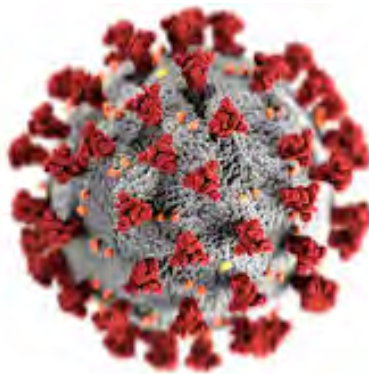




Antarctic COVID-19 Project

Final Report
(11 March 2021)



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1. Executive Summary

In late 2020 (30 September to 21 November), an online survey was distributed to Antarctic researchers as part of an international and interdisciplinary research project (“The impacts of COVID-19 on Antarctica”) led by Dr Daniela Liggett and Dr Andrea Herbert and supported by SCAR¹. The aim of the survey was to determine (1) how the pandemic had affected Antarctic scientists professionally and personally, and (2) what SCAR could do to support the Antarctic research community.

Distributed via some of the key global Antarctic networks (SCAR, COMNAP, APECS, Polarpol and researchers’ personal Antarctica-related networks), the survey was completed in full, or partially, by 406 respondents from all continents, albeit with a strong representation from English-speaking countries (with 37% of respondents originating from the USA, UK, New Zealand or Australia). Efforts to boost non-Western participation by translating the survey into Spanish, Mandarin and Russian did not lead to a significant increase in response rates among Spanish-, Mandarin- or Russian-speaking Antarctic researchers.²

Respondents identified as life scientists (38%), geoscientists (30%), physical scientists (10%), social scientists/humanities scholars (8%), or individuals working in Antarctic management (4%), logistics and operations (3%), or governance (1%)³. Nearly half of respondents identified as early-career researchers (ECRs), which was defined in the survey to include research students or those within five years of finishing their PhD, excluding career breaks. 51% of respondents hold a permanent full-time position.

On average, around a third of participants (32%) reported that the pandemic had a *significant* or *extreme* negative impact on their mental wellbeing, while 23% reported no negative impact, and the rest fall between these two extremes. Despite additional stress arising from governments’ responses to COVID-19, some benefits of travel restrictions and various levels of lockdown/stay-home orders were perceived by our survey respondents. In fact, around half of participants (52%) were able to identify some form of positive impact of the pandemic on their lives. Examples cited included working from home, attending online conferences, or completing online trainings.

The survey results make clear that the impacts of the pandemic are distributed unequally among Antarctic scientists. Studies across disciplines and countries on the impact of COVID-19 on scientists report a disproportionate impact on women, especially those with caregiving responsibilities, and on ECRs. Our survey confirms these trends for Antarctic researchers. Too few participants from countries with developing Antarctic programmes completed the survey to allow for an educated assessment of how these countries’ Antarctic communities have been impacted by the pandemic.⁴

¹ We gratefully acknowledge the generous support received from SCAR, without which this project would not have been possible. In addition, we thank the Antarctic and Southern Ocean Coalition (ASOC), the New Zealand TransAntarctic Association (NZ-TAA) and the University of Canterbury for their support.

² There were 2 Mandarin, 5 Russian, and 24 Spanish-language responses.

³ The category “Other” had 23 responses and was selected by participants who identified themselves as researchers in the fields of benthic ecology, engineering, environmental sciences, geochemistry, oceanography, polar law, science advocacy, tourism, or as a multi- or interdisciplinary researchers in addition to a data manager, two science coordinators and an administrative support staff member.

⁴ We considered this category to include the SCAR Associate Members (numbers in parentheses indicate the number of survey participants from these countries): Austria (0), Belarus (2), Colombia (7), Czech Republic (0), Denmark (2), Iran (1), Monaco (0), Pakistan (0), Romania (3), Thailand (0), Turkey (1), and Venezuela (1).

Survey respondents considered a range of measures to be the most helpful with regard to how SCAR could support those impacted by the pandemic. They fall into five broader categories: (1) Access to additional funding and fellowship opportunities; (2) the facilitation of international collaboration and data-sharing arrangements; (3) the continued offer of access to conferences and workshops online, and (4) emphasising the strategic importance of Antarctic research across all disciplines and its role in capacity development; and (5) consideration of the pandemic's unequal impacts across the Antarctic research community and active accommodation of disadvantaged community members.

Key Recommendations:

1. *Facilitate access to additional funding*
 - a. Support for costs associated with fieldwork / caregiving
 - b. Lobby for, and where feasible develop, additional funding opportunities
 - c. Offer additional fellowships as feasible
2. *Facilitate international collaborations*
 - a. Facilitate access to existing data and the cataloguing of samples
 - b. Facilitate data sharing and, where possible, sample sharing
3. *Facilitate access to web-based opportunities and support*
 - a. Retain opportunities for free online participation in meetings, conferences and workshops
 - b. Facilitate access to web-based activities
 - c. Offer online mentorship schemes
4. *Support and representation for Antarctic science on the strategic level*
 - a. Prioritise the Antarctic research agenda
 - b. Emphasise the importance of all disciplines
 - c. Provide guidance on strategic environmental management to ensure SARS-CoV-2 does not become endemic in Antarctica
5. *Consideration and accommodation of unequal impact of the pandemic*
 - a. Acknowledge uneven impacts of the pandemic in funding reviews or fellowship applications
 - b. Encourage SCAR member bodies to acknowledge disparities in how COVID-19 affected researchers at national levels

After briefly outlining other notable developments within SCAR's COVID-19 research programme in section 2, the remainder of this report (section 3 and onwards) presents the survey results in greater detail.

2. COVID-19 project developments since last report

A more comprehensive overview of each of the working groups and their aims was provided in a previous report to SCAR (1 November 2020). To keep this report as concise as possible, we will refrain from repeating what we included in the November report and will provide a few brief updates on the groups' efforts here.

Updates by Work Packages (WPs)

The Antarctic COVID-19 research programme includes six separate WPs (including a synthesis WP, whose work will commence once the other five WP have finished theirs)⁵. While each WP advances their research efforts individually, there is considerable overlap and cooperation between WPs.

WP1 (Antarctic Futures):

Patrick Flamm, Yelena Yermakova, Bob Frame, Gabriel De Paula, Germana Nicklin, Francisco Tuñez, Renuka Badhe.

This group submitted a draft paper ("Antarctic gateways and gatekeepers: Polar scenarios in a polarising Anthropocene") to *The Anthropocene Review* in January, which is currently under review.

WP 2 (Antarctic Research and Decision-Making):

Cristian Lorenzo, Ilan Kelman, Renuka Badhe, Katelyn Hudson, Won Sang Lee, Pedro Marques Quinteiro, Meredith Nash, Miranda Nieboer, Jennifer Pickett, Morgan Seag, Yelena Yermakova.

This group examines the impact of the pandemic on Antarctic researchers and decision-makers, drawing on results from a survey as well as relevant literature. The rest of this report will focus on the survey that had been undertaken by WP 2.

WP 3 (Antarctic Tourism):

Hanne Nielsen, Gabriela Roldan, Daniela Cajiao, Karen Alexander, Javier Benayas, Valentina Dinica, Andrea Herbert, Elizabeth Leane, Jasmine Lee, Yu-Fai Leung, Amanda Lynnes, Daniela Sampaio, Pablo Tejedo, Yliana Rodriguez, Jane Verbitsky.

In partnership with IAATO, this group researches the impact of the pandemic on Antarctic tourism, addressing questions concerning the challenges, opportunities and potential implications for change on the future of the tourism industry and its operations in a post-pandemic world. WP3 is composed of 14 international researchers representing 7 different countries and speaking 8 different languages.

To address the research questions, WP 3 identified three thematic areas as focal points: a) impacts on Antarctic operations, b) policy and permitting, and c) perceptions of Antarctic tourism. The research employs qualitative and quantitative methods and the data collection methods are: (a) a survey directed to the Antarctic tourism stakeholders (e.g., tour operators, tour guides, port agents, local authorities, etc.), (b) semi-structured interviews with Antarctic tourism stakeholders to understand the implications of policy and permitting of the tourism activity both during the pandemic and in a post-pandemic world, and (c) a review of press releases and other relevant documents. WP3 has submitted a human ethics application through the University of Canterbury. Meanwhile, a systematic literature review of over 140 selected articles (Figure i) is currently underway. The background literature includes 50 journal and academic

⁵ The project team would also like to acknowledge early contributors to the project, including Mary Tahan and Klaus Dodds.

WP 4 (Perceptions of Antarctica):

In two overlapping subgroups (Media representations of Antarctica & Cultural history) using media analysis methods, this group is undertaking an analysis to identify how Antarctica is represented in the media over three COVID-relevant time periods: October-December 2019 (pre-COVID-19); March-May 2020 (early-COVID-19); October-December 2020 (later-COVID-19). Media is being investigated across eight countries: Argentina, Australia, Chile, China, New Zealand, South Africa, United Kingdom and United States of America. This analysis will involve a quantitative semantic analysis and a qualitative thematic analysis.

Regarding COVID-19, Antarctic researchers were often depicted in these articles as a source of inspiration and advice for a population in lockdown due to their experience with isolation. Antarctica

itself was often presented as one of the only places remaining free of the virus, reinforcing notions of purity and exceptionalism. Of course, this was countered by a theme which saw Antarctic tourism as a source of potential contagion, particularly for residents of Argentinian and Chilean gateway cities. Also, the data collection periods coincide with increased political discourse relating to sovereignty claims in both Chile and Argentina. The inclusion of areas such as Argentinian Antarctica, Chilean Antarctica, and the Malvinas/Falklands in national COVID-19 case counts suggests that COVID-19 coverage may potentially reinforce existing narratives relating to sovereignty in and around the Antarctic Peninsula.

WP 5 (Antarctic Wildlife and Wildlife-Human Interactions):

Andres Barbosa & Meagan Dewar

This group is currently producing an Information Summary on their findings for the *Antarctic Environments Portal*. After having several field teams collect data and samples on their behalf, they are also continuing to investigate the indirect effects of the reduced human presence on Antarctic wildlife species. Additionally, some of WP 5's data on penguin movements will be included in a global analysis of the impact COVID-19 has had on animal behaviour, a study led by the International Biologging Society.

WP 6 (Synthesis)

Daniela Liggett, Bob Frame, Peter Convey, Kevin Hughes, Peder Roberts.

Upon completion of the project, this group will synthesize the results from all WPs into a comprehensive assessment (to be published as a scholarly paper).

Project management activities

The **Project Manager** continuously updates the annotated database with relevant publications. It currently holds over 950 items (journal articles, NatureNews, news articles, reports, datasets, institutional responses, and miscellaneous publications).

The **Project Director** presented on preliminary survey results at the Antarctic Science Conference (9-12 February 2021, Christchurch, New Zealand). In early March, survey results will be presented to (1) APECS in form of a podcast, and (2) to the Arctic Science Summit Week (ASSW) in form of a presentation.

3. Introduction: The impact of the COVID-19 pandemic on the Antarctic research community

Scholarship on disasters and responses to disasters has shown how they do not affect people or communities equally or equitably (Hewitt 1983; Lewis 1999; Blaikie et al. 2004). Disasters expose societal vulnerabilities and inequalities in access to resources, capabilities, and opportunities (Boin and Bynander 2015).

Similar consequences are being felt with regard to the COVID-19 pandemic. The pandemic began in early 2020 after the disease first emerged in late 2019 (Gray II et al. 2020; Greely 2020; Khazanchi et al. 2020, Nature Editorial 2021). The uneven differential impacts caused by this global event extend to researchers in general and Antarctic researchers specifically, with further complications due to Antarctica's special geographic and political attributes. Antarctica is the only permanently-uninhabited continent, making long-haul travel essential for any on-site research and involving scientists, support staff, and the travel industry.

Generally, the pandemic is hitting field-based research especially hard. A 2020 study showed field scientists reporting the largest drop in research time, a 30-40% decrease (Myers et al. 2020). As the results of our survey highlight, Antarctic research is no exception.

Pandemics are not fair, and neither is academia (Greely 2020), which does not always treat the people involved equitably. Institutional structures across different disciplines demonstrate persistent patterns of disadvantaging women, minorities, people with caring responsibilities, people in lower income countries, and people without pre-existing networks in their field (Mainguy et al. 2005; Scholefield 2020; Wang and Degol 2017; Wennerås and Wold 2017). These inherent existing inequities are compounded by the unequal impacts of disasters across all of society. Although the verdict is still out on whether the consequences of COVID-19 follow this pattern, existing data suggests this will be the case (e.g., Camerlink et al. 2021; Cushman 2020; Kappel et al. 2021; Myers et al. 2020; Oleschuk 2020).

Antarctic research, which is generally field-heavy, international and collaborative, was expected to be adversely impacted by COVID-19. However, the extent of this impact and how it was perceived across different disciplines, nationalities, career-levels and other demographics were unknown. Motivated by this gap of knowledge, the Scientific Committee on Antarctic Research's (SCAR) Executive Committee as SCAR's Standing Committee on the Humanities and Social Sciences (SC-HASS) to undertake work that would shed light on these unknowns. An international and transdisciplinary research programme, led by Daniela Liggett and Andrea Herbert, was created to address questions around the implications of COVID-19 for Antarctic governance, tourism, and the scientific community. The latter aspect was addressed by a working group that specifically aimed at assessing the impact the pandemic has had on Antarctic research and the people contributing to Antarctic research efforts.

The overarching research questions guiding the work were:

- What are the impacts of COVID-19 on Antarctic research and researchers?
- How do the impacts vary according to demographics such as career stage, gender, nationality, nature of their research? Who are the most vulnerable researchers?
- What kind of assistance to reduce the severity of the pandemic's impacts is most valued by researchers?

For SCAR in particular:

- How can SCAR effectively support researchers in the short term?
- What are the long-term implications of COVID-19 for SCAR's operations and governance?
- What, if any, insights from responding to a pandemic may bring about a step change in how SCAR conducts its business?

4. Survey of the Antarctic research community: Overview and results

An English-language survey designed to gauge the perceived impact of COVID-19 on Antarctic researchers and support staff opened on 30 September 2020 and closed on 21 November 2020. During the eight weeks the survey was available for, 474 people accessed the survey and 406 people responded in full or partially (i.e., responded to at least 10% of the questions)⁶.

After minimal participation in the survey from Russia (2), none from China, and a slow start in Spanish-speaking countries, we decided to translate the survey into Russian, Mandarin and Spanish in the hope that availability of a survey in participants' native tongues would increase response rates. The Mandarin, Russian and Spanish versions of the survey were made available on 20 November, with the survey closing after six weeks on 30 December 2020.

Despite extensive advertising and dissemination of the translated survey (e.g., via SCAR and APECS social media, COMNAP communications, and participating researchers' social media and personal contacts), participation in the translated surveys remained minimal, with 2 Mandarin, 5 Russian, and 23 Spanish responses. The limited uptake might be due to different cultural attitudes to surveys or how a survey had been shared (especially China), differing attitudes to scientific outreach (Russia, also see Schiermeier 2021), and general survey fatigue. Nevertheless, the disappointing level of participation after the survey had been translated is informative in its own right and may shape future approaches to transnational coordination and consultation efforts. These responses are included in this preliminary analysis, although each respondent did not answer every question.

4.1 Demographics

The survey respondents resided in every inhabited continent, with most respondents living in European⁷ countries (37.8%), followed by South America (23.1%), Oceania (14.4%), North America and the Caribbean (10.6%), Asia (13.1%) and Africa (0.9%) (Figures 2 and 3).

⁶ Due to the sensitive nature of the topic and some of the questions, especially those around productivity and mental well-being, we decided to allow participants to skip any question they did not feel comfortable answering. We anticipated that this approach would increase meaningful engagement, even if it was just with aspects of the survey that participants felt strongly about or felt safe sharing their views on.

⁷ Including Russia, as most of its population lives in Russia's Eastern European part.

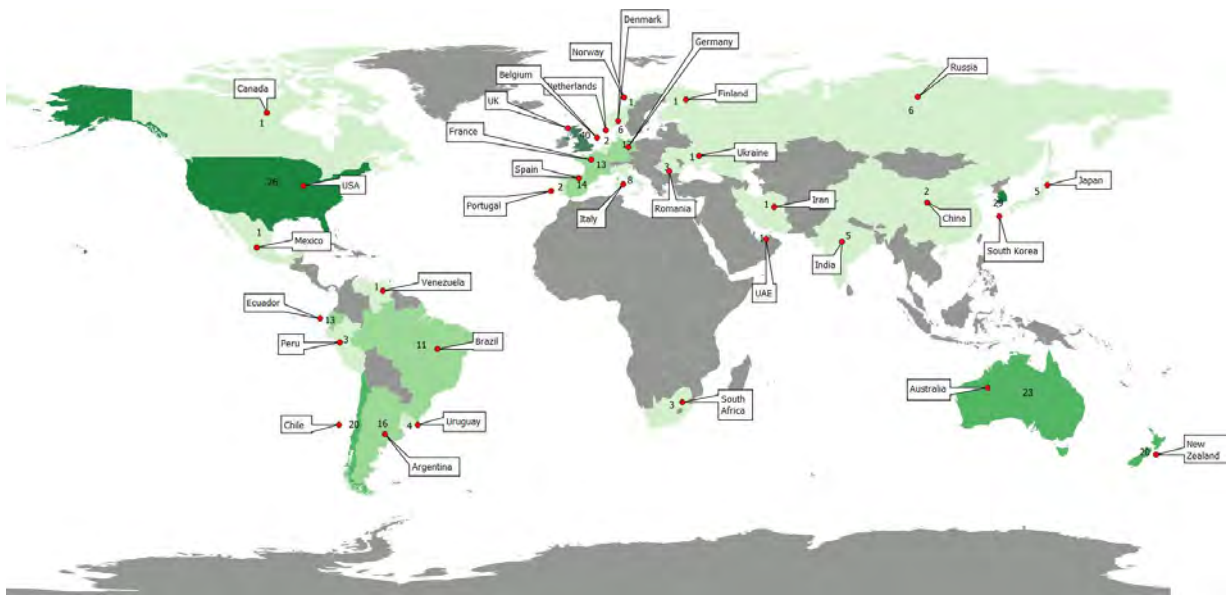


Figure 2. Survey participants' nationalities with response numbers by country

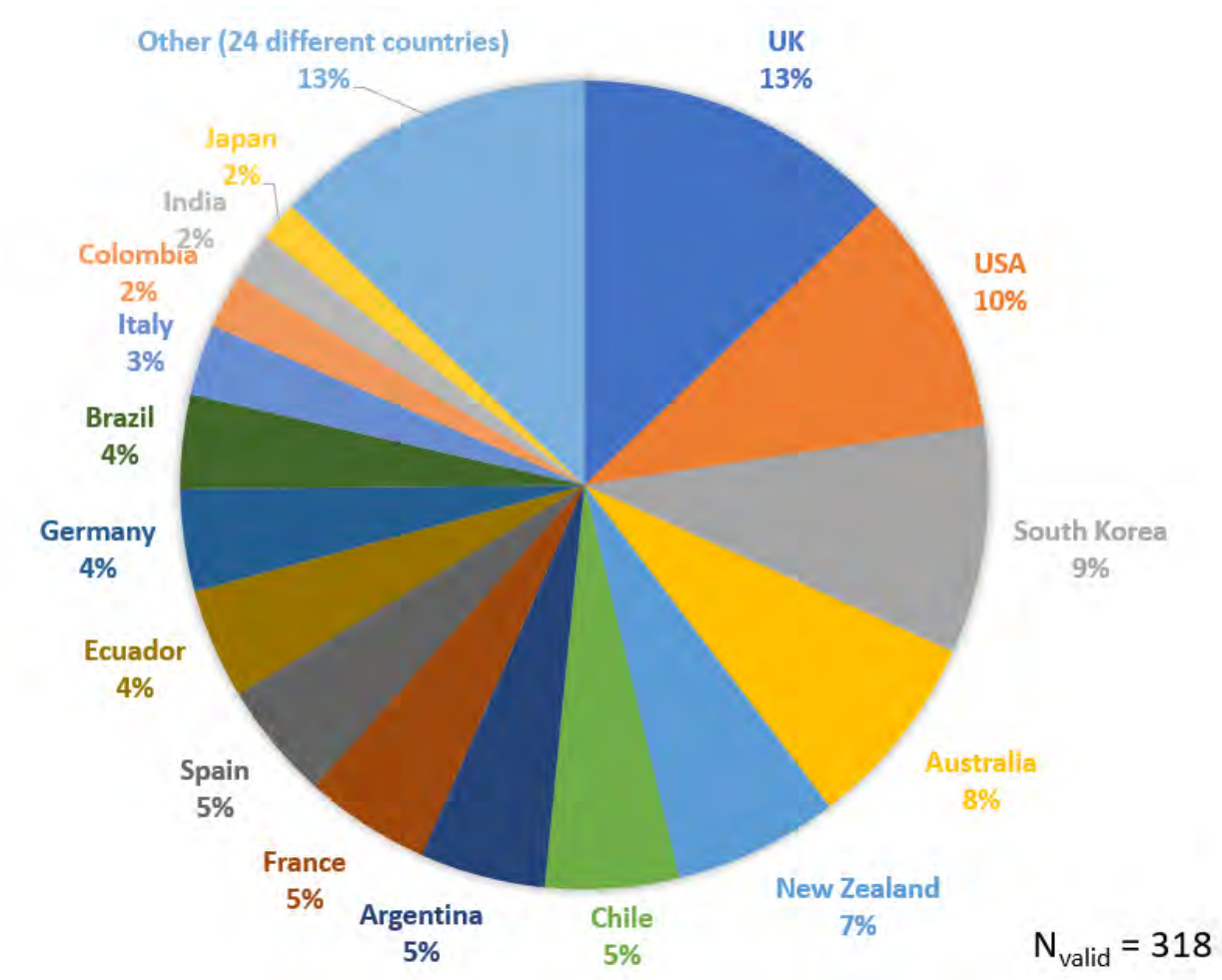


Figure 3. Respondents' nationalities in percentages

160 respondents identified themselves as women, 157 as men, and one as ‘Other’ (despite a ‘non-binary’ option also being provided). A further four respondents indicated that they preferred not to identify their gender (Figure 4), and the remainder skipped the question.

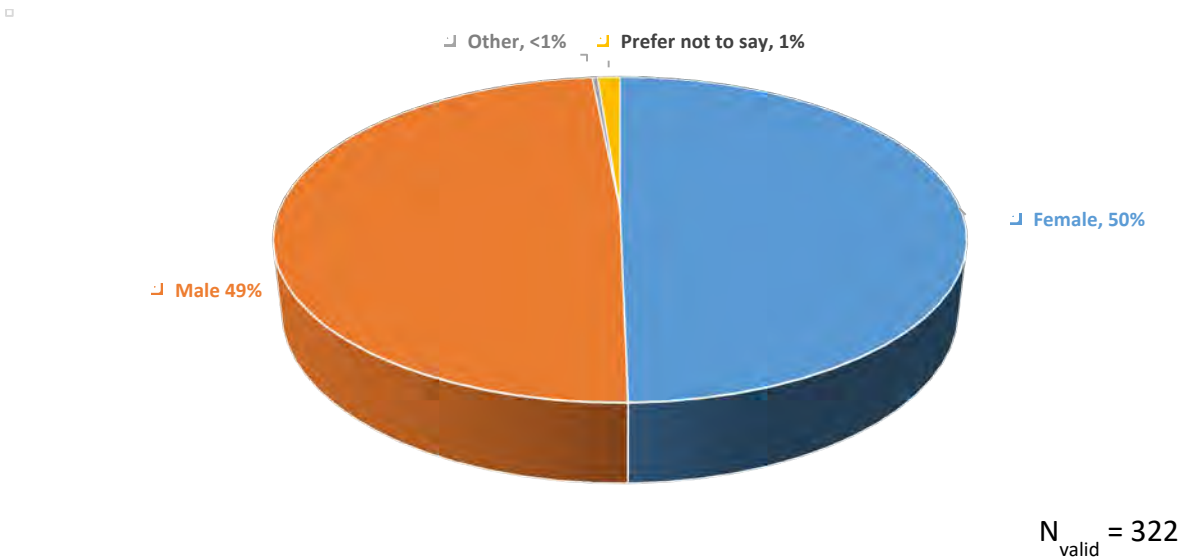


Figure 4. Survey participants by gender

Most respondents were from the fields of life sciences, geosciences, or physical sciences (78% in total). 8 percent of survey respondents were from the social sciences and humanities (Figure 5). Largely, response rates were in line with SCAR’s three Standing Science Groups (geosciences, life sciences, physical sciences) and the Standing Committee on Humanities and Social Sciences (SC-HASS).

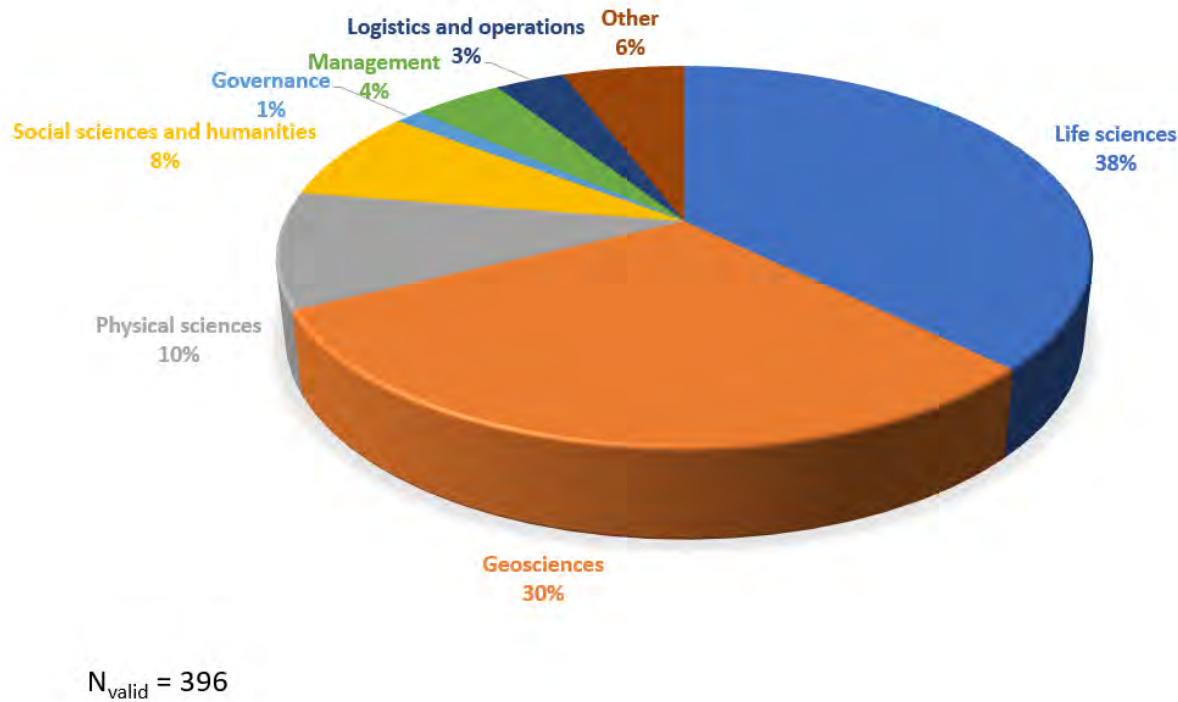


Figure 5. Participants’ main field of research or work

Not surprisingly in this context, for 84% of respondents, Antarctic fieldwork is either extremely (57%) or very (27%) important in their work (Figure 6), and about three quarters of the research participants consider repeated or continuous field seasons as extremely important or very important to achieve their research objectives (Figure 7).

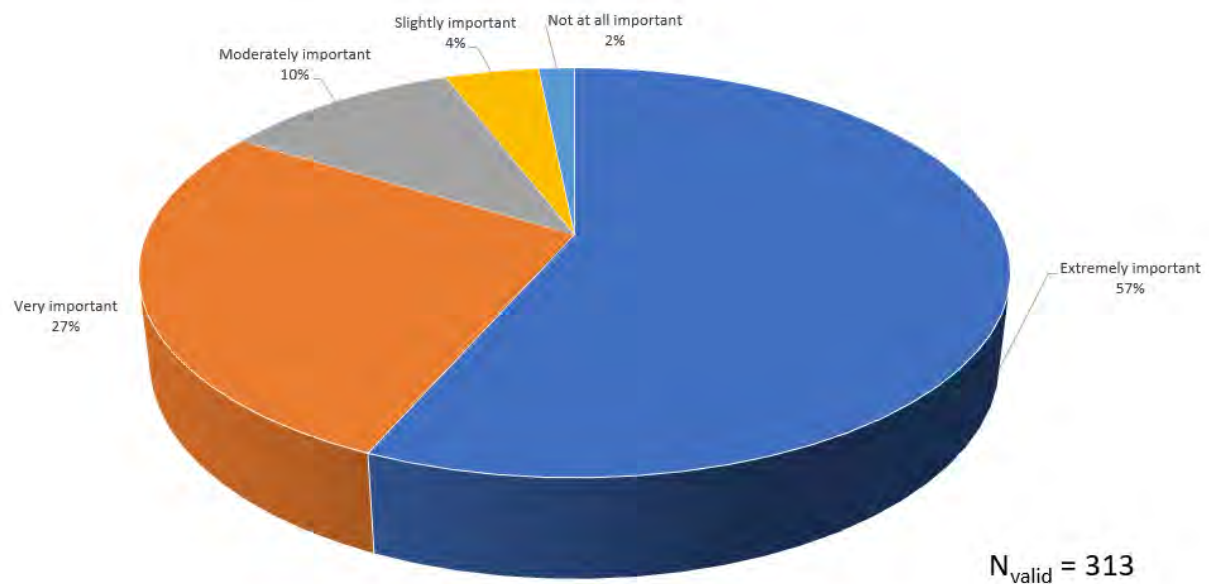


Figure 6. Importance of field work (including field or base support activities)

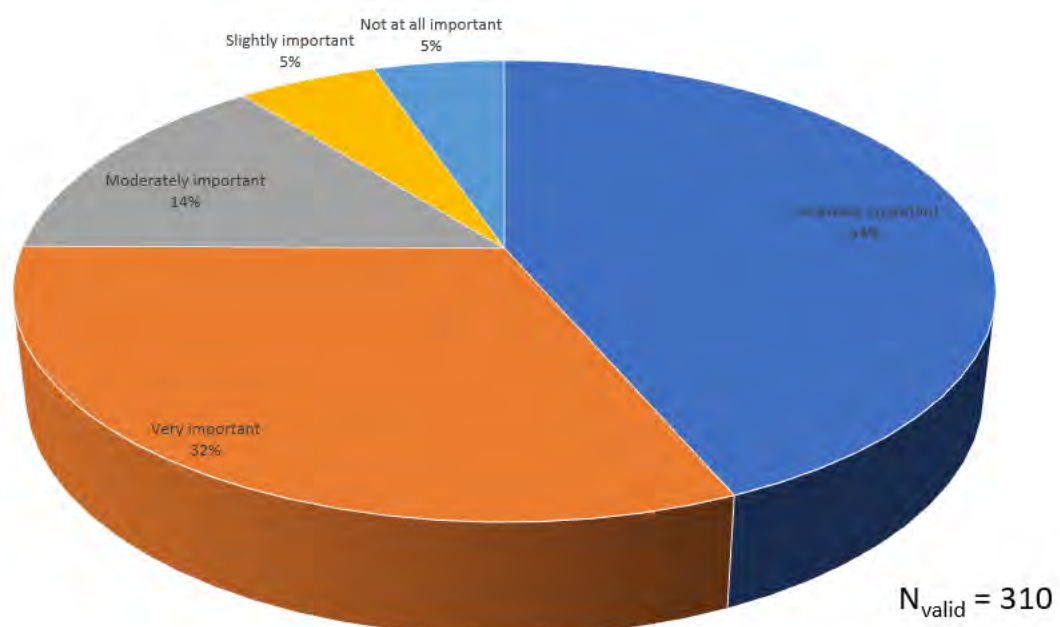


Figure 7. Importance of repeated or continuous field seasons to achieve research objectives

Almost half of the respondents (44%) self-identified as being in the early stages of their career, receiving supervision, with 16% of the respondents being postgraduate research students (Figure 8). At the time of the survey, out of the early-career researchers (ECR) receiving supervision, 42% said they received less supervision as a result of the pandemic while 42% stated that their supervision had not changed. 18% even suggested they received more supervision, e.g., due to an increase in the number of electronic meetings. However, while the hours of supervision may have increased for some, respondents also indicated that it had become harder to progress in their work due to the considerable amount of “self-training” that had to be done in the absence of hands-on supervisory meetings. Despite the surprising number of respondents for whom supervision time had increased, the ones for whom supervision had decreased in quantity or quality were more outspoken on how they had been adversely affected by reduced time for meetings, increased workload and personal pressures (for mentors and mentees alike), lack of more effective face-to-face interactions and brainstorming sessions, and increased institutional demands placed upon supervisors.

Over half of the respondents have a permanent, full-time position, but over a fifth of the respondents have a fixed-term position (of these, the majority work full-time) and the remainder are research students, unemployed or self-employed (Figure 8), putting this entire cohort at an increased risk of being in a financially vulnerable position when their current contract ends or they finish their studies.

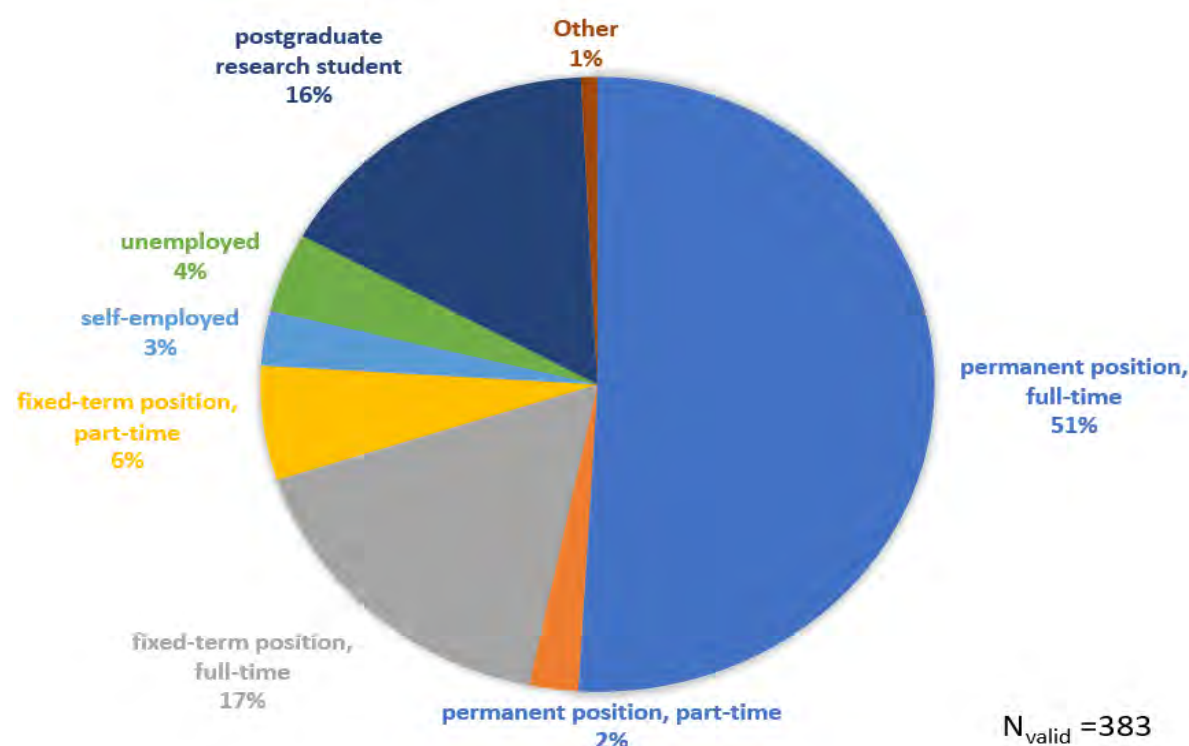


Figure 8. Participants' employment situation

4.2 Impact on professional life

The pandemic has affected Antarctic researchers both professionally and personally. With regard to their work, 84% recalled an occasion when their professional activity suffered because of COVID-19 in the past six months. 99% reported that their 2020-2021 field season had been either cancelled or otherwise changed because of COVID-19.

When asked about the negative impacts COVID-19 had on respondents’ professional life or career, out of 341 survey participants choosing to answer that question, only 20 said that their careers had not been affected by the pandemic. The remainder (see Figure 9) reported wide-ranging adverse impacts, with the most frequently mentioned impacts being reduced opportunities to network (58%), the inability to conduct fieldwork (56%) and the inability to meet existing research objectives (43%). In addition, workloads (for teaching and service, but primarily for administrative duties) had increased considerably, and output quality and quantity were adversely affected, too.

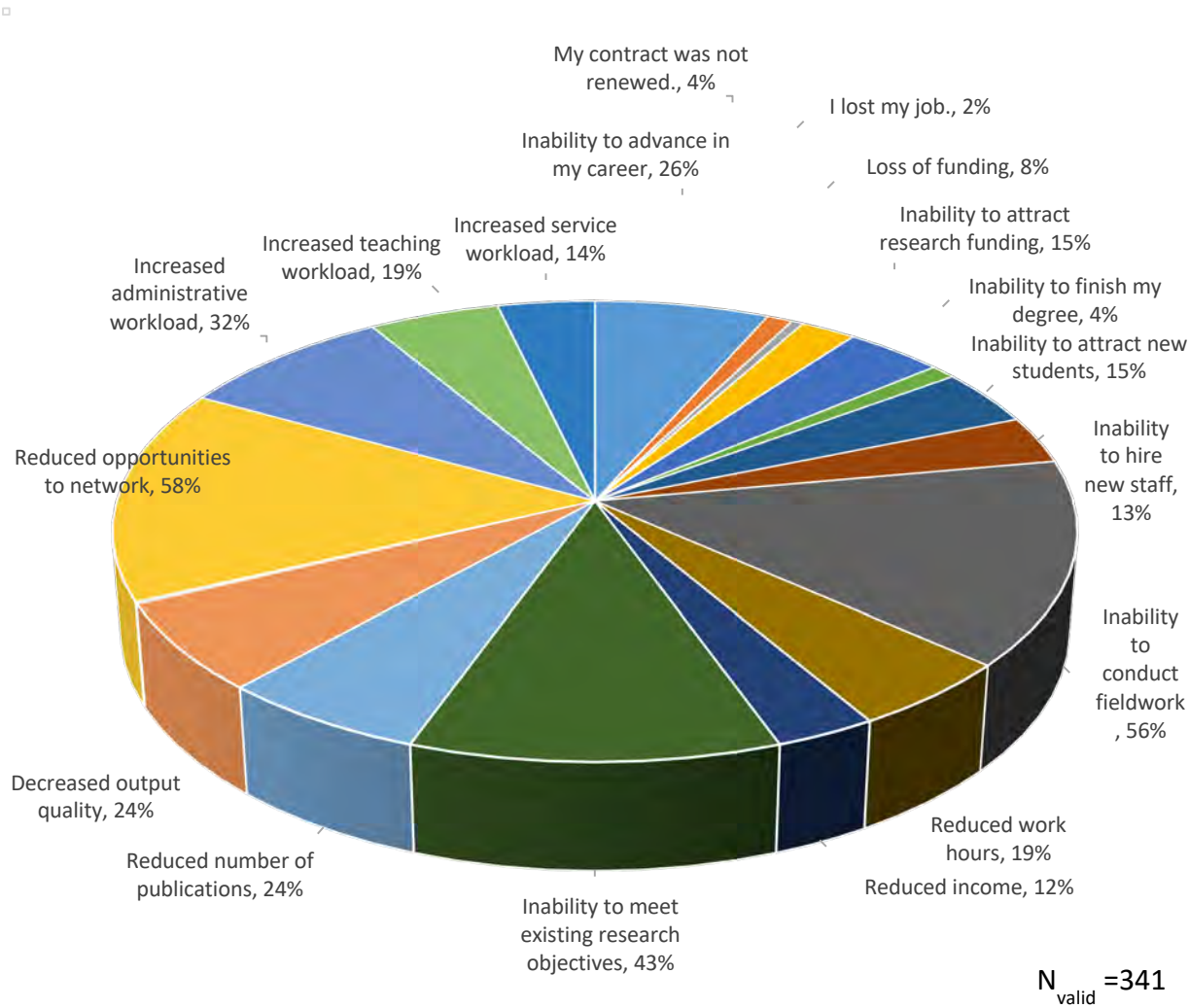


Figure 9. Negative impacts of COVID-19 on professional life or career

Subsequently, when asked about their greatest worry for the future, many participants noted their (impending) financial and job-related instability (see quotes from respondents below). This extended to all career stages, but was most-commented on by ECRs.

This concern may be exacerbated by changing research priorities worldwide. As governments, universities, and other funding bodies have mobilised funds to support biomedical and life sciences research into COVID-19 and some scientists have shifted their research focus accordingly (Scharf 2021), researchers in other disciplines worry that this shift of priorities will negatively affect their own funding (Adam 2020).



*[What worries me is] mostly the uncertainty of it all. Will I be able to **get a job**? Will **funding of my project** be an issue? Will I get sick? Will we go back to some sort of normality?*

- ECR, life/phys. sciences, female

*[My biggest concern about the future is] **enforced retirement** (i.e., being made redundant), as the real and vast economic costs of dealing with COVID-19 need to be paid back. [I'm also worried about] drastic reduction in funding that is available to **non-virus/non-medical research**.*

- Senior researcher, life sciences, male

*That disruptions to Antarctic field seasons will snowball and make it even more **difficult for new investigators** to get funding for Antarctic fieldwork.*

- Life sciences, female

*As time ticks on, I will lose the opportunity to carry out research I believe is important, and what I had "signed up for" in terms of Antarctica. **Feeling very squeezed** as a midcareer interdisciplinary researcher.*

- Interdisciplinary research, female

*[I'm most worried about] not being able to finish my PhD because I had to drastically change my thesis and now have **difficulty concentrating and staying motivated**. Not getting a post-doc because there are now **even fewer jobs than before** and perhaps less funding.*

- ECR, phys. sciences, female

Other concerns by respondents in our survey addressed big-picture issues, such as international developments with regard to climate change, environmental degradation, (geo)political and governance matters, with many of these issues extending far beyond the realm of respondents' Antarctic work.

Antarctic scientists can be geographically mobile, and 20 survey respondents specifically commented on travel restrictions as a source of worry or concern, not only in connection with research plans, but because they cut off avenues for reconnecting with family and loved ones abroad.

*[My biggest concern for the future is] that I will be **unable to see my children** that live in other countries for a long time. My government does not allow us to travel anywhere and has destroyed our economy.*

- Geo sciences, female



*[My biggest concern for the future is] if I will ever be able to see family and partner again. Is a career worth it if you **can't be near the people you love** when you need them or they need you?*

- Geo sciences, female

For those who reported a negative impact of the pandemic on their work-related productivity, the factors having the greatest impact were the inability to do field work, cancellations of scheduled training, forced lockdowns, and stress related to uncertainties and the inability to plan ahead. The presence of other people when working from home, including those for whom respondents are caregivers, was also listed as a detracting factor (Figure 10).

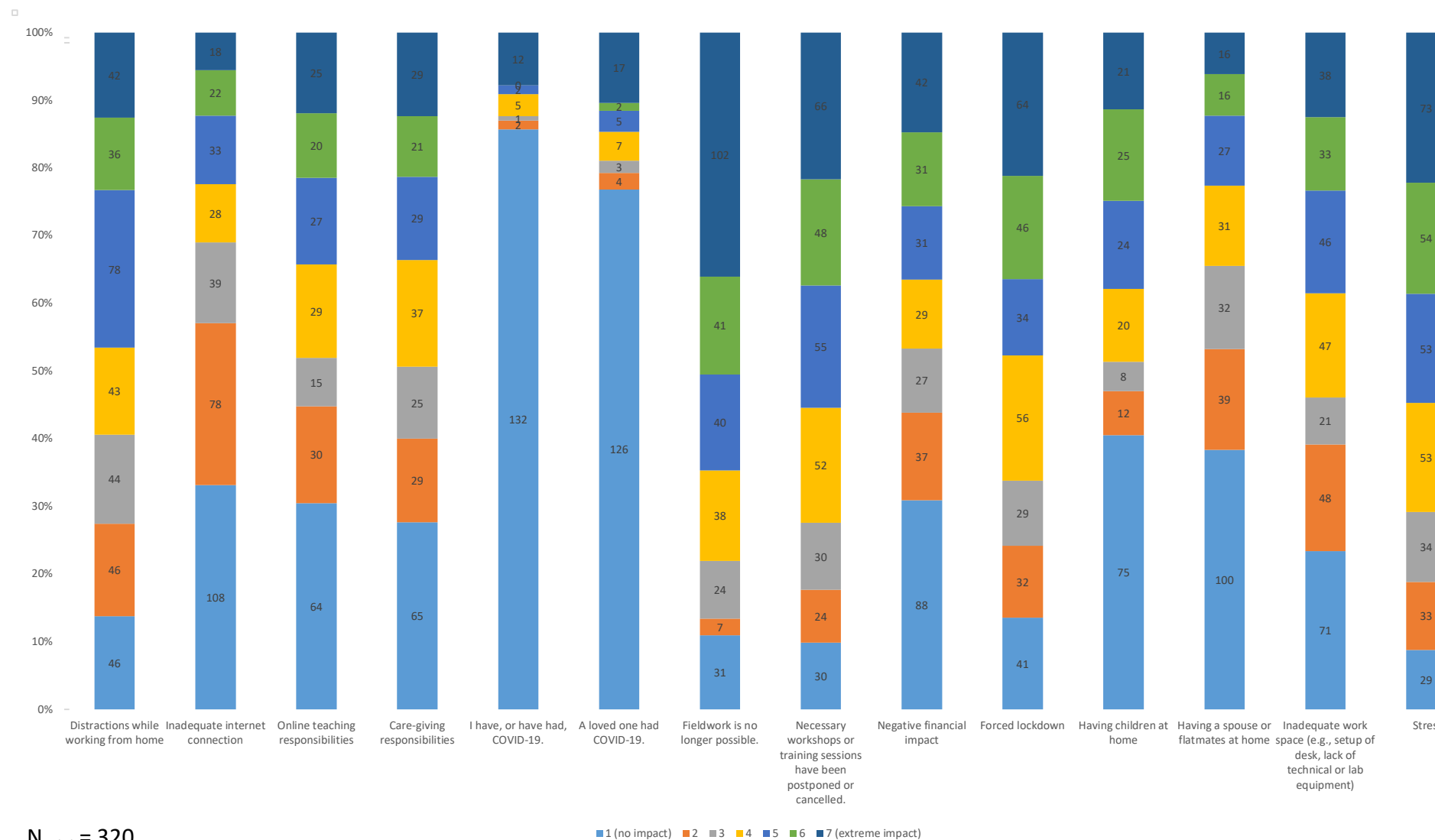


Figure 10. Negative impacts on participants' work-related productivity

Participants utilised a variety of approaches to dealing with the challenges the pandemic posed to their research, ranging from adjusting their expectations (52% of participants who answered this question) to changing research aims (29%) or adjusting their research methods (26%). However, 23% of respondents indicated that they were simply not able to do anything.⁸

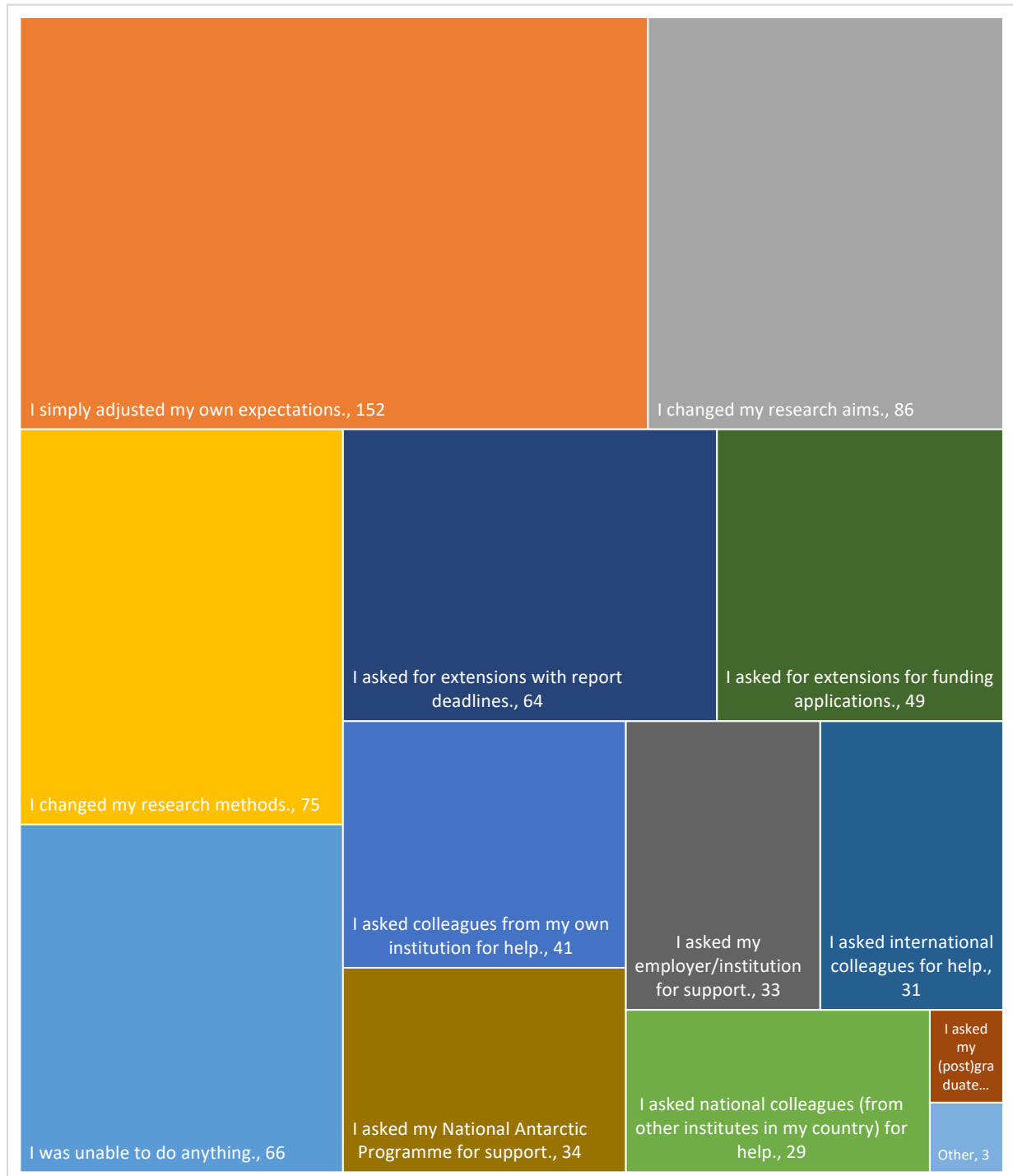


Figure 11. Actions participants took to overcome negative impact on their research (by number of mentions)⁹

⁸ Note that multiple answers were possible, which is why these percentages do not add up to 100%.

⁹ The maroon box in the lower right hand corner says "I asked my (post)graduate students to take on more work., 4".

Whilst we are generally seeing a fairly even distribution across men and women in terms of what actions they have taken in response to the challenges posed by the pandemic, women seem to have displayed a bit more flexibility as adjusting research aims and methods, or even simply adjusting their own expectations, were concerned, whereas men more readily reached out to colleagues (overseas and locally) to ask for help. Women more often asked for help from their home institutions and extension on reporting or funding deadlines than men but the overall sample is too small to draw any reliable conclusions (Table 1).

Table 1. Cross-tabulation (Gender) for actions taken to reduce the impact of COVID-19

		Women	Men	Total
I was unable to do anything.	<i>Count</i>	26	30	56
	<i>Percentage</i>	18.84%	24.79%	
I simply adjusted my own expectations.	<i>Count</i>	73	67	140
	<i>Percentage</i>	52.90%	55.37%	
I changed my research aims.	<i>Count</i>	47	33	80
	<i>Percentage</i>	34.06%	27.27%	
I changed my research methods.	<i>Count</i>	40	30	70
	<i>Percentage</i>	28.99%	24.79%	
I asked colleagues from my own institution for help.	<i>Count</i>	15	20	35
	<i>Percentage</i>	10.87%	16.53%	
I asked national colleagues (from other institutes in my country) for help.	<i>Count</i>	11	14	25
	<i>Percentage</i>	7.97%	11.57%	
I asked international colleagues for help.	<i>Count</i>	14	13	27
	<i>Percentage</i>	10.14%	10.74%	
I asked my (post) graduate students to take on additional work.	<i>Count</i>	1	3	4
	<i>Percentage</i>	0.72%	2.48%	
I asked my employer/institution for support.	<i>Count</i>	19	13	32
	<i>Percentage</i>	13.77%	10.74%	
I asked my National Antarctic Programme for support.	<i>Count</i>	16	14	30
	<i>Percentage</i>	11.59%	11.57%	
I asked for extensions with report deadlines.	<i>Count</i>	38	22	60
	<i>Percentage</i>	27.54%	18.18%	
I asked for extensions for funding applications.	<i>Count</i>	28	19	47
	<i>Percentage</i>	20.29%	15.70%	
	Count total	138	121	259

Note: Only those participants who volunteered their gender and answered the question on actions taken to reduce the negative impacts from COVID-19 could be taken into consideration here. By contrast, Figure 11 also includes all responses to our question on actions taken.

Overall, the survey shows that COVID-19 had the greater negative impact on women, who report more job losses, funding losses, reduced number and perceived quality of publications, and increased teaching and service workload than their male counterparts. This mirrors the situation faced by women in research and science in general: throughout the pandemic, women have submitted fewer papers for publication when compared to pre-pandemic times, whereas men are submitting more

(Collins 2020). In the future, this may further reduce women's chances to get promoted, lead to a larger gender pay gap¹⁰ or, to women even being pushed out of academia altogether (Ibid).

More male than female participants in our survey report that, due to pandemic disruptions, they were unable to hire new staff or were unable to finish their degree. Men recalled more occasions when work or research suffered because of COVID-19 but they also expected the pandemic to have a smaller impact on their productivity and reported an overall higher mental wellbeing than women. Overall, men's careers appear to be less immediately affected by COVID-19 (Table 2).

Table 2. Cross-tabulation (Gender) for negative impacts of COVID-19 on professional life

		Women	Men	Total
Inability to advance in my career	Count	51	31	82
	Percentage	32.08%	19.75%	
My contract was not renewed.	Count	5	7	12
	Percentage	3.14%	4.46%	
I lost my job.	Count	3	2	5
	Percentage	1.89%	1.27%	
Loss of funding.	Count	15	11	26
	Percentage	9.43%	7.01%	
Inability to attract research funding	Count	24	21	45
	Percentage	15.09%	13.38%	
Inability to finish my degree	Count	6	7	13
	Percentage	3.77%	4.46%	
Inability to attract new students	Count	27	23	50
	Percentage	16.98%	14.65%	
Inability to hire new staff	Count	17	25	42
	Percentage	10.69%	15.92%	
Inability to conduct fieldwork	Count	87	93	180
	Percentage	54.72%	59.24%	
Reduced work hours	Count	33	32	65
	Percentage	20.75%	20.38%	
Reduced income	Count	23	17	40
	Percentage	14.47%	10.83%	
Inability to meet existing research objectives	Count	77	63	140
	Percentage	48.43%	40.13%	
Reduced number of publications	Count	49	30	79
	Percentage	30.82%	19.11%	
Decreased output quality	Count	51	26	77
	Percentage	32.08%	16.56%	
Inability to contribute to the research environment	Count	1	0	1
	Percentage	0.63%	0.0%	
Reduced opportunities to network	Count	105	83	188
	Percentage	66.04%	52.87%	
Increased administrative workload	Count	52	54	106
	Percentage	32.70%	34.39%	

¹⁰ Interestingly, our survey also highlighted a discrepancy in the contributions made by the respondents to household incomes. A larger percentage of the total household income was contributed by men (67.9% on average; n=115) than women (59% on average; n=132).

		Women	Men	Total
Increased teaching workload	Count	38	25	63
	Percentage	23.90%	15.92%	
Increased service workload	Count	28	20	48
	Percentage	17.61%	12.74%	
I have not experienced any negative impacts.	Count	5	14	19
	Percentage	3.14%	8.92%	
Count total		159	157	316

A silver lining is that about half of the research participants (53%) when asked to reflect on the benefits of the pandemic situation report that they have experienced some form of positive impact from COVID-19. Working from home, online training, and online conferences were among the most listed positive impacts (Figure 12, and quotes below), though these aspects were perceived as negative impacts¹¹ by other respondents.

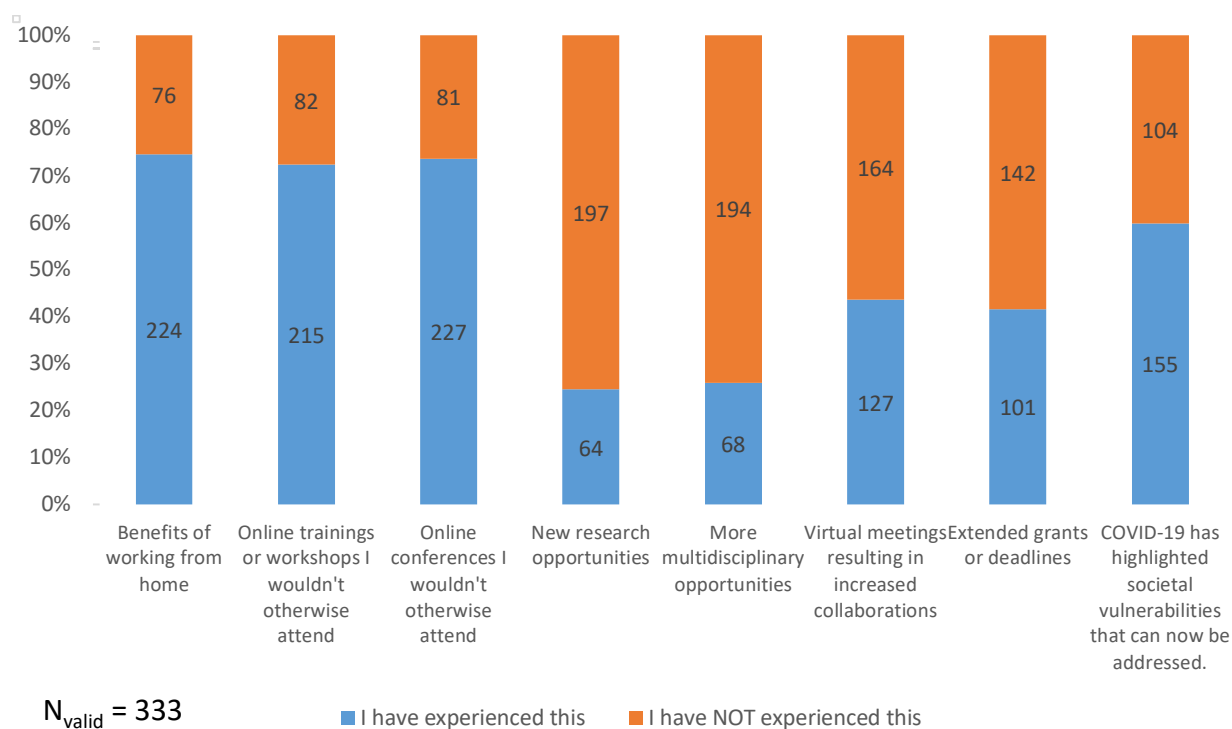


Figure 12. Positive impacts resulting from the COVID-19 pandemic



Lowered work expectations give me time to reassess my work-life balance and future goals.

- Postdoc, geo sciences, female

There is no more social life so I am working all the time and making fast progress on my dissertation.

- ECR, phys. sciences

Increased virtual contact with work colleagues and friends and relations as a result of increased digital capability.

- Senior position, Logistics & Operations, female

¹¹ These negative impacts – discussed in more detail elsewhere – are, e.g., distractions while working from home, connectivity issues or inadequate setup at home, or overexposure to online activities.

Increased *relevance of Antarctic social sciences* – i.e., drawing on experiences of living in contained and constrained environments.

- Senior researcher, social sciences, female

Not spending hours commuting and not going to face-to-face meetings that could be done by video link.

- Life sciences



4.3 Impact on Antarctic operations

How researchers move to and within Antarctica will be crucial for future planning not only with regard to logistics and operations but also to inform environmental management in pandemic or post-pandemic times.

More than 90% of survey respondents indicate that they physically work in Antarctica, with the majority active in the Antarctic Peninsula (21%), King George Island (14%), and East Antarctica or the Southern Ocean (12% each) (see Figure 13).

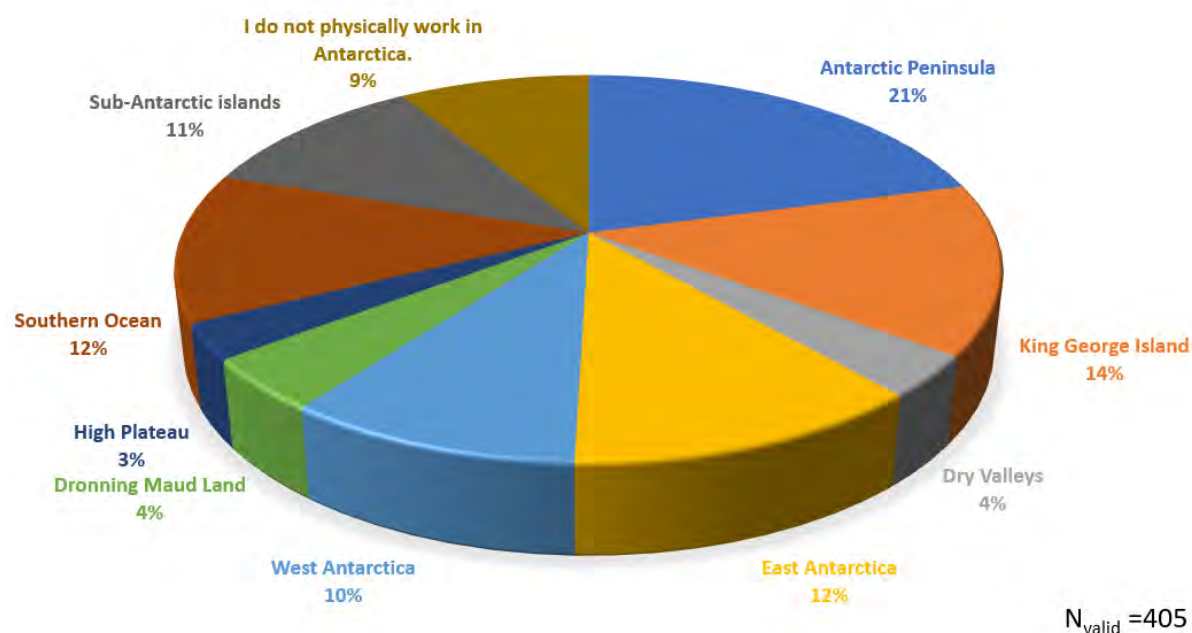


Figure 13. Respondents' geographic areas of work in Antarctica

The respondents' mode of transport from Antarctic gateway ports to the Ice was predominantly by plane (43% of respondents) or ship (33%), with the remaining 24% of respondents using a combination of both, ship and plane, to travel between the gateways and an Antarctic station (N=290).

During their most recent season in Antarctica, just under half of our survey respondents stayed solely at their own research station without visiting other stations (45%) or field camps (48%), but this leaves over 50% of mobile, or highly mobile, respondents who visited at least one other research station (Figure 14).

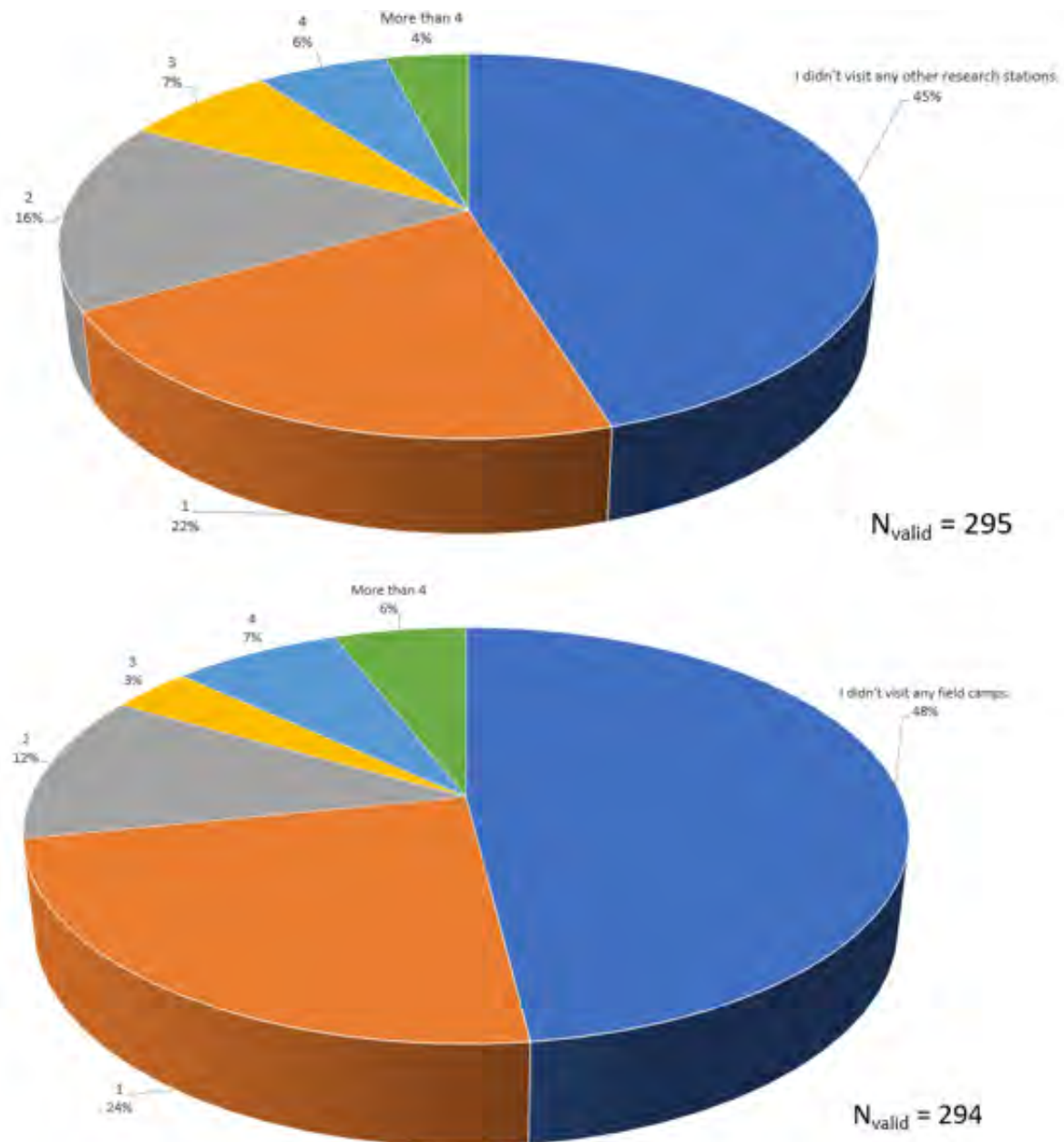


Figure 14. Number of research stations other than own (above) and field camps other than own (below) visited during last stay in Antarctica

For roughly half of researchers, intra-Antarctic transport included planes (26%) or boats (25%). A fifth of respondents indicated they used helicopters (20%) during their last visit. A minority of researchers (7%) did not use any motorized forms of transport while in Antarctica (Figure 15) but mentioned in their notes to have used travel by foot or ski.

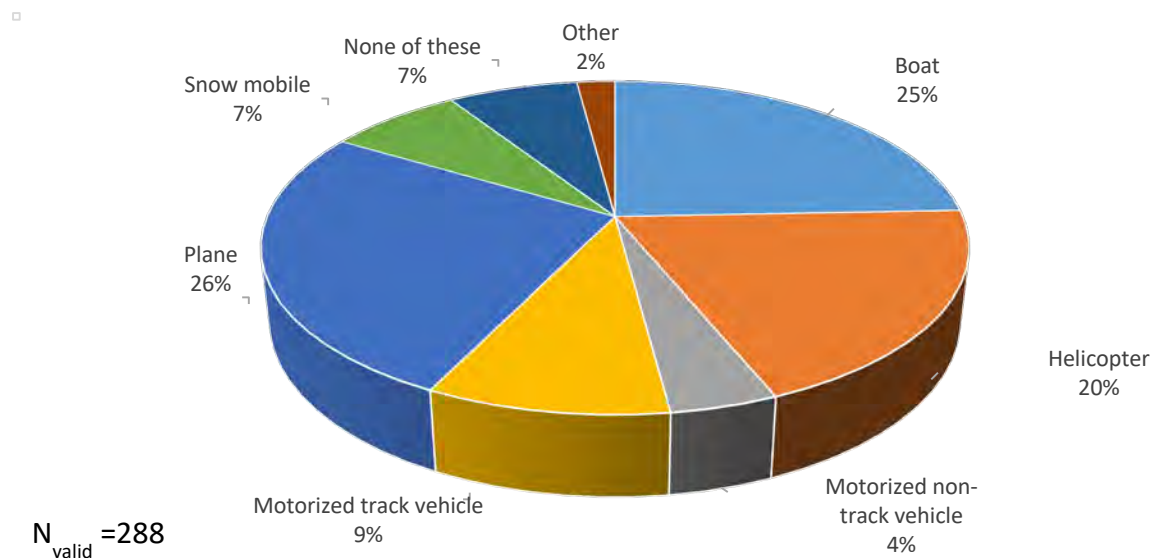


Figure 15. Types of transport used in Antarctica during last visit

Reflecting the demographic profile of our respondents, it comes as little surprise that many of our survey participants collect data or samples in Antarctica (Figure 16). Half of the data or samples that survey participants work with are organic/biological samples (22%), inorganic samples (i.e., air, water, snow, ice, or rock; 16%), and oceanographic data (12%).

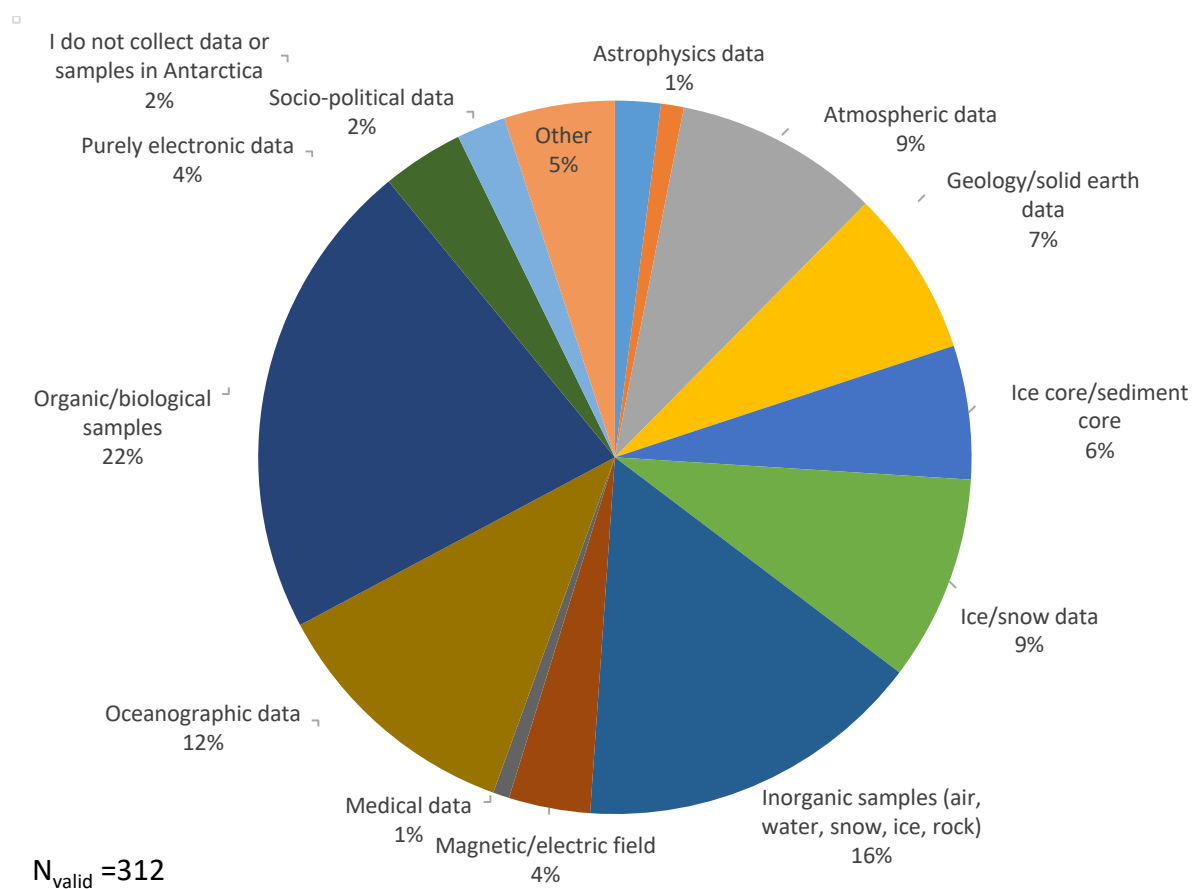


Figure 16. Types of data collected by survey respondents

A third of respondents indicated that their data or samples are collected by themselves (32%), while another third reported that others collect samples or data for them during field campaigns (30%) (Figure 17).

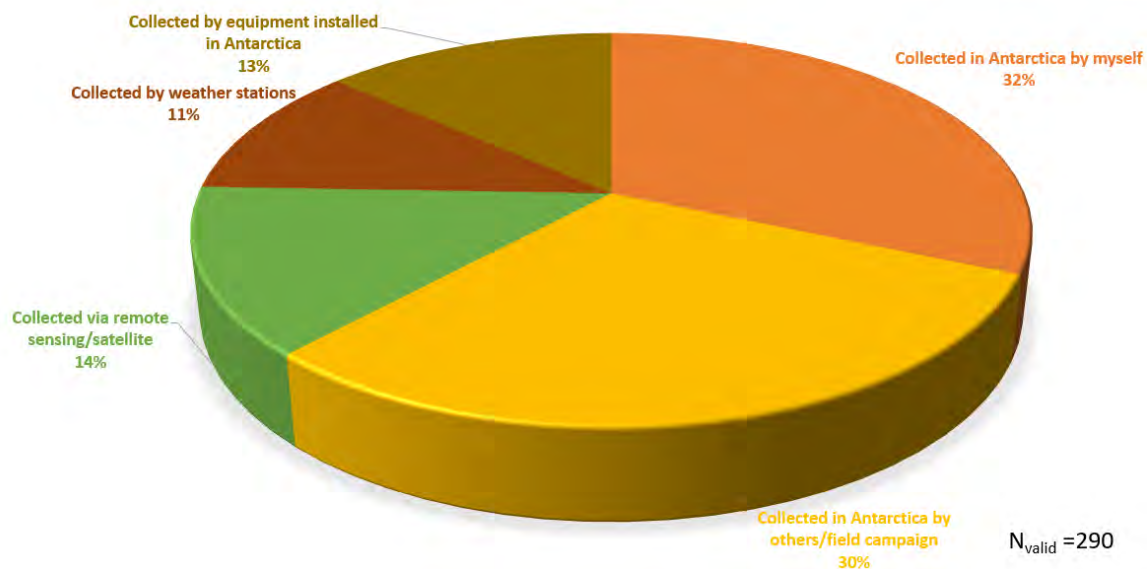


Figure 17. Modes of data collection

About a third of data/samples are transported out of Antarctica by a combination of aircraft and ships (37%) or only by ship (29%). Approximately a fifth of collected data (18%) are transmitted electronically and in real-time (Figure 18).

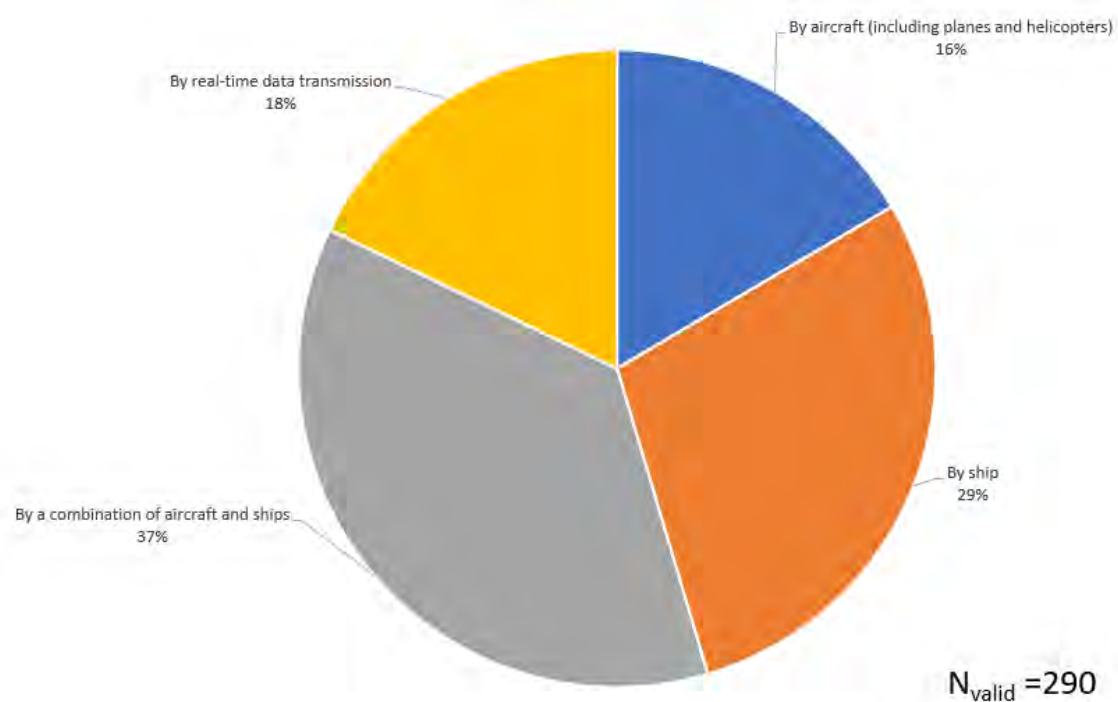


Figure 18. Ways in which data/samples are transported out of Antarctica

As COVID-19 is likely to become endemic in the permanently inhabited continents (Torjesen 2021), understanding how researchers and support staff travel to the Antarctic, where they stay, to what extent they travel between bases, field camps and various sites in Antarctica and what kind of data or samples they collect will be important for informed environmental-management decisions in an attempt to avoid COVID-19 becoming endemic in the Antarctic and potentially affecting Antarctic wildlife.

4.4 Impact on mental wellbeing

As impact on personal lives and wellbeing are concerned, the responses to our survey show a noticeable division. For 32% of respondents the pandemic has had a significantly or extremely negative impact on their mental wellbeing. Increased stress and anxiety levels, fear about the future of Antarctic work, trouble concentrating and lack of motivation as a result of the COVID-19 pandemic has had the greatest negative impact on mental health for our survey respondents (Figure 19).

Other negative impacts on well-being revolved mainly around the importance of human connections and interactions with others – be it as evidenced in loneliness during lockdown (3 separate mentions), the lack of emotional support or concerns about others (loved ones) and fears about loved ones getting COVID-19, not only when they lived far away but also when they were around, with survey respondents fearing that they could involuntarily transfer the virus to them (6 separate mentions). Additional emotional stress was linked to self-esteem matters and crises of confidence, shown in a loss of meaning of life or an “ever-present sense of personal failure from reduced productivity” (Physical scientist, female). The high levels of uncertainty has also caused anxiety and panic in respondents, and the economic impact of the pandemic has had consequences for respondents’ mental well-being. In addition, the climate crisis, the state of global politics or inadequate government responses to COVID-19 were reasons for concern resulting in additional mental stress.



[What worries me most is] that there won't ever be a "return to normal"; I can cope with a lot of the COVID-19-related negatives, but I am terrified about permanently losing access to what brought me joy in life.

- Postdoc, geo sciences, female

*[I have an] ever-present sense of personal failure from **reduced productivity**.*

- Phys. sciences, female

These outcomes align with Turna et al.'s (2021) cross-sectional survey on mental health related to COVID-19, in which the researchers confirm that female gender and younger age are determining factors for anxiety, depression, and stress, especially in people with prior mental health issues.

However, not all of the respondents felt that the pandemic has had a negative impact on their mental wellbeing, with 6% reporting to be “extremely satisfied” with their overall mental health at the time of the survey.

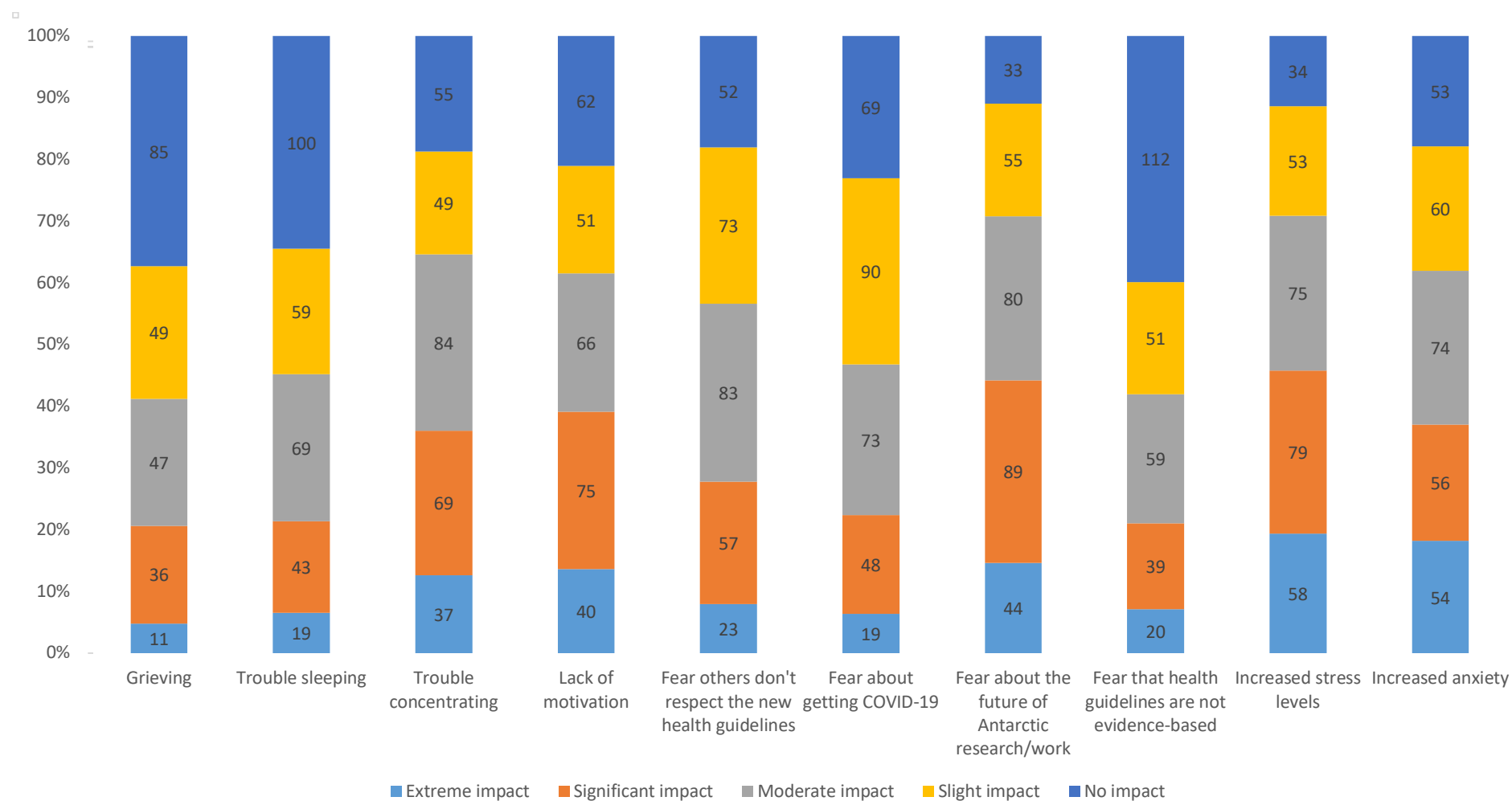


Figure 19. Negative impacts of COVID-19 on mental wellbeing (N=301)

4.5 Impact on structurally vulnerable groups

Women and caregivers

Survey results show that scientists who are women, especially those who care for children, are more often faced with additional challenges such as increased responsibilities and workload. This can result in decreased research productivity, fewer publications, and fewer research hours. Such impacts are in addition to the already-existent gender gap between men and women scientists around the world (European Commission 2019; Huang et al. 2020; Larivière et al. 2013; Woolston 2021). Responsibilities that are not directly research-related and that consequently do not increase a researcher's academic profile are more often taken on by women: faculty service work such as learning and teaching development, student advising, or committee tasks is more often done by women, which has a negative effect on women's publication records (Guarino and Borden 2017; Huang et al. 2020; Woolston 2020b). Universities have adapted to lockdown conditions worldwide by shifting their courses online (Richardson 2020). Online teaching and mentoring is more often undertaken by women (Woolston 2020b). Our survey shows that more women report a higher teaching workload than men, though both report a similarly increased administrative workload.

Researchers with caregiving responsibilities at home feel the increased pressure of forced lockdown more acutely than researchers who are not caregivers (Camerlink et al. 2021; Greely 2020; Scharf 2021). Most survey participants (68%) share a household with other people. 40% of these have one or more minors (i.e., dependents under the age of 18 years) living with them. Caregiving responsibilities include, in the majority, children, followed by parents, partner, relatives, or a combination of two or more of these. Caregivers tend to be women (Shockley et al. 2021), and academic mothers find themselves especially affected by an increase in household and caregiving duties (Bonacini et al. 2021; Langin 2021; Nash and Churchill 2020). This situation intensifies for single-parent scientists who have to juggle a plethora of responsibilities without a primary supporting partner (Arnold 2020). From countries like New Zealand, which so far has fared comparatively well with regard to COVID-19 cases and related mortality rates, to heavily-impacted countries like Italy, caregivers experienced a significant increase in stress (Edwards 2020; Marchetti et al. 2020). Female caregivers are at increased risk of experiencing "multifactorial stress uniquely exacerbated among women" (Connor et al. 2020).

A range of comments made by our survey participants in open-ended questions suggest that women were more significantly adversely impacted by COVID-19 due to child-caring duties (see the quote below as an example). In addition, women's career progression and income levels had been adversely impacted much more than that of men (Table 2). However, the majority of the quantitative parts of the survey that asked participants to rate the level of impacts the pandemic has had on different parts of respondents' work (see Figure 10 above) does not show marked differences between men and women other than in terms of financial implications, stress levels (Table 3) and, as mentioned above, prospects to advance one's career (Table 2).

*[What worries me most is] personally, that I **have fallen behind due to childcare responsibilities**; there has been a narrative that some people have 'more time' due to being stuck at home, but for me the opposite is true, and I have **zero time** for any kind of long term planning or skill development/diversification.*

- Postdoc, phys. sciences, female



Table 3. Negative impacts of COVID-19 on productivity by gender

	Women	Men
Inadequate internet connection	24%	20%
Online teaching responsibilities	23%	19%
Care-giving responsibilities	27%	20%
I have, or have had, COVID-19.	3%	6%
A loved one had COVID-19.	8%	6%
Fieldwork is no longer possible.	54%	54%
Necessary workshops or training sessions have been postponed or cancelled.	47%	50%
Forced lockdown	33%	26%
Negative financial impact	50%	34%
Having children at home	20%	22%
Having a spouse or flatmates at home	22%	12%
Inadequate work space (e.g., setup of desk, lack of technical or lab equipment)	42%	27%
Stress	66%	38%

Note: Any level of negative impact felt (from extreme to moderate) were considered for the purposes of this assessment.

When looking at the impact the COVID-19 has had on mental wellbeing, astonishing differences between what men and women report emerge. This might be because women might be more outspoken about issues of mental wellbeing, but the differences are significant enough to make us question why, for instance, anxiety and stress levels are greater in women than in men or why self-motivation and the ability to concentrate have been so much more adversely impacted in women as compared to men (Table 4). A British study (Etheridge and Spantig 2020, Executive Summary) has found similar results and concluded that

“declines in well-being during the pandemic are strongly associated with family responsibilities, financial circumstance, and with age: the young have been much more strongly affected than the old. In terms of explaining the gender gap, we find a quantitatively important role for social factors. Having a larger social network before the pandemic is strongly associated with larger well-being declines after the pandemic’s onset. Women reported more close friends before the pandemic than men, and higher loneliness than men after the pandemic’s onset.”

This significant gender disparity will need to be taken into consideration when identifying how best to support women and men involved in the Antarctic community.

Table 4. Negative impact of COVID-19 on mental wellbeing by gender

	Men	Women
Grieving	22%	37%
Trouble sleeping	33%	49%
Trouble concentrating	46%	74%
Lack of motivation	45%	69%
Fear others don't respect the new health guidelines	43%	59%
Fear about getting COVID-19	38%	50%
Fear about the future of Antarctic research/work	64%	70%
Fear that health guidelines are not evidence-based	36%	39%
Increased stress levels	55%	79%
Increased anxiety	44%	72%

Early-career researchers (ECRs)

ECRs are similarly adversely affected. The pandemic exacerbates existing inequalities in the PhD experience, ranging from biased allocation of financial support and bias against marginalised groups to differences between disciplines (Tatham 2020). Postdocs, “disenchanted with working life” (Woolston 2020d), are increasingly considering leaving academia due to unsustainable working conditions such as long hours, lack of job security, workplace discrimination and bullying (Gomollón-Bel and Wang 2020; Woolston 2020e). The “toxic culture and expectations of success in academia” (Hume and Soar 2020) added to the uncertainties of the long-term consequences of the pandemic means increased pressure for those just starting out in their careers. As one of the latest *Nature* editorials suggested, “[a] year of lost or deferred science could be much more damaging to those early in their careers than to their senior colleagues” (Nature Editorial 2021).

The assumption that younger researchers feel more pressure than older, established ones is supported by our survey: the older participants are, the better their appraisal of their mental health. Similar trends can be applied to participants’ perceptions of their future productivity: the less Antarctic experience participants have, the more they expect that their Antarctic output will decrease.

Nearly half of the respondents in our survey identify as ECRs, i.e., they are within 5 years (excluding career breaks) of finishing their PhDs (in both directions including pre-PhD). The pandemic has impacted on supervision more negatively than positively, with supervision in terms of quantity or quality having decreased since the start of the pandemic for roughly 42% of ECRs who were being mentored or supervised (see quotes on the next page and Figure 20, with the panel on the right providing a breakdown of changes in supervision only for those who were receiving supervision). For a few ECRs, supervision or mentoring have increased due to the convenience of having more frequent online meetings or because these ECRs connected with colleagues or mentors internationally to a greater extent.

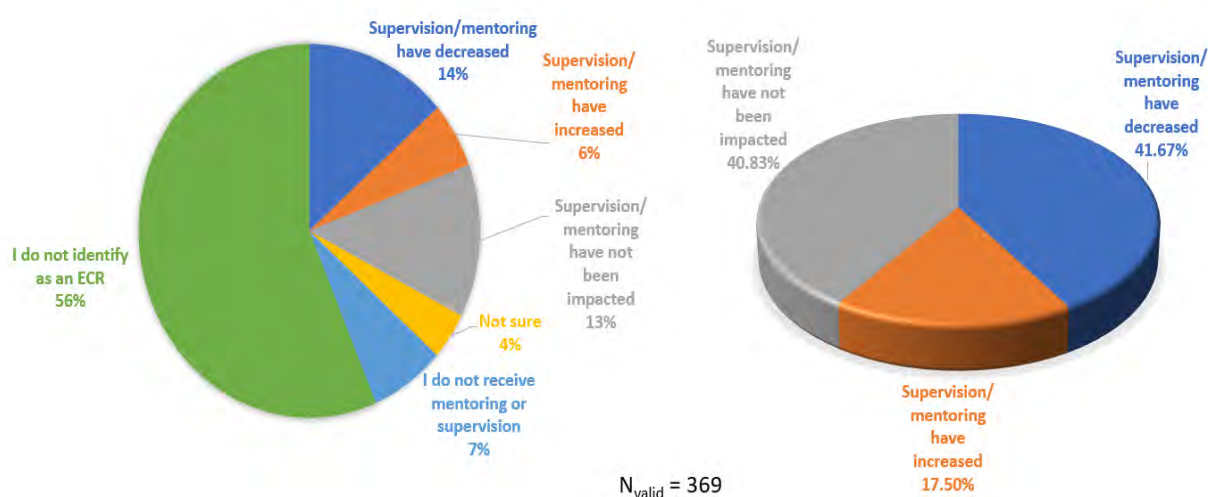


Figure 20. Impact of COVID-19 pandemic on mentoring or supervision

*Initially the amount and quality of my contact with supervisors and mentors **decreased**. Recently we made some changes so that I could still get the assistance I needed, but **it took about 6 months to get settled** into a new way of working.*

- ECR, life sciences, female

*I hear from my supervisor much less. All **informal mentoring has stopped**. My relationship with my supervisor is strained by funding reductions and my **drop in productivity**. Feeling pretty abandoned.*

- ECR, phys. sciences, female



*[What worries me most is] that my **dissertation is going to take a lot longer** to write than I expected so my funding will run out and I will have to get a job which will slow me down more. Also this means longer with **a terrible income** that means I can't save and my retirement [fund] is not getting any contributions. Also if I do finish, getting a **job in research seems very unlikely**.*

- ECR, phys. sciences, female

The pandemic exacerbates difficulties for ECRs whose academic path is already uncertain. As Roach and Sauermann (2017) report, science and engineering PhD students tend to lose interest in academic career over the course of their graduate training. A worsening academic job-market outlook brought on by the pandemic is likely to aggravate this, with ECRs increasingly looking for alternatives to academia (Shaw and Chew 2020; Woolston 2020a, 2020c, 2020f). In some instances, universities have begun to discuss and implement strategies to counteract these tipping-point pressures, e.g., by adjusting tenure-track durations or extending deadlines for funding applications (Gomollón-Bel and Wang 2020). While ECRs have previously had options to pursue careers in academia or in industry, the squeeze on opportunities in both areas is limiting perceived future prospects.

*[Negative impacts include the] perception that **fewer jobs** are or will become available when I finish my studies. [There is] **more pressure** to finish work to a **higher standard** under difficult circumstances.*

- ECR, life sciences, female



*While working for [employer], my supervisor initially was constantly communicating with me. If I am honest, I **felt pressured to be even more productive than "normal" times**. Eventually, my supervisor went back to normal. Now, as a PhD student, I am **receiving a lot more guidance** as I am within the first couple of months of starting my project. This has been handy because I could discuss any questions I have fairly quickly and continue advancing with my project.*

- ECR, life/phys. sciences, female

Although survey responses show some differences between ECRs in different disciplines, all ECRs voice similar concerns for their future prospects more generally. The differences lie in the detail and in how a concern about the future is experienced. Field-based natural science ECRs are worried because their data collection has ceased or is in danger of ceasing because of restricted access to the field. ECRs who work in interdisciplinary studies or the social sciences and humanities fear that these disciplines

will be further disadvantaged as even more focus and funding might be shifted to field-based sciences (see quote below).

*I'm a PhD student [...] working in the **social sciences and humanities**. COVID-19 has triggered a financial crisis for [country's] universities and as a result the career prospects of HDR students and ECRs in general **are projected to shrink considerably**, particularly in the disciplines I work across, where opportunities were pretty slim to begin with. In terms of the future, I'm really concerned about **job prospects**, which can make it hard to stay motivated at times.*

- ECR, social sciences and humanities



These findings on the impact of the pandemic on ECRs align with Rabanal et al. (2021) who ran a survey among Earth System ECRs and found that “personal aspects” (e.g., lack of motivation, loneliness, distance from the work environment, uncertainty about future jobs, reduction in productivity, etc.) weighed heavily on them, and that forced transitioning to working from home has further complicated efficient work for some of them.

At the same time, some ECRs have reported some positive aspects arising as a result of the pandemic, including new online-based opportunities and more time for upskilling or focused work on their research. Some of these positive aspects could be sustained into the future, e.g., by continuing accessible online options for participation.

Researchers from developing countries

The pandemic's impact on scientists is felt differently depending on the researcher's place of origin. Developing countries are economically worse affected than developed countries (Egger 2021; Rios 2020). It is becoming clear that ethnicity and socio-economic level influence both COVID-19 risk levels (Clift et al. 2020; Krogstad and Lopez 2020) and mental health experiences (Arañez Litam and Oh 2020; Barroso 2020; Miconi et al. 2020; Ruiz et al. 2020).

Scientists from 31 countries responded to the survey. Despite targeted efforts to include Indigenous participants, no respondent self-declared as such. Similarly, we have too few participants from developing countries to be able to make any meaningful comparisons between Antarctic researchers in developed and those in developing economics. Also, regional and national restrictions were not taken into account for this survey as they were fast-developing and too unpredictable in terms of their length, timing and levels of restriction, but comparisons between the severity of the pandemic, effectiveness of government measures to control it, and the perceived impact on survey participants' lives and work would warrant a closer look in follow-up studies.

Nonetheless, the quotes provided below offer a couple of different perspectives from respondents from the Global South that are worthwhile keeping in mind when developing plans on how SCAR could most effectively put in place measures that help to mitigate at least some of the impacts of COVID-19 on the work and lives of Antarctic science community members.



I am at the top of the scientist career in my country [Latin America] and my monthly salary is U\$S 500. Imagine [...] the salary of an early-career scientist: U\$S160. With those salaries and no funds it is almost impossible to publish. So, our research is not known.

- Senior researcher, geosciences, female

*Sometimes you wonder how we still manage to get good scientific results on **such equipment!** We win due to enthusiasm and unselfish devotion to Antarctica! What saves us is that we can work as leaders! And the devices are good - if [we have them].*

- Senior researcher, geosciences, male



5. Recommendations to SCAR

The results from our survey suggest an acceptance of the need to curtail travel and fieldwork. Respondents indicated that support for working from home would be helpful for Antarctic research. The survey highlights a greater need for creating professional opportunities (e.g., via online workshops and conferences, data and sample-sharing arrangements and research funding) than a need for assistance for personal circumstances, though this was also deemed helpful.¹² Some participants deemed access to childcare (20%) and access to equipment (24%) as helpful in reducing the negative impacts of COVID-19.

Access to additional funding, more fellowship opportunities, access to data collected by others, and access to technology-based opportunities (e.g., online conferences, virtual mental health support and mentoring) are regarded as the best strategies to help reduce the negative impacts of COVID-19 (Figure 21).

Specifically, respondents elaborated that additional funding was required to cover/supplement the respondent's own salary or scholarship support (10 individual mentions) or to pay students or other staff (22 separate mentions) for research, teaching or project support. Funding was also requested for (additional) lab work/analyses (4 separate mentions) and field work/equipment (10 separate mentions), to cover living costs (2) or quarantine expenses (3), travel expenses (5), logistics and operating costs (such as increased electricity bills; maintaining sample collections or transferring samples) (3), administrative burdens (1), or more generically for research and data analysis or to cover publication costs and online training/conferences.

Participants mentioned a wide range of data and samples that, if they were made available, would be very helpful, including recorded electronic data (e.g., oceanographic, meteorological, isotope, satellite images, climate data, and all kinds of biological and genome data) and physical samples (such as rock samples, biological samples, sediment cores, fossil collections) as well as bibliographic data.

Equipment that was listed separately by participants as helpful includes laptops, lab access, statistical software, functioning home offices, satellite modems and various technical and scientific equipment (including gliders, microscopes, core loggers, data loggers) to operational units such as boats, vessels and ATVs.

In this section, drawing on our research participants' suggestions and the results of the survey as the impacts of COVID-19 on members of the Antarctic research community are concerned, we explore the strategies that SCAR, in collaboration with its national member organisations, could most effectively pursue to serve the Antarctic research community and lessen some of the adverse impacts arising from the pandemic.¹³

¹² The distribution of responses can be as important as the averages. For instance, only people with the time and equipment to answer the survey would have done so, suggesting a bias towards those who have reasonable home working environments. Similarly, while several factors are labelled as "being neither helpful nor unhelpful", this statement was offered as a mid-point on a Likert-scale-type set of answers. The distribution might have been bimodal (or trimodal) which, if this were the case, would indicate that some people do need, for instance, access to childcare whereas others do not.

¹³ Naturally, some of the options we list may not be feasible for SCAR to pursue as these might be the responsibilities of national funding bodies or other agencies. We nonetheless include these here as we want to ensure that the key points raised by the survey respondents are being reflected in this report.

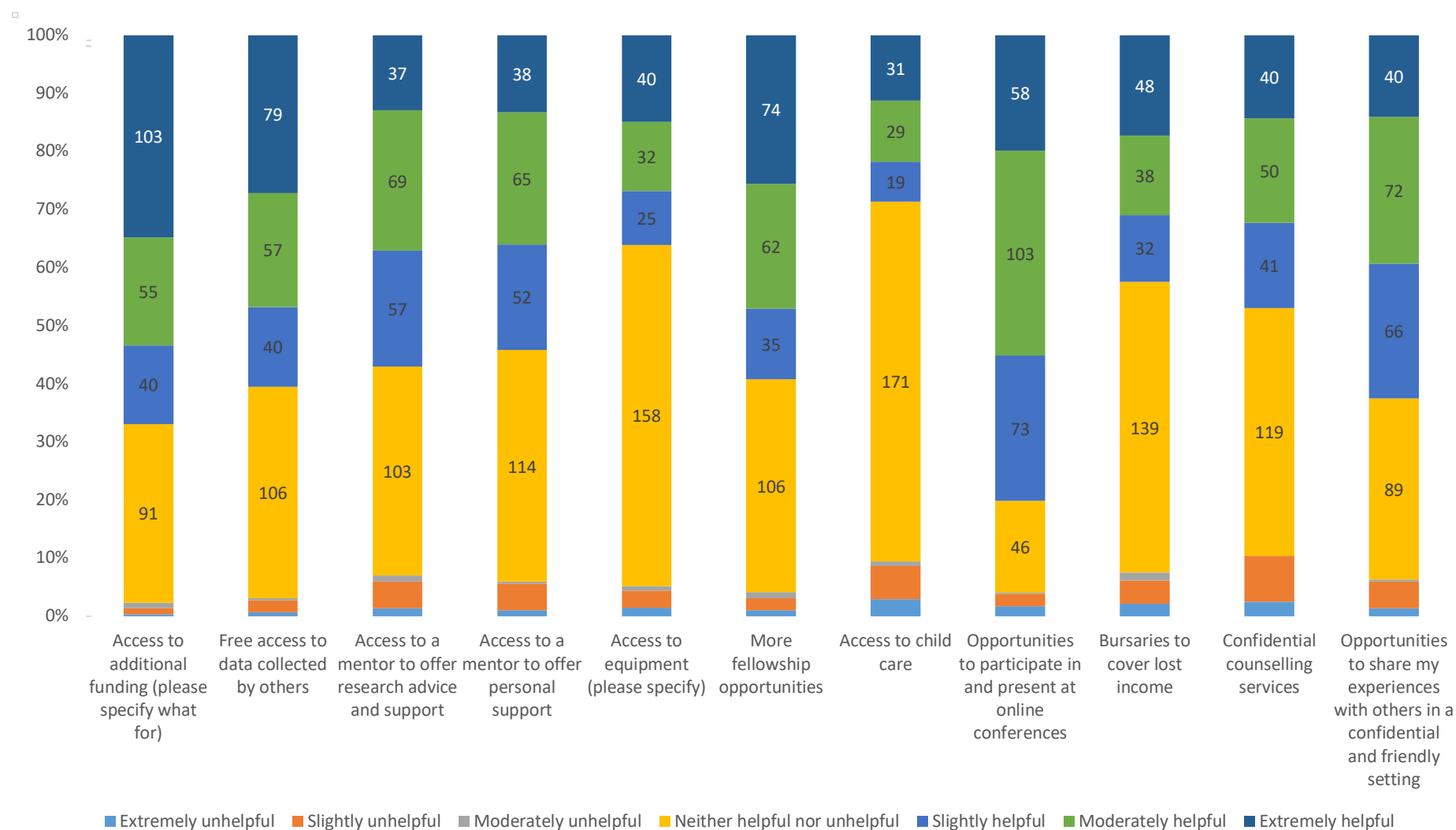


Figure 21. Participants indicate the extent to which actions would be helpful in reducing the negative impacts of the pandemic (N=296)

(a) Provide access to additional funding¹⁴

- Funding for fieldwork and fieldwork-related expenses, travel, additional staff/students;
- Funding for caregiving costs to support those most affected by the pandemic (cf. Nature Editorial 2021); and
- Opportunities for more funded fellowships (possibly working with NGOs and philanthropic organisations to lobby for funding).



***Funding opportunities** would be most welcome. **Writing groups** (virtual) could be helpful. Keep up the good work with the **job board** and everything else. Thanks for listening.*

- ECR, phys. sciences, female

(b) Facilitate international collaborations

- Connecting researchers working in similar fields or with similar data;
- Facilitating data-sharing between researchers with and without field access to Antarctica, and between ECRs and senior researchers, possibly through the establishment of a data-sharing platform; and
- Encourage the sharing of information about the location of physical samples from Antarctica (maybe via a meta-catalogue of samples) and encourage the sharing of samples where possible.

*Planning initiatives to **spur collaborative Antarctic research** [would be useful], so we can help each other be successful. Facilitate either the formation of new, or advertising of existing, mechanisms to access and use existing Antarctic data.*

- Life sciences, female



*Facilitate **international collaborations** to work on existing sample and data collections while we wait out the coronavirus.*

- Life sciences, male

(c) Facilitate access to web-based opportunities and support

- Access to a mentor to offer research advice and (personal) support online (possibly enhance linkages with APECS in this respect but possibly also establish a SCAR mentorship programme across career levels and also to connect researchers from countries with developing Antarctic programmes with researchers across the international Antarctic community);
- Continue offering opportunities to participate in and present at online conferences and workshops, ensuring that online participation remains free of charge*;
- Facilitate the offer of online training/up-skilling opportunities;

¹⁴ We realise that offering more funding might be out of reach for SCAR, but lobbying its national members to possibly stimulate the opening of national funding streams, especially for ECRs, might well be within the scope of SCAR's activities.

- Explore to what extent it is feasible to offer online access to archived materials and scholarly publications that might not be open-access publications; and
- Offer online support via confidential fora for struggling researchers and for connecting ECRs and senior researchers.

*Keep making archives and documents **available online** (that is really helpful).*

- Senior researcher, life sciences, female



*Virtual-only meetings are **no replacement for in-person activities**. It is good that new tools to make meetings remote-friendly will exist for those who couldn't travel as much prior to the pandemic, but I hope we will **not overemphasize these virtual-only meetings**. They just do not cut it.*

- Geo sciences, female

*Making future scientific meetings, conferences, and other events either exclusively virtual or at least offering a virtual component even once travel restrictions are lifted, was considered to be useful and desirable by the majority of *Nature* readers (Remmel 2021) as well as by many of our survey respondents. Not only would it allow easier access for researchers worldwide and reduce conference costs (this is especially important for ECRs), but it could potentially reduce the conference-related carbon footprint. Despite acknowledging a certain level of 'screen fatigue' and the loss of the social aspects of science collaboration, the researchers polled by *Nature* overwhelmingly embraced virtual meetings as the way forward – from an ethical and scholarly perspective.

(d) Support and representation for Antarctic research at a strategic level

- Advocating with stakeholders (governments, NAPs, or funding agencies) for prioritizing Antarctic science, especially in regard to fieldwork and interdisciplinarity;

*Publicly support, uphold and **commit to the value of interdisciplinarity** (i.e., with humanities and social science streams) research so we do not have to keep begging for money and convince others of its value (also, specifically, research that includes Indigenous peoples initiatives and perspectives). It is exhausting.*

- Interdisciplinary studies, female



***Be a voice** and speak up loudly to government organisations that are key decision makers **about the need for science to continue** into the future.*

- Life sciences, female

- Lobbying for, or facilitating, a work culture change, especially when it comes to remote work opportunities;
- Providing guidelines to facilitate safe transport to and fieldwork in Antarctica; and
- Future-proofing environmentally responsible and safety-conscious operations in Antarctica to prevent SARS-CoV-2 from being endemic in Antarctica.

*I wish work from home was encouraged at my organisation. I am very exhausted by the time I reach my office. Plus, I'm burning out. Work from home is not treated as a possible thing to do. **So can SCAR honour and encourage scientists to work from home especially if there is no lab work?** I can't even concentrate on writing because of the stress I am going through. Sitting with a mask all day and none of my colleagues care to wear a mask. There is [also] no social distancing because of lack of space.*

- Postdoc, geo sciences, female



*If possible, **inquire and guide partner institutions to offer flexible work from home opportunities.** Try creating additional incentives for these institutes to do the same. Like rating and awarding institutes based on the mental wellbeing of their employees, safety precautions etc.*

- Postdoc, phys. sciences

*Even though almost all of my work can be done from home (I've made specific arrangements with purchasing new laptop and fast broadband connection), **made to work from the office** while COVID-19 spreads. Multiple people at work have had it but I'm still expected to come to office, which leads to anxiety/stress.*

- Postdoc, phys. sciences, female

(e) Take into account pandemic impact for work or funding reviews

The survey has shown that the pandemic has had a significant impact on mental health and productivity among participants, with further differences regarding severity depending on factors such as caregiving responsibilities and gender. To balance these differences, Langin (2021) suggests

- giving scientists the option to submit COVID-19 impact statements (detailing how the pandemic impeded their work) to funding agencies.

For SCAR, this might mean taking into account how pandemic disruptions impacted on individuals seeking support, e.g., fellowship applicants and visiting academics, and considering the weight of additional responsibilities, e.g., caregiving duties (cf. Nature Editorial 2021). Similarly, in order to support people with caring responsibilities, Greely (2020) proposes that

- faculties and research institutes treat people with significantly increased personal responsibilities (pandemic-induced) like they are on medical- or family leave (in regard to expectations on amount of research and publishing and tenure and promotion clocks), and announce this publicly and promptly.



*I am very happy to learn when **timelines (grants, fellowships, funding, etc.) get extended** and are flexible. These times are so unpredictable.*

- Life sciences, female

Tatham (2020) puts forward the idea that universities and research institutions protect their structurally most vulnerable members, ECRs, by introducing wider opportunities for them, e.g.,

- activating student protections when publishing, facilitating access to wider research placements, extending timeframes, and recognizing the need to earn money while studying full-time.

In summary, the following actions were indicated by survey participants to be the most helpful to alleviate pandemic-related negative impacts, noting that some of these might well be outside SCAR's realm of influence and responsibility:

Table 5. Suggested actions to support researchers in order of weighting

Suggested actions	Details	Most helpful for	
		ECRs	Caregivers
Provide additional funding opportunities	<ul style="list-style-type: none"> • for fieldwork and fieldwork-related expenses; • for work-related travel; • for additional work force/staff; • taking into account personal circumstances or additional responsibilities. 		
		X	X
Provide additional fellowships	<ul style="list-style-type: none"> • primarily for ECRs but also for researchers from countries with developing Antarctic programmes • consider asking for a personal impact statement. 	X	X
Facilitate data sharing and, where feasible, sample-sharing	<ul style="list-style-type: none"> • between nations/teams with Antarctic access and those without; • between ECRs and mid-to-late career scientists; • access to archived materials and scholarly publications. 		
		X	
Provide access to web-based activities	<ul style="list-style-type: none"> • confidential online support for struggling researchers (career-related); • confidential counselling services; • online conferences, workshops, meetings and training programmes (free of charge). 	X	
		X	X
		X	
Support and represent the Antarctic research community on a strategic level	<ul style="list-style-type: none"> • advocate with stakeholders for prioritising Antarctic science (esp. in regard to fieldwork and interdisciplinarity); • lobby for work culture change (remote work opportunities). 		
			X
Facilitate collaboration	<ul style="list-style-type: none"> • for ECRs, e.g., work experience/placement; • internationally (e.g., between nations with Antarctic access and those without) • mentorship programmes 	X	
Provide guidance	<ul style="list-style-type: none"> • to facilitate safe and environmentally sound transport to Antarctica and movement within Antarctica; • to support environmental decision-making with the goal of preventing COVID-19 from becoming endemic in the Antarctic. 		

6. Final remarks

The pandemic has shown the importance of robust science systems. These systems must be strengthened further (Rovenskaya et al. 2020; International Science Council 2021) and made more disaster-resilient, not only by enhancing agility, reliability and the science-policy interface, but also by ensuring continuing access for those who contribute to it. This is essential especially for the more vulnerable members of the science community. Recent improvements in diversity in science are at risk of being undone by COVID-19 (Woolston 2020b), and consequently, the call for inclusive academic work spaces is loud (Maas et al. 2020; Woolston 2020b). This support focus must extend not only to minorities and the structurally disadvantaged, but also to emerging researchers, in order to ensure a just, welcoming workplace and safeguard the long-term sustainability of research (Times Higher Education 2020).

Our survey has shown that what is true for the challenges that scientists worldwide face also holds true for those working under the umbrella of SCAR. Groups of researchers who were already vulnerable, i.e., ECRs, women (especially those with caregiving duties), and researchers from developing economics and countries with developing Antarctic programmes report a greater state of concern about their future in a research environment. While comparatively few participants from interdisciplinary studies and the humanities and social sciences responded to our survey, concerns about the potential devaluation of these disciplines in future research funding and support were clear in the responses received from this group. For researchers from field-based natural sciences, the concern that was voiced most loudly regarded ongoing and future restrictions to data-gathering and data-sharing opportunities. Worries about the future of Antarctic science and research as well as personal careers was evident through all career stages, but most noticeable in the responses from emerging researchers.

The polar sciences are facing challenging times and unprecedented disruptions as the repercussions of the pandemic develop. This involuntary pause may be taken by decision-makers and institutions as an opportunity to ‘reset’, in order to move towards a more resilient (and thus equitable) Antarctic research environment (cf. Petrov et al. 2020 for a perspective on the Arctic) – a “science for the post-normal age” of uncertainty (Funtowicz and Ravetz 1993). The virus, by many researchers estimated to be around for a long time (Phillips 2021), is likely to inform and shape our reality for the foreseeable future.

We feel satisfied that this survey was a useful first step towards understanding and supporting the varied needs of Antarctic researchers. Many participants expressed their approval of having been given the opportunity to voice their concerns and communicate the challenges that the pandemic has presented them. We hope that this document is useful in informing SCAR’s response to COVID-19 and can assist Antarctic researchers in adjusting to their changing research environments.

*It will be extremely important and useful for the recognized international academic institutions (like SCAR, or even COMNAP and the ATCM) to **make these COVID 19 difficulties public and official** so that the research management authorities and funding organizations are made aware and consider these circumstances in their work.*

- Life sciences, male



*[Can SCAR] **provide formal documents on the possible impacts** on the Antarctic researches due to the COVID-19 so that researchers could persuade their funders to amend plans adequately by referring it?*

- Geo sciences, male

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Appendix: Copy of the Antarctic COVID-19 Community Survey

Impacts of COVID-19 on the Antarctic research community

Understanding the impacts of COVID-19 on the Antarctic research community

This survey has been created by a research team affiliated with the Scientific Committee on Antarctic Research's (SCAR) Standing Committee on the Humanities and Social Sciences (SC-HASS). SCAR and SC-HASS want to better understand the impact of COVID-19 on the Antarctic research community.

Your responses to this survey will be used to inform the work of SC-HASS's Antarctic COVID-19 research team and may be used in academic publications, presentations, or workshops.

A report summarising the survey results will be made available to the SCAR Executive Committee which provided initial funding for this project. The survey results will inform decision-making and organisational responses within SCAR, its subsidiary groups and beyond. In particular, the survey results are expected to shape SCAR's strategies to mitigate any potential negative impacts of COVID-19 on the Antarctic research community.

All data collected in this survey are stored securely and will be destroyed after ten years.

In this survey, we ask about your work and wellbeing. Some of the questions ask about the impact that COVID-19 has had on you at multiple levels, including financial and mental impact. We realise that these questions have the potential to cause upset or distress. You are under no obligation to answer these questions, but if you do experience distress from reading or answering these questions and are in need of emotional support, please consult <https://checkpointorg.com/global/>.

Your participation in this survey is voluntary, confidential, and anonymous. It will take approximately 15-20 minutes to complete this survey. By clicking the red arrow below, you give consent to the use of the responses you provide as mentioned above.

This research has been reviewed and approved by the University of Canterbury's Human Ethics Committee. If you have any questions regarding this survey, please contact any of the project investigators: Andrea Herbert (andrea.herbert@canterbury.ac.nz) or Daniela Liggett (daniela.liggett@canterbury.ac.nz).

Thank you for your participation.

Antarctic work demographics

Q1. What type of organization or institution do you work for? Tick all that apply.

- University
- Technical college
- Research institute
- NGO
- Private business
- I am retired.
- I am self-employed.
- Other (please specify)

Q2. If you are an Early-Career Researcher (up to 5 years post-PhD, excluding career breaks), how has the pandemic impacted your mentoring or supervision?

- Supervision or mentoring have increased during the pandemic.
- Supervision or mentoring have decreased during the pandemic.
- Mentoring or supervision have not been impacted.
- I do not receive mentoring or supervision.
- I do not identify as an Early-Career Researcher.
- Not sure

Q3. If your mentoring or supervision have been impacted (positively or negatively) by the pandemic, please provide us with some details.**Q4. What best describes your current employment status?**

- permanent position, full-time
- permanent position, part-time
- fixed-term position, full-time
- fixed-term position, part-time
- self-employed
- furloughed
- postgraduate research student (e.g., PhD, MSc/MA student)
- unemployed

Q4.1 In what capacity are you employed on a fixed-term contract?

- As a postdoctoral researcher
- As a research assistant
- In a teaching-only capacity
- As a laboratory technician
- Other (please specify)

Q5. Which of the following best describes your main field of research or work?

- Geosciences
- Life Sciences
- Physical Sciences
- Social Sciences and Humanities

- Logistics and Operations
- Management
- Governance
- Other (please specify)

Q6. In addition to your main field of work, are you involved in any of the following activities?

	Not involved	Less than 50% of my work time and/or income	50% or more of my work time and/or income
Antarctic research			
Policy-making			
Antarctic tourism			
Antarctic operations			
Antarctic consulting			
Other (please specify)			

Q7. When did you become involved with Antarctic work or study?

- prior to the 1980s
- in the 1980s
- in the 1990s
- in the 2000s
- between 2010 and 2015
- after 2015

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Q8. In which geographic area of Antarctica do you work? Select all that apply.

- Antarctic Peninsula
- King George Island
- Dry Valleys
- East Antarctica
- West Antarctica
- Dronning Maud Land
- High Plateau
- Southern Ocean
- Sub-Antarctic Islands
- Other (please specify)
- I do not physically work in Antarctica.

Q9. How important is Antarctic fieldwork (including field or base support activities) in your job?

- Extremely important
- Very important
- Moderately important
- Slightly important
- Not at all important

Q10. How important are repeated or continuous field seasons to achieve your research objectives?

- Extremely important
- Very important
- Moderately important
- Slightly important
- Not at all important

Q11. What type of data or samples do you collect in Antarctica? Select all that apply.

- Organic/biological samples
- Inorganic samples (air, water, snow, ice, rock)
- Atmospheric data
- Oceanographic data
- Ice/snow data
- Astrophysics data
- Geology/solid earth data
- Magnetic/electric field data
- Ice core/sediment core
- Medical data
- Socio-political data
- Purely electronic data
- Other (please specify)
- I do not collect data or samples in Antarctica.

Q12. How are the data or samples you require for your research collected? Select all that apply.

- collected in Antarctica by myself
- collected in Antarctica by others/field campaign
- collected via remote sensing/satellite
- collected automatically (e.g., weather stations)

- collected by equipment installed in Antarctica
- Other (please specify)

Q13. How are your data or samples transported from Antarctica to your home institution? Select all that apply.

- By aircraft (including planes and helicopters)
- By ship
- By a combination of aircraft and ships
- By real-time data transmission
- Not applicable

Q14. When was your most recent Antarctic field season?

- 2020/21
- 2019/20
- 2018/19
- 2017/18
- 2016 or earlier

Q15. What mode of transport did you use to get to Antarctica in your most recent field season? Consider only the last leg of the journey here, e.g. from one of the gateway ports.

- By plane
- By ship
- Combination of both

Q16. During your most recent field season, what modes of intra-continental transport did you use? Select all that apply.

- Plane
- Helicopter
- Motorized track vehicle
- Motorized non-track vehicle
- Snow mobile
- Boat
- None of these
- Other (please specify)

Q17. In your last field season, how many research stations, in addition to your main base, did you visit?

- I didn't visit any other research stations.
- 1
- 2
- 3
- 4
- More than 4

Q18. In your last field season, how many field camps away from your research station did you visit?

- I didn't visit any field camps.
- 1
- 2
- 3
- 4
- More than 4

Q19. Over the past 6 months, can you recall any occasion when your work or research suffered because of COVID-19?

- Yes
- No

Q20. Has your 2020/21 field season been amended, postponed, or cancelled because of COVID-19?

- Yes, it has been cancelled.
- Yes, it has been postponed. Please specify until when it has been postponed.
- Yes, it has been amended (e.g., shortened, or otherwise impacted). Please specify how it has been impacted.
- No, it is going ahead as scheduled.
- Not sure
- Not applicable

Q21. What actions, if any, did you take to overcome the negative impact on your research caused by COVID-19? Select all that apply.

- I was unable to do anything.
- I simply adjusted my own expectations.
- I changed my research aims.
- I changed my research methods.

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- I asked colleagues from my own institution for help.
- I asked national colleagues (from other institutes in my country) for help.
- I asked international colleagues for help.
- I asked my (post)graduate students to take on additional work.
- I asked my employer/institution for support.
- I asked my National Antarctic Programme for support.
- I asked for extensions with report deadlines.
- I asked for extensions for funding applications.
- Other (please specify)

Q22. Outside Antarctica, where do you usually (i.e., prior to 2020) conduct your work? Select all that apply.

- Laboratories or offices in my research centre/university
- Libraries or archives
- I work from home.
- Other (please specify)

Q23. What is negatively impacting your work-related productivity? (1 = no impact, 7 = extreme impact)

	1 (no impact)	2	3	4	5	6	7 (extreme impact)	Not applicable
Distractions while working from home								
Inadequate internet connection								
Online teaching responsibilities								
Care-giving responsibilities (please indicate to whom: children - parents - friends, etc.)								
I have, or have had, COVID-19.								
A loved one had COVID-19.								
Fieldwork is no longer possible.								

Necessary workshops or training sessions have been postponed or cancelled.								
Negative financial impact								
Forced lockdown								
Having children at home								
Having a spouse or flatmates at home								
Inadequate work space (e.g., setup of desk, lack of technical or lab equipment)								
Stress								
Other (please specify)								

**Q24. What negative impacts has the COVID-19 pandemic had on your professional life or career?
(Select all that apply.)**

- Inability to advance in my career
- My contract was not renewed.
- I lost my job.
- Loss of funding
- Inability to attract research funding
- Inability to finish my degree
- Inability to attract new students
- Inability to hire new staff
- Inability to conduct fieldwork
- Reduced work hours
- Reduced income
- Inability to meet existing research objectives
- Reduced number of publications
- Decreased output quality

- Inability to contribute to the research environment (e.g., service roles, editorial board obligations)
- Reduced opportunities to network
- Increased administrative workload
- Increased teaching workload
- Increased service workload
- Other (please specify)
- I have not experienced any negative impacts.

25. What, if any, positive impacts related to COVID-19 have you experienced in your work?

	I have experienced this	I have not experienced this	Not applicable
Benefits of working from home			
Online trainings or workshops I wouldn't otherwise attend			
Online conferences I wouldn't otherwise attend			
New research opportunities			
More multidisciplinary opportunities			
Virtual meetings resulting in increased collaborations			
Extended grants or deadlines			
COVID-19 has highlighted societal vulnerabilities that can now be addressed.			
Other (please specify)			

Q26. How will COVID-19 impact your research and support activities for the upcoming Antarctic seasons (2020/21 and beyond)?

- Extremely negatively
- Moderately negatively
- Slightly negatively
- Neither positively nor negatively
- Slightly positively
- Moderately positively
- Extremely positively

Q27. To what extent will your Antarctic output (e.g., publications, reports, presentations, public outreach) change in 2020/21, compared to 2018/19?

- It will decrease significantly.
- It will decrease slightly.
- It will not change.
- It will increase slightly.
- It will increase significantly.
- I don't know.

Q28. For how long do you anticipate COVID-19 to affect your productivity?

- Only over the short term (until the next Antarctic field season starts in late 2020)
- Over a medium term (until the end of the 2021/22 field season)
- It will have a long-term effect (beyond the end of the 2022 field season).

Q29. To what extent would the following help you in reducing the negative impacts of COVID-19?

- Access to additional funding (please specify what for)
- Free access to data collected by others (please specify what kind of data)
- Access to a mentor to offer research advice and support
- Access to a mentor to offer personal support
- Access to equipment (please specify)
- More fellowship opportunities
- Access to child care
- Opportunities to participate in and present at online conferences
- Bursaries to cover lost income
- Confidential counselling services
- Opportunities to share my experiences with others in a confidential and friendly setting
- Other (please specify)

Q30. Regarding your overall mental health, how are you feeling right now?

- Extremely dissatisfied
- Moderately dissatisfied
- Slightly dissatisfied
- Neither satisfied nor dissatisfied
- Slightly satisfied

- Moderately satisfied
- Extremely satisfied

Q31. What negative impacts, if any, has the COVID-19 pandemic (had) on your mental wellbeing?

	Extreme impact	Significant impact	Moderate impact	Slight impact	No impact	Not applicable
Grieving						
Trouble sleeping						
Trouble concentrating						
Lack of motivation						
Fear others don't respect the new health guidelines						
Fear about getting COVID-19						
Fear about the future of Antarctic research/work						
Fear that health guidelines are not evidence-based						
Increased stress levels						
Increased anxiety						
Other (please specify)						

Q32. What are your greatest concerns regarding the future? (Leave blank if none)

Q33. If you wish to indicate specific needs for yourself (i.e., reasonable adjustments required, or related to disabilities), please do so here.

Q34. What specifically could SCAR, COMNAP, the ATCM, or any other pertinent organisation, do to help you?

Q35. Do you have any additional comments?

Demographics

Q36. In this last part of the survey, we would like to ask you some demographic questions.

What is your gender?

- Woman
- Man
- Non-binary
- Other (please specify)
- Prefer not to say

Q37. What is your nationality?

Q38. What is your ethnicity, i.e., the cultural group to which you perceive you belong? (Leave blank if you prefer not to answer.)

Q39. In which country is your main residence?

Q40. How old are you?

- under 20 years
- 20 to 29 years
- 30 to 39 years
- 40 to 49 years
- 50 to 59 years
- 60 to 69 years
- 70 years or older

Q41. What is your highest tertiary qualification?

- Graduate certificate/diploma
- Bachelor's degree
- Postgraduate certificate/diploma
- Master's degree
- PhD
- Other (please specify)

Q42. In which year did you complete your highest degree?

Q43. How many people live in your household, yourself included?

Q44. How many of the members of your household are under the age of 18 years?

Q45. What percentage of the total household income do you contribute with your income? Your best estimate is fine. (Leave blank if you prefer not to answer.)

Q46. Thank you for your participation. We very much appreciate that you took the time to complete this survey.

If you have experienced distress from reading or answering any of our questions and are in need of emotional support, please consult <https://checkpointorg.com/global/>.

If you have any questions regarding this survey, please contact any of the project investigators: Andrea Herbert (andrea.herbert@canterbury.ac.nz) or Daniela Liggett (daniela.liggett@canterbury.ac.nz).

A brief overview of the survey results will be made available on the SCAR website and will be announced via the SCAR Newsletter. However, if you wish to receive a personal update and notification of the survey results, please click "Yes" below to enter your email address. Your email address cannot be linked to the responses in this survey.

- Yes, I would like to receive an update and notification of the survey results
- No, thanks