper understanding of the marine environment's complexities. It also cultivates a strong sense of responsibility for ocean protection, encouraging trainees to share their experiences through onboard science communication and outreach activities (see **Box 1**).

The POGO shipboard training program began in 2003, in partnership with the Japan Agency for Marine-Earth Science and Technology (JAMSTEC), with 16 trainees participating in six different legs of the BEAGLE expedition aboard R/V *Mirai*. Five years later, the Atlantic Meridional Transect (AMT) Shipboard Training Fellowship was established in collaboration with Plymouth Marine Laboratory (PML), funded by the Nippon Foundation (NF). In 2015, POGO and

NF supported Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI)'s first floating summer school, known as the North-South Atlantic Training Transect (NoSoAT). From this partnership between POGO, NF,

AWI, and the Strategic Marine Alliance for Research and Training (SMART), the Ocean Training Partnership was established in 2017.

POGO training opportunities onboard research vessels can occur through grants

that support training-dedicated cruises (e.g., NoSoAT) or fellowships for individuals to join research cruises with the option of pre- and/or post-cruise training periods at a host institute (e.g., AMT fellowships). In the latter case, principal

BOX 1. NoSoAT/SoNoAT: A Platform for Public Outreach and Communication

POGO shipboard training programs develop practical skills for ocean observing, academic research, and reporting. However, for scientific work to have the greatest impact, scholars must also communicate their findings to broader audiences beyond specialist fields. The need to engage wider society in ocean matters through citizen science and outreach programs has gained increasing recognition (see Glithero et al., 2024, and references therein).

To equip trainees with the skills and motivation to engage non-experts, recent NoSoAT/SoNoAT expeditions have included dedicated outreach and communications modules (Figure B1). In 2019, SoNoAT engaged with partner schools in the United Kingdom, Germany, Ireland, Brazil, and Japan, providing them with educational materials on ocean observations, including historical and live data for use in lessons. During the cruise, around 200 students interacted directly with onboard trainees and tutors via live video calls, asking questions and tracking the ship's route. Students also participated in a "shrunken cup" experiment that teaches about the effects of ocean pressure. These interactions illustrate the importance of science and knowledge transfer for SoNoAT trainees.

The 2022 NoSoAT partnered with Educational Passages to include "miniboats" in the outreach program. These 1.5 m uncrewed vessels, equipped with satellite transmitters and sensors for air and water surface temperature, were assembled and decorated by schoolchildren in collaboration with our partners in Ireland (University of Galway), Germany (AWI), Spain (Spanish National Research Council, Instituto Español de Oceanografía) and South Africa (South African Environmental Observation Network). Three miniboats were launched from R/V *Polarstern* and one from South Africa's R/V *Algoa* (Department of Forestry, Fisheries and the Environment - Oceans & Coasts Research). Students and the public tracked the boats online (<https://educationalpassages.org/events/pogo/>) while learning to analyze data and predict courses based on wind and ocean currents.

Designed for recovery, refurbishment, and relaunch, the miniboats serve as a modern "message in a bottle." Within five months, all four vessels reached land—two in West Africa and two in South America. Boats landing in Brazil and Guyana were recovered by locals, with potential plans for relaunch. However, the Irish and South African vessels, which landed in remote areas of Côte d'Ivoire, remain unrecovered. Collectively, these first miniboats traveled over 24,000 km in the South Atlantic.

LIVE CALLS WITH SCHOOLS



Brazil, Germany, Ireland, Japan, Spain, South Africa, and UK



ENGAGING ACTIVITIES

Where is Polarstern?



Miniboats



FIGURE B1. Pictures show outreach activities from the SoNoAT (2019) and NoSoAT (2022) cruises. Photo credits: L. Krug, C. Rohleider, T. Mtontsi, E. Brodte, Elburton Primary, Devonport High School for Girls, Woodfield Primary, Colegio Cisneros Alto, and Scoil Bhríde Leacach

investigators (PIs) leading or involved in research cruises can apply to host one or more fellows either for a “Targeted Fellowship” or an “Open Fellowship.”

The Targeted Fellowship involves the PI’s institution requesting support for a known ECOP from a developing country, with the purpose of strengthening existing collaborations among institutions in developed and developing countries. The Open Fellowship, on the other hand, involves the allocation of places via a candidate selection process. In this case, POGO coordinates a call for applications and manages the evaluation process with the host institution to select the successful applicant(s). These calls usually occur three to six months before the cruise begins, allowing time for reviewing a large volume of applications and interviewing short-listed candidates. This timeline also ensures that successful candidates have adequate time to complete the necessary paperwork and pre-cruise training certifications, as required. However, occasionally, a berth becomes available at shorter notice. Therefore, NF-POGO launched the annual Open Call for Shipboard Training Fellowships in 2019. The Open Call application requires a letter of support from the candidate’s supervisor and an application form that collects details about the candidate’s travel availability during the year, qualifications, and specific training interests, including

geographical areas and research topics. When training opportunities arise at short notice, POGO evaluates the Open Call candidates’ suitability for the specific offer.

POGO advertises its shipboard training opportunities through its official website, mailing list, and newsletter, and on social media platforms and the Ocean Training Partnership portal. Announcements are then re-shared by member institutions, academic networks, and the NF-POGO Alumni Network for the Ocean (NANO), reaching a broad audience.

To date, 147 ECOPs (55% female, 45% male, and 1% other) from 43 countries in Africa, Asia, Europe, and Latin America have received training through the POGO shipboard training program (Figure 1; Table 1).

THE NORTH-SOUTH ATLANTIC TRAINING TRANSECT

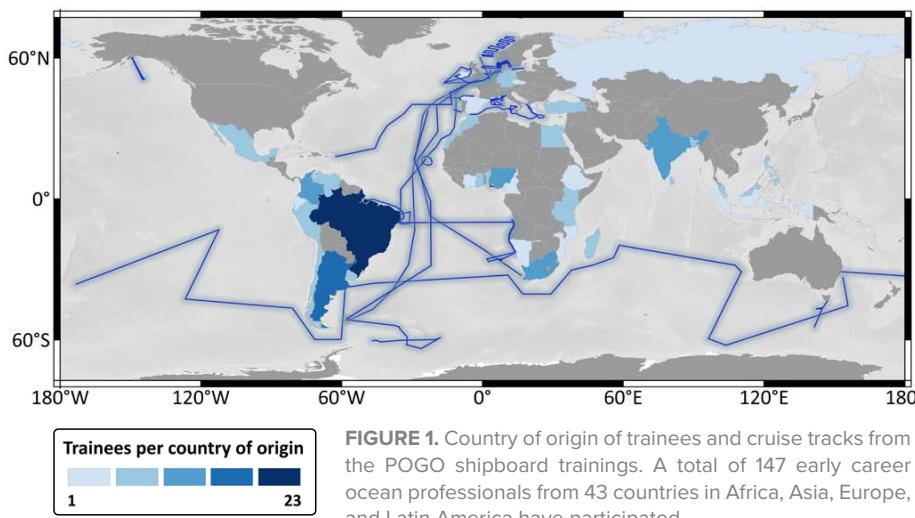
The North-South (South-North) Atlantic Training Transect (NoSoAT/SoNoAT) is hosted on transit expeditions of R/V *Polarstern* (AWI, 2017), while the vessel travels between the ship’s home harbor in Germany and the Southern Hemisphere. There have been four floating summer schools to date (2015, 2016, 2019, and 2022), each typically accommodating 25 to 35 trainees and seven to 10 instructors representing multiple

nationalities (Figure 2). Over the course of one month, trainees engage in an intensive program that combines both practical and theoretical sessions. Vertical cast samplings are performed at stations using various oceanographic devices, alongside en route sampling via the ship’s underway system. Trainees are organized into smaller groups and rotate through various disciplines, including core topics and others that change from year to year. The topics include oceanography, microbiology, climate and atmosphere, ocean and climate governance, remote sensing, bathymetry, art and science, and outreach and science communication. The modules are taught by a diverse team of instructors that includes researchers, professors, and technicians. The program culminates in a final sampling station, led and run entirely by the scholars, as well as presentations of individual short projects conducted by the trainees in parallel with the other activities.

NoSoAT/SoNoAT offers a unique learning environment by combining hands-on experience with interdisciplinary and international exposure. The program promotes the development of independent research skills as well as collaborative work and encourages trainees to bridge the gap between the scientific community and the public. Related outreach and science communication activities have produced content for social media and engaged with school children from various countries (see Box 1 for details).

THE ATLANTIC MERIDIONAL TRANSECT (AMT)

Initiated in 1995, the AMT crosses more than 100° of latitude and a range of ecosystems, from subpolar to the tropical Atlantic Ocean, between the United Kingdom and destinations in the South Atlantic (see Rees et al., 2024). The program provides a platform for multidisciplinary ocean research and international scientific collaboration in a stimulating environment. Since 2008, POGO fellows have joined the cruises to participate in



scientific activities where they gain essential research skills and professional development (Figure 2). In addition, fellows spend periods pre- and post-cruise at the host institution (either PML or the National Oceanography Centre) to help with logistics, complete sea survival training and medical examinations required to board British vessels, and learn to analyze and interpret research results.

Through individual training opportunities such as the AMT program, fellows

receive personalized guidance from a dedicated supervisor before, during, and after their cruises. This gives them a more comprehensive learning and networking experience as they spend periods of study/work at the host institution, collaborate with the research teams, and participate in the institution's daily routine. It is not uncommon for trainees to keep in close contact with their scientific hosts and publish results with them (e.g., Tilstone et al., 2017).

TRAINING IMPACTS AND KNOWLEDGE TRANSFER

Since 2015, POGO has sent out four surveys to former trainees (who completed training at least five years prior) as a means for evaluating the long-term impacts of the fellowships in terms of sustained capacity development. The surveys include questions on background, demographics, and direct or indirect professional and career-related impacts of the training. Responses have been received

TABLE 1. List of shipboard trainings provided by POGO and partners, ordered by total number of participants.

TRAINING/EXPEDITION(S)	PARTNERS	OCEAN BASIN(S)	TRAINNEES	DAYS AT SEA (AVERAGE)	YEAR(S)
North-South and South-North Atlantic Training Transects	AWI, SMART, NF	Atlantic Ocean	54	30	2015, 2016, 2019, 2022
BEAGLE Expedition (legs 1-6)	JAMSTEC	South Pacific, Indian, and Atlantic Oceans	16	29	2003–2004
Tropical Estuary monitoring	UFPA, NF	Marajó Bay, Amazon Basin	14	2	2024
Atlantic Meridional Transect	PML, NOC, NF	Atlantic Ocean	13	42	2008–2014, 2017–2019, 2023–2024
GEOMAR Expeditions (MSM72, M148, M159, M189, PS135/2)	GEOMAR, NF	Atlantic Ocean, Mediterranean Sea	11	29	2018–2019, 2023
Partnerships within IEO (RADMED, Radiales, RADPROF)	IEO, NF	Mediterranean Sea, North Atlantic Ocean	10	19	2018–2023
Gulf of Guinea expedition	NIOMR, NF	Gulf of Guinea	6	3	2020
Partnerships within Eurofleets+ (BITS, HERAS, IENSN and Sines expeditions)	Eurofleets+, DTU-Aqua, CCMAR, IPMA, NF	North Sea, North Atlantic Ocean	6	16	2021–2023
Porcupine Abyssal Plain Observatory	NOC, DTU-Aqua, NF	North Atlantic Ocean	5	21	2013, 2017–2019
Partnerships within @SeaNetwork (Belgica, NORSEAT, and SEAmester expeditions)	@SeaNetwork, UGent, UCT, NF	North Atlantic Ocean, South Atlantic Ocean	4	16	2023–2024
International Nutrient Inter-comparison Voyage	CSIRO, NF	South Pacific Ocean	2	13	2023
GEOTRACES North Atlantic 'FRidge'	PML, NF	North Atlantic Ocean	1	43	2017
Antarctic Deep-Water Rates of Export (ANDREX)	PML, NF	Southern Ocean	1	56	2019
Polar Ocean Ecosystem Time Series – Western Core Box (POETS-WCB)	BAS, NF	Southern Ocean	1	38	2019
Mediterranean Ocean Observing System on Environment (MOOSE)	IFREMER, IRD, CNRS, UPMC, NF	Mediterranean Sea	1	14	2019
Mission Open Sea	IH, NF	North Atlantic Ocean	1	17	2022
Ocean Observatories Initiative	WHOI, NF	North Pacific Ocean	1	19	2024
		Total Trainees	147		

AWI = Alfred Wegener Institute for Polar and Marine Research. BAS = British Antarctic Survey. CCMAR = Centro de Ciências do Mar do Algarve (Portugal).

CNRS = Centre National de la Recherche Scientifique (France). CSIRO = Commonwealth Scientific and Industrial Research Organisation (Australia).

DTU-Aqua = National Institute of Aquatic Resources at the Technical University of Denmark. IEO = Instituto Español de Oceanografía (Spain).

IFREMER = Institut Français de Recherche pour l'Exploitation de la Mer (France). IH = Instituto Hidrográfico (Portugal). IPMA= Portuguese Institute for Sea and Atmosphere.

IRD = Institut de Recherche pour le Développement (France). JAMSTEC = Japan Agency for Marine-Earth Science and Technology. NF = Nippon Foundation.

NIOMR = Nigerian Institute for Oceanography and Marine Research. NOC = National Oceanography Centre (UK). PML = Plymouth Marine Laboratory (UK).

SMART = Strategic Marine Alliance for Research and Training. UCT = University of Cape Town (South Africa). UFPA = Federal University of Pará (Brazil).

UGent = Ghent University (Belgium). UPMC = Sorbonne University Pierre and Marie Curie Campus (France). WHOI = Woods Hole Oceanographic Institution (USA).



FIGURE 2. (left) South-North Atlantic Training Transect (SoNoAT) scholars are gathered with Chief Scientist Karen Wiltshire and teaching team member Peter Lemke onboard R/V *Polarstern* in 2019. (right) POGO fellow Yessica Pacheco with supervisor Marika Takeuchi and PhD student Jack Williams work with a marine snow catcher during the Atlantic Meridional Transect-30 cruise. *Photo credits: F. Beckman and W. Major*

from 38 shipboard trainees, equivalent to 42% of all shipboard training fellows between 2003 and 2019.

The alumni were asked about their positions at the time of training, their current positions, and whether the training has helped them to obtain their current positions. Most respondents (52.6%) were students, and 42% of them had master's degrees at the time of their training. At the time of answering the survey, the respondents were PhD students (19%), postdoctoral fellows (16.7%), lecturers/professors (14.3%), junior/senior researchers (14.3%), or other less represented categories, which included directors or deputy directors (Figure 3).

Trainees were asked about the impacts of the training on their educations and careers, and on their professional positions. Responses indicated that the shipboard training was highly relevant to all aspects, especially enhancing networking and collaboration opportunities and securing more fulfilling and permanent positions. Testimonials frequently confirmed that the training helped them secure PhD positions in their home countries or abroad.

About 85% of survey respondents had the opportunity to share the knowledge acquired during the training by presenting lectures or seminars. Likewise, 74% of them had supervised at least one student and/or colleague since their training.

Three in every four survey respondents stated that they were able to pass their knowledge on to those they supervised. Past trainees were also asked about tangible scientific and outreach outcomes from their training: 47.4% of respondents had published at least one peer-reviewed research article, 52.6% had posted at least one popular science article on social media, and 65.8% had contributed data from their training to databases.

These results indicate the strong potential for knowledge transfer and a “cascade” effect from the training, whereby the benefits reach a broader audience than just the initial trainees. Over the years, students or former students of POGO trainee alumni have received fellowships themselves.

IMPACT AND FUTURE OF POGO'S SHIPBOARD TRAINING PROGRAM

POGO, with its network of over 55 member institutions, and its partners have successfully established an international shipboard training program tailored to meet the specific needs of different trainees and training providers. The program offers a range of opportunities that include both one-on-one focused and multidisciplinary group training, accommodates scholars from undergraduates to postdoctoral fellows, and uses vessels of varying sizes, from small boats in estuarine environments to large transoceanic

icebreakers. This flexibility allows us to work with a multitude of partners in a collaborative endeavor that does not rely heavily on a single institution or ship to provide training. With in-kind contributions from our partners, this form of training can be very cost-effective, requiring only the cost of a return flight in cases where there is no pre- or post-cruise training. In cases where the trainees are recruited from the same or neighboring countries, the training can also be self-funded, as is generally the case with European shipboard training opportunities (e.g., Eurofleets+). Nonetheless, to be truly global and inclusive, this type of training requires dedicated funding, and the Nippon Foundation has been instrumental in providing a large number of fellowships.

The success of the POGO program builds on the following aspects:

- Young oceanographers have the opportunity to work closely with experienced researchers, building professional relationships and fostering collaboration, which is essential for their future careers.
- Trainees gain a deeper understanding of the ocean as an interconnected system and see firsthand how their work contributes to broader environmental and scientific objectives.
- The program is teaching future trainers, and the knowledge is being passed

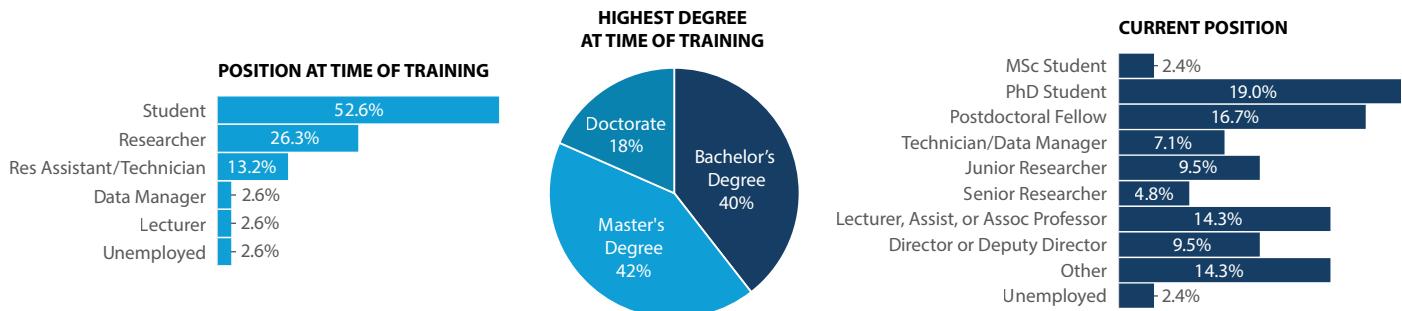


FIGURE 3. Responses to surveys shown here indicate the impacts of POGO shipboard training on past trainees' education and careers and their current positions (n = 38).

on to a broader audience through training, supervision, and mentorship. In the longer term, our objectives are:

- To expand the partnership to offer training in the Pacific and Indian Oceans.
- To diversify our training programs by working with regional and other international groups, such as the new @SeaNetwork.

By continuing and expanding our efforts in providing shipboard training to ECOPs in developing countries, and consistently evaluating the effectiveness of our program, we will further strengthen and distribute ocean observing capacity more globally, contributing to addressing Vision 2030's Challenge 9 (Skills, knowledge and technology for all; Arbic et al., 2024).

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