Greener Solvents Project

Solvent Use in Conservation

2024 Survey Results

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Executive Summary

The Greener Solvent Project created by Sustainability in Conservation (SiC) aims to support greener solvent research and connect conservators with resources that provide information on solvents with lower impacts on health and the environment. During the 2022 Greener Solvents Expert's Meeting organized by the Getty Conservation Institute (GCI) and the Royal Institute for Cultural Heritage, Belgium (KIK-IRPA), experts recognized the gap in our knowledge regarding current solvent use in cultural heritage. One specific meeting outcome was thus the need for a survey to understand which solvents are used, to determine the types of solvent safety resources referenced by conservators, and to gain insights into conservator's potential and longer term solvent-associated health problems.

To accomplish these goals, a peer-reviewed, web-based survey was created in 2023 using Qualtrics. The questions composed within the survey initially took inspiration from previous surveys about solvent use in conservation. Drafts of the survey were reviewed by experts, including the participants and contributors from GCI/KIK-IRPA Greener Solvents Expert's Meeting, and an external professor in Public Health, before review by UD's Institutional Review Board, translation into 8 languages, and worldwide dissemination in 2024. Researchers utilized Excel and the Tableau suite to interpret and visualize the survey data after clean-up to ensure accurate representation. Of the 878 responses collected, 293 lacked the necessary responses to all the questions for generating comparative data. The remaining 585 could be deemed valid and were included in data interpretation.

Key Takeaways

Survey Respondents

The survey reached worldwide and achieved an international response. Since the majority of respondents come from Europe and North America, the data is more representative of solvent use there than in other continents.

Most respondents are practicing conservators, working in a variety of conservation disciplines. The largest specialty group was paintings, followed closely by objects, and 226 respondents picked more than one specialty.

The greatest number of respondents work in public institutions (e.g. museums, regional conservation centers), followed by private practice, and hybrid work situations. The other answers were all university related, with answers from students, instructors, and those who work in a university managed space.

Solvent safety and hazards awareness

Approximately half of the respondents have received workplace safety and hazard training in the past year. Of them, about 75% reported that it included chemical hazard training.

According to survey results, completion of training has a slightly different outcome based on type of workplace. Respondents working in public institutions have the highest familiarity with SDS sheets. Others working in institutions or university related have the highest completion of chemical hazard

training and workplace training. Those in private practice report the lowest percentage of completeness for chemical hazard training, as well as workplace training.

Just over half of the survey respondents were familiar with the Globally Harmonized System for Classification and Labelling of chemicals (GHS), showing that this system hasn't made a major impact on the field.

This survey collected data regarding disposal of solvents, acknowledging the life cycle of solvents. Most respondents dispose of their solvents using evaporation, and then private waste management programs. There are conservators who dispose of their solvents into municipal waste services. It is unclear how solvents are evaporated and where fumes are extracted to.

From the responses it seems that conservators turn first to PPE over proper air flow and ventilation (which should always be a first step). 98% of the respondents said they use PPE, while fewer (75%) use proper air flow and ventilation. Fume hoods are available for 61% and other emergency measures such as showers and eye wash stations were available to less than half of the respondents.

Health Concerns

A lack of correlation is observed in the survey data between safety resources and experienced health problems. This questions the actual implementation of solvent safety knowledge and appropriate measures, and corresponds for instance, with the indications of inappropriate PPE use as noted above.

In more than half of the overall responses, respondents noted no observed health problems associated with solvent use. The people who reported symptoms experienced mostly acute minor health problems. This can be anticipated given the greater ease in being able to associate short-term symptoms with immediate exposure to solvents, and the greater difficulty in concretely being able to identify related long-term health effects.

Also within each specialty 50% or more of responses reported experiencing no health problems associated with solvent use. Objects and paintings have the greatest percentage of responses reporting acute minor health problems.

The top ten most health concerning solvents as identified by the respondents were **xylene**, **toluene**, **acetone**, aromatic solvents, **white spirits**, **ethanol**, **ethyl acetate**, dimethylformamide, methyl ethyl ketone, and **petroleum distillates**. Those noted in bold were also among the top ten most generally used solvents.

Most used solvents

The top 10 solvents across all disciples were: ethanol, acetone, isopropanol, white spirit, acetic acid, mineral spirits, xylene, Shellsol D40/T/D, toluene, ethyl acetate.

Another important finding is which solvents are not reported being used, such as some particularly harmful solvents that were mentioned in the 1998 AIC survey. This shows a greater awareness of

solvent properties and a significant change in the right direction in conservation practice over the past 25 years.

For the top 5 solvents there are similarities in solvent trends across the different specialties, but also some outliers which don't appear in the general top 10 such as hexane for electronic media. Toluene is also in the top 5 for preventive and book and paper.

Across all the continents ethanol is the most widely used. Toluene, and also xylene are in the top 5 for Asia and South America.

Conclusions

The survey successfully met the original objectives and provided information on the current use of solvents in conservation today.

The survey has revealed gaps in the understanding and implementation of proper and safe solvent use in practice, and highlighted the need for more professional approach towards solvent exposure workplace practices in conservation at large.

Though the survey met many of its goals, there were limitations both inherent in the survey structure and related to the geographical spread of the data, which hindered the possibility to draw certain conclusions regarding solvent use.

Next Steps

Increasing the familiarity of conservators with GHS would be a highly beneficial next step.

Distributing a new solvent survey semi-frequently is also recommended. This would provide better insights into any developments or changes in solvent use over time. Suggestions for such surveys are:

Ideally these subsequent surveys would similarly undergo a rigorous review system, which could include a greater involvement of conservators from different specialties to ensure that the survey goals can be achieved.

Revised questions could gauge conservators' confidence in implementing safety protocols and resources when using solvents.

A future survey could consider asking respondents about their considerations of environmental impacts with solvent use.

A future survey could ask which reasons might prevent respondents from switching to a safer/greener solvent alternative.

Being able to collect anonymized medical information on conservators' later-in-life health complaints would also be highly valuable in evaluating these impacts from solvent use.

Survey results support the need for the ongoing research within the Greener Solvent Project into finding alternatives for toluene and xylene within conservation practice.

Introduction

Inherently aligned with sustainability goals a conservator's goal is to help preserve cultural heritage for the future. Whilst they will evaluate their treatment approaches and decisions in terms of the benefit for the object's lifetime and longevity, they might not assess how their solvent choice in that treatment will affect themselves and the environment. Yet intrinsically, from a sustainable perspective, a conservator must be concerned with both the lifetime of the object and their own. A central need in this are informed solvent choices to reduce harm.

Accordingly, Sustainability in Conservation (SiC) created the Greener Solvent Project in reaction to the lack of research around sustainable solvent practices in cultural heritage. The Greener Solvent Project's goal is to support research and connect conservators with resources that provide accurate information on greener solvent assessments and potential alternatives, thereby enabling solvent selections for reduced health and environmental impacts. To complete this objective, this project focuses on creating open-access resources which are informed by contemporary solvent research into practical, accessible greener solvent alternatives. Whilst the terminology of 'green' will continue to evolve, key aspects for consideration are the impacts related to a material's production, use and end-of-life. A solvent can therefore be deemed "greener" based on its life cycle assessment and health and safety hazards. Since every organic solvent carries hazards the terminology is both inherently and critically comparative.

Currently, the Greener Solvent Project's handbook, called *Greener Solvents in Conservation: An Introductory Guide*, aims to describe how conservators can implement safer, greener solvent practices immediately. It offers accessible information on assessing solvents, finding safer alternatives and how to dispose of hazardous solvents. This guidebook is freely available on the Sustainability in Conservation website, and is also available to purchase from Archetype.

Another open access initiative is The Greener Solvent Project's open database, containing information regarding solvent use, based on substrate. As a conservator's consideration of which solvent is suitable depends in the first place on the type of object, this database is organized to describe the health, safety, and environmental hazards of the solvent and offer appropriate solvent alternatives regarding materiality. To populate this database, further research into solvent alternatives is necessary, in tandem with understanding what solvents conservators use today.

In December 2022, the Getty Conservation Institute alongside the Royal Institute for Global Heritage (KIK-IRPA) organized an Expert's Meeting to discuss future steps for the Greener Solvent Project. During this meeting, 14 professionals with a formidable knowledge of greener chemistry and sustainability gathered to consider solvent use in conservation. In the end, a vote was reached to determine the most important subsequent actions of the Greener Solvent Project. Amongst these was noted the need to research solvent alternatives for xylene and toluene (Fife, Doutre, 2024).

Definitively, the experts recognized the pressing need for a survey regarding current solvent use in cultural heritage. The previous survey known regarding solvent use in conservation was done by the American

Institute of Conservation in 1998, which was only for AIC members. The Greener Solvent Project's survey, conducted from April to June of 2024, was made as widely accessible to every conservator in the field as possible.

The survey asks conservators how regularly they use solvents, and which they use, providing insights into which solvents most critically need to be replaced or require appropriate alternatives. To address concerns based on health, safety, and environmental hazards, the survey also asks how conservators use solvents in their workplace, including their PPE provisions and how they dispose of used chemicals. Furthermore, this survey looks at solvent use corresponding to health effects. Until now, as far as the authors are aware, this link has never been examined within cultural heritage. The survey's goals are to understand how cultural heritage conservation professionals use solvents in their current practices, inform on the personal and potentially broader impacts of this solvent use and provide guidance for ongoing research into alternatives.

Methodology

Survey Creation

The web-based survey was created in the spring and summer of 2023 in collaboration with Naomi Toyama, then a senior at the University of Delaware majoring in Art Conservation, and Lucile Pourett, a graduate student of conservation at École supérieure d'art d'Avignon. The survey was made from a compilation of previous surveys[1] about solvents in art conservation where the most relevant questions to this survey's goals were chosen and implemented in the 2024 survey. A draft was submitted to the experts from the GCI Greener Solvents experts meeting for peer review to finalize the questions. Afterwards, the survey was translated into 8 other languages (traditional Chinese, simplified Chinese, Japanese, German, Italian, French, Spanish, and Portuguese) by SiC volunteers Momoko Okuyama, Julia Wagner, Annalisa Marra, Lucile Pourret, Josefa Orrego, Catarina Pinheiro, Hilary Kwan, and Chenyue Xu to ensure greater global accessibility. Because the survey involves research with human subjects, the survey was submitted to the University of Delaware's Institutional Review Board (IRB) to ensure adherence to ethical regulations and protection of the subjects. On November 28th 2023, the survey was reviewed and approved.

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[1] (Survey 1): AIC. 1998. "Health and Safety News - Results of the Health and Safety Committee Survey." *AIC News* 23, no. 1: 42-45. https://www.culturalheritage.org/docs/default-source/publications/periodicals/newsletter/aic-news-vol-23-(1998).pdf?sfvrsn=a89e0f20_4

(Survey 2): Dantec, Nathalie Palmade-Le. n.d. "L'UTILISATION DES SOLVANTS ORGANIQUES." Google Form Survey for Thesis Research at the University School of Research Humanities, Creation and Heritage, supported by the Comue Université Paris-Seine. Last accessed August 14, 2024. https://docs.google.com/forms/d/e/1FAIpQLSfXjScLugTayU2nNz5sB93KE9xDzPT3zpHHjXToJCbluye_Lg/viewform?vc=0&c=0&w=1&flr=0

The final survey consisted of 27 questions in total and was created in Qualtrics. There was 1 drop down, 9 multi-select multiple choice, and 15 single-select multiple choice, and 2 free-text short answer questions. Of the 24 multiple choice questions, 16 allowed for additional free-text short answer responses outside of the choices provided in the "Others (please specify)" box.

A link to the survey can be found here.

Dissemination

Initial dissemination of the survey link involved e-blasts to the University of Delaware and SiC's list of contacts in collections care and conservation professional organizations (e.g. ICOM-CC, ICCROM, ICON, ICOMOS and over 100 regional organizations in Europe, South America, North America, Asia and Oceania). The contacts were asked to aid in dissemination by forwarding the email or re-posting the survey on their social media and other web outlets.

Data Collection

From April to June in 2024, the survey was live via Qualtrics. Responses were automatically collected before they were exported to a Microsoft Excel file for data interpretation and visualization.

Data Interpretation and Visualization

Data interpretation began with data clean-up using Microsoft Excel and Tableau Prep Builder. Because the survey was disseminated in multiple languages, non-English answers were translated to English with the aid of Google Translate and other online translator sites. Professional language translators were considered, but the simple nature of the short answers allowed for translations without their assistance. Free-text short-answer survey responses were also edited for clarity and recategorized as necessary to more accurately represent the data. At times, responses were updated based on the short answers associated with the same question to ensure consistency in the data. Free text responses were edited for clarity and categorized. In addition, data clean-up involved eliminating empty and incomplete responses that provided no solvent-use data. Eliminated incomplete responses corresponded with 0-45% survey completion. Of the 878 responses collected, only 585 were valid and included in the data interpretation. 545 out of 585 respondents answered every question in the survey. On average, the respondents completed 97% of the survey, and the median time for completion was 8 minutes. Tableau Prep Builder and Desktop were used for data interpretation and visualization. Visualization was also accomplished with Excel depending on the complexity and breadth of the data.

Survey Results

The results are organized thus: demographics, safety data, solvent use and personal safety. Every section includes the question from the survey that generated its data, indicated by a text box prior to its corresponding figures.

Response Population Statistics

The following section identifies who responds to the survey and gathers data based on where and what kind of conservation the respondent practices.

Geography

Q: What country/countries do you currently and predominantly base your practice in?
Multi-select answer options: List of countries

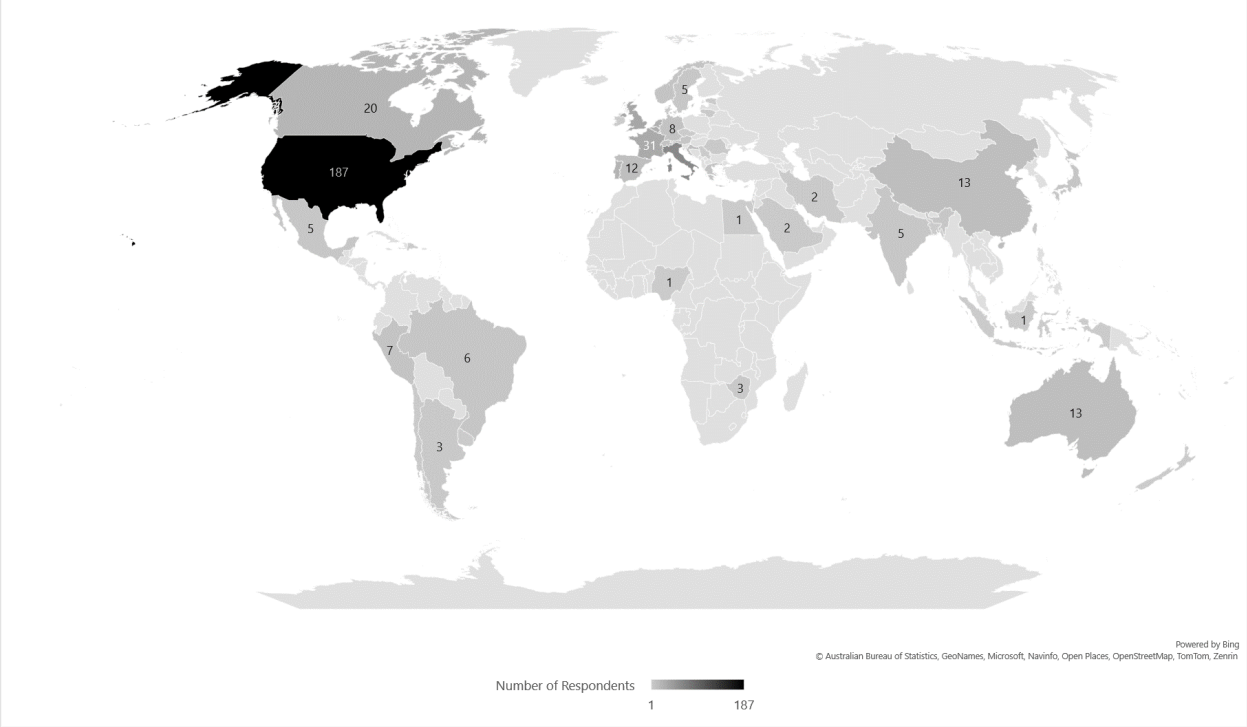


Figure 1. *A world map depicting the distribution of responses per country. The darker the color of each country indicates more respondents.*

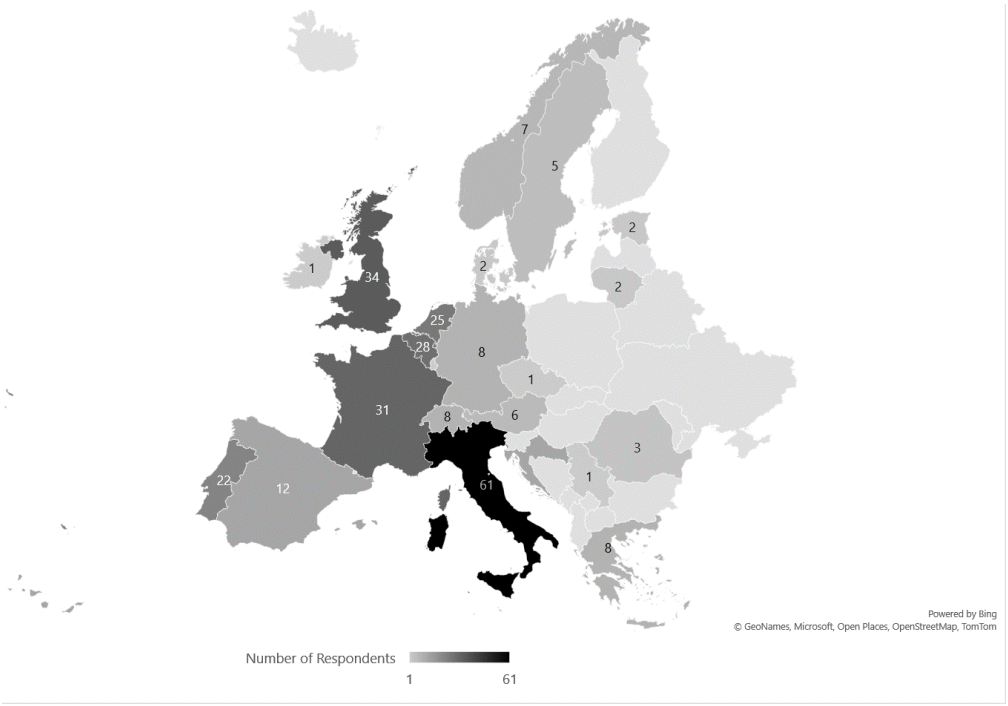


Figure 2. *A closeup map on the distribution of European Responses.*

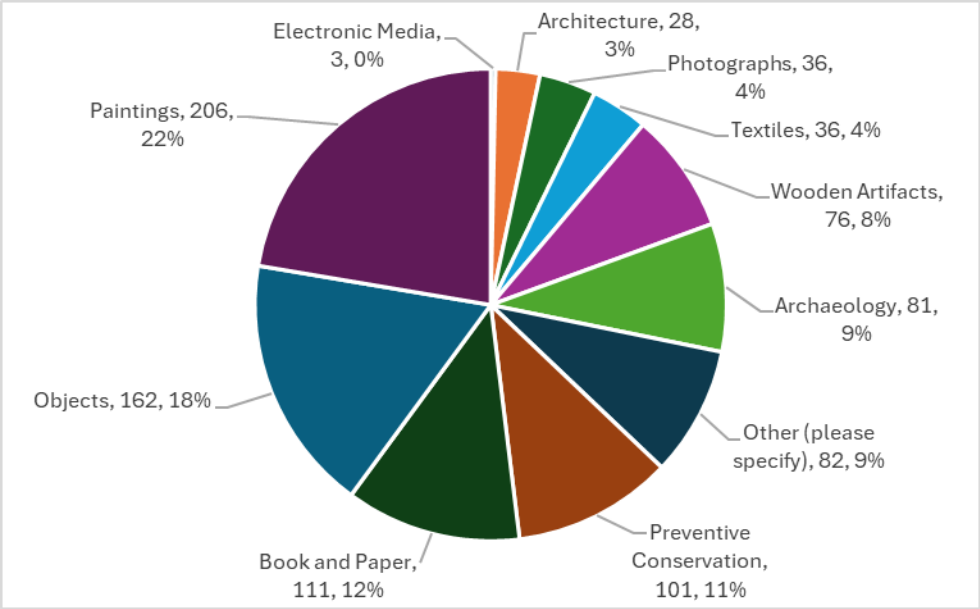
CONTINENT	SUM OF RESPONSES	INDIVIDUAL COUNTRIES RESPONSES			
AFRICA	5	Egypt-1	Nigeria-1	Zimbabwe- 3	
ASIA	40	Bangladesh-1	Brunei-1	China -13	Hong Kong-5
		India – 5	Indonesia - 1	Iran - 2	Israel-1
		Japan-6	Saudi Arabia - 2	Taiwan -3	
AUSTRALIA / OCEANIA	14	Australia- 13	New Zealand- 1		
EUROPE	285	Austria – 6	Belgium – 28	Canary Islands - 1	Croatia- 12
		Czech Republic – 1	Denmark – 2	Estonia - 2	France – 30
		Germany- 7	Greece – 8	Ireland – 1	Italy - 60
		Lithuania – 2	Luxemburg – 1	Malta - 3	Netherlands -25
		Norway – 7	Portugal – 22	Romania -3	Serbia – 1
		Spain – 12	Sweden – 5	Switzerland – 8	United Kingdom - 34
NORTH AMERICA	212	Canada – 20	Dominican Republic- 1	Mexico – 5	United States - 187
SOUTH AMERICA	19	Argentina – 3	Brazil – 6	Peru – 7	Uruguay -1

Table 1. Table for the Geographical Distribution of Respondents. *This figure presents the table, showing the distribution by continent and country. In the validated data, 21 respondents skipped this question while 564 answered it. This question was multi-select, meaning respondents can choose more than one country they practice in. Therefore, each respondent is counted as many times as they answered a unique country. They have been listed for each country they reported; for example, if one person said they practiced in the United States and Canada, then both countries would be represented. Within this table, it is organized alphabetically and by continent.*

Most respondents come from Europe and North America. These continents, in their following solvent data, have a more accurate representation of what solvents are being used than those continents with smaller sample sizes.

Specializations

Q: What is your area of specialization? (List taken from AIC's Conservation Specialties tab)
Multi-select answer choices: Architecture, Archaeology, Book and Paper, Electronic Media, Objects, Preventive Conservation, Photographs, Paintings, Textiles, Wooden Artifacts, and/ or Other (Please Specify)



Specialty	Archaeology		Architecture		Book and Paper		Electronic Media		Objects		Other (please specify)	
Count, Percent of total	81	9%	28	3%	111	12%	3	0%	158	18%	82	9%
Specialty	**Paintings**		**Preventive Conservation**		**Photographs**		**Textiles**		**Wooden Artifacts**			
Count, Percent of Total	206	22%	101	11%	36	4%	36	4%	76	8%		

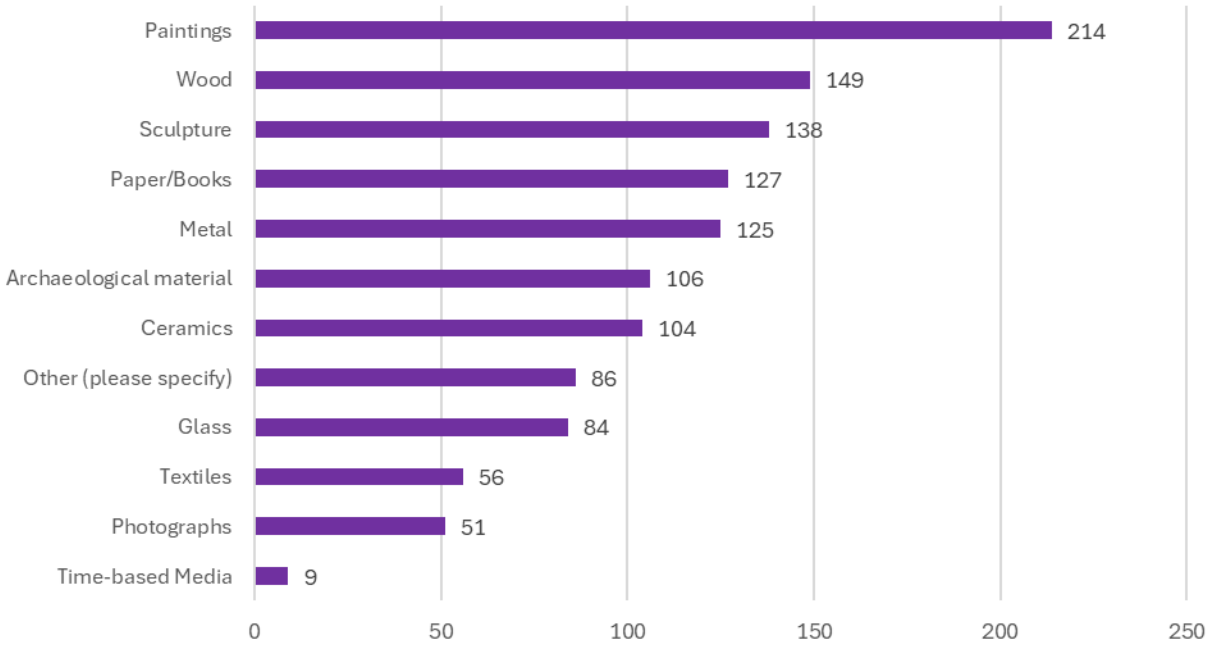
Figure 4. Specialties Distribution. *This figure features a pie chart and a table containing the count and percentage of total of each specialization option. For this question, 566 respondents answered and 19 did not. This multi-select question allowed respondents to select more than one specialty they work in (i.e. a respondent could answer Preventive Conservation and Archaeology). Therefore, each respondent is counted as many times as they answered a unique specialty.*

Other (please specify) represent the free text responses that respondents answered to clarify, specify, or to include an answer they felt was not represented in the original answer choices. In this question, it was the 5th most reported answer, with 82 responses. Out of these answers, 10 report they work on sculptures, 9 work on contemporary art, and 8 work with stone. To see the rest of the answer distribution of the other category, see Appendix.

The largest group of specialties reported was paintings, followed closely by objects. This data was multi-select, and 226 respondents picked more than one specialty.

Materials

Q: What materials/types of objects do you work with most frequently?
Multi-select answer choices: Paintings, Wooden Artifacts, Sculpture, Paper/Books, Metal, Archaeological Materials, Glass, Textiles, Photographs, Time-based media, and/or Other (please specify)



	Time-based Media	Photographs	Textiles	Glass	Other (please specify)	Ceramics	Archaeological material	Metal	Paper/Books	Sculpture	Wood	Paintings
Count	9	51	56	84	86	104	106	125	127	138	149	214

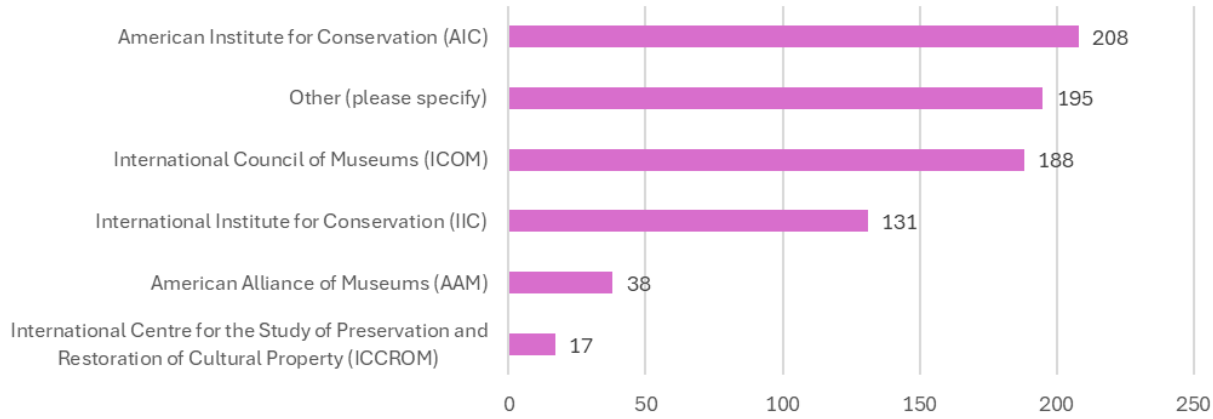
Figure 5. Material Type *This bar graph includes a table that shows the count of different material types that respondents conserve. Out of the validated data, 559 respondents answered this question and 26 did not. This question was multi-select, so respondents could pick multiple answer choices. (i.e. a respondent can choose both glass and textiles, and be counted in both)*

86 respondents used the free 'Other (please specify)' text answer to clarify material types or discipline (# respondents): organic objects (12), plastics (11), stone (8), plaster (6), wall paintings (5), lacquer (5), researchers (4), specimens (4), taxidermy (3) ,contemporary art (3), frames (2), composite objects (2), marine objects (2), natural history specimens (2), gemstones (2), painted surfaces (2), musical instruments (2), gilding (2), sculpture (2), Asian paintings (1), composite objects (1), fossils (1), jewelry (1), cinema 1), mosaics (1), mixed media objects (1).

Most respondents work with paintings, which corresponds with the **Specialty Distribution (Figure 4)**. 308 respondents picked more than one material type.

Affiliations

Q: Are you affiliated with any organizations pertaining to your country's conservation/restoration practices (member, volunteer, etc.)?
Multi-select answers choices: Over 30 different international affiliations, and Other (please specify)



	International Centre for the Study of Preservation and Restoration of Cultural Property (ICCROM)	American Alliance of Museums (AAM)	International Institute for Conservation (IIC)	International Council of Museums (ICOM)	Other (please specify)	American Institute for Conservation (AIC)
Count of Responses	17	38	131	188	195	208

Figure 6. Affiliation Distribution. *This figure includes a bar graph and table, showing the count for each affiliation preselected. It is sorted from the most responses to the least from the answer choices provided. For this question, 464 respondents answered while 121 respondents did not answer out of the already validated data. One respondent can choose multiple answer choices in this question type. (i.e., a respondent might be a part of the American Alliance of Museum (AAM) and the International Council of Museums (ICOM))*

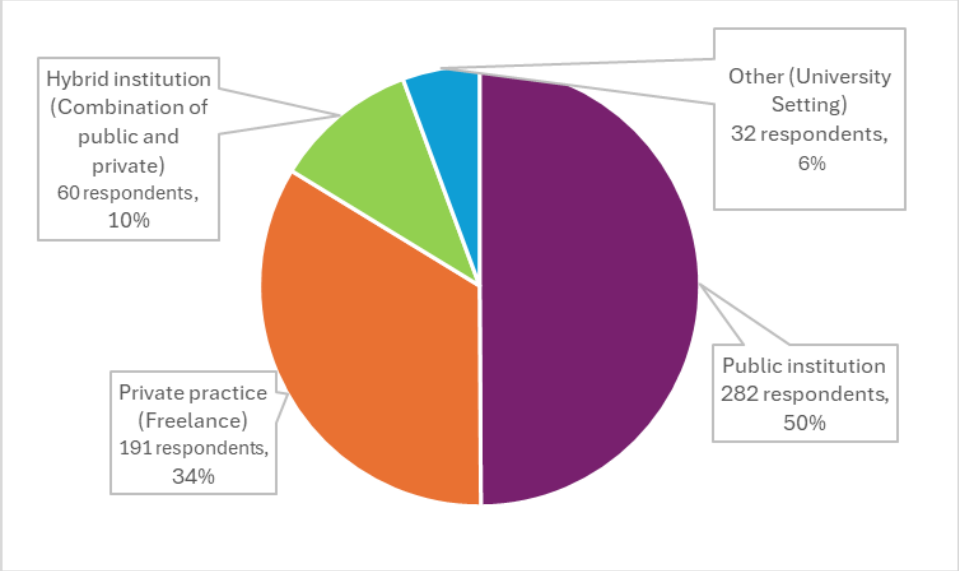
In this graph's case, any answer choices that were included in the survey with 10 or less responses were omitted from the graph for clarity. They are listed here instead. 10 respondents are a part of the International Council on Monuments and Sites (ICOMOS), 6 are a part of the American Association for State and Local History (AASLH), 4 are a part of the Institute of Museums and Library Services (IMLS), 3 are a part of Canadian Museum Association (CMA), 3 are a part of the Canadian Conservation Institute (CCI), 2 are a part of Museum Associations (UK), 2 are a part of Canadian Heritage Information Network (CHIN), 1 is a part of the Association of European Open Air Museums (AEOM), 1 is a part of Museum Association of the Caribbean (MAC), and 1 is a part of the Association of Children's Museum.

In the Other (please specify) section 28 respondents answered that they were a part of the Institute of Conservation (ICON), 12 reported that they were affiliated with Australian Institute for the Conservation of Cultural Materials (AICCM), and 10 reported they were with Fédération Française des Conservateurs-Restaurateurs (FFCR). See Appendix with all free response answers to this questions.

Most of the respondents are part of the American Institute of Conservation, but it is just narrowly more than the Other Responses, which are also regional except ICOMOS. The international organizations ICOM and IIC were respectively the second and third highest affiliations amongst respondents.

Institution Types

Q: Do you work primarily in a public institution, a hybrid institution, or in private practice?
Single-select answer choices: Private practice (Freelance), Hybrid institution (Regional center, other workplaces that are a combination of public and private), Public institution (Museum, art gallery, heritage care organization, government funded workplace) or Other (please specify)



Institution type	Public	Private	Other	Hybrid
Count	282	191	35	60
Percentage of total	50%	34%	6%	10%

Figure 7. Institution Type. *This figure contains a pie chart and graph with the count and percentage of what kind of institution that the respondents work in. 568 respondents answered this question, 17 did not answer. This question was single-select, so respondents can only select one kind of institution. The percentage represents the choice out of the total number of respondents who answered this question.*

Although an Other (please specify) choice was given, the answers were all university related. To see their full responses, please refer to Appendix.

The greatest number of respondents work in a public institution, followed by private practice, and hybrid institutions. The other answers were all university related, with some answers from students, some from instructors, and some who work in a university managed space.

Conservation Experience Within the Last 3 Years

Q: Have you practiced conservation in the past three years?
Single-select answer choices: Yes or no

Answer	Count	Percentage of Total
Yes	555	97%
No	15	3%

Table 2. Conservation Experience. *This table contains the count and percentage of how many respondents have practiced conservation within the last three years. This question is a single-select, so respondents may only choose one answer. 570 respondents answered this question, while 15 did not answer.*

97% of respondents have practiced conservation within the last three years. This data indicates the following solvent data is based on current and recent practices, not from long-retired conservators.

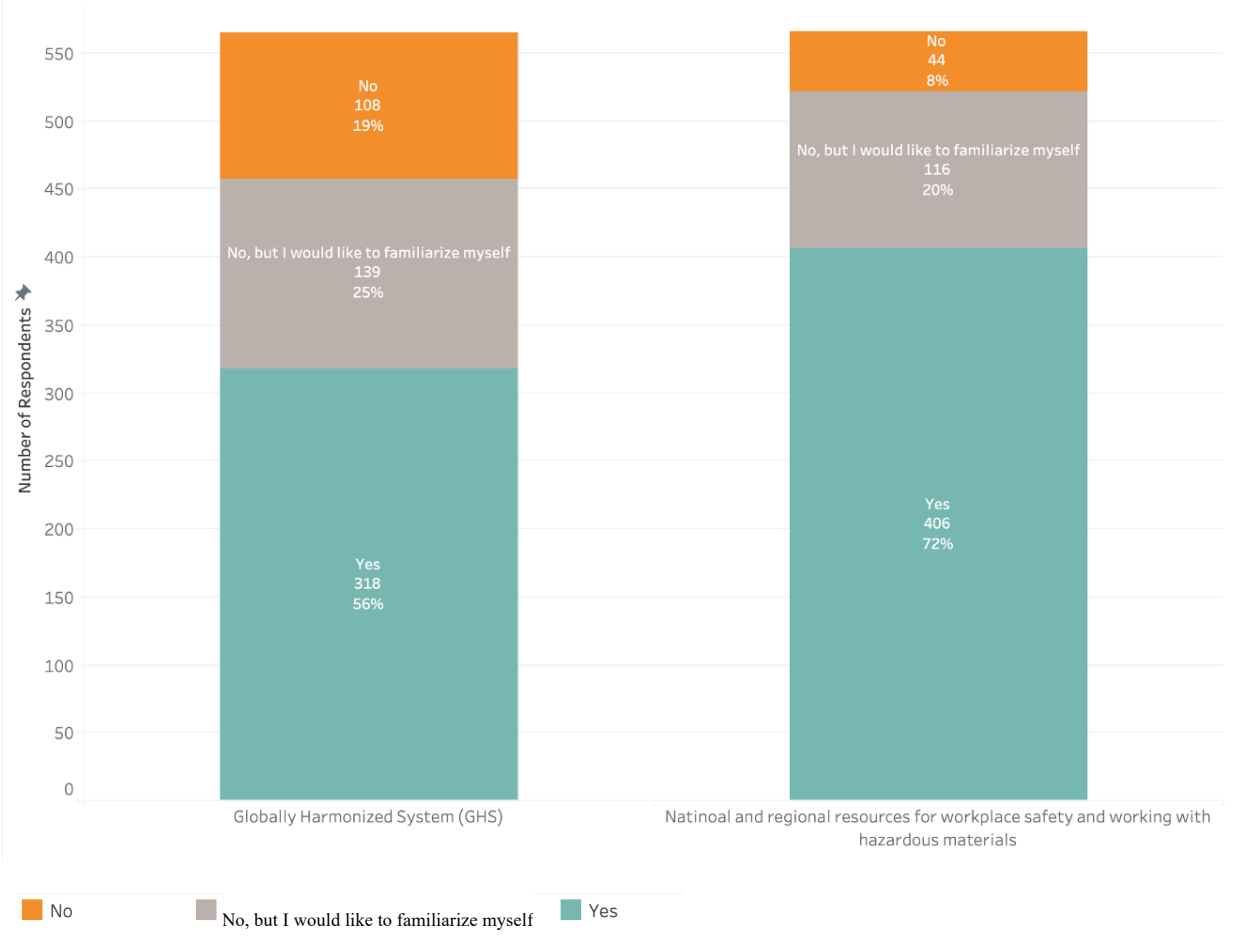
Safety and Hazards Training

The following section identifies respondents' familiarity with hazard and safety information regarding solvent use, experience with workplace safety and hazard training, and involvement with standardized risk assessments for organic solvent uses.

Hazard and Safety Informational Resources

Q: Are you familiar with the Globally Harmonized System for Classification and Labeling of Chemicals?
Single-select answer choices: No; No, but I would like to familiarize myself; or Yes

Q: Are you familiar with your country's/region's resources for workplace safety and working with hazardous materials?
Single-select answer choices: No; No, but I would like to familiarize myself; or Yes



	Yes		No, but I would like to familiarize myself		No	
	Count	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Familiarity with the Globally Harmonized System and Labeling of Chemicals (GHS)	318	56%	139	25%	108	19%
Familiarity with your country's/region's resources for workplace safety and working with hazardous materials	406	72%	116	20%	44	8%

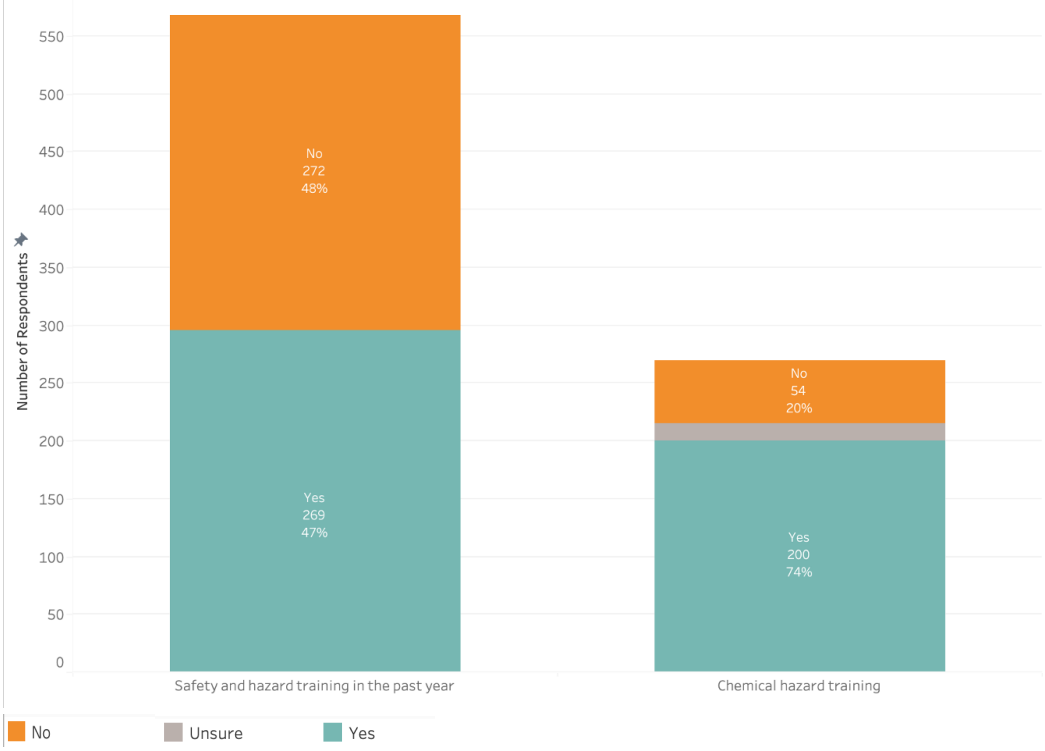
Figure 8. Familiarity with GHS and National/Regional Workplace Safety and Hazardous Materials Resources*. Bar graph and corresponding table highlighting 565 respondents' answers to their familiarity with the GHS and 566 respondents' answers to their familiarity with their national or regional resources for workplace safety and working with hazardous materials. 20 respondents did not respond to whether they were familiar with GHS while 19 respondents did not respond to whether they were familiar with their national or regional resources. Both questions were single-select multiple choice questions. The sum of responses per each answer and percentage of the total respondents who answered the questions are represented in the graph and tables.*

Respondents who answered these two questions have a greater familiarity with their national and/or regional resources for workplace safety and working with hazardous materials than with GHS. Approximately 16% less respondents were familiar with GHS than their national or regional resources.

Hazard and Safety Training

Q: Have you undergone workplace safety and hazard training in the past year? *Single-select answer choices: No or Yes*

Q: Did this training include chemical hazard training? *Single-select answer choices: No, Unsure, or Yes*



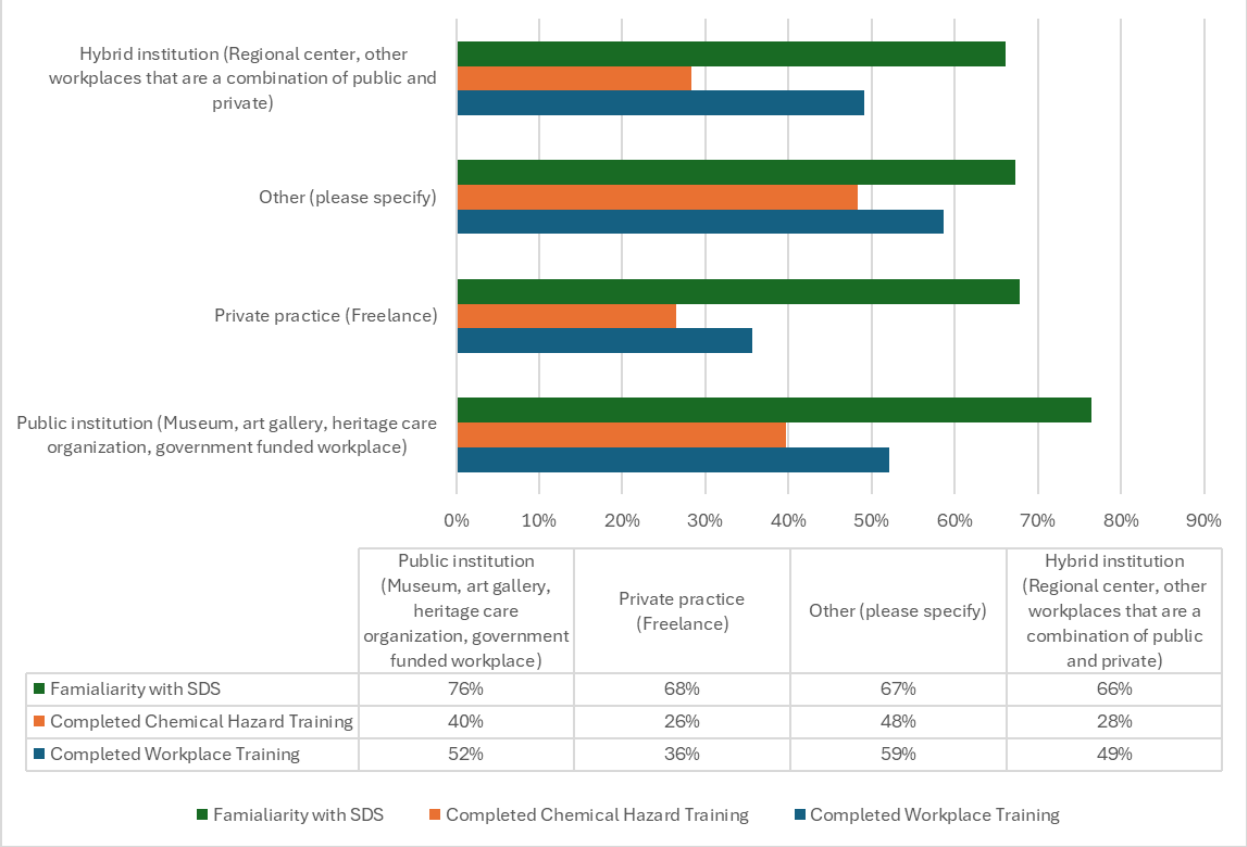
	Yes		No	
	Count	Percent	Count	Percent
Have you undergone workplace safety and hazard training in the past year?	269	47%	272	48%

	Yes		Unsure		No	
	Count	Percent	Count	Percent	Count	Percent
Have you undergone workplace safety and hazard training in the past year?	200	74%	15	6%	54	20%

Figure 9. Workplace Safety and Hazard and Chemical Hazard Training. *Bar graph and corresponding tables showing 568 respondents' answers to whether they have received workplace safety and hazard training in the past year. 17 respondents did not respond to this question. Of the 269 people who responded yes, 74% or 200 respondents also answered "Yes" to the training including chemical hazard training, 6% or 15 respondents responded that they were "Unsure," and 20% or 54 respondents answered "No." The sum of responses per each answer and percentage of the total respondents who answered the questions are represented in the graph and tables.*

Approximately half of the respondents who provided responses to whether they have received workplace safety and hazard training in the past year did receive the training. Of them, about 75% reported that it included chemical hazard training.

Institution Type Versus Chemical Safety and Hazard Training



	Public institution (Museum, art gallery, heritage care organization, government funded workplace)	Private practice (Freelance)	Other (please specify)	Hybrid institution (Regional center, other workplaces that are a combination of public and private)
Famialiarity with SDS	76%	68%	67%	66%
Completed Chemical Hazard Training	40%	26%	48%	28%
Completed Workplace Training	52%	36%	59%	49%

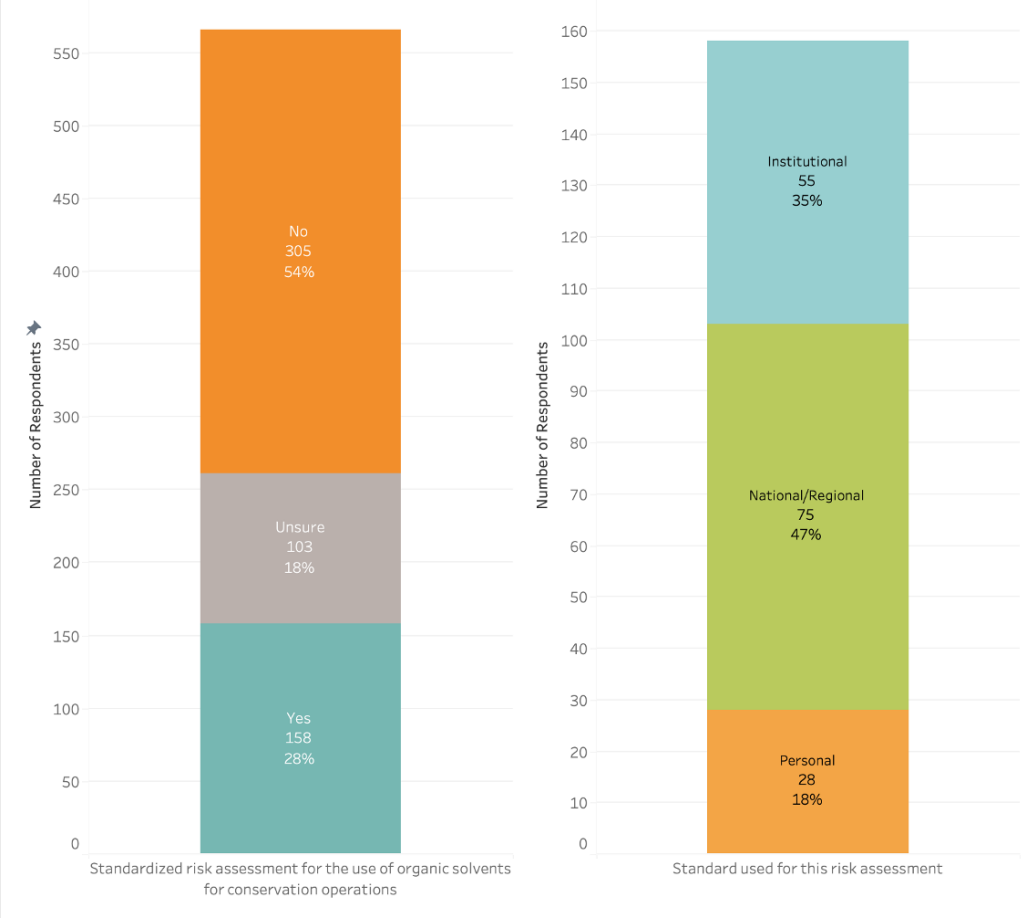
Figure 10. Institution Type versus Chemical Safety Resources. *A graph and table that show the percentage of respondents from each institution type who have completed chemical hazard training AND workplace training AND have familiarity with Safety Data Sheets (SDS). The percentage represents how many respondents per institution type also reported to have familiarity with SDS sheets, Completed Chemical Hazard Training, and Completed Workplace training.*

This graph shows that completion of training has a slightly different outcome based on type of institution. Respondents working in public museums have the highest familiarity with SDS sheets. Others working in institutions or university related have the highest completion of chemical hazard training and workplace training. Those in private practice report the lowest percentage of completeness for chemical hazard training, as well as workplace training.

Standardized Risk Assessment for Organic Solvent Use

Q: Have you ever conducted or consulted a standardized risk assessment for the use of organic solvents for conservation operations? *Multi-select answer choices: No, Unsure, or Yes*

Q: What was the standard used for this risk assessment? *Multi-select answer choices: Institutional, National/Regional, or Personal*



	Yes		Unsure		No	
	Count	Percent	Count	Percent	Count	Percent
Have you ever conducted or consulted a standardized risk assessment for the use of organic solvents for conservation operations?	158	28%	103	18%	305	54%
	Personal		National		Institutional	
What was the standard used for the risk assessment?	28	17.72%	75	47.47%	55	34.81%

Figure 11. Standardized Risk Assessment for Use of Organic Solvents for Conservation Operations. *Bar graph and corresponding table showing 566 respondents' answers to whether they have performed a standardized risk assessment for use of*

organic solvents for conservation operations. 19 respondents did not answer this question. All 158 respondents who answered yes further elaborated whether the standard used for the training was personal, national, or institutional. The sum of responses per each answer and percentage of the total respondents who answered the questions are represented in the graph and tables. See specific standards used organized by country in ***Appendix.***

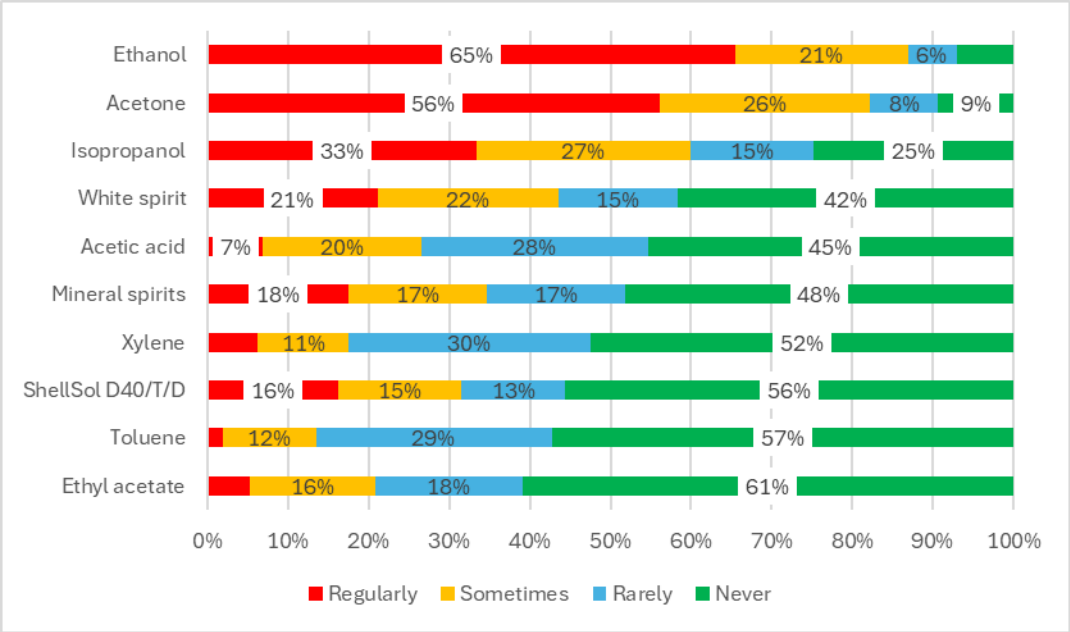
Approximately half of the respondents who answered whether they consulted or conducted a standardized risk assessment for organic solvent use answered “No.” Only about a quarter of the respondents answered “Yes.” Of them, almost half referenced national or regional standards.

Solvent Use

This section is organized first by general trends, followed by solvent use by class. Hazards discussed per solvent are based on SDS sheets and the 2012 OSHA Hazard Communication Standard in accordance with the Globally Harmonized System of Classification and Labelling of Chemicals (GHS).

General Trends

I. Top 10 Most Used Solvents Overall



Solvent	Solvent Class	Regularly	Sometimes	Rarely	Never	Overall Use
Ethanol	Alcohol	65%	21%	6%	7%	93%
Acetone	Ketones, Nitriles, and Other Halogen Compounds	56%	26%	8%	9%	91%
Isopropanol	Alcohol	33%	27%	15%	25%	75%
White spirits	Petroleum Distillate	21%	22%	15%	42%	58%
Acetic acid	Carboxylic Acids, Esters, and Ethers	7%	20%	28%	45%	55%
Mineral spirits	Petroleum Distillate	18%	17%	17%	48%	52%
Xylene	Aromatic	6%	11%	30%	52%	48%
ShellSol D40/T/D	Petroleum Distillate	16%	15%	13%	56%	44%
Toluene	Aromatic	2%	12%	29%	57%	43%
Ethyl acetate	Carboxylic Acids, Esters, and Ethers	5%	16%	18%	61%	39%

Figure 12. Top 10 Most Used Solvents Overall. *This graph and table contain the data of the use type of the top 10 most used solvents in this survey. To calculate the most used overall solvents, the percentages of the regular, sometime, and rare use were added together. This calculation shows how much a given solvent is used at all by a conservator. This means that some solvents,*

although they might be more regularly used, may score lower overall. However, if sorted by regular use, this does not change the top 10 solvents, only the order in which they appear.

Out of the 38 solvents, the most overall used solvent was ethanol, followed closely by acetone and isopropanol, with over 75% of respondents using them. Ethanol and isopropanol are commercially available and relatively safe to use. Acetone presents a slight hazard based on safety and the environment but is not the most concerning solvent on this list. Acetic acid, the 5th most used solvent, presents a slight health hazard.

Xylene is the 7th most used solvent, while toluene is the 9th most used solvent from this dataset. Both aromatic solvents are highly harmful to human health. Xylene in addition can be particularly harmful to aquatic life if incorrectly disposed of. These two solvents were highlighted at the GCI's Expert Meeting's as solvents needing replacement, based on their environmental, health, and safety hazards. This data provides evidence that toluene and xylene are used enough in the field to support researching alternatives.

Three petroleum distillates also make this list; white spirits, mineral spirits, and Shellsol D/T/D40, respectively 4th, 6th, and 8th most used overall. They are produced from petroleum, a nonrenewable source. These three solvents represent unsustainable practices for the long-term in a world where an overreliance of fossil fuels is detrimental to the climate itself. Also, white and mineral spirits pose a threat to human health.

Ethyl acetate, the 10th most used solvent, has relatively minor hazards.

For geographic trends, please refer to Appendix.

II. Top 5 Solvent Per Specialty

Ranking	Archaeology	Architecture	Book and Paper	Electronic Media	Objects	Other Not Specified
1	Acetone	Acetone	Ethanol	Ethanol	Ethanol	Ethanol
2	Ethanol	Ethanol	Acetone	Acetone	Acetone	Acetone
3	White spirit	White spirit	Isopropanol	Acetic acid	Isopropanol	Isopropanol
4	Isopropanol	Isopropanol	Acetic acid	Hexane	White spirit	White spirit
5	Acetic acid	Solvesso/Stoddard solvents/Ligroin	Toluene	Isopropanol	Mineral spirits	Acetic acid

Ranking	Paintings	Preventive	Photographs	Textiles	Wooden Artifacts
1	Ethanol	Ethanol	Ethanol	Acetone	Acetone
2	Acetone	Acetone	Acetone	Ethanol	Ethanol
3	Isopropanol	Isopropanol	Isopropanol	Acetic acid	White spirit
4	White spirit	Acetic acid	Acetic acid	Mineral spirits	Isopropanol
5	ShellSol D40/T/D	Toluene	White spirit	Isopropanol	ShellSol D40/T/D

Figure 13. Top 5 Solvents Most Used Per Specialty. *This table shows the top 5 solvents per specialty, based on the highest percentage of most overall use. In this ranking system, 1 is the most used. This is calculated by adding the regularly, sometimes, and rarely percentages together to obtain the overall statistic. For respondents who responded with having more than one specialty, they have been counted for each unique specialty they listed.*

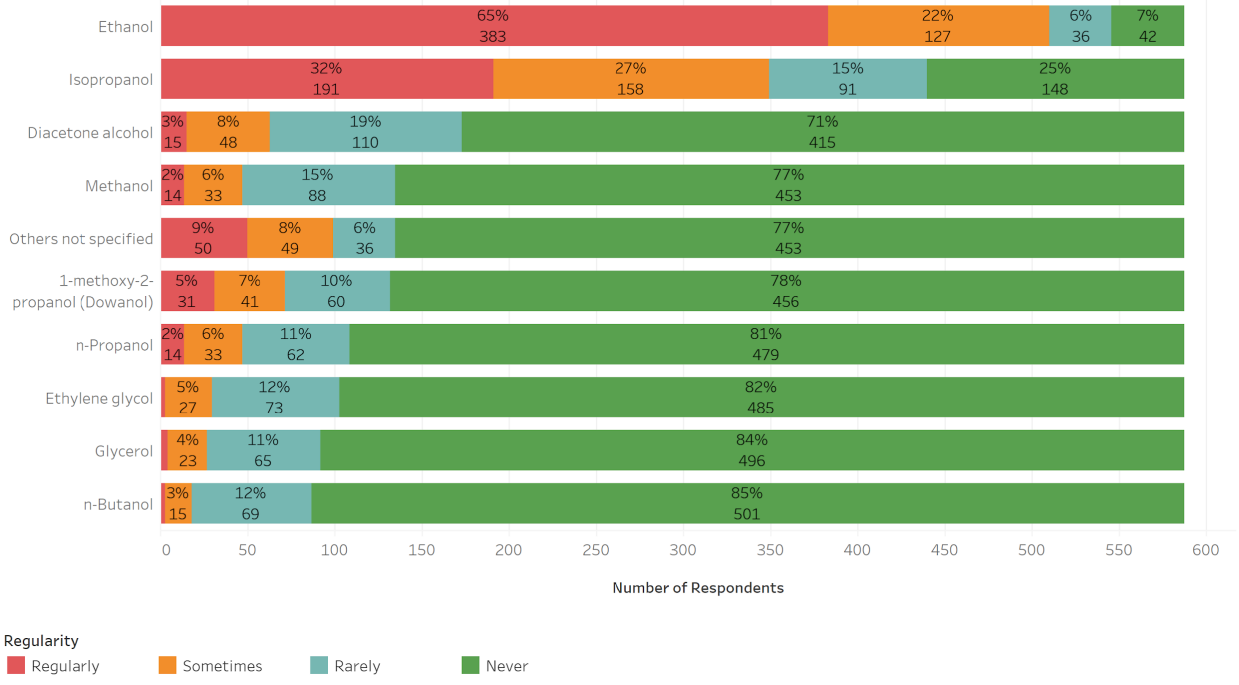
The most overall used solvents for many specialties are acetone or ethanol. This correlates with the **Top 10 Most Used Solvents Overall (Figure 13)**, where they are the two highest solvents reported. In fact, the only two solvents not previously in the overall top 10 were hexane (4th most used solvent in electronic media) and Solvesso / Ligroin / Stoddard solvent 5th most used solvent for architecture. This data cannot accurately associate the specific solvents used per discipline because many respondents listed more than one specialty type. For instance, if a respondent listed practicing both paintings and architecture, there was no substrate specification reporting per solvent.

Solvent Classes

The following subsection reports the frequency of use categorized per solvent organized by solvent classes. The top 10 most used solvents overall are labeled with an asterisk (*) in the tables below. Safety hazards discussed per solvent are based on SDS sheets and the 2012 OSHA Hazard Communication Standard in accordance with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

III. Alcohols

Q: Please indicate the frequency that you use the alcohols pure and/or in mixtures; the default choice is "Never". *Single-select answer choices: Regularly, Sometimes, Rarely, Never*



	Regularly		Sometimes		Rarely		Never	
	Count	Percent	Count	Percent	Count	Percent	Count	Percent

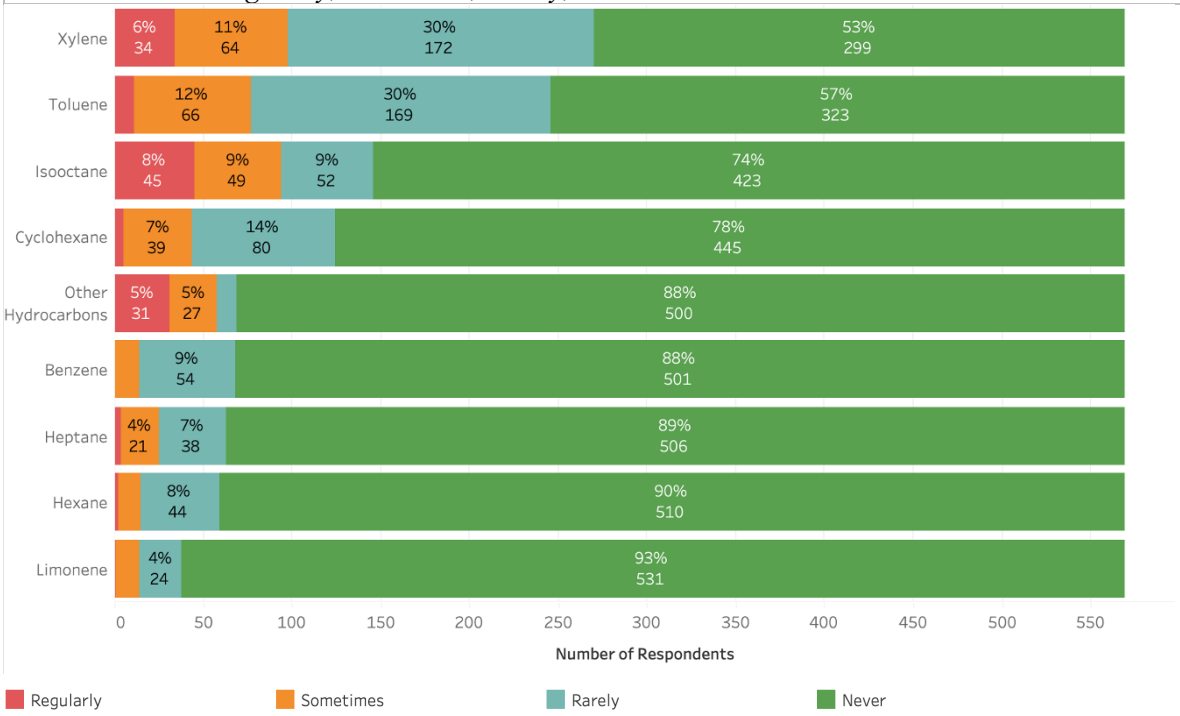
Ethanol*	383	65%	127	22%	36	6%	42	7%
Isopropanol *	191	32%	158	27%	91	15%	148	25%
Diacetone alcohol	15	3%	48	8%	110	19%	415	71%
Methanol	14	2%	33	6%	88	15%	453	77%
Others not specified	50	9%	49	8%	36	6%	452	77%
1-methoxy-2-propanol (Dowanol)	31	5%	41	7%	60	10%	456	78%
n-Propanol	14	2%	33	6%	62	11%	479	81%
Ethylene glycol	485	82%	73	12%	27	5%	3	1%
Glycerol	496	84%	65	11%	23	4%	4	1%
n-Butanol	501	85%	69	12%	15	3%	3	1%

Figure 14. Alcohol Solvent Use. *This graph and table contain both count and percentage of total use for the solvents classified in the Alcohol category. All 585 responses responded to this single-select question, where the only answer choices were regularly, sometimes, rarely or never. Each stacked bar represents the regularity of use per solvent. Solvents are organized by the most used overall, a calculation of adding the regularly, sometimes, and rarely used. The number and percentage of respondents for each answer choice are detailed in the graph and table. Statistics hidden for the ease of viewing in the graph are represented in the table. Other (please specify) represent the free text responses that respondents answered to clarify, specify, or to include an answer they felt was not represented in the original answer choices. The most answered other response was Benzyl Alcohol, with 28 responses. For other responses, see* ***Table 3****.*

All 585 (100%) of the respondents indicated using alcohols. Ethanol and isopropanol are by far the most used alcohols from this selection, with over 75% of respondents using them. Both appear high on the **Top 10 Most Used Solvents Overall (Figure 13).** These solvents are readily available and relatively safe to use, compared to some other solvents on the survey list. The rest of the answers fall under 31% used, meaning that they are used much less than ethanol and isopropanol. Ethanol is over twice as regularly used as isopropanol.

IV. Alicyclic, Aliphatic, and Aromatic Hydrocarbons

Q: Please indicate the frequency that you use alicyclic/aliphatic/ and aromatic hydrocarbons pure and/or in mixtures; the default choice is "Never". *Single-select*
answer choices: Regularly, Sometimes, Rarely, Never



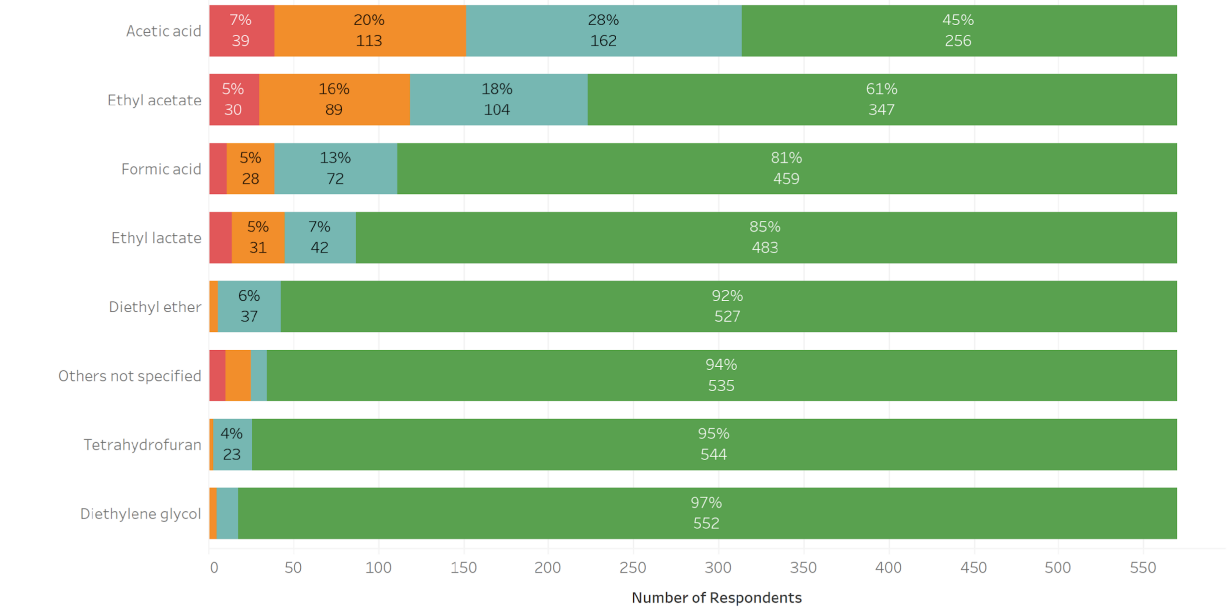
	Regularly		Sometimes		Rarely		Never	
	Count	Percent	Count	Percent	Count	Percent	Count	Percent
Xylene* $C_6H_4(CH_3)_2$	34	6%	64	11%	172	30%	299	53%
Toluene* $C_6H_5CH_3$	11	2%	66	12%	169	30%	323	57%
Isooctane C_8H_{18}	45	8%	49	9%	52	9%	423	74%
Cyclohexane C_6H_{12}	5	<1%	39	7%	80	14%	445	78%
Other Hydrocarbons	31	5%	27	5%	11	2%	500	88%
Benzene C_6H_6	0	0%	14	2%	54	9%	501	88%
Heptane $CH_3(CH_2)_5CH_3$	4	<1%	21	4%	38	7%	506	89%
Hexane C_6H_{14}	2	<1%	13	2%	44	8%	510	90%
Limonene $C_{10}H_{16}$	1	<1%	13	2%	24	4%	531	93%

Figure 15. Alicyclic, Aliphatic, Aromatic Hydrocarbon Solvent Use. *Bar graph and corresponding table highlighting 569 respondents and their answers to this question. 16 respondents did not answer the question. Each stacked bar represents the regularity of use per solvent. Solvents are organized by the most used. The number and percentage of respondents for each answer choice are detailed in the graph and table. Statistics hidden for the ease of viewing in the graph are represented in the table. "Other Hydrocarbons" represent the free text responses that respondents answered to clarify, specify, or to include an answer they felt was not represented in the original answer choices. See* ***Table 3 for the specific other hydrocarbon answers.***

569 (97%) of the respondents indicated using alicyclic, aliphatic, and aromatic hydrocarbon solvents. The most popular in this class are xylene, toluene, and isooctane. According to 2012 OSHA Hazard Communication Standard in accordance to GHS, xylene is classified with Category 4 acute dermal toxicity and acute inhalation vapor toxicity as well as Category 3 specific target organ toxicity upon single exposure in the respiratory and central nervous system (CNS). Toluene and isooctane are classified with Category 3 specific target organ toxicity upon single exposure targeting the CNS. Furthermore, toluene and xylene are **among Top 10 Most Used Solvents Overall (Figure 12)**. Isooctane is not only the most regularly used (8% of respondents) within the three, but it is also the most regularly used hydrocarbon solvent. Xylene follows behind at 6% of respondents regularly using it, and toluene is at 2%. However, it is important to note that all three solvents are regularly used by less than 10% of the people who answered the question. More than half the people who reported use of xylene (64%) and toluene (69%) rarely use it, and there is an even spread of people who rarely, sometimes, and regularly use isooctane.

V. Carboxylic Acids, Esters and Ethers

Q: Please indicate the frequency that you use carboxylic acids, esters, ethers pure and/or in mixtures; the default choice is "Never". *Single-select answer choices: Regularly, Sometimes, Rarely, Never*



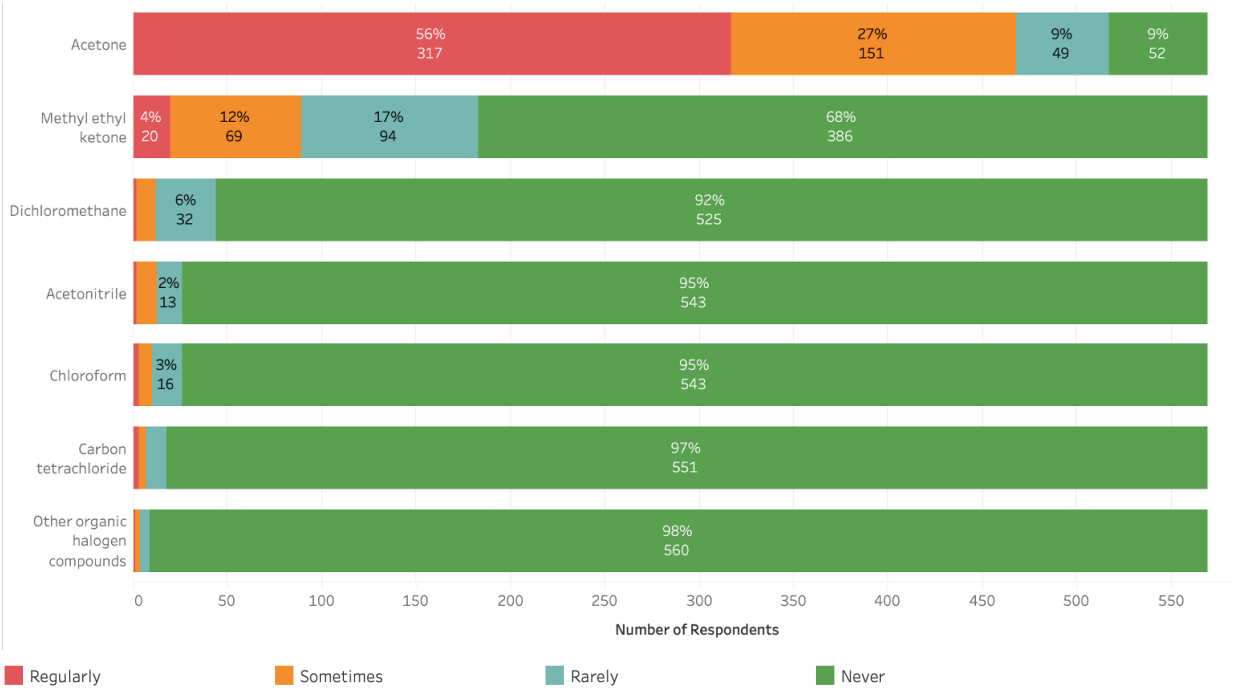
	Never		Rarely		Sometimes		Regularly	
	Count	Percent	Count	Percent	Count	Percent	Percent	Percent
Acetic acid *	39	7%	113	20%	162	28%	256	45%
Ethyl acetate*	30	5%	89	16%	104	18%	347	61%
Formic acid	11	2%	28	5%	72	13%	459	81%
Ethyl lactate	14	2%	31	5%	42	7%	483	85%
Diethyl ether	1	0%	5	1%	37	6%	527	92%
Others not specified	10	2%	15	3%	10	2%	535	94%
Tetrahydrofuran	1	0%	2	0%	23	4%	544	95%
Diethylene glycol	0	0%	5	1%	13	2%	552	97%

Figure 16. Carboxylic Acids, Esters, and Ethers Solvent Use. *This graph and table contain both count and percentage of total use for the solvents classified in the Carboxylic Acids, Esters, and Ethers category. 570 responses responded to this single-select question, where the only answer choices were regularly, sometimes, rarely or never. Each stacked bar represents the regularity of use per solvent. Solvents are organized by the most used overall, a calculation of adding the regularly, sometimes, and rarely used. The number and percentage of respondents for each answer choice are detailed in the graph and table. Statistics hidden for ease of viewing in the graph are represented in the table. Other (please specify) represent the free text responses that respondents answered to clarify, specify, or to include an answer they felt was not represented in the original answer choices. For other responses, see* ***Table 3****.*

570 (97%) of respondents indicated use of solvents in this class. Acetic acid and ethyl acetate are the two most common carboxylic acids, esters, and ethers, with respectively 55% and 39% overall use. They are both represented in the top 10 most used solvents in **Top 10 Most Used Solvents Overall (Figure 12).** Acetic acid has problematic environmental and health hazards, while ethyl acetate is relatively safe to use. The next most used solvent from this class is formic acid, with less than 19 % overall use.

VI. Ketones, Nitriles, and Organic Halogen Compounds

Q: Please indicate the frequency that you use ketones/nitriles/ and organic halogen compounds pure and/or in mixtures; the default choice is "Never". *Single-select*
answer choices: Regularly, Sometimes, Rarely, Never



	Regularly		Sometimes		Rarely		Never	
	Count	Percent	Count	Percent	Count	Percent	Count	Percent
Acetone* CH_3COCH_3	317	56%	151	27%	49	9%	52	9%
Methyl ethyl ketone C_4H_8O	20	4%	69	12%	94	17%	386	68%
Dichloromethane CH_2Cl_2	2	<1%	10	2%	32	6%	525	92%
Acetonitrile CH_3CN	2	<1%	11	2%	13	2%	543	95%
Chloroform $CHCl_3$	3	<1%	7	1%	16	3%	543	95%
Carbon tetrachloride CCl_4	3	<1%	4	<1%	11	2%	551	97%
Other organic halogen compounds	1	<1%	3	<1%	5	<1%	560	98%

Figure 17. Ketones, Nitriles, and Organic Halogen Compounds Use. *Bar graph and corresponding table highlighting 569 respondents and their answers to this question. 16 respondents did not complete this question. Each stacked bar represents the regularity of use per solvent. Solvents are organized by the most used. The number and percentage of respondents for each answer choice are detailed in the graph and table. Statistics hidden for the ease of viewing in the graph are represented in the table. "Other organic halogen compounds" represent the free text responses that respondents answered to clarify, specify, or to include an answer they felt was not represented in the original answer choices. See* ***Table 3*** *for other specific organic halogen compound answers.*

569 (97%) of respondents use solvents in this class.The top three most used ketones, nitriles, and organic halogen compounds are acetone, methyl ethyl ketone (MEK), and dichloromethane. Acetone is by far the most used. It is not only the most used in this solvent class but is also the second most used solvent overall in the **Top 10 Most Used Solvents Overall (Figure 12)**. About 60% of people who reported using the solvent use acetone regularly. Though it is widely used and often considered one of the relatively safer solvents to use, OSHA in accordance with GHS still classifies acetone as a Category 3 hazard specific target organ toxicity upon single exposure targeting the central nervous system. This same classification is also applied to MEK and dichloromethane. Of the people who reported using MEK, 90% of them use it sometimes or rarely. Only 5 % of people who report using dichloromethane use it regularly.

VII. Petroleum Distillates

Q: Please indicate the frequency that you use petroleum distillates pure and/or in mixtures; the default choice is "Never"
Single select-*answer options: Regularly, Sometimes, Rarely, Never*

	Regularly		Sometimes		Rarely		Never	
	Count	Percent	Count	Percent	Count	Percent	Count	Percent
White spirit*	118	21%	127	23%	85	15%	240	42%
ShellSol D40/T/D*	88	15%	86	15%	75	13%	321	56%
Mineral spirits*	97	17%	96	17%	99	17%	278	49%
Solvesso/Stoddard solvents/Ligroine	60	11%	81	14%	71	12%	358	63%
Other (please specify)	15	3%	22	4%	11	2%	522	92%

Figure 18. Petroleum Distillates Solvent Use. *This graph and table contain both count and percentage of total use for the solvents classified in the Petroleum Distillates category. 570 responses responded to this single-select question, where the only answer choices were regularly, sometimes, rarely or never. Each stacked bar represents the regularity of use per solvent. Solvents are organized by the most used overall, a calculation of adding the regularly, sometimes, and rarely used. The number and percentage of respondents for each answer choice are detailed in the graph and table. Statistics hidden for ease of viewing in the graph are represented in the table. Other (please specify) represent the free text responses that respondents answered to clarify, specify, or to include an answer they felt was not represented in the original answer choices. For other responses, see* ***Table 3.***

570 (97%) of respondents indicated using solvents in this class. Petroleum distillates are inherently unsustainable because their production directly comes from crude oil. This process is already harmful to the environment, prior to impacts of solvent use and disposal. White spirits, Shellsol D40/T/D, and Mineral spirts all make **Top 10 Most Used Solvents Overall (Figure 12).** The distribution of regular, sometime, and rare use is spread mostly evenly among all petroleum solvent distillate options; each category is about a third of overall solvent use.

VIII. Other Free Text Solvent Responses

Solvent Class	Solvents	Count
Petroleum Distillates	VM&P Naptha	9
	Shellsol D38	8
	Shellsol D60	4
	Petroleum benzene	2
	Shellsol D70	2
	Dearomatized petroleum essence 100 140	1
	Odorless Mineral Spirits	1
	Odorless White Spirits	1
	Other refined petroleum products (other than produced by Shell)	1
	Petroleum Spirits	1
	Propyl propionate	1
	Silicone solvents	1
	Varsol	1
Ketones, Nitriles, Organic Halogen Compounds	Dimethylformamide (DMF)	1
	Tetrachloroethylene (perchloroethylene)	1
Carboxylic Acids, Esters, and Ethers	Butyl Acetate	4
	Citric Acid	3
	Ethyl Acetate	3
	1,8 Cineole (Eucalyptol)	3
	Propylene Carbonate	2
	Tannic Acid	1
	Thiourea	1
	Oxalic Acid	1
	Abietic Acid	1
	DBE (Dibasic Ester)	1
	2-Methyltetrahydrofuran	1
	Amyl Acetate	1
Alicyclic, Aliphatic, and Aromatic Hydrocarbon	Shellsol A100	12
	Shellsol A	8
	Cyclododecane	1
	Exxol DSP 80-110	1
	Naphthalene	1
	Siedegrenzbenzine (boiling point gasolines)	1
	TMO (2,2,5,5-tetramethyloxolane)	1
	Turpentine	1

Alcohols	Benzyl alcohol	28
	Denatured Alcohol	3
	Methoxymethylbutanol	1
	Polyvinyl alcohol	1
	n-pentonal	1
	n-hexanol	1
	Diethyl ketone	1
	2- ethoxy ethanol	1
	Isopropyl alcohol and acetone Mixture	1
	Cellosolve	1
	Industrial methylated spirits-ethanol/methanol mix	1
	Household alcohol	1
Others	Solvent Mixture	6

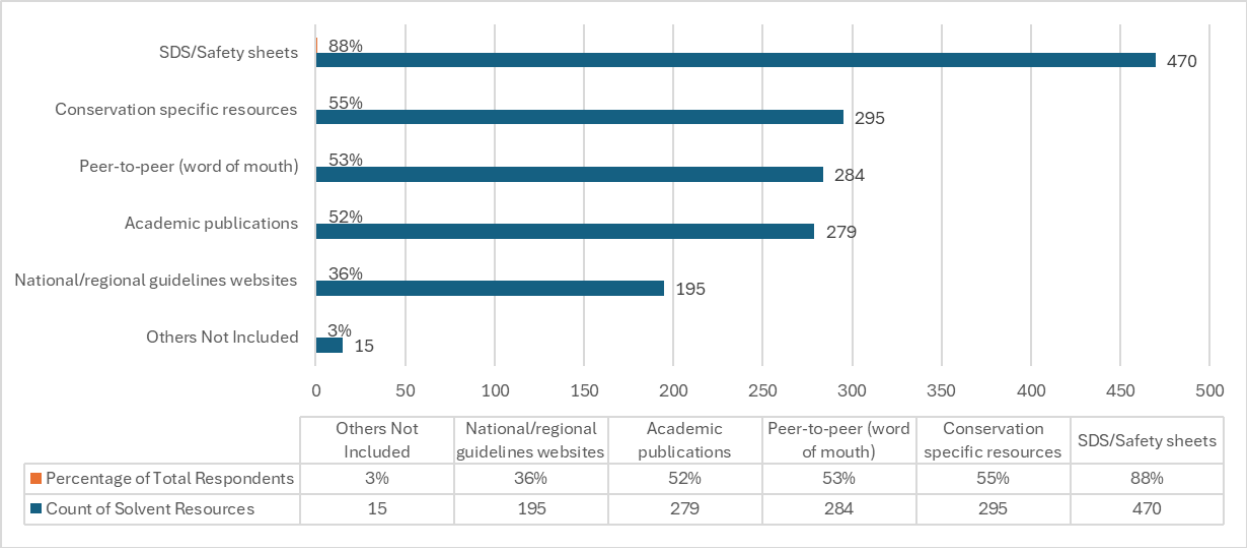
Table 3: All Solvent Classes Free Text Responses. *The table lists all the "Other (please specify)" free-text answers from the previous solvent use questions. Some solvents, such as ShellsolA, can be classified by more than one solvent class. These solvents are categorized in the solvent class that is the most representational of their health hazard in this table. One of the responses that noted "Naphtha" didn't specific VM and P. Solvent mixtures include mineral spirits blend; shellsol D40 and ligroin; shellsol A, D40, D60, T, and petroleum naphta; naphtha and mineral spirits; shellsol and Exxsol 150. People also answered, "Lacquer Thinner" and "Dimethyl" which were not included into the table.*

Several solvents that were not originally included in the solvent use questions had high numbers of representations in the free-text answers. "VM&P Naphtha" and "Shellsol D38," each had 9 and 8 responses respectively. "Shellsol A100" and "Shellsol A" had 12 and 8 responses each, and there were 28 responses noting "benzyl alcohol."

Other Solvent Use Information

IX. Solvent Sources

Q: What source(s) do you consult when searching for solvent-related information? *Multi-select choices: SDS/ Safety sheets, Conservation specific resources, Peer-to-peer (word of mouth), Academic publications, National/ regional guidelines websites, Others not included*



	Others Not Included	National/regional guidelines websites	Academic publications	Peer-to-peer (word of mouth)	Conservation specific resources	SDS/Safety sheets
Percentage of Total Respondents	3%	36%	52%	53%	55%	88%
Count of Solvent Resources	15	195	279	284	295	470

Figure 19: Solvent Resources. *This is a graph and table. This graph shows from where 536 respondents obtain their solvent related information, while 49 respondents did not answer out of the already validated data. One respondent can choose multiple answer choices in this question type. The Percentage of Total Respondents represents the frequency of Respondent per answer choice and is indicated above each bar that it represents.*

Others Not Included are the free text responses that respondents answered to clarify, specify, or to include an answer they felt was not represented in the original answer choices. 7 respondents consult solvent literature, 9 consult national / regional guidelines not listed, 1 uses the internet and 1 does not use solvents. For specific answers, refer to Appendix.

Out of the 536 respondents who answered this question, 88% use SDS / Safety Data Sheets. If the respondent did not report using solvent resources, it is unclear whether they opted to skip this question. None of the free text answers responses indicated not using solvent resources. The respondents indicated that the other kinds of resources than SDS are less commonly used. As this question was multi-select, it does not mean that if a conservator uses one type of resource that they do not use another.

X. Solvent purchasing/ supplier

Q: Where are your solvents purchased from? *Multi-Select answer choices: Chemical Suppliers, Conservation material supplier, Hardware Store, and/or Other (please specify)*

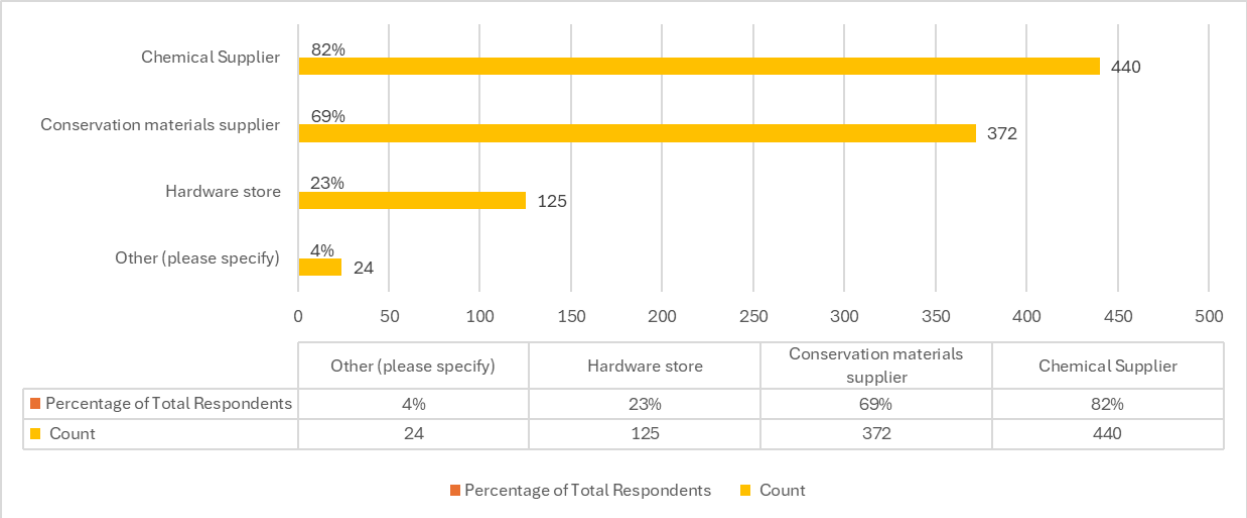


Figure 20: Solvent Supply. *This graph and corresponding table show where respondents purchase their solvents from. There were 536 respondents who answered this multiselect question, and 49 who did not answer out of the already validated data. One respondent can choose multiple answer choices in this question type. The Percentage of Total Respondents represents the frequency of Respondent per answer choice and is indicated above each bar that it represents. (ie, 82 % of Respondents buy their solvents directly from a Chemical Supplier).*

Other (please specify) represent the free text responses that respondents answered to clarify, specify, or to include an answer they felt was not represented in the original answer choices. 24 respondents entered free text to describe their solvent supply in more depth. 6 of those answers were unsure of how they got their solvents, 7 go to pharmacies, grocery stores, and cosmetic suppliers, and 3 indicate that their university supplies solvents. 1 gets their solvents from a local service, and the last 1 gets their solvents from online art stores. Refer to Appendix for full answers.

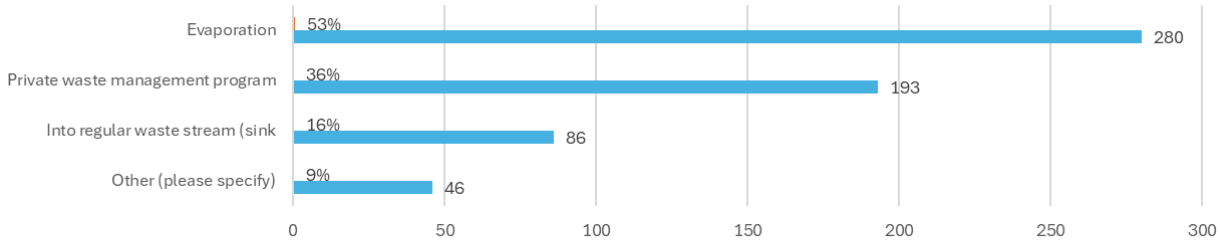
Of the respondents answering this question most (75%) purchase their chemicals from a chemical supplier, followed closely by conservation specific suppliers. Fewer get their solvents from commercial stores, like hardware stores. Two answers also in the Other (please specify) category, both from South America, specifically talked about the difficulties in procuring solvents because of strict federal regulation against solvents used in drug production.

> *"[I get solvents from the] Black Market. Acetone is illegal in countries where cocaine base is produced"*

> *"In Brazil, products such as xylene, toluene, etc. are allowed for very specific uses. The others are all controlled by the army or federal police and the licenses are extremely expensive. It became very difficult for an independent restorer to buy solvents. The result of our work remains very limited and we try to invest much more in conditioning to protect the works that could not be completely treated"*

XI. Solvent disposal

Q.How do you dispose of the solvents, once used? - *Multi- Select*
Answer options: Evaporation, Private Waste Management Program, Into regular waste stream (sink, landfill), and/or Other (please specify)



	Other (please specify)	Into regular waste stream (sink	Private waste management program	Evaporation
Percentage of Total Respondents	9%	16%	36%	53%
Count	46	86	193	280

Percentage of Total Respondents Count

Figure 21: Solvent Disposal Methods. *This is a graph and corresponding table that shows how respondents dispose of their solvents. There were 532 respondents who answered this multi-select question, and 53 who did not answer out of the already validated data. One respondent can choose multiple answer choices in this question type. The Percentage of Total Respondents represents the frequency of Respondent per answer choice and is indicated above each bar that it represents. (ie, 53% of respondents evaporate their solvents to dispose of them)*

The Other (please specify) answer choice represents the free text responses that respondents answered to clarify, specify, or to include an answer they felt was not represented in the original answer choices.46 respondents chose to fill in text, which have been sorted generally based on answer type. 11 indicated their workplace manages it but gave no indication of which category their answer belongs. 2 burn their solvents, 2 drain their solvents (into water waste), 2 recycle their solvents, and 5 keep their waste. 6 elaborated on their Private Waste Management program, and 2 elaborated on their Evaporation methods. The full answers, in their translated form, are available in Appendix.

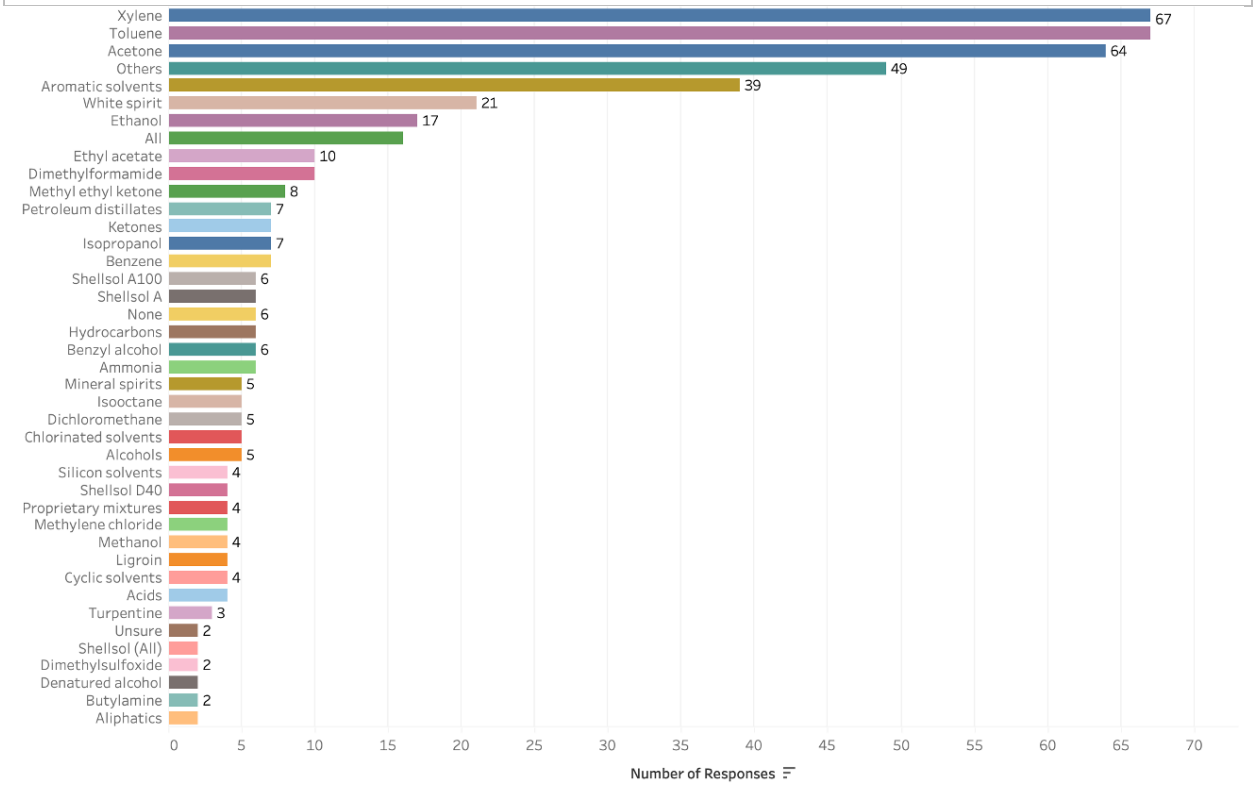
This question was multi-select and respondents could provide multiple answers. Of the 532 respondents 53% evaporate their solvents. Less popular is a private waste management program, and even less popular is the regular waste management system. Some of the other respondents indicated that they put very small amounts of ethanol or acetone diluted with water into the regular waste.

Personal Safety

The following section shows and discusses the survey results regarding the solvents of the highest health concerns, reported health problems associated with solvent use, accessible protective measures, and available protective measures in association with health problems. Reported health problems are further interpreted in relation to the type of institution, specialization, and location.

Solvent of Highest Concern

Q: Which organic solvents cause you to have the most health concerns? *Free-text answer*



Solvent	Number of Responses	Solvent	Number of Responses	Solvent	Number of responses
Xylene*	67	Benzene	7	Proprietary mixtures	4
Toluene*	67	Shellsol A100	6	Methylene chloride	4
Acetone*	64	Shellsol A	6	Methanol	4
Others	49	None	6	Ligroin	4
Aromatic solvents	39	Hydrocarbons	6	Cyclic solvents	4
White spirit*	21	Benzyl alcohol	6	Acids	4
Ethanol*	17	Ammonia	6	Turpentine	3
All	16	Mineral spirits*	5	Unsure	2
Ethyl acetate*	10	Isooctane	5	Shellsol (All)	2
Dimethylformamide	10	Dichloromethane	5	Dimethylsulfoxide	2

Methyl ethyl ketone	8	Chlorinated solvents	5	Denatured alcohol	2
Petroleum distillates	7	Alcohols	5	Butylamine	2
Ketones	7	Silicon solvents	4	Aliphatics	2
Isopropanol*	7	Shellsol D40*	4		

Figure 22: Solvent of Greatest Health Concern. *Bar graph and corresponding table showing the free-text answers from 290 respondents about the solvents causing the most health concerns. 295 did not answer the question. The data is sorted by the greatest sum of responses per solvent answer. Respondents listed more than one solvent, resulting in a total of 504 responses. Some respondents named specific solvents while others provided more general answers such as solvent classes, all solvents, none, or unsure. One-off answers were grouped together under "Others."*

As far as possible solvents described with an identifiable alias were accordingly assigned to a specifically listed solvent above (e.g. Isopropyl [alcohol] was accounted for under isopropanol) or appropriately grouped (e.g. Chlorinated solvents include chloroform and chlorinated hydrocarbons, Silicone solvents include D4, D5, and cyclosiloxanes.) Other answers included solvents used within proprietary products (e.g epoxies and solvents contained in them), solvents/products marketed as green 'non-toxic', as well as some other chemicals/non-solvents (e.g. bleach, reagents for chemical spot tests and triethanolamine). ;

A number of people answered 'all'. Their answers reflect concern with cumulative exposure, lack of their (and/or general) knowledge on the health impacts, and workspace safety concerns. These answers are often accompanied by the mention of particular solvents which are accounted for in the presented data. There were also answers of 'not sure', and some answered 'none'.

In answering this question, many people include information aside from the specific solvents that cause them the most health concern. The specific text answers can be found in the overall survey data but this information can be generally divided into the six categories below:

Frequency of use: Many respondents mentioned that they were concerned about the solvents they named because they use them often, regularly, or for long periods of time. However, there are responses that name solvents that the respondents do not or rarely use or are rather used by ***others who share their working space****.*

Accessible protective measures during use/exposure: The concern with a specific solvent is mostly due to a lack of protective measures in place during use. This includes a lack of gloves and of knowledge in solvent safety information, but most commonly ***the lack of proper ventilation is the cause for concern****. Someone also detailed concern about the use of less toxic solvents with no protection over many years. Another described their concern despite working minimally and outdoors with the solvents.*

Career stage during exposure: For those who mentioned the career stage when they developed a concern for a particular solvent all noted that their concerns developed during decades in the past, during early career, or when they were still university students.

Solvent and associated health symptoms: The most common association is headaches or migraines (to a lesser degree) with solvents such as acetone, isopropanol, white spirits, mineral spirits, aromatic solvents, Shellsol A100/D40, xylene, and toluene. One person mentioned that they experienced headaches with acetone despite wearing PPE. There were also reports of isooctane causing irritation of the lungs while using a fume hood; fluorene leading to fevers; ethanol and dizziness; defatting skin from acetone and isopropanol use; nausea with ethyl acetate; and cyclohexane causing heart palpitations.

Purchasing details: Three respondents discussed the challenges with sourcing particular solvents. One prefers using grain liquor purchased from the liquor store as they do not have to use it with major ventilation apparatus unavailable to them. Another person wrote. "Solvents replacing aromatics particularly xylene are difficult to access and very expensive. Purchasing from laboratories is becoming more and more difficult, they refuse to sell us products even in small quantities because we do not have equipment that they consider suitable." The last respondent discussed the price difference between different distributors of the same solvent..

Miscellaneous comments: One respondent who named aromatic solvents as their solvent of highest concern further clarified their answer and wrote "while the exposure is quite low with proper precautions, I still feel concerned when I'm undertaking cleaning or varnishing interventions. At least with cleaning interventions, there are now multiple substitutions or methods that can be used but for varnishing sometimes we still have to resort to nasty solvents." The conservator and their colleague who uses

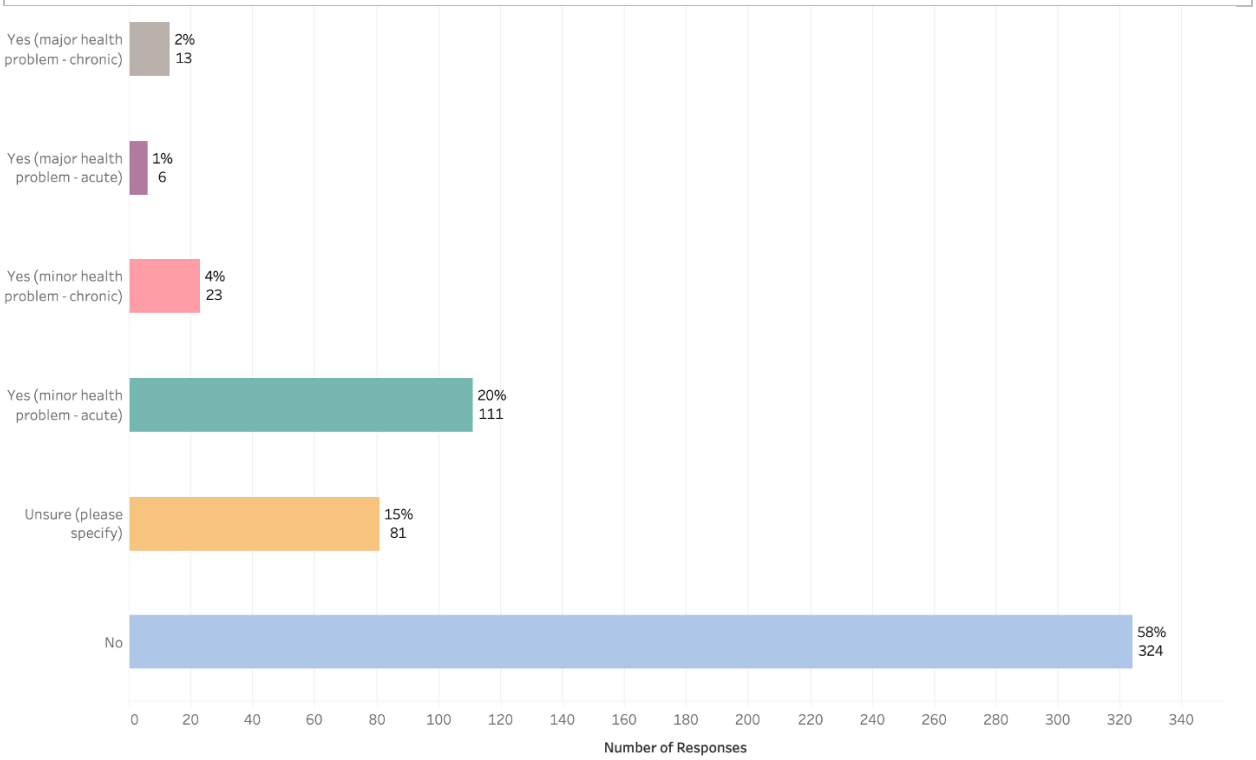
*methoxypropanol with Gamblin Conservation Colors and Laropal A81 was concerned because it might be carcinogenic and the SDS does not provide that information. Another person mentioned using toluene for tape removal and stated that t*hey are looking for a safer alternative. One person expressed concern for solvents that evaporate quickly and are mutagenic. Other comments that don't seem to answer the question directly and express limited concern are as follows: "avoid the most toxic, opting for less toxic as possible; comment, didn't list any solvents;" "Mixtures of products to apply solvents in gelled form and in dressings;" "Almost anything can be used safely if the right protection is in place. I don't use it if I can't use it safely;" "Always with protection of PFF2/N95 masks and nitrile gloves, in a very ventilated environment. I have no worries in terms of health;" "I work on eliminating solvents such as toluene and acetone from my practice, but acetone is widely used and I find it hard to stop using it;" "Benzene. Maybe I need to do some tests with benzene in the future;" "Because I take care of my health, I hardly use organic solvents;" and "I research whether a solvent is a carcinogen or mutagen and do not use if they are classified in this manner."

Xylene and toluene saw the highest number of responses for the solvent causing the greatest health concern. Many people who wrote xylene also included toluene in their response and vice versa. Toluene and xylene are amongst the top ten most overall used solvents but less than 10% of respondents use them regularly. The data suggests that conservators are aware of the dangers of toluene and xylene and choose to use them sparingly. Aside from toluene and xylene, seven other of the top ten most overall used solvents were also mentioned in this question (ethanol, acetone, isopropanol, white spirit, mineral spirits, ShellSol D40, and ethyl acetate). Acetic acid, the remaining most used solvent, was only mentioned once in all the free responses.

Reported Health Problems

1. I. Health Problems Associated with Solvent Use

Q: Do you think you have experienced any health problems related to the use of solvents?
Multi-select answer choices: Yes (major health problem – chronic); Yes (major health problem – acute); Yes (minor health problem – chronic); Yes (minor health problem – acute); Unsure (please specify); and No



	Yes (major health problem – chronic)	Yes (major health problem – minor)	Yes (minor health problem – chronic)	Yes (minor health problem – minor)	Unsure	No
Percentage of total responses	2%	1%	4%	20%	15%	58%
Number of responses	13	6	23	111	81	324

Figure 23: Health Problems Associated with Solvent Use *Graph and corresponding table highlighting a total of 557 responses from 531 respondents on their experience with health problems associated with solvent use. 54 respondents did not answer the question. 28 respondents selected two choices. 2 of the 28 who answered that they experienced chronic major health problems also answered that they experienced acute major health problems and acute minor health problems. Of the 7 who answered that they experienced acute minor health problems, 6 reported they were also unsure and 1 reported they experienced no health problems. Of the 8 who reported experiencing chronic minor health problems, 3 also experienced acute minor health problems and 5 unsure. The sum of responses and percentage of all the responses to this question is detailed in the graph and table. The data is organized from the most serious to least serious health effects. "Unsure (please specify)" represents the free text responses that respondents answered to clarify, specify, or to include an answer they felt was not represented in the original answer choices and the responses are detailed in* ***Figure 24****.*

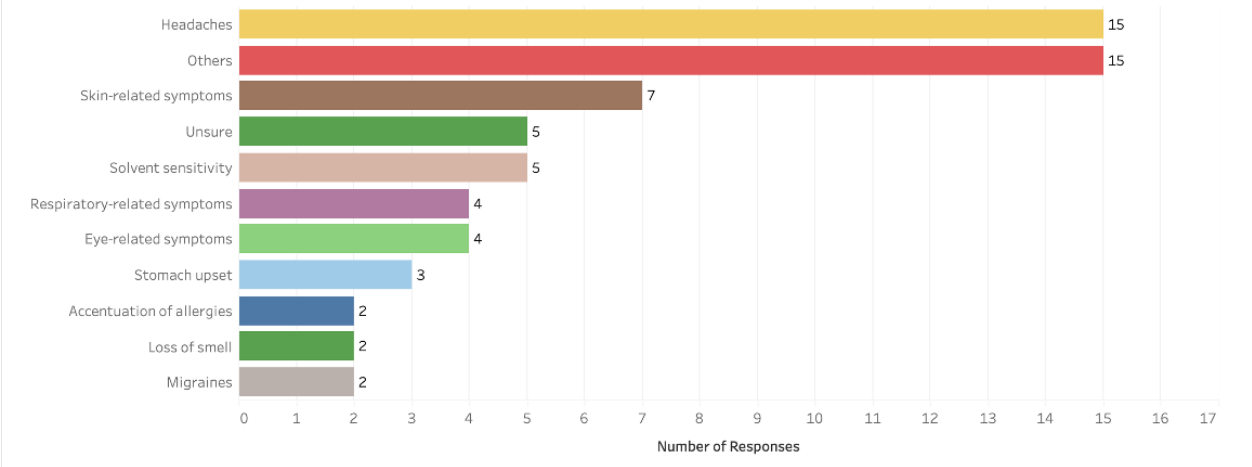
The answers to this question are subjective and the correlation between any health problems experienced and solvent use is dependent on the respondents' observations. Professional medical examination and

research is necessary to ascertain the direct relationship between health symptoms experienced and the cause of the symptoms.

While more than half the responses report that the respondents did not observe any health problems associated with solvent use, the people who reported experienced symptoms saw mostly acute minor health problems. This is likely because acute minor health problems can be immediately observed during use or shortly after exposure to the solvent whereas chronic major symptoms develop over time and cannot be readily linked back to solvent use.

XII. Health Problems Associated with Solvent Use - "Unsure"

Q: Do you think you have experienced any health problems related to the use of solvents? - "Unsure (please specify)" Free-text answers



	Headaches	Others	Skin-related symptoms	Unsure	Solvent sensitivity	Respiratory-related symptoms
Number of responses	15	15	7	5	5	4
	Eye-related symptoms	Stomach upset	Accentuation of allergies	Loss of smell	Migraines	
Number of responses	4	3	2	2	2	

Figure 24: Health Problems Associated with Solvent Use - "Unsure" *56 respondents elaborated on their answers to their "unsure" answers for experiencing health problems related to solvent use in text. Some respondents reported more than one symptom, resulting in 64 responses. The sum of responses per solvent answer is detailed in the graph and the data is organized from the highest to lowest number of responses.*

The symptoms recorded in free-text could generally be grouped into the above categories (descriptions of these are included in Appendix). Other further, potential symptoms mentioned (the respondents acknowledged no direct link could be made with solvent use) included cancer, chronic cough and essential tremors . In general, a lack of surety was sometimes repeated in the answer.

Some people made direct associations of health symptoms with specific solvents (e.g. headaches). A few people provided a specific solvent of concern but with unspecified health symptoms. There were also responses that provided only a solvent or material of concern and no association, or a symptom associated with working conditions. Some noted symptoms appearing later in life after exposures when they were unaware of solvent health and safety measures; whilst others stated that clinical review or testing had revealed no health issues related to solvent use.

Though the question did not ask for specific symptoms, the majority of the responses discussed the symptoms the respondents experienced upon exposure to a solvent, whether the solvent was specified or not. The top three symptoms reported aside from "others" or "unsure" were headaches, skin-related symptoms (i.e. strange smelling skin, rash, dry skin, skin irritation, itching, and skin pain), and general solvent sensitivity. All three symptoms are non-life threatening and likely short-term symptoms that can be immediately observed upon use of a solvent. In fact, most symptoms reported are non-life threatening. Long term, major symptoms can be difficult to correlate with solvent use without proper medical examination and testing.

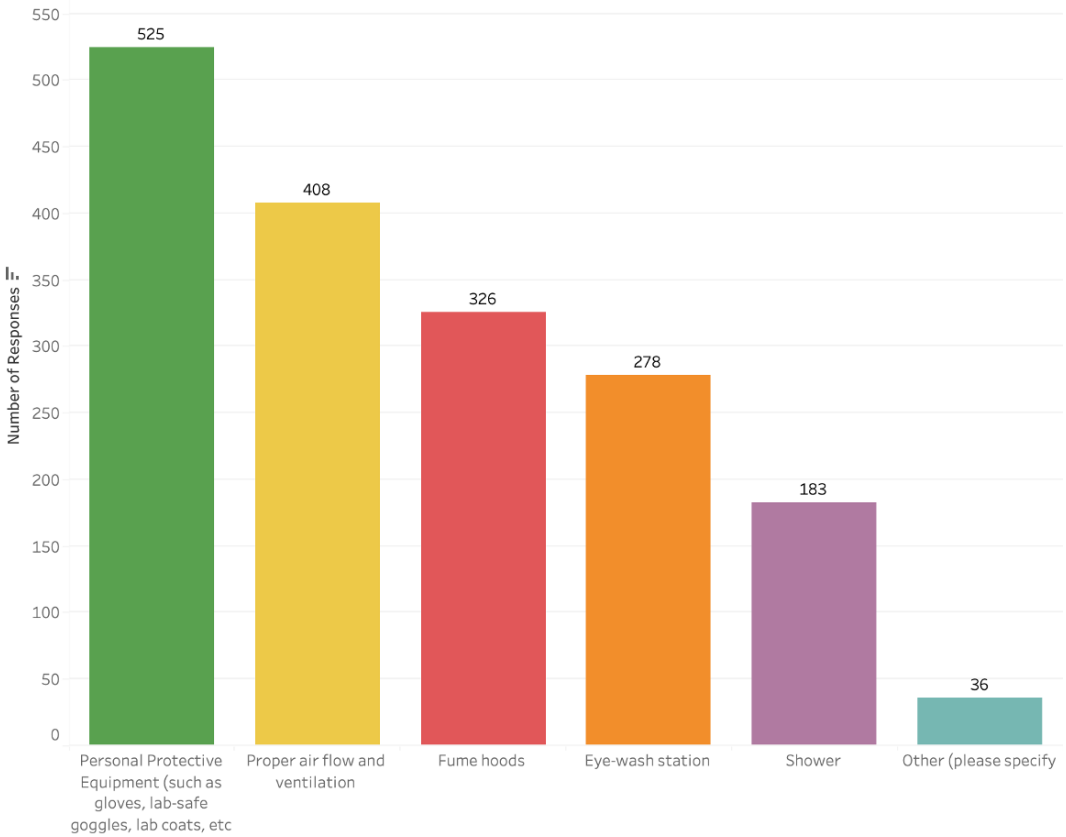
The volume of responses to this free-text question could also speak to the fact that major and minor health problems were not defined in the survey.

Data detailing some of the comments and indicating health problems reported per institution type, geographic region and specialization can be found in Appendix.

Accessible Protective Measures

XIII. Workplace Protective Measures

Q. What protective measures are accessible to you at your workplace? *Multi-select answer choices: Personal Protective Equipment (such as gloves, lab-safe goggles, lab coats, etc.); Proper air flow and ventilation; Fume hoods; Eye-wash station; Shower; Other (please specify)*



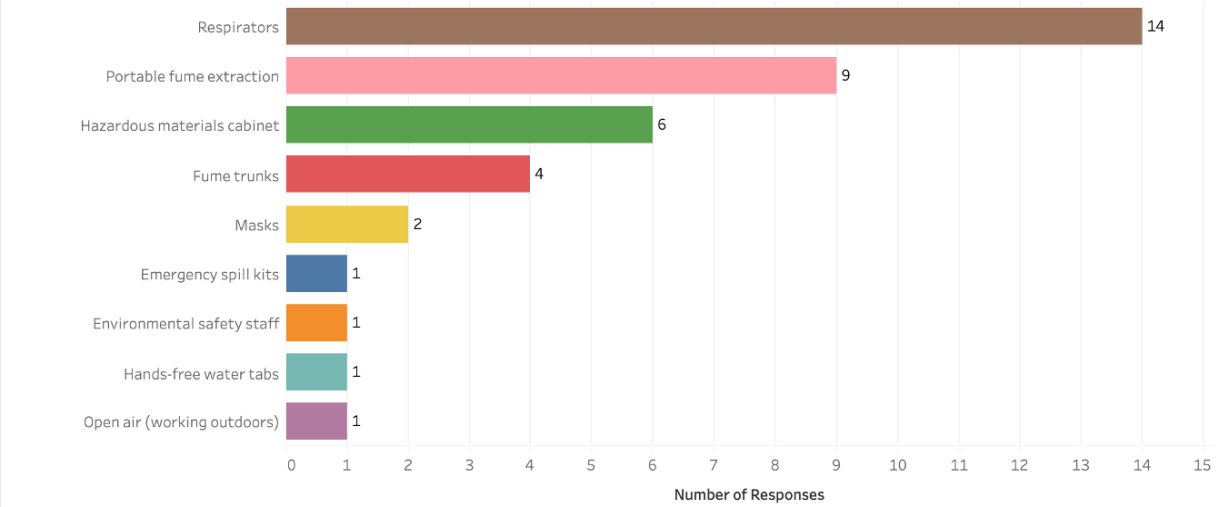
	Personal Protective Equipment (such as gloves, lab-safe goggles, lab coats, etc.)	Proper air flow and ventilation	Fume hoods	Eye-wash station	Shower	Other (please specify)
Number of responses	525	408	326	278	183	36

Figure 25: Accessible Workplace Protective Measures *Bar graph and corresponding table detailing responses from 535 respondents about the type of protective measures available at their workplace. 50 respondents did not answer this question. Because this is a multi-select question, respondents can choose more than one protective measure, resulting in 1,756 responses. The sum of each choice is detailed in the graph and table, organized from the highest to lowest number of responses. "Other (please specify)" represents the free text responses that respondents answered to clarify, specify, or to include an answer they felt was not represented in the original answer choices and the responses are detailed in* ***Figure 26.***

Personal protective equipment received the highest number of responses (98%) followed by proper air flow and ventilation (75%), fume hoods (61%), eye-wash station, shower, and others.

XIV. Other Workplace Protective Measures

Q. What protective measures are accessible to you at your workplace? - Other (please specify)
Free-text answer



	Respirators	Portable fume extraction	Hazardous materials cabinet	Fume trunks	Masks
Number of responses	14	9	6	4	2
	Emergency spill kits	Environmental Safety staff	Hands-free water tabs	Open air (working outdoors)	
Number of responses	1	1	1	1	

Figure 26: Other Accessible Workplace Protective Measures *Bar graph and corresponding table showing 36 individuals and their free-text responses detailing other accessible workplace protective measures. Two responses reiterated their answers to the original survey question. Three responses were comments and did not provide data that could be implemented. Some respondents listed more than one available protective measure in their answers. The data is organized by the greatest to the lowest number of responses to the proposed protective measure. These protective measures feature a variety of aliases and details. These aliases and details are summarized below:*

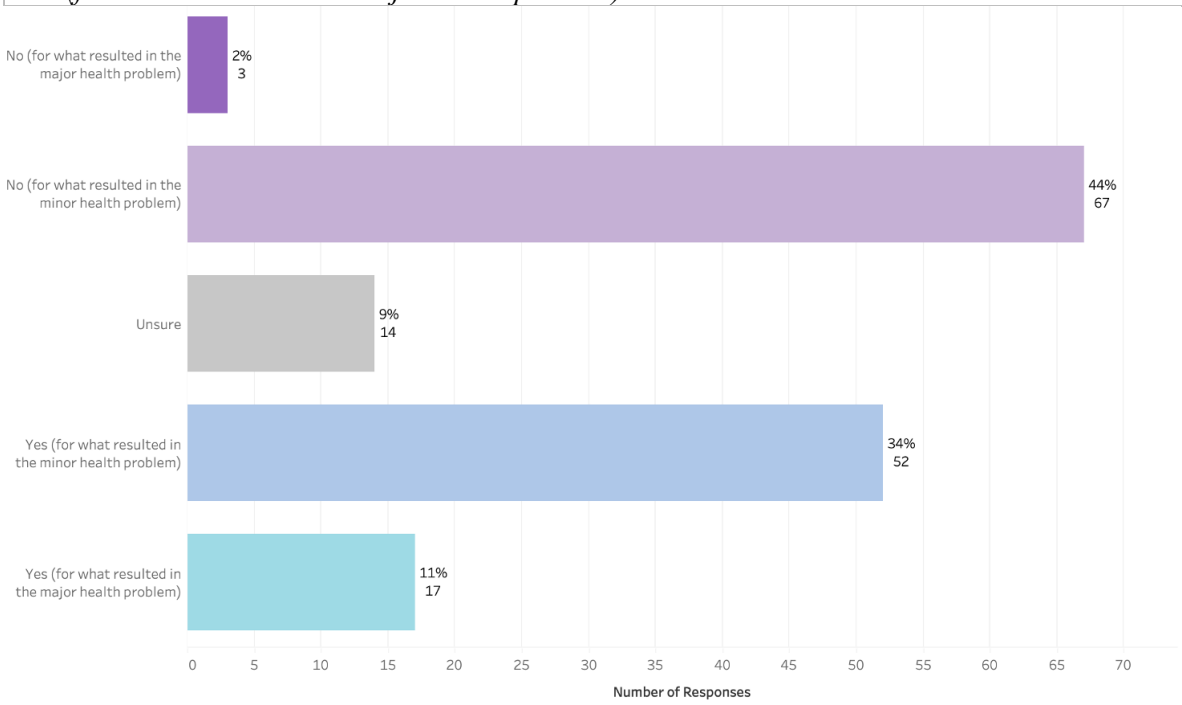
Respirators were also called cartridge masks, solvent masks, and face/gas mask with solvent filters/specific filters/ necessary filters for each solvent/ cartridges for organic fumes. Two responses specified using half-face respirators and one mentioned "respiratory protective devices - fresh air hose breathing apparatus for use with full face mask." Another response also detailed that they get annual respirator fit tests. Portable fume extraction was described as mobile extraction units, portable extraction, portable fume extractors, portable fume trunks, spot air extractor, portable ventilation, mobile fume trunks, and task exhausts. Hazardous materials cabinet were also considered fume cupboards, ventilated in-lab storage, biosecurity cabins, and storage cabinets for solvents. Fume trunks were interchangeable with solvent trunks and extraction arms. Masks were only considered respirators if they detailed some association to solvent filtration. Otherwise, they were considered medical disposable face masks or the like.

In addition to the proposed protective measures in **Figure 41**, the next top three protective measures proposed by the respondents were respirators, portable fume extraction, and hazardous materials cabinets.

Protective Measures and Reported Health Problems

XV. Personal Protective Equipment Use and Reported Health Problems

Q: Do you recall wearing proper Personal Protective Equipment (PPE) prior to noticing symptoms? *Multi-select answer choices: No (for what resulted in the major health problem); No (for what resulted in the minor health problem); Unsure; Yes (for what resulted in the minor health problem); Yes (for what resulted in the major health problem)*



	No (for what resulted in the major health problem)		No (for what resulted in the minor health problem)		Unsure		Yes (for what resulted in the minor health problem)		Yes (for what resulted in the major health problem)	
	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent
Number of Response	3	2%	67	44%	14	9%	52	34%	17	11%

Figure 27: PPE and Reported Health Problems. *Bar graph and corresponding table detailing the multi-choice responses of 147 respondents out of 153 who had reported experiencing health problems with solvent use. 6 respondents chose two answer choices resulting in 152 responses in total. The data is organized by the level of PPE and severity of the health problem in both the graph and table. The total number and the percentage of responses for each answer choice are reported.*

A total of 46% of responses to this question did not wear PPE and experienced health problems, both major or minor, while a total of 45% of responses wore PPE and still experienced health problems. “No (for what resulted in the minor health problem)” received the highest number of responses at 44% of responses to this question followed by “Yes (for what resulted in minor health problems)” at 34%. The data suggests that wearing PPE may not be enough protection against health problems associated with solvent use. While the appropriate PPE should be worn, the proper usage and solvent exposure limits when using PPE should also be understood. The current survey data currently does not have the means to gauge this understanding.

XVI. Solvent-Related Information and Reported Health Problems

Approximately 60% of people with access to each type of solvent information source reported not experiencing any health problems related to solvent use. Across the solvent information sources, 20-24% of people reported experiencing acute minor health problems. The ratios between the health problem answers for each information source are very similar. This indicates that people's exposure to solvents and the resulting health problems does not correlate with the source of the solvent information.

Discussion

The survey accomplished its two goals of gauging the current state of solvent use in cultural heritage conservation and identifying the greatest research needs in finding solvent alternatives to various degrees.

Current state of solvent use in the cultural heritage field

Overall, this survey illuminated what solvents are being used, and how conservators interact with those solvents. Primarily, this survey created a top 10 list of the most used solvents overall, as well as a top 5 list based on specialty. The top 10 overall list informs which solvents are being used. Combining this information with the solvent hazards creates a list of which solvents most need replacing. Out of the top 10 solvents (ethanol, acetone, isopropanol, white spirits, mineral spirits, shellsol T/D/38, acetic acid, ethyl acetone, toluene, and xylene), the Greener Solvent Project aims to seek alternatives for the most harmful solvents.

Another important finding of the survey is observing which solvents are not noted as being used, which includes some particularly harmful solvents like benzene and carbon tetrachloride. This is in stark contrast to the 1998 AIC survey which found a more significant use of benzene, methylene chloride, chloroform, carbon tetrachloride, trichloroethylene, perchloroethylene, cellosolves, carbon disulfide, methanol, hexanes, ethyl ether, pyridine, dimethylformamide (DMF), methyl ethyl ketone (MEK), and tetrahydrofuran (THF). This shows a greater awareness of solvent properties and a significant change in conservation practice over the past 25 years.

The current state of solvent use relies on the respondents' understanding of health, safety, and environmental hazards and concerns and the survey successfully gathered information about all three.

Health

Information about reported health concerns was gathered, and revealed that institution type, PPE, and knowledge and training did not have much of an impact on whether a conservator experiences health concerns due to solvent use. The survey indicates that conservator's rely more heavily on PPE in their solvent safety practices, than structural engineering controls. Whilst most conservators might have access to PPE, fewer note access to more effective protection such as engineering controls (ventilation). This contradicts good practice where considering the appropriate location for use (e.g. potentially under a fume hood only) and ensuring good air flow and ventilation should be a first step. Even without specific installations, ensuring sufficient air flow and ventilation (open window and a fan) should always be a first step. Further, since the typical mask/respirators used in conservation are only recommended for acute exposures under limited time perdions, prioritizing sufficient ventilation in the working location is an aspect that should be accentuated.

Safety

This survey also reveals that conservators use multiple sources of solvent information, and the most common is the Safety Data Sheet. Data regarding what kinds of chemical training conservators receive indicates that half of conservators did not receive chemical training within the last year but have

completed training within their lifetime. More respondents were aware of regional and national safety guidelines rather than the globally harmonized

Environment

This survey collected data regarding disposal of solvents, acknowledging the life cycle of solvents. Most respondents dispose of their solvents using evaporation, and then private waste management programs. There are conservators who dispose of their solvents into municipal waste services. It is unclear how solvents are evaporated and where fumes are extracted to.

Survey limitations

Data Skew and Sample Size Limitations

The survey data exhibited skew, primarily in terms of geographic representation. Small sample sizes from Africa, Australia/Oceania, and South America resulted in less representative data, as smaller samples tend to under-represent broader trends. Expanding the survey pool in these areas could have helped reduce this skew and provide a more balanced dataset.

Survey Structure Limitations

Several structural limitations within the survey impeded data interpretation. One recurring issue was incomplete responses, which made it difficult to determine whether respondents understood “no answer” as a default response of "never" or if they chose to stop answering entirely. This ambiguity particularly affected the solvent data, as the survey indicated “never” as the default but did not include it explicitly as a response option. Consequently, it was challenging to determine if a blank response indicated “never” or a skipped question.

Additionally, questions with multi-select options introduced complexities when trying to correlate solvent use with specific conservation specialties. Respondents could select multiple answers for each question, making it difficult to assign a particular solvent to a specific specialty. While this multi-select structure limited the precision of specialty data, it did provide insight into the range of solvents conservators might use to accommodate multiple object types.

There was also no mechanism within the survey to connect reported health effects to specific solvent use. Even if such a link could be established, self-reporting would still limit reliability, as certain health effects from solvent use are more noticeable than others.

Finally, the free-text format of the solvent question created ambiguity, making it hard to distinguish between responses referring to solvent mixtures and those indicating individual solvents. When responses were listed with commas, it was unclear whether they were mixtures or distinct solvents. This could be mitigated in future surveys by instructing respondents to specify if a response is a mixture. These survey design limitations restricted our ability to make robust links between various types of data, such as solvent use and health effects, and underscored the need for greater clarity in survey structure.

Next steps

The results for the survey have made way for the next steps for the Greener Solvent project: first, to create a new structure for future surveys; and second, to continue research into alternatives for the topmost identified solvents that present the greatest harm.

It is recommended to distribute a new solvent survey semi-frequently (i.e. every 5-10 years) to develop a better understanding of solvent use over time. The subsequent surveys will have revised questions in order to reach the goal of providing accurate solvent alternatives, specifically for each material type and to make better correlations across the data. To ensure we reach these goals, it is also recommended we distribute a pilot version of the survey and gauge responses from conservators of different specialties.

The following question specific additions and changes are also recommended in the next survey:

- To ensure 100% completion of the survey, each question should be mandatory to proceed to the next question. This will eliminate confusion surrounding blank answers that can be interpreted as both survey incompletion or not applicable.
- While keeping the default choice as “Never” for solvent use questions, an additional question should be added ascertaining that the respondent has read through the question and agree that they do not use any of the solvents listed. For example, there can be checkbox next to the statement “I’ve read the question, and I don’t use any of the listed solvents.”
- To reduce vague and uncertain answers, rephrase the question asking about the solvents of highest concern. Instead, specify one solvent that you use that are you concerned about
- Free text answers should be structured in the question.
    - In regards to solvents, specify whether a list is a mixture of solvents or not
    - In regards to reported health concerns and unsure answers, specify the symptoms they experienced in relation to solvent use
- Rephrase the question about health concerns to address the fact that the association between health problems and solvent use has limitations. For example, “Do you think you have experienced the following health problems as a result of solvent use (multi-select)?” can be asked instead.
- Include a question concerning the confidence of conservators’ knowledge of a solvent’s hazards. This question could be a single select answer option and the answer could be phrased as XX% confident. The more confident, the higher the percentage
- Include a question regarding how many treatments in the past three years require the use of solvents. This question could offer single select answer options, and the choices could be reported in percentages.
- Include a solvent section that features silicone solvents.
- Include a question that features solvent applications, like gels and adhesives.
- Include a set of questions about PPE and health symptoms. There should be questions asking respondents if they are confident in their knowledge about the exposure limits with the use of PPE and what different types of PPE and their mode of protection (e.g. Are you familiar with the solvents that nitrile gloves protect against? Do you know the length of time for which you can use a solvent with the PPE?).

- Include a set of questions about how and if conservators currently track their reported health problems potentially due to solvent use, especially long-term effects.

It is hoped that this survey data will also encourage the conservation field to consider improvements to solvent use generally, and create more resources to empower conservators to choose materials and equipment that can achieve this goal.

Acknowledgements

The creation, translation, and review of this survey were made possible through the contributions of numerous dedicated individuals. For survey creation, we extend our gratitude to Naomi Toyama and Lucile Pourret for their invaluable efforts in designing and structuring the survey. For survey translation, our many thanks are due to Julia Wagner, Momoka Okuyama, Annalisa Marra, Lucile Pourret, Josefa Orrego, Catarina Pinheiro, Hilary Kwan, and Chenyue Xu. Anna Beaumont and Daniela Molinari helped in the dissemination, and we are grateful to the many people, too numerous to mention individually, who reached out and shared the survey through their personal professional contacts in the field.

We also acknowledge the valuable and much appreciated feedback from Alan Phenix and the GCI/KIK-IRPA Greener Solvents Expert's Meeting attendees and contributors. Special thanks are further due to Irene Kuo, Associate Research Professor in Public Health at George Washington University, DC, for her thoughtful review, and to the University of Delaware Institutional Review Board (IRB) for their oversight and guidance throughout the research process.

We sincerely thank the Royal Society of Chemistry for their support through a Sustainable Laboratories Grant.

Thank you to all respondents for your contributions to this study.

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Appendix

1. Institution type

Free Text Groupings	Count	Response			
University	32	University (private, non-profit)	In formation	Student (La Cambre)	University of Delaware
		Studies	A university lab operating on soft money (contracts from individuals and organizations)	Student	University of Antwerp, department conservation restoration
		University setting	La Cambre (university)	Educational institution	Education
		Private university	Department of Art Conservation/Restauration on Academy of Fine Arts	Student	Student
		Private university library	University, Academia	University	School
		University	University	School Restoration	School
		Private University Library	University Museum	Student ENSAV	university
		University	higher education	School	School, la cambre
Private	16	Private restoration Lab	works on sites (churches, town halls, castles,	Independent for national museums and	Freelance

			public civil buildings)	local authorities on site and in the workshop	
		Private workshop	Private practice as employee	freelance + institution scolaire (master in conservation restauration)	Freelance Museum
		Freelance	Freelance craftsman	Private entrepreneur	Freelance
		Private studio owner	I work both as a freelance conservator (have worked for public institutions) and at the University that teaches conservation	entrepreneur	Inside a private company
Hybrid	7	private, subsidized museum	in the last 3 years I have been 2 years in a museum, 1 year private	Both institution and private practice	Research heritage center
		Private art museum	Individual business	the three types...	
Public	1	National Park Service			

2. Solvent Resources

Free Text Groupings	Count	Response			
Solvent Literature	8	amanda clydesdale book, scottish and another book	L. Masschelein Kleiner LES SOLVANTS IRPA/KIK	Chemical Hygiene Plan of my department	Manufacture info/instructions
		Book	Academics studying green solvents	Chemical Hazard manuals	
National / Regional Guidelines	9	OSHA	https://www.ilo.org/dyn/icsc/showcard.home and the various articles from the	AIC Wiki, Cameo	CAMEO

			CHEM21 work from Prat et al 2008-2016		
		Databases (INRS, Seirich,...)	STiCH	ECHA	COSHH (as specified earlier for UK)
		REACH, PubChem,			
Courses	6	Workshops	Solvent Course at la Cambre	Courses taken during School	Course at the Institute of Chemicals at the University of Sao Paulo
		formation continue (Inp, A French university)	Refresher courses on solvents		

Not Included: One respondent answered that they don't use solvents, one respondent who had" 30 years of experience in synthetic organic chemistry in industrial research" and one respondent answered that they use the internet for solvent information.

3. Solvent Supply Sources – Free Response

Free Text Groupings	**Count**	**Response**			
Unspecified	6	Unsure	Through our lab assistant	I don't use solvents.	unsure
		Not responsible for purchases	In Brazil, products such as xylene, toluene, etc. are allowed for very specific uses. The others are all controlled by the army or federal police and the licenses are extremely expensive. It became very difficult for an independent restorer to buy solvents. The result of our work remains very limited and we try to invest much more in conditioning to protect the works that could not be completely treated.		
Pharmacy / Cosmetics / Grocery Stores	9	Pharmacy	Cosmetic supplies store	Pharmacy, Supermarket	pharmacy/ online
		Acetone from beautician supplier (cheapest!)	(Ethanol is available at the drugstore. Turpentine is available online.)	Pharmacy	

University Supplies	6	In my case, the university takes care of procuring the solvents.	Provided by school	Some of our chemicals come from a local university chemistry department

Other Responses not included:

1- *Local Art Stores: "Prestige brands like W&N"*
1- *Local Services provides: "Local service provider"*
1- *Black Market: "Black market. Acetone is illegal in countries where cocaine base is produced"*
1- *Liquor Store: "Liquor store for grain alcohol"*

4. Disposal Methods – Free Responses

Free Text Groupings	Count	Response			
University	12	University waste management program	unsure, disposed of by university	University EHS	University waste management program
		University EHS waste management	University waste management program	The teachers take care of it	In my case, the university takes care of the disposal of the solvents. But we are not informed about this.
		University waste management/ disposal	University waste management program	University chemical waste program	University Health and Safety bulk waste program
Workplace organizes Waste Management	10	The agency I work with has a procurement officer who figures out waste management	Specific containers managed by the museum	Museum waste disposal service	hazardous waste/solvent waste into museum-run disposal program, general lab waste into trash. Some solvent waste gets into trash
		hazardous removal	Institution collects solvent waste -- where it goes after that, I don't know!	institutional waste management program	Organizational facilities/EHS program
		Through the disposal program	Our museum follows the national rules about solvent waste disposal for companies and collects everything for the entire department		

		provided by my Institute		
Keeps Waste	5	Still have it	They just finish	not discarded
		By making a solvent bin in the workshop but which is currently a problem to eliminate	I look forward to a solution being created for their removal from our premises.	

Other answers:

- *2- Burns: "Use as fire starters in outdoor settings"*
  "Incineration"
- *1- Burial: "Buries"*
- *1- Doesn't Use " I don't use solvents.*
- *2- Drain: "Dilution with water*
  "Ethanol and small amounts of acetone in the drain"
- *2- Recycle: "Recycle"*

"We have "dirty" solvents (kept by type), to use when purity isn't an issue. If a small beaker of solvent is only dipped into once (ie for testing) I pour the remainder back into the original container."

- *3- Unsure*

5. Used in Risk Assessment

Countries	Standards Used for Risk Assessment
Argentina	Reading specific bibliographies
Australia	Safe Work Australia
	AS/NZS International Organization of Standardization (ISO): ISO 31000, 2018 Risk Management – Principles and Guidelines
	Australian Standards
	Chemwatch
	Dangerous Goods Class
Austria	Employer carried out risk assessment through a labor inspectorate
Belgium	European Union Risk Assessment by the European Chemicals Agency (ECHA)
	Internal document provided by institution's safety and prevention department. They comply with national and international guidelines and laws regarding the use of harmful substances.
Brunei	56Y5
Canada	Le Système d'information sur les matières dangereuses utilisées au travail or The Information System on Hazardous Materials Used at Work (SIMDUT)

	WHMIS
	Environmental Management and further health and safety requirements
	Government of Canada website on "Volatile organic compounds in consumer and commercial products (https://www.canada.ca/en/environment-climate-change/services/managing-pollution/sources-industry/volatile-organic-compounds-consumer-commercial.html)
Denmark	Registration, Evaluation, Authorization, and Registration of Chemicals (REACH)
	ECHA
	Arbejdstilsynet – AT Guide (Norwegian Labor Inspection Authority) (https://at.dk/regler/at-vejledninger/arbejde-stoffer-materialer-c-1-3/)
Estonia	Local standard for chemical disposal and risk analysis
France	French regulations and labor code (code du travail)
	Institut National de Recherche et de Sećurité (INRS) - conception des lieux de travail Obligations des maîtres d'ouvrage reglemenation (Design of workplace: Obligations of Project Owners Regulations) (ed773.pdf)
	REACH
Germany	TH Köln- University of Applied Sciences in Cologne
Hong Kong	HK regulations on chemical management
	SDS
Italy	Current regulations
	ECHA
	Istituto nazionale per l'assicurazione contro gli infortuni sul lavoro or National Institute for Insurance against Accidents at Work (INAIL)
	NHS
	REACH 2007
	Risk phrases and diagrams
	Threshold limit values (TLV) and Occupational exposure limits (OEL)
Japan	労働安全衛生法 or Industrial Safety and Health Act (Jap)
Mexico	Personal application of national information "about the solvent, its toxicity, ecological footprint, remanence"
Netherlands	Dutch arbo
	Reading about hazards
Nigeria	Quarantine specifically for wooden object showing signs of deterioration
Norway	REACH
	The Norwegian Occupational Safety and Health Authority's risk assessment (guidelines)
Peru	Hazards solvent manual
	ISO 31000
Spain	Occupational risk assessment of my job carried out by my company
	Spanish occupational health and safety regulations
	Asociación Española de Normalización or Spanish Standardization Association (UNE)
Switzerland	Safety guide for the use of solvents, produced by SUVA (suva.ch)
	Glaxosmithkline or GSK's solvent sustainability guide
	File on chemical risks and safety sheet toxicology of solvents published by INRS
United Kingdom	British HSE (Health & Safety Executive)
	Control of Substances Hazardous to Health (COSHH)
	MSDS
	Dangerous Substances and Explosive Atmospheres Regulations (UK, 2002)
	Workplace Exposure Limits (UK, 2005)
	Correct use of PPE, labelling of containers with correct hazard symbols, use of extraction or use in fume cupboard
	Chemicals are categorised using the H numbers as a guide. These feed into a colour coded system eg red bad, green good to be very simple
	ISO 31000
	Loosely based on a mix of COSHH legislation and personal sustainability goals
	Oxford University Safety Office
	Sypol - COSHH Management
	UK PPE and RPE regulations
	BS standards
United States	GHS
	OSHA PELs
	ACS.org
	sifacilities.si
	Risk assessment determined and led by university health and safety department to keep us in compliance
	Studies conducted by the Safety Services Office of my institution

	The assessment was completed by the practicing conservator and reviewed for approval by the head of the environmental health and safety department
	SDS sheets
	Health and safety department review SDS to determine how we can mitigate risks

Other comments: China - “Is it harmful to human health;” China - “put personal and work safety first”; Netherlands - “How to store and use chemicals correctly”; Netherlands - “I do not know. Somebody came to measure exposures”; Netherlands - “Possibility of the solvent causing cancer or blindness, being an endocrine disruptor, or causing fire;” Iran - “It depends on the situation, objects, or institutes;” Spain – “I don’t know exactly, several;” UK – “Not sure I understand what this question wants. I carried out RAs for COSHH (control of substances hazardous to health). Listing the substances used in the studio, quantities, how they are stored, used and disposed, risk phrases for the substances and how;” UK – “read up the details and dispose nicely”; US – “Usage of alcohol (ethanol and isopropanol) in paper conservation”

6. Affiliations and Other Organization Free Text

Organization	Abbreviation	Count
Insitute of Conservation (UK)	ICON	28
Australian Institute for the Conservation of Cultural Materials	AICCM	12
Fédération Française des Conservateurs-Restaurateurs (French Federation of Conservator/ Restorers)	FFCR	10
Canadian Association for the Conservation of Cultural Property	CAC-ACCR	9
Asociación de conservadores-restauradores de España (Association of Conservator/Restorers of Spain)	ACRE	7
Restauratoren Nederland (Restoration Netherlands	RN	7
Western Association for Art Conservation	WAAC	6
Midwest Regional Conservation Guild	MRCG	6
Grupo español international institute of conservation (Spanish Group-International Institute of Conservation)	GE-IIC	6
Nordiska Konservatorsförbundet (Nordic Association of Conservators)	NKF	5
Verband der Restauratoren (Association of Restorers	VdR	5
Canadian Association of Professional Conservators	CAPC	4
Centro Studi Di Geopolitica e Strategia Maritima (Center fior the study of geopolitcals and marine strategy)	CESMAR7	4
La Cambre, University Program	La Cambre	4
Canadian Association of Professional Conservators	BAPCR	3
Österreichischer Restauratorenverband (Professional Association of Austrian Restorers)	ÖRV	3
Hrvatski restauratorski zavod) Croatian Conservation-Restoration Association	HRZ	3
European Confederation of Conservator-Restorers Organisations	ECCO	3
Gruppo Italiano dell'International Institute for Conservation (Italian Group- International Institute of Conservation	IGIIC	3
Archives and Records Association	ARA	2
associazione restauratori d'Italia (Italian Restoration Association	ARI	2
Associação Profissional de Conservadores Restauradoers de Portugal	ARP	2
Centre de Conservation du Quebec (Center of Conservation of Quebec)	CCQ	2
Confederazione Nazionale dell'Artigianato e Piccola Media Impresa (National Confederation of Crafts and Small and Medium Enterprises)	CNA	2
International Association of Book and Paper conservators	IADA	2
文化財保存修復学会は (The Japan Society for the Conservation of Cultural Property)	JSCCP	3

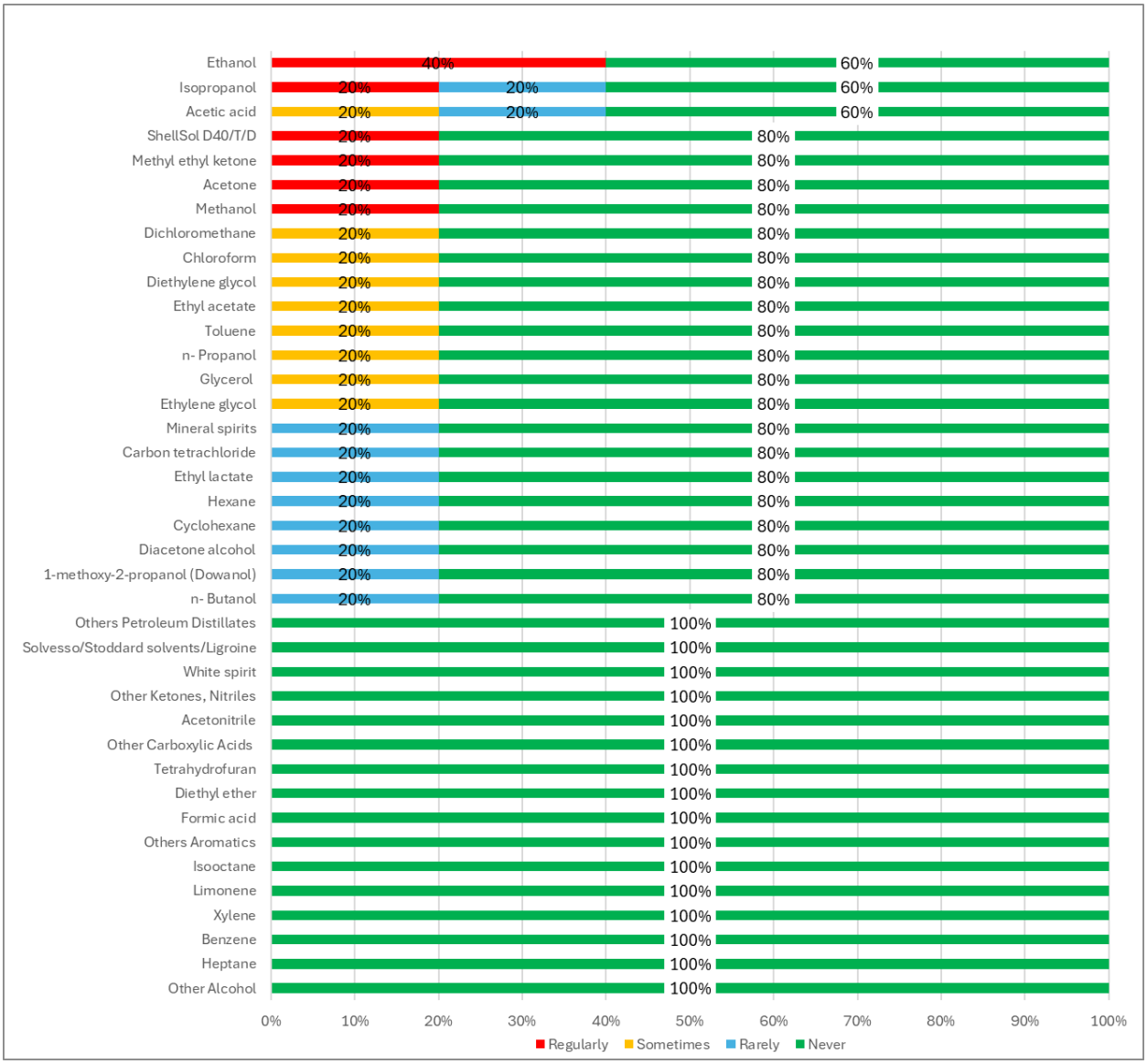
New England Conservation Association	NECA	2
Section française de l'institut international de conservation (French Section of the International Institute of Conservation)	SFIIC	2
association suisse de conservation et restauration (Swiss Assocation for conservation and restoration)	SKR	2
Society for Protection of Natural History Collections	SPNHC	2
International Council of Museums – Conservation Committee	ICOM-CC	2
bouclier bleu français (French section of Blue Shield)	BBF	2
Confederazione Nazionale dell'Artigianato e Piccola Media Impresa (National Confederation of Artisans and Small Businesses)	CNA	2
New Zealand Conservators of Cultural Material	NZCCM	1
American Library Association	ALA	1
Association for Heritage Preservation of the Americas	APOYOnline	1
Association Professionelle de Conservateurs-Restauareteurs dOeuvers d'art, Beroepsvereniging voor Conservators-Restaurateurs van Kunstvoorwerpen (Professional Assocation of Conservator/Restorers of Art Objects)	APROA-BRK	2
Asociación Argentina de Conservadores y Restauradores (Argentine Association of Conservators and Restorers)	ASACOR	1
British Antique Furniture Restorers Association	BAFRA	1
China Association for Conservation Technology of Cultural Heritage (CACTCH)	CATCH	1
Congreso Latinoamericano de Arqueometría (CLA) y del Simposio Latinoamericano sobre Métodos Físicos y Químicos en Arqueología, Arte y Conservación del Patrimonio Cultural (LASMAC)) (Latin American Congress of Archaeometry, and the Latin American Symposium of Physcial and Chemical methods in Archaeology, Art, and Conservation of Cultural Patrimony)	CLASMAC	1
Conservadors-Restauradors Associats de Catalunya (Conservators – Restorers Associates in Catalonia)	CRAC	1
Croatian Museum Society	Croatian Museum Society	1
Deutsche Gesellschaft für Kulturgutschutz e.V., (The German Society for Protection of Cultural Property)	DGKS	1
Federal Emergency Management Agency- Heritage Emergency National Task Force	FEMA (HENTF)	1
nstituto Nacional de Antropología e Historia (National Institute of Anthropology and History)	INAH	1
INCCA	INCCA	1
International Association of Sound and Audiovisual Archives	IASA	1
Israel Society for the Conservation and Preservation of Cultural Property (המועצה לשימור אתרי מורשת בישראל)	ISCPCP	1
Ministry of Culture	Ministry of culture	1
Society of American Archivists	SAA	1
YOuth in COnservation of CUltural Heritage)	YOCOCU	1
Asociación de alumnos y exalumnos de la Escuela Superior de Conservación-Restauración de Bienes Culturales de Aragón (Association of Alumni of the Superior School of Conservation / Restoration)	ACYRA	1
ASSINPAC?	ASSINPAC	1
Australia Museum and Galleries Association	AMaGA	1
Association for Scientific Research in the Graphic **Arts**	ARSAG	1
KhiCon?	khicon	1
Asociación Española de Documentación Musical (Spanish Association of Musical Documentation)	AEDOM	1

Guild of Book Workers	Guild of Book workers	1

This appendix features all of the written responses for the specialty distribution, containing all Other answers. Any answer that responded that the respondent had not been part of any other affiliated organization have been removed.

Trends per Continent

7. Africa Overall Solvent Use



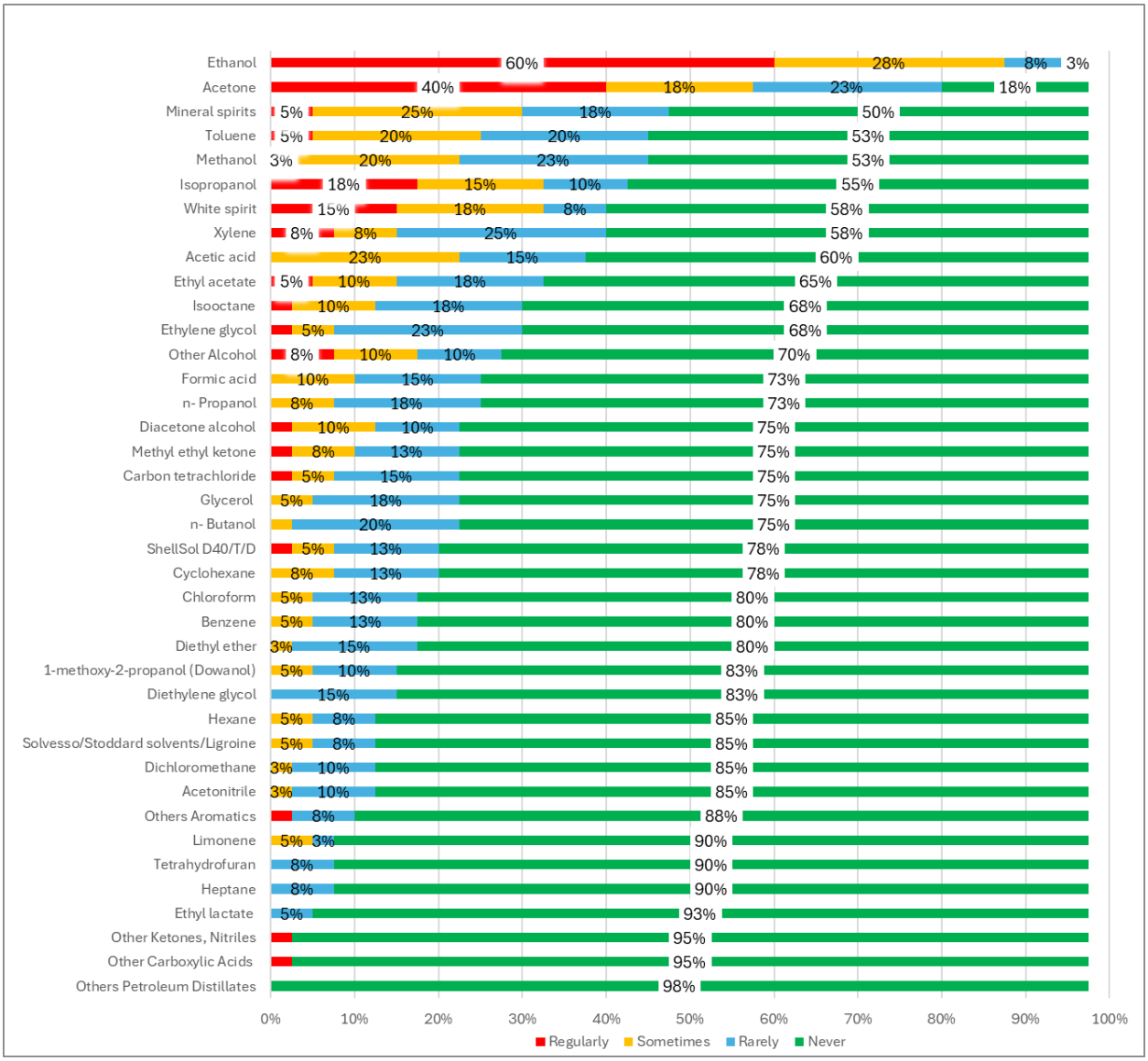
African Solvent Choice, sorted by Most used	Regularly	Sometimes	Rarely	Never
Ethanol	40%	0%	0%	60%
Isopropanol	20%	0%	20%	60%
ShellSol D40/T/D	20%	0%	0%	80%
Methanol	20%	0%	0%	80%

METHYL ETHYL KETONE	20%	0%	0%	80%
ACETONE	20%	0%	0%	80%
ACETIC ACID	0%	20%	20%	60%
DIETHYLENE GLYCOL	0%	20%	0%	80%
DICHLOROMETHANE	0%	20%	0%	80%
GLYCEROL	0%	20%	0%	80%
ETHYL ACETATE	0%	20%	0%	80%
CHLOROFORM	0%	20%	0%	80%
ETHYLENE GLYCOL	0%	20%	0%	80%
N- PROPANOL	0%	20%	0%	80%
TOLUENE	0%	20%	0%	80%
CARBON TETRACHLORIDE	0%	0%	20%	80%
N- BUTANOL	0%	0%	20%	80%
HEXANE	0%	0%	20%	80%
1-METHOXY-2-PROPANOL (DOWANOL)	0%	0%	20%	80%
ETHYL LACTATE	0%	0%	20%	80%
CYCLOHEXANE	0%	0%	20%	80%
DIACETONE ALCOHOL	0%	0%	20%	80%
MINERAL SPIRITS	0%	0%	20%	80%
ACETONITRILE	0%	0%	0%	100%
DIETHYL ETHER	0%	0%	0%	100%
FORMIC ACID	0%	0%	0%	100%
OTHER KETONES, NITRILES	0%	0%	0%	100%
LIMONENE	0%	0%	0%	100%
TETRAHYDROFURAN	0%	0%	0%	100%
OTHERS PETROLEUM DISTILLATES	0%	0%	0%	100%
HEPTANE	0%	0%	0%	100%
BENZENE	0%	0%	0%	100%
OTHER CARBOXYLIC ACIDS	0%	0%	0%	100%
SOLVESSO/STODDARD SOLVENTS/LIGROINE	0%	0%	0%	100%
OTHERS AROMATICS	0%	0%	0%	100%
WHITE SPIRIT	0%	0%	0%	100%
ISOOCTANE	0%	0%	0%	100%
OTHER ALCOHOL	0%	0%	0%	100%
XYLENE	0%	0%	0%	100%

Figure A1 ***African Most Used Solvents Overall.*** *This graph and table represent the most used solvents in Africa, based on the most used overall. To calculate most used overall, regular, sometime, and rare use are added together to gain an understanding of how a conservator uses a solvent, if at all.*

From this dataset, Africa has a small sample size of 5 respondents. Therefore, this data cannot be considered is not representative of current African solvent use based on the small sample size. However, it is important to acknowledge the data collected. Ethanol, isopropanol, and acetic acid are the three top solvents, which all feature in . This is unsurprising, based on the **Top 10 Most Used Solvents Overall (Figure 13),** which contains all three solvents.

8. Asia Overall Solvent Use



ASIAN SOLVENT CHOICE, SORTED BY MOST USED	REGULARLY	SOMETIMES	RARELY	NEVER
ETHANOL	60%	28%	8%	3%

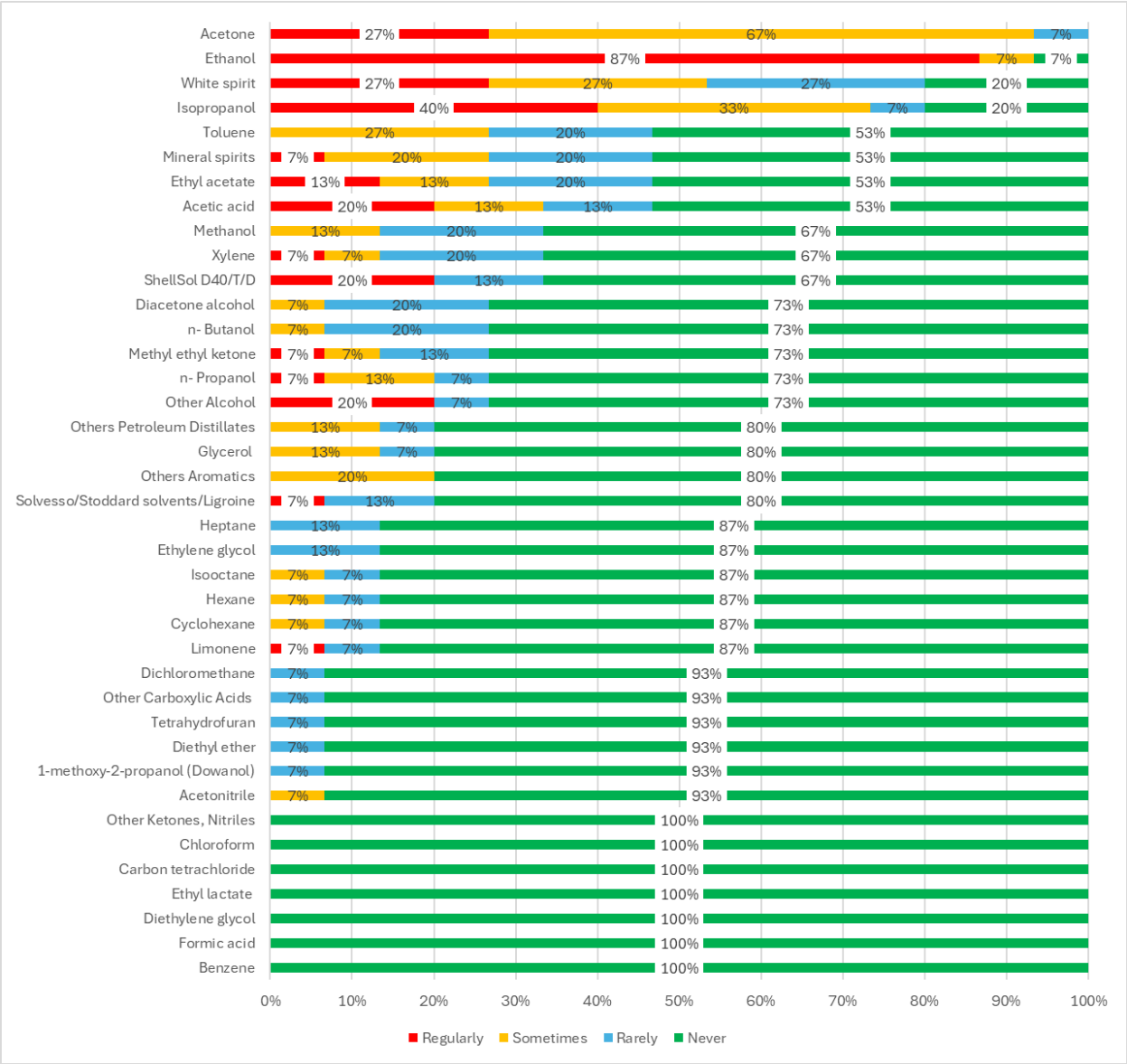
ACETONE	40%	18%	23%	18%
MINERAL SPIRITS	5%	25%	18%	50%
TOLUENE	5%	20%	20%	53%
METHANOL	3%	20%	23%	53%
ISOPROPANOL	18%	15%	10%	55%
WHITE SPIRIT	15%	18%	8%	58%
XYLENE	8%	8%	25%	58%
ACETIC ACID	0%	23%	15%	60%
ETHYL ACETATE	5%	10%	18%	65%
ISOOCTANE	3%	10%	18%	68%
ETHYLENE GLYCOL	3%	5%	23%	68%
OTHER ALCOHOL	8%	10%	10%	70%
FORMIC ACID	0%	10%	15%	73%
N- PROPANOL	0%	8%	18%	73%
DIACETONE ALCOHOL	3%	10%	10%	75%
METHYL ETHYL KETONE	3%	8%	13%	75%
CARBON TETRACHLORIDE	3%	5%	15%	75%
GLYCEROL	0%	5%	18%	75%
N- BUTANOL	0%	3%	20%	75%
SHELLSOL D40/T/D	3%	5%	13%	78%
CYCLOHEXANE	0%	8%	13%	78%
CHLOROFORM	0%	5%	13%	80%
BENZENE	0%	5%	13%	80%
DIETHYL ETHER	0%	3%	15%	80%
1-METHOXY-2-PROPANOL (DOWANOL)	0%	5%	10%	83%
DIETHYLENE GLYCOL	0%	0%	15%	83%
HEXANE	0%	5%	8%	85%
SOLVESSO/STODDARD SOLVENTS/LIGROINE	0%	5%	8%	85%
DICHLOROMETHANE	0%	3%	10%	85%
ACETONITRILE	0%	3%	10%	85%
OTHERS AROMATICS	3%	0%	8%	88%
LIMONENE	0%	5%	3%	90%
TETRAHYDROFURAN	0%	0%	8%	90%
HEPTANE	0%	0%	8%	90%
ETHYL LACTATE	0%	0%	5%	93%
OTHER KETONES, NITRILES	3%	0%	0%	95%
OTHER CARBOXYLIC ACIDS	3%	0%	0%	95%

OTHERS PETROLEUM DISTILLATES	0%	0%	0%	98%

Figure A2- Asian Most Used Solvents Overall. *This graph and table represent the most used solvents in Asia, based on the most used overall. To calculate most used overall, regular, sometime, and rare use are added together to gain an understanding of how a conservator uses a solvent, if at all.*

From this dataset, Asia has a small sample size of 40 respondents. AThis is 35 more respondents than Africa, so it is more representative data. However, there is room for improvement to have a larger sample size from Asia would to increase the data's accuracy. Asia's top three solvents are ethanol, acetone, and mineral spirits. All three feature in This is unsurprising, based on the **Top 10 Most Used Solvents Overall (Figure 13)** which contains all three solvents. Only 3% of Asian conservators from this data do not use ethanol at all in their practice. Toluene, the 4th most used solvent overall in Asia, is almost used almost as much as mineral spirits in Asia, but neither are used very regularly.

9. *Australian /Oceanian Overall Solvent Use*



Australian / Oceanian SOLVENT Choice, SORTED BY Most used	Regularly	Sometimes	Rarely	Never
Acetone	27%	67%	7%	0%
Ethanol	87%	7%	0%	7%
Isopropanol	40%	33%	7%	20%
White spirit	27%	27%	27%	20%
Toluene	0%	27%	20%	53%
Acetic acid	20%	13%	13%	53%
Ethyl acetate	13%	13%	20%	53%

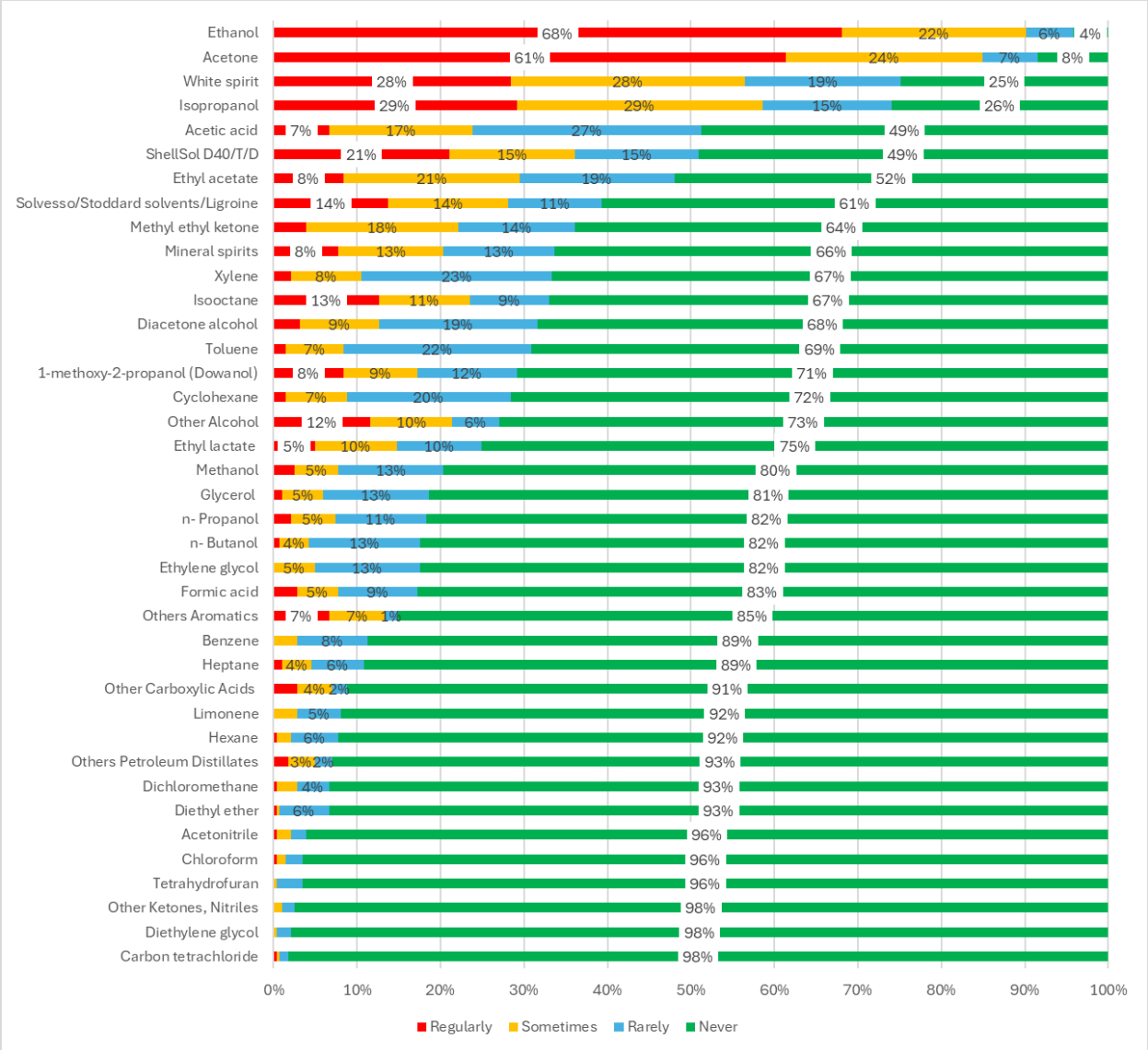
Mineral spirits	7%	20%	20%	53%
Methanol	0%	13%	20%	67%
Xylene	7%	7%	20%	67%
ShellSol D40/T/D	20%	0%	13%	67%
n- Butanol	0%	7%	20%	73%
n- Propanol	7%	13%	7%	73%
Diacetone alcohol	0%	7%	20%	73%
Other Alcohol	20%	0%	7%	73%
Methyl ethyl ketone	7%	7%	13%	73%
Glycerol	0%	13%	7%	80%
Others Aromatics	0%	20%	0%	80%
Solvesso/Stoddard solvents/Ligroine	7%	0%	13%	80%
Others Petroleum Distillates	0%	13%	7%	80%
Ethylene glycol	0%	0%	13%	87%
Cyclohexane	0%	7%	7%	87%
Heptane	0%	0%	13%	87%
Hexane	0%	7%	7%	87%
Limonene	7%	0%	7%	87%
Isooctane	0%	7%	7%	87%
1-methoxy-2-propanol (Dowanol)	0%	0%	7%	93%
Diethyl ether	0%	0%	7%	93%
Tetrahydrofuran	0%	0%	7%	93%
Other Carboxylic Acids	0%	0%	7%	93%
Acetonitrile	0%	7%	0%	93%
Dichloromethane	0%	0%	7%	93%
Benzene	0%	0%	0%	100%
Formic acid	0%	0%	0%	100%
Diethylene glycol	0%	0%	0%	100%
Ethyl lactate	0%	0%	0%	100%
Carbon tetrachloride	0%	0%	0%	100%
Chloroform	0%	0%	0%	100%
Other Ketones, Nitriles	0%	0%	0%	100%

Figure A3- Australian / Oceanian Most Used Solvents Overall. *This graph and table represent the most used solvents in Australia / Oceania, based on the most used overall. To calculate most used overall, regular, sometime, and rare use are added together to gain an understanding of how a conservator uses a solvent, if at all.*

Australia and Oceania had 14 respondents, which is a small sample size. Therefore, the data cannot represent is not entire accurate to true solvent use in Australia and Oceania. There is room for improvement to have a bigger sample size from Australia and Oceania to gather more accurate data. Acetone, ethanol,

white spirits, and isopropanol were the top 4 solvents. This continent has a top 4 solvents because white spirits and isopropanol were tied for the 3rd most used solvents. These four solvents featurerank in the top 10 most used solvents overall, from **Top 10 Most Used Solvents Overall (Figure 13).** Acetone had a 100% use, meaning that every conservator who responded to this survey from this region uses acetone in their practice. Interestingly, most of the acetone use was sometimes and not regular use. Toluene was the 5th most used overall, but is never used regularly.

10. European Overall Solvent Use



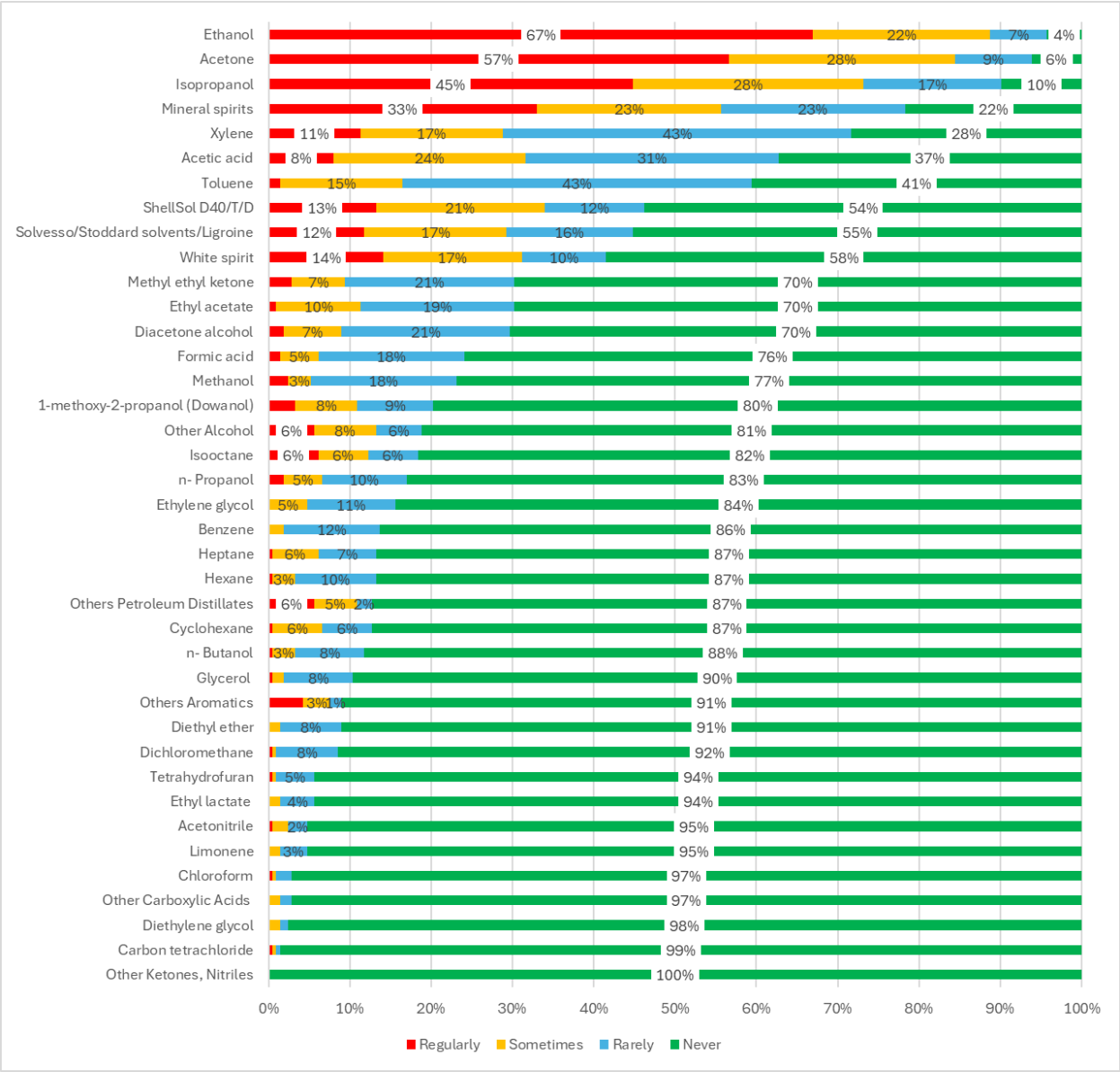
European SOLVENT Choice, SORTED BY Most used	Regularly	Sometimes	Rarely	Never
Ethanol	68%	22%	6%	4%
Acetone	61%	24%	7%	8%
White spirit	28%	28%	19%	25%
Isopropanol	29%	30%	16%	26%
Acetic acid	7%	17%	27%	49%
ShellSol D40/T/D	21%	15%	15%	50%
Ethyl acetate	9%	21%	19%	52%
Solvesso/Stoddard solvents/Ligroine	14%	15%	11%	61%
Methyl ethyl ketone	4%	18%	14%	65%
Mineral spirits	8%	13%	13%	67%
Xylene	2%	9%	23%	67%
Isooctane	13%	11%	10%	68%
Diacetone alcohol	3%	10%	19%	69%
Toluene	1%	7%	23%	70%
1-methoxy-2-propanol (Dowanol)	9%	9%	12%	72%
Cyclohexane	1%	7%	20%	72%
Other Alcohol	12%	10%	6%	74%
Ethyl lactate	5%	10%	10%	76%
Methanol	2%	5%	13%	80%
Glycerol	1%	5%	13%	82%
n- Propanol	2%	5%	11%	83%
Ethylene glycol	0%	5%	13%	83%
n- Butanol	1%	4%	13%	83%
Formic acid	3%	5%	10%	84%
Others Aromatics	7%	7%	1%	86%
Benzene	0%	3%	9%	90%
Heptane	1%	4%	6%	90%
Other Carboxylic Acids	3%	4%	2%	92%
Limonene	0%	3%	5%	93%
Hexane	0%	2%	6%	93%
Others Petroleum Distillates	2%	3%	2%	94%
Diethyl ether	0%	0%	6%	94%
Dichloromethane	0%	2%	4%	94%
Acetonitrile	0%	2%	2%	97%
Tetrahydrofuran	0%	0%	3%	98%
Chloroform	0%	1%	2%	98%

OTHER KETONES, NITRILES	0%	1%	1%	99%
DIETHYLENE GLYCOL	0%	0%	2%	99%
CARBON TETRACHLORIDE	0%	0%	1%	99%

Figure A4- European Most Used Solvents Overall. *This graph and table represent the most used solvents in Europe, based on the most used overall. To calculate most used overall, regular, sometime, and rare use are added together to gain an understanding of how a conservator uses a solvent, if at all.*

Europe had a larger sample size, of 285 respondents. The larger the sample size, the more representative and accurate the data can be. Ethanol, acetone, and white spirits are the top 3 most commonly used solvents by European conservators answering this survey in Europe. These solvents rank in the top 10 most used solvents overall from **Top 10 Most Used Solvents Overall (Figure 13)**. At one percentage point Following close behind white spirits, by one percentage point, is isopropanol. Ethanol and acetone both have over 90% widespread use in Europe. Toluene, in the top 10 most used solvents overall, ranks only 14th in Europe but still has with 31% overall use.

11. North American Overall Solvent Use



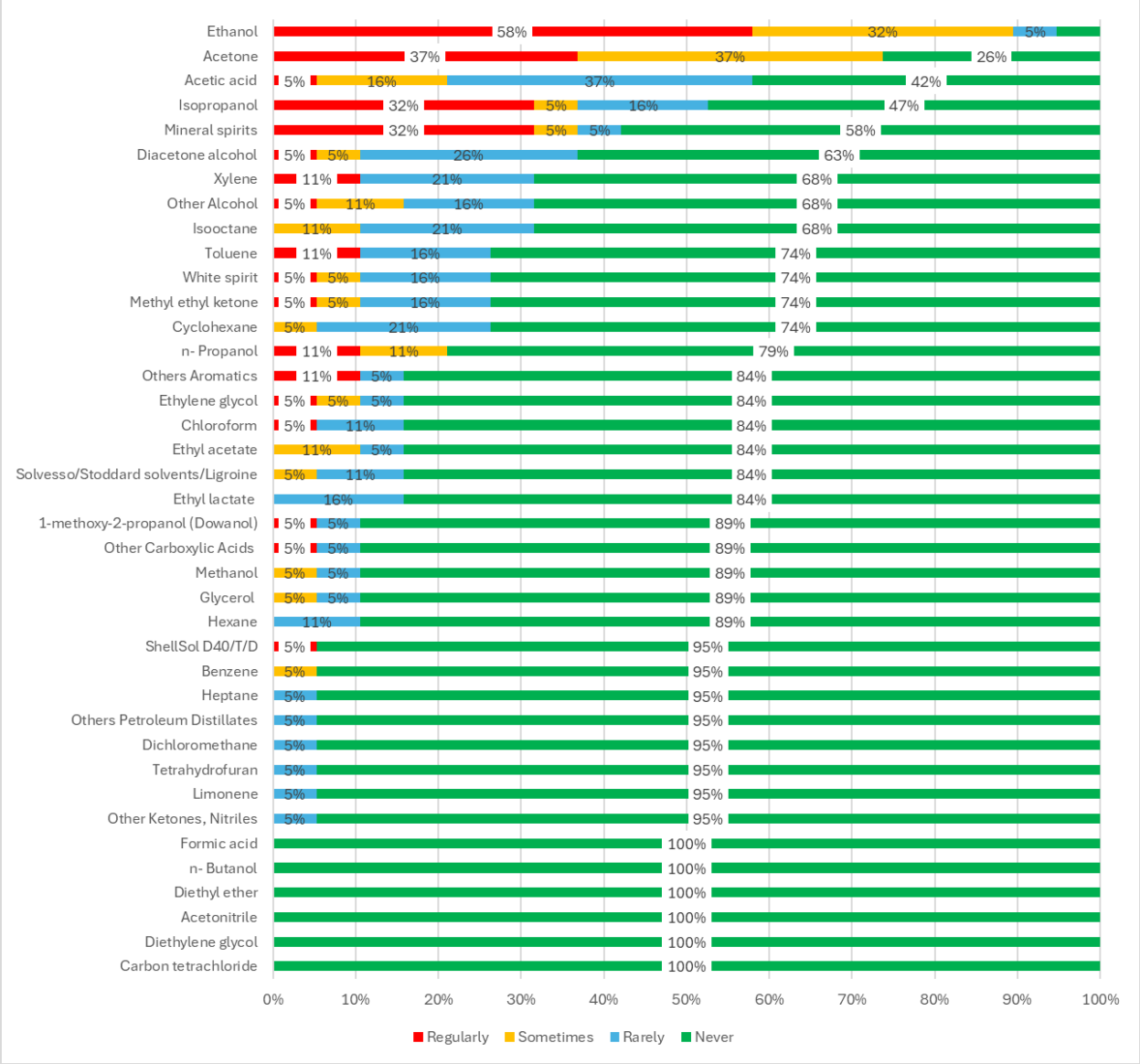
North American Solvent Choice, sorted by most used	Regularly	Sometimes	Rarely	Never
Ethanol	68%	22%	7%	4%
Acetone	57%	28%	10%	6%
Isopropanol	45%	29%	17%	10%
Mineral spirits	33%	23%	23%	22%
Xylene	11%	18%	43%	29%
Acetic acid	8%	24%	31%	38%
Toluene	1%	15%	43%	41%
ShellSol D40/T/D	13%	21%	12%	54%
Solvesso/Stoddard solvents/Ligroine	12%	18%	16%	56%
White spirit	14%	17%	10%	59%
Ethyl acetate	1%	10%	19%	70%
Methyl ethyl ketone	3%	7%	21%	70%
Diacetone alcohol	2%	7%	21%	71%
Formic acid	1%	5%	18%	77%
Methanol	2%	3%	18%	78%
1-methoxy-2-propanol (Dowanol)	3%	8%	10%	80%
Other Alcohol	6%	8%	6%	82%
Isooctane	6%	6%	6%	82%
n- Propanol	2%	5%	10%	84%
Ethylene glycol	0%	5%	11%	85%
Benzene	0%	2%	12%	87%
Heptane	0%	6%	7%	88%
Hexane	0%	3%	10%	88%
Cyclohexane	0%	6%	6%	88%
Others Petroleum Distillates	6%	5%	2%	88%
n- Butanol	0%	3%	9%	89%
Glycerol	0%	1%	9%	90%
Others Aromatics	4%	3%	1%	92%
Diethyl ether	0%	1%	8%	92%
Dichloromethane	0%	0%	8%	92%
Tetrahydrofuran	0%	0%	5%	95%
Ethyl lactate	0%	1%	4%	95%
Limonene	0%	1%	3%	96%
Acetonitrile	0%	2%	2%	96%
Other Carboxylic Acids	0%	1%	1%	98%
Chloroform	0%	0%	2%	98%

DIETHYLENE GLYCOL	0%	2%	0%	99%
CARBON TETRACHLORIDE	0%	0%	0%	100%
OTHER KETONES, NITRILES	0%	0%	0%	100%

Figure A5- North American Most Used Solvents Overall. *This graph and table represent the most used solvents in North Ameri, based on the most used overall. To calculate most used overall, regular, sometime, and rare use are added together to gain an understanding of how a conservator uses a solvent, if at all.*

North America has a larger sample of 208 respondents, making it the second largest after the European sample size. This size is considered sufficiently large to represent ample to look at the data as representing North American solvent use because of the size of the sample. For each of tThe top three solvents used in North America - ethanol, acetone, and isopropanol - over 90% use overall was noted , all with solvent use over 90%, are ethanol, acetone, and isopropanol, all These three solvents also feature at found at the top of the **Top 10 Most Used Solvents Overall (Figure 13).** Xylene has 62% use overall, making it the 5th most common solvent in North America, and . Toluene is in 7th place with has 59% overall use. However,, although both report low regular use is reported for both xylene and toluene.

12. South American Overall Solvent Use



South American Solvent Choice, sorted by Most used	Regularly	Sometimes	Rarely	Never
Ethanol	58%	32%	5%	5%
Acetone	37%	37%	0%	26%
Acetic acid	5%	16%	37%	42%
Isopropanol	32%	5%	16%	47%
Mineral spirits	32%	5%	5%	58%
Diacetone alcohol	5%	5%	26%	63%
Other Alcohol	5%	11%	16%	68%
Xylene	11%	0%	21%	68%

ISOOCTANE	0%	11%	21%	68%
CYCLOHEXANE	0%	5%	21%	74%
TOLUENE	11%	0%	16%	74%
METHYL ETHYL KETONE	5%	5%	16%	74%
WHITE SPIRIT	5%	5%	16%	74%
N- PROPANOL	11%	11%	0%	79%
ETHYLENE GLYCOL	5%	5%	5%	84%
OTHERS AROMATICS	11%	0%	5%	84%
ETHYL ACETATE	0%	11%	5%	84%
ETHYL LACTATE	0%	0%	16%	84%
CHLOROFORM	5%	0%	11%	84%
SOLVESSO/STODDARD SOLVENTS/LIGROINE	0%	5%	11%	84%
GLYCEROL	0%	5%	5%	89%
METHANOL	0%	5%	5%	89%
1-METHOXY-2-PROPANOL (DOWANOL)	5%	0%	5%	89%
HEXANE	0%	0%	11%	89%
OTHER CARBOXYLIC ACIDS	5%	0%	5%	89%
HEPTANE	0%	0%	5%	95%
BENZENE	0%	5%	0%	95%
LIMONENE	0%	0%	5%	95%
TETRAHYDROFURAN	0%	0%	5%	95%
DICHLOROMETHANE	0%	0%	5%	95%
OTHER KETONES, NITRILES	0%	0%	5%	95%
SHELLSOL D40/T/D	5%	0%	0%	95%
OTHERS PETROLEUM DISTILLATES	0%	0%	5%	95%
N- BUTANOL	0%	0%	0%	100%
FORMIC ACID	0%	0%	0%	100%
DIETHYL ETHER	0%	0%	0%	100%
DIETHYLENE GLYCOL	0%	0%	0%	100%
ACETONITRILE	0%	0%	0%	100%
CARBON TETRACHLORIDE	0%	0%	0%	100%

Figure A6: South American Most Used Solvents Overall. *This graph and table represent the most used solvents in South America, based on the most used overall. To calculate most used overall, regular, sometime, and rare use are added together to gain an understanding of how a conservator uses a solvent, if at all.*

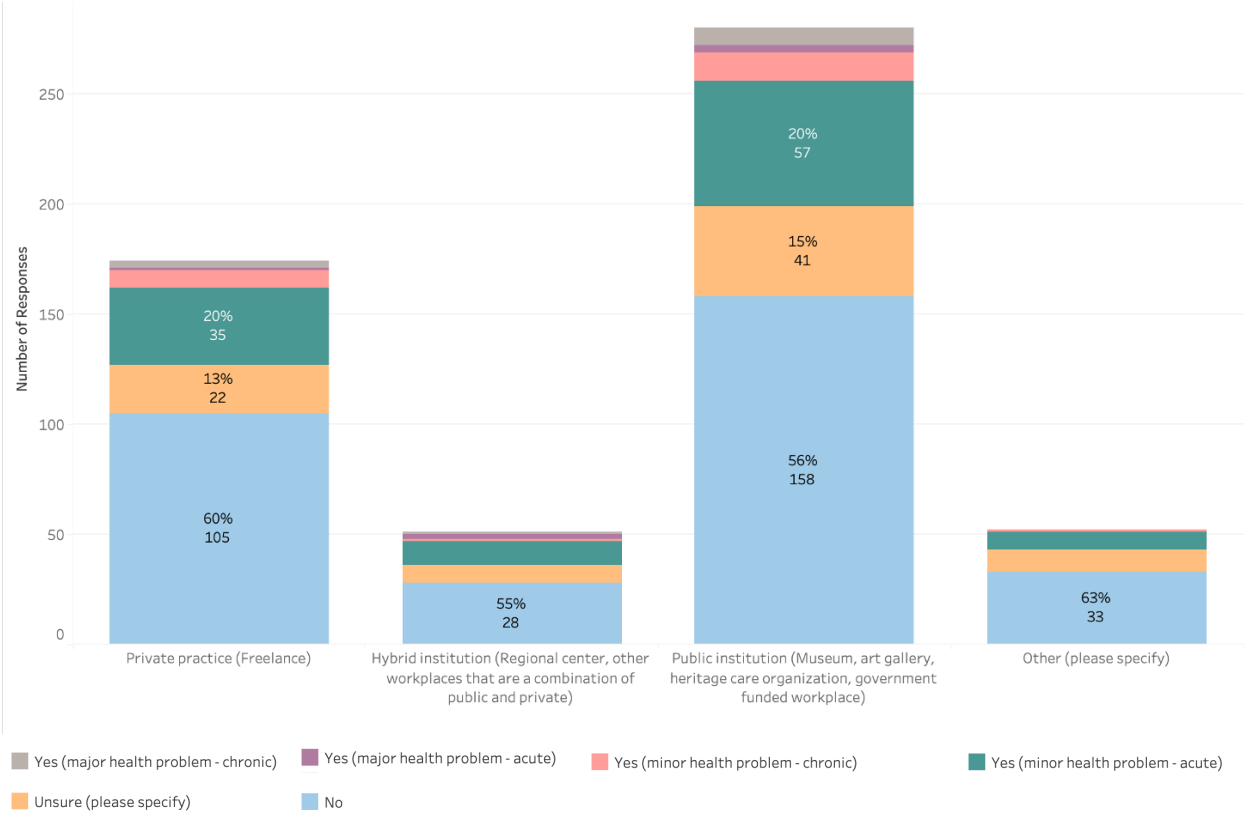
South America had a small sample size of 14, making it a small sample size. The data cannot be considered is lowers the accuracy of the data and makes this data less representative of actual solvent use in what South America is truly using as solvents. However, from the data reported, ethanol, acetone, and acetic acid were the top 3 solvents used in South America. These three solvents all appear on **Top 10 Most Used Solvents**

Overall (Figure 13). Although acetone was the second most reported solvent for South America, it has a much lower use here compared to Europe, Australia and Oceania, and North America. Some of the free text responses from South America detailed the federal regulations on acetone because of its use in drug production. This could account for the disparity.

13. Descriptions of Health Symptoms

Skin-related symptoms include strange smelling skin, rash, dry skin, skin irritation, itching, and skin pain. Respiratory-related symptoms were tightness in the lungs, heaviness in breathing, worsening asthma, and asthma. Some who mentioned solvent sensitivity specified that they developed sensitization to specific solvents, were sensitive to fumes, and experienced unspecified temporary effects when inhaling adhesive solvents. Eye-related symptoms include blepharitus, dry eyes, eye irritation, and cornea rupture. Stomach upset also included stomach aches. One of the two people who mentioned accentuation of allergies specified that their tree pollen allergy developed after entering a conservation training program. Loss of smell was also described as a lesser sense of smell. One of two who mentioned migraines reported their accentuation with solvent use. Dizziness also includes wozziness. Symptoms that fell into the other category were unique answers that were proposed only once. They include acute symptoms, cancer, chronic cough, dizziness, fatty liver disease, hypertension, inflammation of organs, lightheadedness, major symptoms, minor-not chronic symptoms, nausea, rhinitis, sore throat, topical sensitivity in fingers, and tremors.

14. Health Problems Experienced by Type of Institution

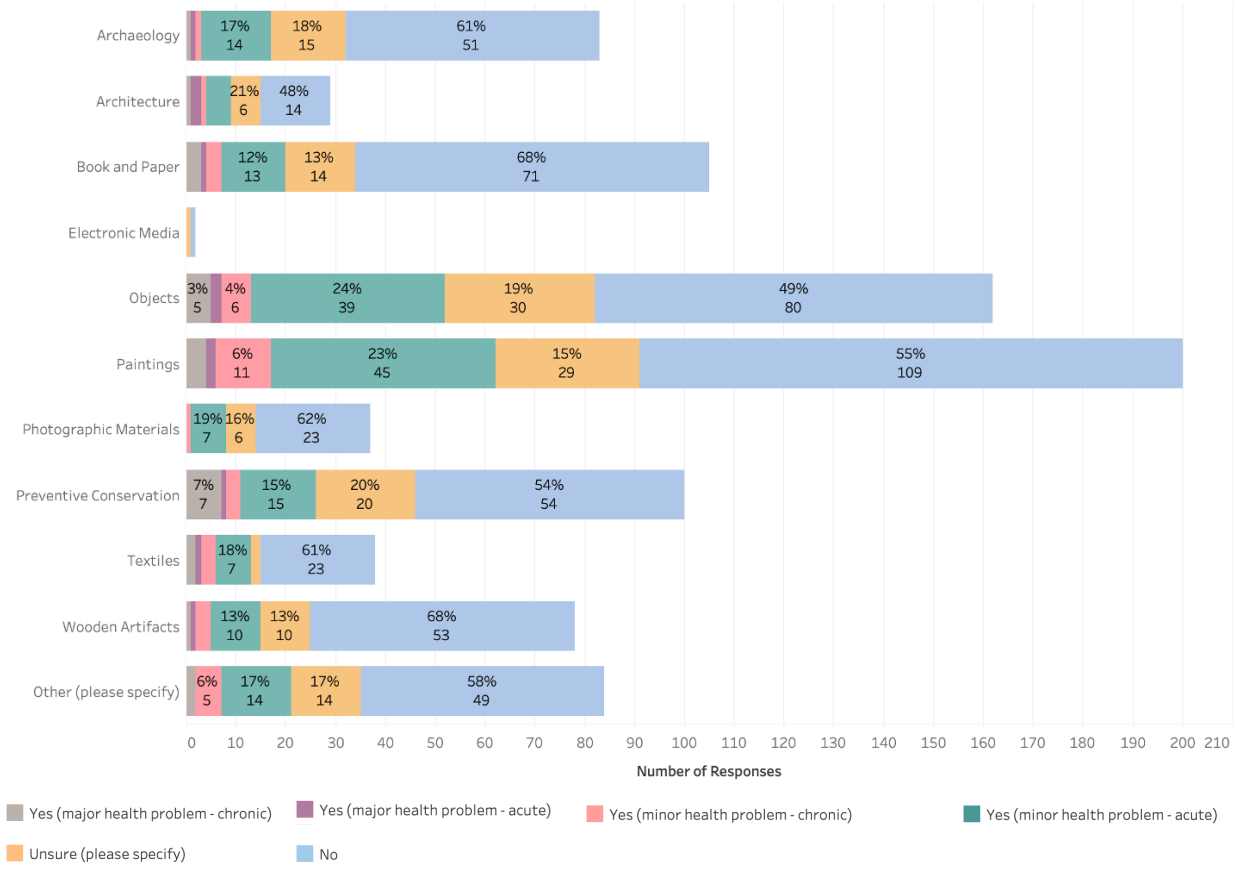


	Yes (major health problem – chronic)		Yes (major health problem – acute)		Yes (minor health problem-chronic)		Yes (minor health problem-acute)		Unsure		No	
	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent
Private practice	3	2%	1	1%	8	5%	35	20%	22	13%	105	60%
Hybrid institution	1	2%	2	4%	1	2%	11	22%	8	16%	28	55%
Public institution	8	3%	3	1%	13	5%	57	20%	41	15%	158	56%
Others	N/A	N/A	N/A	N/A	1	2%	8	15%	10	19%	33	63%

Figure A7: Health Problems Experienced in Different Institutions. *Bar graph and corresponding table sorting the 557 responses from 531 respondents to whether respondents experienced health problems related to solvent use by the institution at which the respondents work. 174 responses belonged to those who reportedly worked in private practice. 51 responses corresponded to hybrid institutions, and 280 responses for public institutions. 52 responses belonged to other institutions.*

Within each institution type, more than 50% of responses detailed that the respondents did not experience any health symptoms related to solvent use. Of the "Yes" responses, acute minor health problems accounted for the highest magnitude of responses in all institutions. The ratios between the number of responses for different reported health problems experienced are very similar across the institutions. Private practice and public institutions appear to have a slightly higher percentage of responses reporting chronic health problems whether it is major or minor than hybrid institutions. Hybrid institutions have a slightly greater percentage of responses reporting acute health problems whether they are major or minor.

15. Health Problems Experienced by Specializations



	Yes (major health problem – chronic)		Yes (major health problem – acute)		Yes (minor health problem-chronic)		Yes (minor health problem-acute)		Unsure		No	
	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent
Archeology	1	1%	1	1%	1	1%	14	17%	15	18%	51	61%
Architecture	1	3%	2	7%	1	3%	5	17%	6	21%	14	48%
Book and Paper	3	3%	1	1%	3	3%	13	12%	14	13%	71	68%
Electronic Media	-	-	-	-	-	-	-	-	1	50%	1	50%
Objects	5	3%	2	1%	6	4%	39	24%	30	19%	80	49%
Paintings	4	2%	2	1%	11	6%	45	23%	29	15%	109	55%
Photographic Materials	-	-	-	-	1	3%	7	19%	6	16%	23	62%
Preventive Conservation	7	7%	1	1%	3	3%	15	15%	20	20%	54	54%
Textiles	2	5%	1	3%	3	8%	7	18%	2	5%	23	61%
Wooden Artifacts	1	1%	1	1%	3	4%	10	13%	10	13%	53	68%
Other (please specify)	2	2%	-	-	5	6%	14	17%	14	17%	49	58%

Figure A8: Reported Health Problems Experienced by Specializations *Bar graph and corresponding table detailing responses from 531 respondents to whether they experienced health problems associated with solvent use by specialty. Because respondents could identify with more than one specialty, their responses to their reported health problems are represented in multiple specialties, resulting in a total of 918 responses. The sum and percentage of responses for each health problem within each specialty are detailed in the graph table. The data is organized alphabetically aside from "Others (please specify)" sorted to the bottom.*

Approximately 50% or more of all responses within each specialty reported experiencing no health problems associated with solvent use. However, it should be noted that certain specialties have limited sample size which would impact the significance of the 50% responses reporting no health issues (i.e. electronic media with only two respondents, so one person makes up 50% of the population). Objects and paintings have the greatest percentage of responses reporting acute minor health problems. Though the differences in percentages are small, textiles had the greatest percentage of responses reporting chronic minor health problems; architecture with the greatest percentage for acute major health problems; and preventive conservation with the greatest chronic health problems. However, this data is only suggestive of trends and does not accurately represent the health problems experienced per specialty as many people identified with more than one specialty.

16. Reported Health Problems by Continent

South American Reported Health Problems, Yes and Unsure

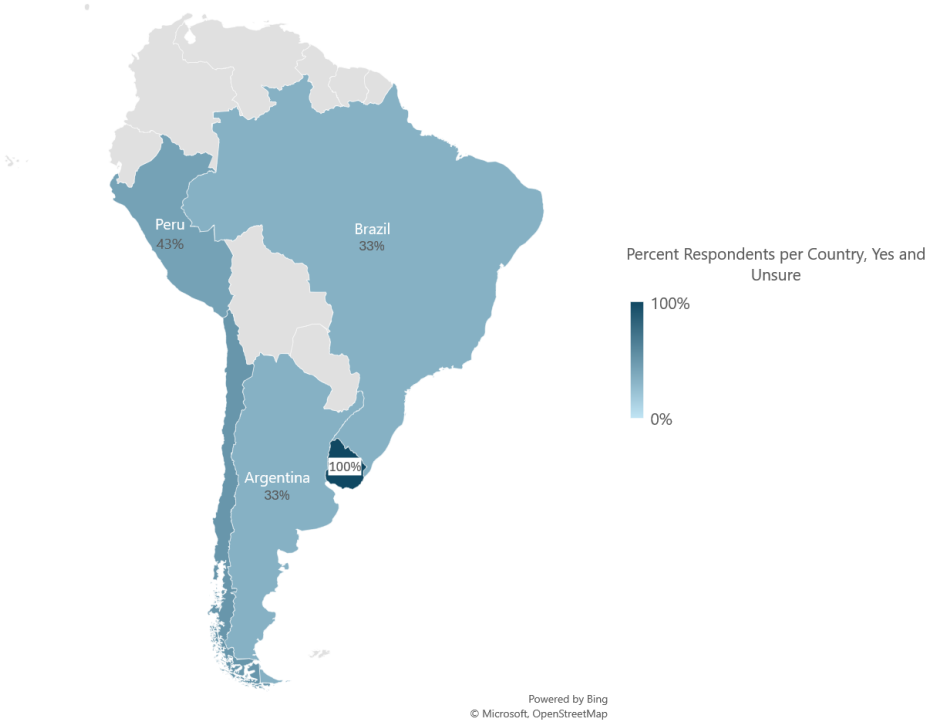


Figure A9: South American Reported Health Problems, Yes and Unsure: *This map shows the frequency that a respondent reported a health concern or an unsure health concern. The frequency is calculated by dividing the number of respondents reporting health problems by the number of respondents reporting per country. To see a table with this data, see* ***Figure A14.***

North American Reported Health Problems, Yes and Unsure

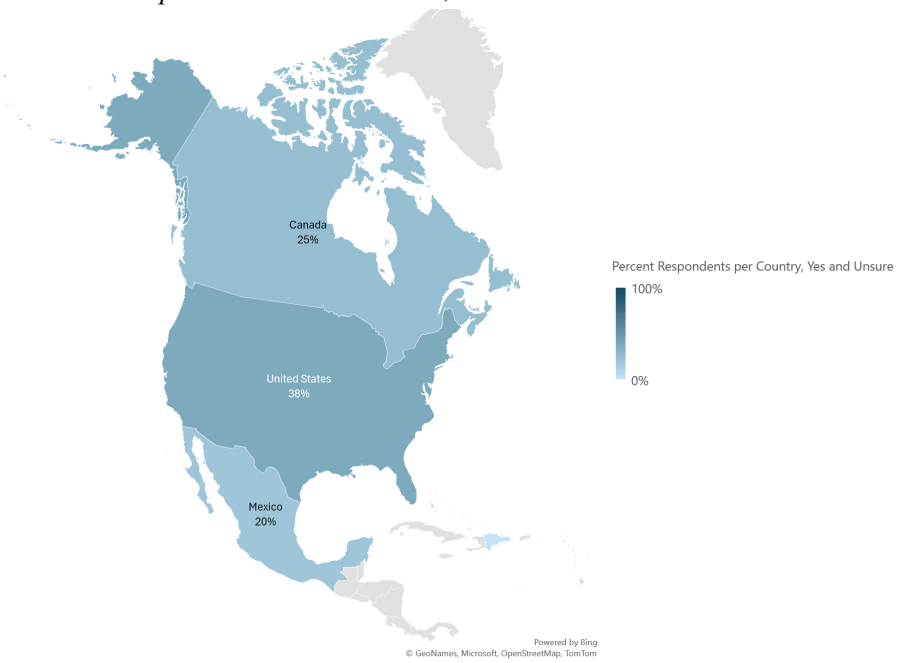


Figure A10: North American Reported Health Problems, Yes and Unsure: *This map shows the frequency that a respondent reported a health concern or an unsure health concern. The frequency is calculated by dividing the number of respondents reporting health problems by the number of respondents reporting per country. To see a table with this data, see* ***Figure A14.***

Asian Reported Health Problems, Yes and Unsure

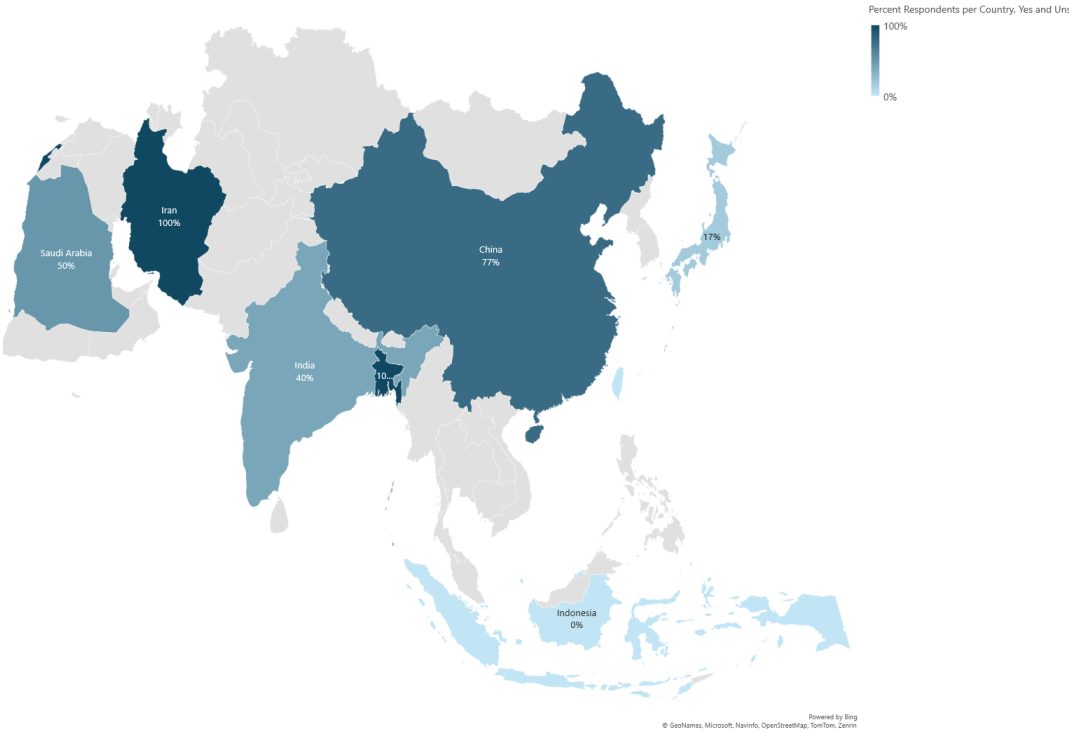


Figure A11: Asian Reported Health Problems, Yes and Unsure: *This map shows the frequency that a respondent reported a health concern or an unsure health concern. The frequency is calculated by dividing the number of respondents reporting health problems by the number of respondents reporting per country. To see a table with this data, see* ***Figure A14.***

Australian / Oceanian Reported Health Problems, Yes and Unsure

Figure A12: Australian / Oceanian Reported Health Problems, Yes and Unsure: *This map shows the frequency that a respondent reported a health concern or an unsure health concern. The frequency is calculated by dividing the number of respondents reporting health problems by the number of respondents reporting per country. To see a table with this data, see* ***Figure A14.***

African Reported Health Problems, Yes and Unsure

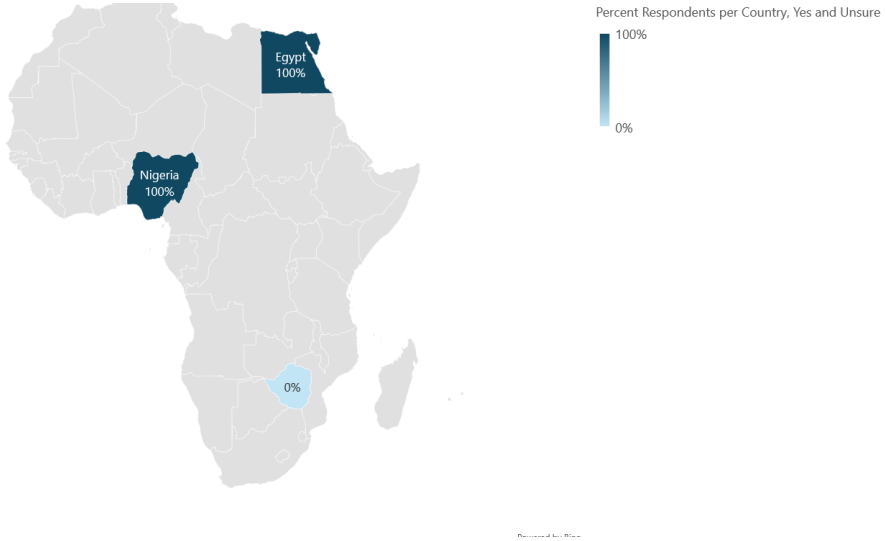
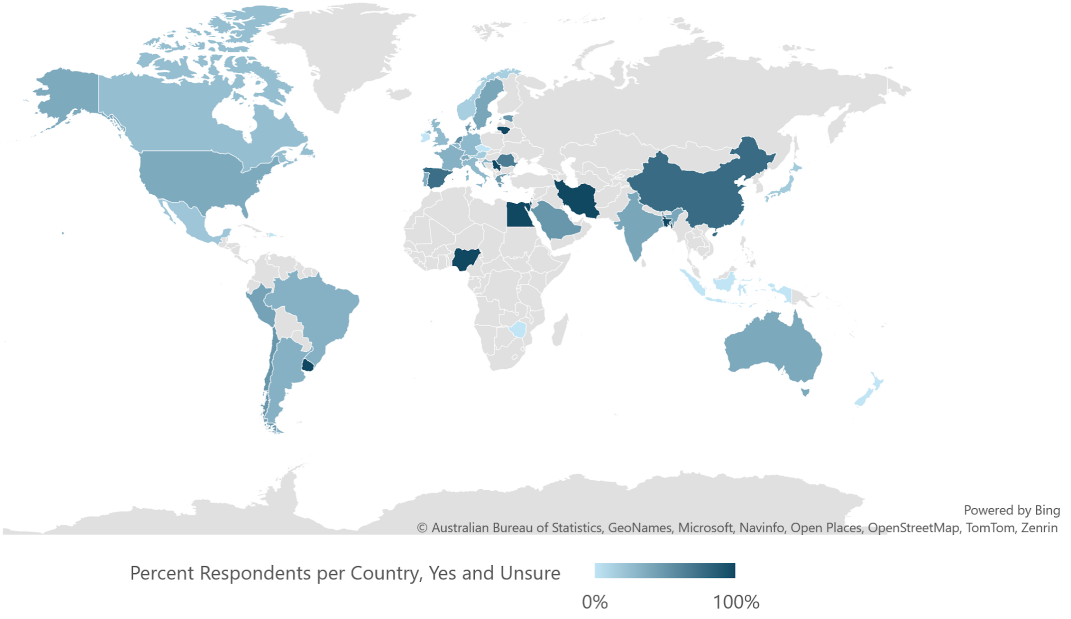


Figure A13: African Reported Health Problems, Yes and Unsure: *This map shows the frequency that a respondent reported a health concern or an unsure health concern. The frequency is calculated by dividing the number of respondents reporting health problems by the number of respondents reporting per country. To see a table with this data, see* ***Figure A14.***



CONTINENT	INDIVIDUAL COUNTRIES RESPONSES, IN PERCENTAGE OF YES / UNSURE TO REPORTED HEALTH CONCERNS			
AFRICA	Egypt-100%	Nigeria-100%	Zimbabwe- 0%	
ASIA	Bangladesh-100%	Brunei-0%	China –77%	Hong Kong-40%
	India – 40%	Indonesia – 0%	Iran – 100%	Israel-100%
	Japan-17%	Saudi Arabia – 50%	Taiwan –0%	
AUSTRALIA / OCEANIA	Australia- 38%	New Zealand- 0%		

EUROPE	Austria – 17%	Belgium – 29%	Canary Islands – 0%	Croatia- 33%
	Czech Republic – 0%	Denmark – 2	Estonia - 2	France – 30
	Germany- 29%	Greece – 50%	Ireland – 0%	Italy – 28%
	Lithuania – 100%	Luxemburg – 100%	Malta – 0%	Netherlands –55%
	Norway – 14%	Portugal – 36%	Romania –67%	Serbia – 100%
	Spain – 75%	Sweden – 40%	Switzerland – 38%	United Kingdom – 27%
NORTH AMERICA	Canada – 25%	Dominican Republic- 0%	Mexico – 20%	United States – 38%
SOUTH AMERICA	Argentina – 33%	Brazil – 33%	Peru – 43%	Uruguay –100%

Figure A14: Continental Reported Health Concern Table. *A table and graph that has the frequency of reported health concern per country. The frequency is calculated by dividing the number of respondents reporting health problems by the number of respondents reporting per country.*

As with all other continental data from this survey, sample size matters in determining the accuracy of the data. Africa has the smallest sample size, followed by Australia, South America, and then Asia with a slightly larger sample size. North America and Europe have much larger sample sizes. The same follows with country sample size respectively. The most accurate data comes from the countries with the larger sample sizes, like the United States, Italy, the Netherlands, and the United Kingdom.

Accounting for the sample sizes, there are some countries with over 50% of their respondents reported health concerns or unsure of health concerns. These countries include Nigeria, Bangladesh, China, Iran, Israel, Lithuania, Luxemburg, the Netherlands, Romania, Serbia, Spain, and Uruguay. Again, it could be a figure of a small sample, but it also could be representative of federal safety and workplace laws in effect.