

Assessing the MMA Intern Program's Impact on Science



2015 Maria Mitchell Association Interns

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Assessing the MMA Intern Program's Impact on Science

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Abstract

The goal of this project was to evaluate and publicize the impact of the Maria Mitchell Association (MMA) interns on science. We compiled a list of all former MMA interns and distributed a survey to solicit information from interns about their experiences at the MMA and during their career. From these survey responses, we conducted interviews with a small group of interns to gain deeper insight into their life journeys. Data from these surveys and interviews was used to create a large database of former interns, as well as infographics and profiles highlighting the impact of MMA internship alumni on science. After analyzing this data, we recommend that the MMA implement yearly updates to this intern database, incorporate intern alumni into their programming, and improve the internship program itself by expanding opportunities for research, collaboration, and mentor engagement.

Executive Summary

The Maria Mitchell Association (MMA) was founded in 1902 to preserve the legacy of Maria Mitchell, America's first female professional astronomer. Mitchell was a lifelong researcher and educator who sought to create opportunities for all to study science; she taught the importance of curiosity and real-world experimentation (Maria Mitchell Association, 2023). Since 1914, the MMA has offered internship opportunities in the fields of astronomy, education, marine science, natural science, historic preservation, and administration to continue Mitchell's legacy of hands-on learning. These internships have been especially successful in supporting women in science, who have traditionally been underrepresented, further supporting Maria Mitchell's goal of equality in education (Martinez & Christnacht, 2021).

Internships like those offered by the MMA can have a lasting impact on students. These internships give undergraduates the chance to gain real-world research experience that can improve their job prospects (Nunley, et al., 2016), help them determine their ideal major and career path (Galbraith & Mondal, 2020), and provide them with valuable skills and academic tools they can use in their academic and professional work (Binder, et al., n.d.). Since its inception, over 850 interns have participated in the MMA internship program, representing those with the same curiosity and love of the natural world that Maria Mitchell espoused. To best support and publicize this program, the MMA would like a record of the experiences of these interns during their internship and beyond, and their impact on science.

Goals and Objectives

The goal of this project was to compile a digital database of interns' experiences during their time at the MMA and assess the interns' impact on science.

To accomplish our goal, we identified four objectives.

1. Collect data through independent research, surveys, and interviews on how the MMA internship shaped the interns' career choices, and professional and academic accomplishments.
2. Develop a comprehensive database of intern information, as well as instructions for how the MMA can update and maintain the database.
3. Create detailed profiles of a select group of MMA interns that the organization can use for fundraising and promotional purposes.
4. Design infographics to highlight historical trends and display the measurable impact of the MMA internship program on the scientific community.

Methodology

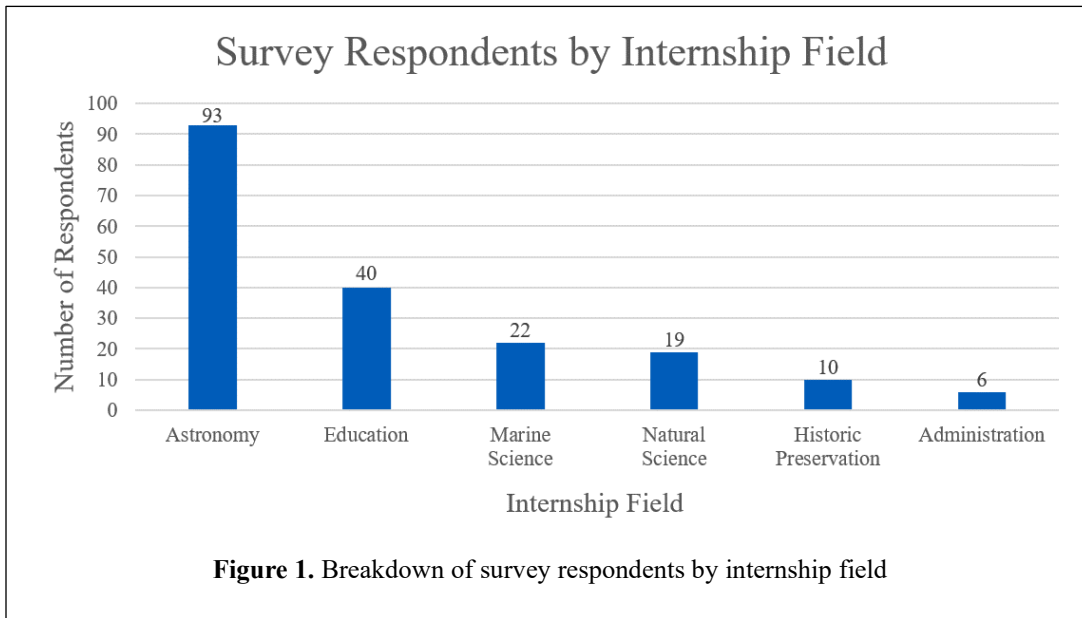
To complete these objectives, we conducted independent research to create an initial database of former interns' names and available contact information, distributed a survey to these interns asking questions about their experiences at the MMA and accomplishments after their internship, and conducted a small number of interviews to gain in-depth insight into the stories of a select group of former interns.

Using the information we gathered, we created a series of infographics highlighting interesting or surprising statistics about the success of the internship program and accomplishments of former interns. We also created a small number of profiles that gave in-depth overviews of specific interns' experiences and career

achievements. Finally, we compiled all information from research, survey responses, and interviews into a single database to be given to the MMA for future use.

Results

After we completed our initial research, we were able to identify the names and internship types of 859 former interns. Of the 859 interns identified in this study, 430 were in the field of astronomy, 247 were education, 89 were marine science, 64 were natural science, 16 were historic preservation, and 13 were administration. In total, we received 190 survey responses with 511 survey invite links sent (a response rate of 37%). These responses covered all six internship fields, as shown in Figure 1.



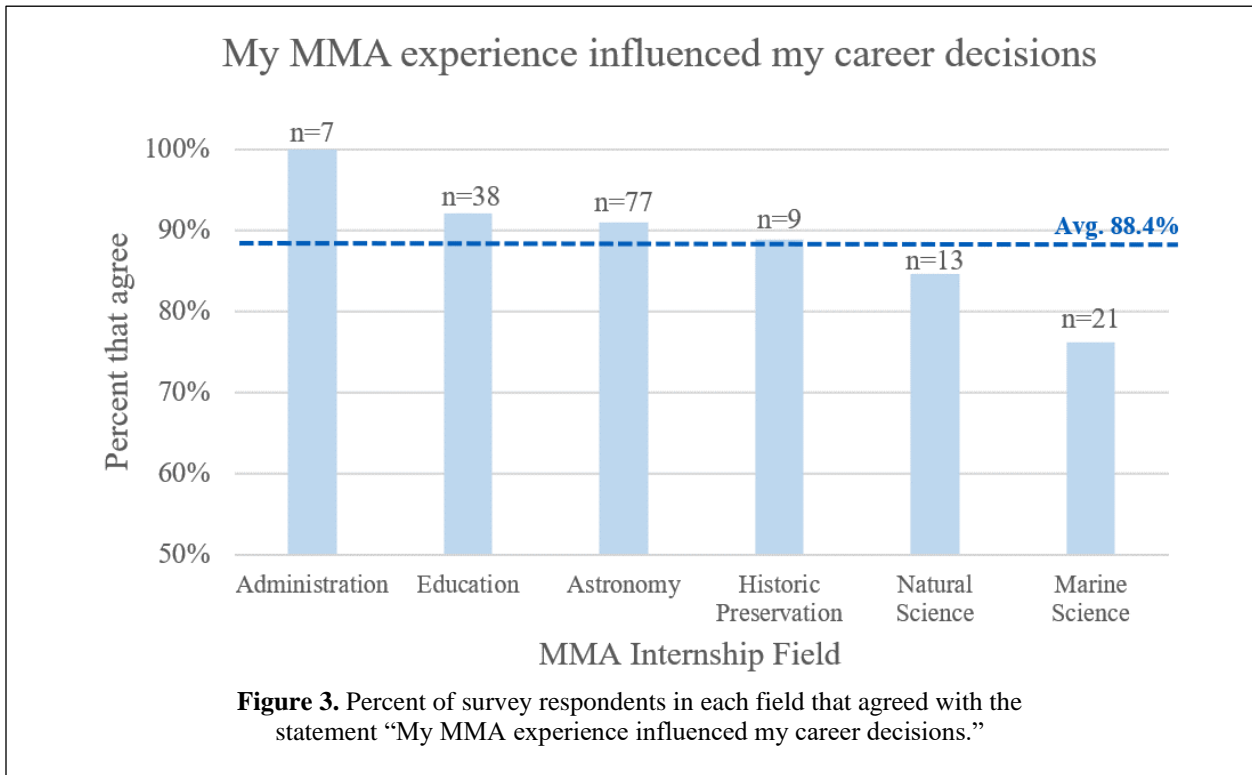
Interviews were conducted with 22 interns, with representatives from years between 1964 and 2022. At least one intern from each internship type was interviewed, with 10 interviewees in the field of astronomy, 4 in natural science, 4 in marine science, 2 in education, 1 in historic preservation, and 1 in administration. We used these interviews to create detailed profiles of a select group of 12 interns, combining their biographical information with stories and quotes from these interviews to highlight their unique places in the history of the MMA.

We created two Excel workbooks, one containing data from our research and one containing data from survey responses. The first workbook contains raw data from our research, with publicly available information about former interns. The second workbook contains information taken from survey responses; to maintain the confidentiality of survey respondents, all identifiable information was kept separate from opinion-based survey responses. All sheets with identifiable information are easily sortable by a variety of information, including name, internship type, and internship year (Figure 2).

	E	F	G	H	I	J
1	Year	Internship	Current Position	Gender	Age	Race
2	2022	Aquarium Internship	Substitute Teacher	Female	21-29	White
3	2022	Natural Science Museum Internship	Vet student	Female	21-29	Asian,White
4	2021	NSF-REU Internship in Astronomy	Language Assistant	Male	21-29	White
5	2021	NSF-REU Internship in Astronomy	PhD Student	Female	21-29	White
6	2018	NSF-REU Internship in Astronomy	Postdoctoral Researcher	Female	21-29	White
7	2017	Aquarium Internship	PhD student/marine biology advisor	Female	21-29	White
8	2017	NSF-REU Internship in Astronomy	Research Analyst	Female	21-29	Asian,White
9	2017	Natural Science Museum Internship	Lead clinical laboratory specialist	Female	21-29	White
10	2016	Environmental Education Intern	Lead Editor	Female	21-29	White
11	2016	NSF-REU Internship in Astronomy	Associate Program Officer	Female	21-29	Asian
12	2015	Environmental Education Intern	Resilience & Sustainability Analyst	Female	30-39	White
13	2015	NSF-REU Internship in Astronomy	Data Scientist	Female	21-29	White
14	2015	NSF-REU Internship in Astronomy	Postdoc	Male	21-29	White
15	2015	NSF-REU Internship in Astronomy	Senior Research Assistant	Female	21-29	American Indian
16	2014	Environmental Education Intern	Communications Specialist	Female	30-39	White
17	2014	NSF-REU Internship in Astronomy	Lead Quantum Scientist	Female	21-29	White
18	2014	NSF-REU Internship in Astronomy	Postdoctoral Teaching Fellow	Male	30-39	White

Figure 2. Sample screenshot of “Intern Identifiable Data” spreadsheet that was given to the MMA

Our core findings included the satisfaction of interns with their internship. Satisfaction ratings for the program were high across fields, with 98% (174 of 177) of respondents indicating that their overall MMA experience was positive. Many respondents also stated that the internship experience was valuable to them, influenced their career decisions (shown in Figure 3), and provided them with transferable skills.



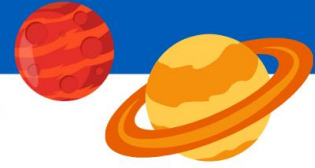
We also examined the measurable impact of the Maria Mitchell Association internship program on science. Results from survey responses regarding career achievements and impact on science were combined into infographics, including Figure 4.

Curiosity can Change the World

Astronomy



Of the 93 astronomy survey respondents...



99%

of astronomy interns agree their **MMA experience was valuable**

56%

of female astronomy interns went on to receive a **doctorate degree**

40%

of former astronomy interns currently work as **educators**

95%

of astronomy interns have **conducted research** in their career

51%

of astronomy interns have **worked at a non-profit**

38

patents held by former astronomy interns

58

books/ co-authored **books published** by former astronomy interns

2

former astronomy interns have given **TED Talks**



"My proudest career achievement is doing what the MMA taught me to love."

-Tess Jaffe, 1992 MMA Astronomy Intern

"My favorite part of the MMA is the amazing people and a strong sense of belonging."

-Kim-Vy Tran, 1993 MMA Astronomy Intern

Figure 4. Sample infographic highlighting the success of MMA astronomy interns, generated using [Canva](#)

Recommendations

To continue this project in the future, we identified two main areas for future project work:

1. Additional intern interviews with interns who we were unable to contact during this project.
2. Updated survey questions that add or clarify information, or streamline answer inputs for respondents.

Based on the team's methodology and responses from the survey, the team has created a list of recommendations for the Maria Mitchell Association to be able to keep up to date on the contact information of former interns and retain interest from program alumni. These recommendations are as follows:

1. Update intern alumni database with each year's interns
2. Reach out to update information on a regular basis
3. Hold regular alumni events
4. Leverage social media to connect with alumni

Portions of the survey asked questions pertaining to issues that former interns had with their internship and how they would have liked to see it changed. These responses were used to offer insight into what recommendations we could give to the Maria Mitchell Association to make the internship program as successful as possible in the future. These recommendations are as follows:

1. Further opportunities for research in other internship fields
2. More interaction between interns of different fields
3. Increased oversight and guidance throughout the internship

One question that was asked to former interns was what type of internship they believed the MMA should add to their program. Based on survey responses, we recommend exploring internships in the following areas:

1. Non-profit Financials
2. Indigenous History and Natural Practices
3. Geological Studies

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1.0 Introduction

In October 1847, Maria Mitchell (Figure 1¹), a young astronomer from the small Massachusetts island of Nantucket, climbed to the roof of the local bank (Maria Mitchell Association, 2023). Inside the bank, her friends and family partied, sharing conversation and company; above them, Mitchell gazed up at the dark skies over Nantucket, as she had many times before (ibid.). Yet on this night, [she identified a new comet](#), leading to fame and the opportunity to change the world of science forever (ibid.). Following this discovery, Mitchell dedicated herself to education, becoming the first female professor of astronomy in America by teaching at Vassar College (ibid.). She promoted hands-on research, naturalism, and equality in learning, especially in the male-dominated field of astronomy (ibid.).

Opened in 1902, the Maria Mitchell Association (MMA) has worked to fill the void left by Mitchell's 1889 death, creating opportunities for young scientists to do research on the island where Maria Mitchell grew up.



Figure 1. Portrait of Maria Mitchell
(<https://www.britannica.com/biography/Maria-Mitchell>)

Since 1914, the MMA has offered a variety of internships in fields ranging from astronomy to natural science to education, carrying on Maria Mitchell's legacy (Maria Mitchell Association, 2023). Over the years, the MMA internships have become a highly competitive opportunity, with over 660 total applicants in 2023 for around 35 open positions. The students who have completed these internships represent those with the same love of science and the natural world as Mitchell herself. Over 850 interns have passed through the doors of the association, many of whom have gone on to have long and successful careers (Annual Reports | Maria Mitchell Association, n.d.). However, the MMA has never created or maintained a record of the careers of these interns and their impact on the scientific community.

The goal of this project was to compile a digital database of interns' experiences during their time at the MMA and assess the interns' impact on science. To complete our goal, we identified four objectives.

1. Collect data through independent research, surveys, and interviews on how the MMA internship shaped the interns' career choices, and professional and academic accomplishments.
2. Develop a comprehensive database of intern information, as well as instructions for how the MMA can update and maintain the database.
3. Create detailed profiles of a select group of MMA interns that the organization can use for fundraising and promotional purposes.
4. Design infographics to highlight historical trends and display the measurable impact of the MMA internship program on the scientific community.

¹ All pictures and figures from outside sources will be cited. Any picture or figure without citation was taken/created by a member of the research team or by a Maria Mitchell Association employee.

We accomplished these goals by creating a survey to distribute to former interns, asking questions about their time on Nantucket and at the MMA, their career journey and accomplishments, and demographic information that would help us identify trends within their responses. We also completed interviews with a small group of former interns to gain an in-depth understanding of their individual stories. Using the information from the survey and interviews, we created a series of infographics and intern profiles which the MMA can use to publicize the impact of their former interns on the scientific community. This will help the MMA continue to maintain and expand the internship program that is so important to preserving Maria Mitchell's legacy.

2.0 Background

2.1 Nantucket and the MMA

Born in 1818 on Nantucket, Maria Mitchell's 1847 discovery of a comet earned her recognition within the scientific community. Her achievements as a Vassar College professor, researcher, and naturalist only served to solidify this fame. Founded in 1902, the Maria Mitchell Association seeks to preserve her legacy of scientific education and discovery (Maria Mitchell Association, 2023). According to the MMA's website, "The Maria Mitchell Association creates opportunities for all to develop a life-long passion for science through education, research, and first-hand exploration of the sky, land, and sea of Nantucket Island" (Maria Mitchell Association, 2023). As shown in Figure 2, the MMA is primarily located on Vestal Street and includes the Natural Science Museum, Vestal Street Observatory, Research Center, Administrative Offices, and the Mitchell House, along with the Loines Observatory on Milk Street and the Aquarium on Washington Street. In these various facilities, the MMA offers a variety of opportunities for young scientists to gain experience with research and fieldwork.



2.2 Women in STEM

Being born to a Quaker family with parents who "advocated equal education for girls," Maria Mitchell had opportunities in education that many other women of her time were not fortunate enough to have (Michals, 2015). After completing secondary school at age 16, Maria "opened a school training girls in math and science" (Michals, 2015). Following her passing, the Maria Mitchell Association would continue Maria's legacy by devising "strategies to encourage and keep girls in STEM and support women in STEM at the beginning, middle, and late career stages" (Maria Mitchell Association, 2023).

According to the US Census Bureau, there has been a steady growth of women in STEM fields (Martinez & Christnacht, 2021). In 1970, "women made up 38% of all U.S. workers" and only "8% of STEM workers"

(Martinez & Christnacht, 2021). By 2021, women made up 48% of all U.S. workers and 35% of STEM workers (National Science Foundation, 2023). Certain STEM occupations, such as social scientist, have seen a more dramatic increase in female representation (less than 20% female in 1970 to roughly 65% in 2019) than occupations such as engineering (less than 5% in 1970 to roughly 15% in 2019) (Martinez & Christnacht, 2021). In astronomy, a field more closely associated with the outreach and scientific education endeavors of the MMA, the percentage of doctorates in astronomy that were earned by women has increased from less than 20% in 1992 to more than 40% in 2022 (American Institute of Physics, 2022). While these increasing percentages of women in STEM careers are evidence that change is occurring, there is still work to be done by the MMA and other organizations to continue inspiring women and girls to pursue a STEM education through internships, fellowships, and other opportunities.

2.3 What is an Internship?

The [National Association of Colleges and Employers](#) (NACE) defines an internship as “a form of experiential learning that integrates knowledge and theory learned in the classroom with practical application and skills development in the professional setting” (NACE, 2023). NACE further states that internships “provide students the opportunity to gain valuable applied experience, develop social capital, explore career fields, and make connections in professional fields” (NACE, 2023). NACE’s Guide to Internships includes the following criteria that they believe should be met by each internship:

- A learning experience with a real-world opportunity to apply the knowledge gained in the classroom. It must not be simply to advance the operations of the employer or replace the work that a regular employee would routinely perform.
- Learned skills and knowledge that are transferable to other employment settings.
- A defined beginning and end that is mutually agreed upon and consistent with institutional sponsor guidelines and schedules.
- A position description with clear responsibilities and required/desired qualifications.
- Clearly defined learning objectives/goals supportive of the student’s academic program goals and institutional requirements.
- Direct supervision by a professional(s) with relevant expertise and educational and/or professional experience who provides productive feedback, guidance, and the resources and equipment necessary to successfully complete the assignment. (NACE, 2023)

This definition of internships can help establish the differences between internships, fellowships, co-ops (cooperative education positions), and volunteer opportunities. Some of the main differences between internships and fellowships are focus, eligibility, and duration (University of Alaska, 2022). While internships are focused on introducing interns to the professional work environment and supervising them as they complete daily tasks, fellowships are less closely supervised and generally focus on the completion of a project (University of Alaska, 2022). Fellowships in the US can last between a few months to over a year while internships generally do not exceed a few months (University of Alaska, 2022). Additionally, fellowships are generally completed by graduates and postgraduate students with a more extensive academic background than interns who are typically undergraduates (University of Alaska, 2022).

Internships differ from co-ops in that co-ops are typically a longer and more extensive work commitment than internships, generally referring to a multi-work term agreement (Virginia Polytechnic Institute and State University, 2023). Co-ops generally occur during the academic year, are full-time, and may require the student to extend the time it takes to complete their academic degree (Virginia Polytechnic Institute and State University, 2023). Finally, internships differ from volunteer experiences in that many internships are paid, and the purpose of an internship is for the student to gain experience, develop skills, and professionally benefit from the experience (ELI Abroad, 2023). Volunteering, on the other hand, is generally a much smaller time commitment and is typically completed because the individual has a “desire to help out” (ELI Abroad, 2023).

2.4 MMA Internships

The MMA currently offers eleven internship and fellowship opportunities. As shown in Figure 3, these internships span six key fields: education, astronomy, marine science, natural science, historic preservation, and administration. Each internship and fellowship that the MMA currently offers, along with information about the programs, are listed in Table 1.

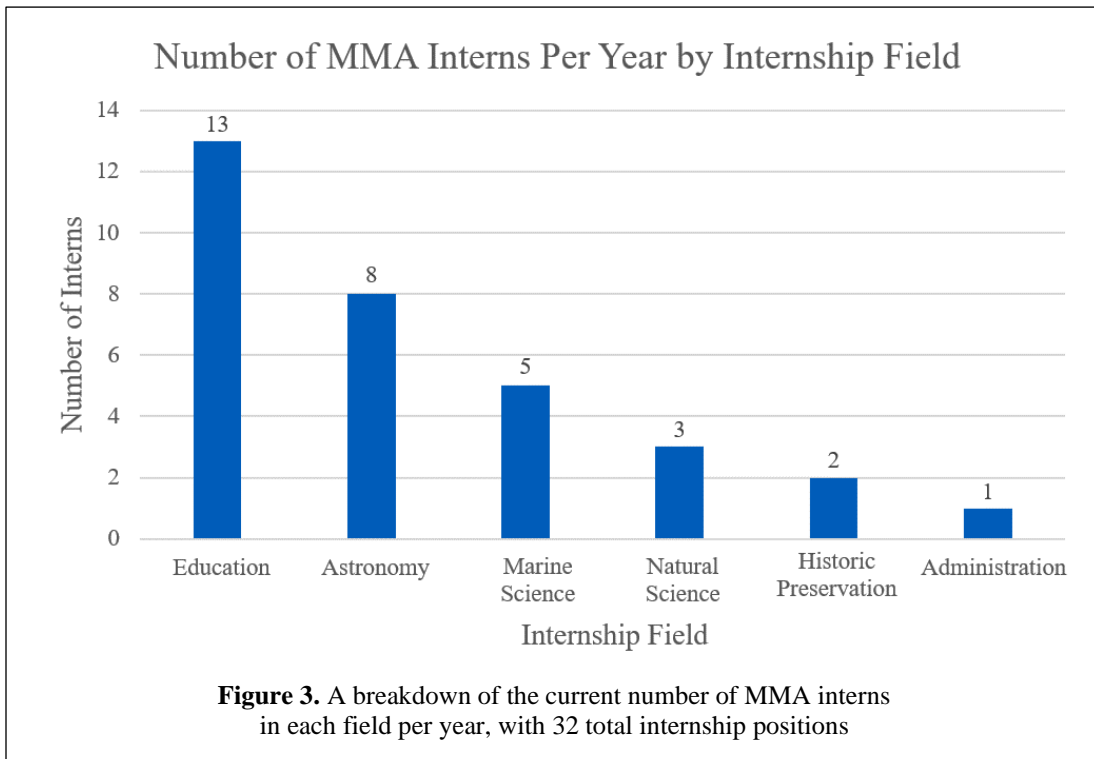


Table 1. Breakdown of current internships offered by the Maria Mitchell Association

Internship/ Fellowship	Description	Number of Positions	Intern Level of Education	Field(s) of Study	Paid/ Unpaid
Post-Baccalaureate Observatory Fellowship	Year-long research fellowship in astronomy	2	Recent Graduates	Astronomy, related fields	Paid
NSF-REU (National Science Foundation- Research Experiences for Undergraduates) Internship in Astronomy	Summer research internship in astronomy; interns are paired with experts	6	Undergraduates	Astronomy, physics, related fields	Paid
Aquarium Internship	Help run MMA's Aquarium and work on independent research	5	Undergraduates	Marine biology, ecology, related fields	Paid
Natural Science Internship	Help run MMA's Natural Science Museum (NSM)	3	Undergraduates	Natural science, ecology, related fields	Paid
Assistant Discovery Camp Director	Assist with running the MMA's Discovery Camp	1	Recent Graduate	Education	Paid
Environmental Education Internship	Assist in developing environmental education programming for the Discovery Camp	10	Undergraduates	Education, environmental sciences, related fields	Paid
Returning Environmental Education Internship	Assist in developing environmental education programming for the Discovery Camp	2	Undergraduates	Education, environmental sciences, related fields	Paid
Communications and Marketing Internship	Working at Mitchell House and supporting the MMA's administrative teams	1	Undergraduates	Communications, marketing, media management, related fields	Paid
Event Planning and Development Internship	Working at the Mitchell House and supporting the MMA's administrative teams	1	Undergraduates	Communications, marketing, media management, related fields	Paid
Mitchell House Internship	Work on preservation of Maria Mitchell House	1	Undergraduates	Social sciences, related fields	Paid

Astronomy

With Maria Mitchell being a “force behind women’s rights and women’s education in the nineteenth century,” it was only fitting that the Maria Mitchell Association funded women in pursuit of higher education (Maria Mitchell Association, 2023). Starting in 1912, the Maria Mitchell Association began offering “The Maria Mitchell Memorial Fellowship of the Harvard Observatory,” an award valued at \$500 for a woman to study astronomy through the Harvard Observatory (Whitney, Cannon, et al., 1917). These women were often part of the “Harvard Computers”: a group of women hired at the Harvard Observatory to “compute” astronomical values such as the brightness and position of stars (Nelson, 2008). Beginning in 1916, this MMA fellowship was changed to “a permanent Directorship of the Nantucket Observatory,” being run by Margaret Harwood on the island of Nantucket (Cannon, 1917). Currently, the MMA offers a year-long [Maria Mitchell Observatory Post-Baccalaureate Research Fellowship](#) for “pre-graduate school” students who are “interested in astrophysics” (Maria Mitchell Association, 2023).

While the MMA first started offering undergraduate astronomy opportunities in 1912, the modern iteration of the program was not introduced until 1987, with support from the [National Science Foundation’s Research Experiences for Undergraduates](#) (NSF-REU) program (National Science Foundation, 2023). The NSF-REU internships at the MMA were based on internships overseen by former [MMA Director Dorrit Hoffleit](#) during her 1957-1978 tenure (CT Women’s Hall of Fame, n.d.). Hoffleit was an avid astronomer and successor to Maria Mitchell’s legacy of teaching and supporting young women in science; she pioneered the MMA internship program’s focus on hands-on research on Nantucket itself, which was continued with the creation of the NSF-REU internships (CT Women’s Hall of Fame, n.d.). Through the NSF-REU, “students are granted stipends and, in many cases, assistance with housing and travel” to partake in research programs of host institutions such as the MMA (National Science Foundation, 2023). The purpose of the NSF-REU is to get undergraduate students involved in research and “attract a diverse pool of talented students into careers in science and engineering” (National Science Foundation, 2023). Over its decades of running the NSF-REU, the MMA has established itself as a “leader in training the next generation of astronomers,” receiving the [Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring](#) from President Obama in 2009 (Maria Mitchell Association, 2023). Today, the MMA continues to offer this research opportunity to six students each year who explore concepts ranging from dark matter to the culture of astronomy (Maria Mitchell Association, 2023).

Education

In line with Maria Mitchell’s belief in learning by doing, the MMA runs [Summer Discovery Camp Programs](#) for children aged five to twelve, which are “dedicated to developing knowledge and an interest in the natural world, connecting youth to Nantucket’s local environment, and inspiring action to protect the natural world” (Maria Mitchell Association, 2023). Each summer since 1985, the MMA has hired 3-10 [Environmental Education Interns](#) to design and lead the Discovery Camp programs following two weeks of intensive training (Maria Mitchell Association, 2023). One such intern, the Assistant Discovery Camp Director, serves as part of the leadership team and works alongside the Camp Director to supervise the programs, mentor and support other interns, serve as a lifeguard for waterfront activities, and ensure camper success (Maria Mitchell Association, 2023). The remaining environmental education interns receive training on best practices for writing and implementing lesson plans, group management, conflict resolution, socio-emotional learning support, collaboration, and general environmental education (Maria Mitchell Association, 2023). Equipped with this knowledge, these interns work with co-instructors to

execute educational and engaging programming for campers, lead hikes, and design educational props (Maria Mitchell Association, 2023).

Marine Science

Around the year 1985, the Maria Mitchell Association began hiring aquarium interns to work in the [MMA Aquarium](#) (Maria Mitchell Association, 2023). These paid internship opportunities are open to both undergraduate and graduate students who are interested in marine biology and environmental education. Responsibilities of these interns include “exhibit design, collection and husbandry of 75+ marine species, plumbing and troubleshooting of filtration systems, program and tour leadership, volunteer management, and retail in the giftshop” (Maria Mitchell Association, 2023). The number of aquarium interns per year generally ranges from one to six (Maria Mitchell Association, 2023).

In 2003, the Maria Mitchell Association also began collaborating with the [Nantucket Shellfish Association](#) (NSA) to conduct “a long-term study of the [Nantucket Bay Scallop](#) to understand scallop longevity, reproduction and survival, and habitat preferences” (Maria Mitchell Association). This effort is extremely important, as “Nantucket is one of the last places where wild bay scallops are regularly harvested” (Maria Mitchell Association, 2023). Over the past 20 years, the MMA has occasionally hired interns, referred to as Bay Scallop Research Assistants, to work on this project.

Natural Science

Since 1985, the MMA’s [Natural Science Museum](#) has hosted a variety of interns who are interested in the fields of biology, ecology, zoology, museum studies, and environmental education (Maria Mitchell Association, 2023). In this highly competitive internship program, students are able to pursue a variety of interests at the Museum including the husbandry of 20+ species, exhibit design, animal collection, museum operations, educational programming, volunteer management, collections preservation, and customer service (Maria Mitchell Association, 2023). Two or three undergraduate interns are hired each year from a pool of approximately 80 applicants. In addition to the undergraduate interns, the Museum hires five to ten high school interns and around fifteen volunteers to assist with the day-to-day operations.

Administration

Since 2003, the MMA has offered internships in marketing, communications, and office work (Maria Mitchell Association, 2023). These interns work closely with administrators at the MMA, assisting in the planning of the many events the association hosts for outreach, education, and fundraising (Maria Mitchell Association, 2023). These opportunities allow students who are interested in the scientific work of the MMA, but wish to go into administrative work, to gain experience with the association. Since 2003, there have been up to two marketing, communication, and administration interns at the MMA per year (Maria Mitchell, 2023).

Mitchell House

The [Mitchell House](#) Internship, started in 1999, allows interns to work in the historic birthplace of Maria Mitchell (Maria Mitchell Association, 2023). This house opened as a museum in 1903, one year after the founding of the Association, and is open during the summer seasons (Maria Mitchell Association, 2023). Since 2003, the MMA has had twenty-two Mitchell House interns who have worked with staff to run the

museum through guided tours, children’s history lessons, and conservation projects related to the House and its collections (Maria Mitchell Association, 2023).

2.5 Benefits of Internship Programs for Students

While the main purpose of an internship is for students to gain relevant professional work experience, these programs can be advantageous in a variety of other ways (NACE, 2023). Below, we describe some of the most well-supported benefits of internship programs for students.

Employment Rate

Internships provide employers with a channel to engage with new talent and develop a pipeline of future employees (Willison, 2012). This pipeline of future employment means that interns often benefit from increased employment rates and improved career outcomes (Nunley et al, 2016). Depending on the organizations and institutions studied, different studies report varying percentages of interns who get hired at the company that they interned for. The MMA is a smaller organization and cannot hire a high percentage of their interns full-time; currently four of the fourteen full-time employees at the association are former interns (Annual Reports | Maria Mitchell Association). There are, however, other companies, such as Wallaroo Media in Utah, that fill full-time positions almost exclusively from their pool of current interns (Steele, 2017).

However, just because the MMA is not able to hire all their interns as full-time employees does not make it any less valuable of an internship. A study conducted in the United States, which submitted approximately 9400 randomly generated resumes to entry-level job openings in the field of business, found that resumes including internship experience, regardless of internship relevance and college major, had a 14% greater interview rate than those with no internship experience at all (Nunley et al, 2016). Further, in a study conducted on the design and benefits of academic internships primarily in the fields of political science and environmental science, it was found that 79% of students who completed an internship responded positively when asked if their employment opportunities were strengthened by their completion of an internship program (Wolinsky-Nahmias & Auerbach, 2022).

Career Decisions

Internships are also very helpful for students as they make decisions about which field of study is right for them (Galbraith & Mondal, 2020). In a study conducted by Dr. Diane Galbraith and Dr. Sunita Mondal at Slippery Rock University (SRU) about the power of internships and their impact on career preparation, the majority of students surveyed indicated that real-world applications and hands-on experience were the most impactful part of their internship (Galbraith & Mondal, 2020). For most students, classroom learning is largely conceptual and does not provide the full picture of how this material can be applied to a student’s career. Of the SRU students surveyed, a “significant” number of respondents indicated that their internship helped them realize that “their choice of major and subsequent career choice was indeed the right option for them” (Galbraith & Mondal, 2020). Interns at the Maria Mitchell Association are given the chance to apply the theories they learn in college to hands-on fieldwork through the use of the MMA’s telescopes and facilities, which can aid them in future decision-making in their academic and professional journeys.

Confidence

Although sometimes difficult to directly assess, one of the most important benefits of internships is that they help students gain confidence in their ability to do work and positively contribute to their company. When interning at an organization like the MMA, interns gain experience in their field, which can then benefit them as they move on to their full-time professional career. In a qualitative study conducted in the United Kingdom about the student internship experience, “all students reported a significant increase in both self-confidence and the ability to communicate” (Rowe & Mulroy, 2004). One student stated that their internship boosted their confidence in interacting with others and attending meetings, which they had not done frequently before (Rowe & Mulroy, 2004). Internships can help students learn the best ways to conduct themselves in a professional manner, which enables them to communicate with a diverse group of colleagues and resolve interpersonal conflicts (Rowe & Mulroy, 2004).

Academic

Along with personal and professional benefits, internships like the MMA, in which interns have the opportunity to work with experts in their field, are able to offer academic benefits to students as well. While research on the academic benefits of internships in the United States is limited, studies have been conducted in the United Kingdom that indicate an association between students taking part in a “placement year” and improved grades (Reddy & Moores, 2012). Placement years in the UK are longer work experiences for students to gain applied experience in their field (Sheffield Hallam University, 2023). While placement years are not the same as internships, these UK studies can still provide valuable insight into the impacts of work experience on students. In a study conducted across multiple departments of 30 undergraduate students or more offering placement years at Aston University, students pursuing placement opportunities had 2-7% higher marks than their peers who did not take placement years (Reddy & Moores, 2012). Another study, which studied 15,730 students at the undergraduate level in the UK, reported that a year-long work experience had a “positive and reliable effect on final year marks” (Binder, et al.). Students who undertook these work experiences had an average of a 2.7% increase in final-year marks compared to students who did not partake in these experiences (Binder, et al.).

2.6 Benefits of Internships for Employers

While the benefits of internships for students are more commonly discussed, internships also offer several benefits for employers such as the MMA. First, internships are an extremely cost-effective method for accessing talent (Willison, 2012). While interns are generally paid significantly less than regular, full-time employees, they are motivated individuals who are eager to demonstrate their skills (Willison, 2012). Interns increase the productivity of companies by “completing small add-value tasks or ‘back-burner’ projects,” which frees up full-time employees to complete work that requires more time or experience (Chern, 2018). Equipped with relevant knowledge gained through their courses, interns can provide fresh perspectives and positive attitudes that can benefit any organization (Willison, 2012).

In addition to their cost-effectiveness, internship programs also help organizations develop their current staff (Willison, 2012). When an intern begins doing work in their field for the first time, they often require much support and guidance. This creates an opportunity for current employees of the organization to develop their leadership skills by managing these temporary interns (Willison, 2012). The process of recruiting for internship programs also helps organizations grow their brand, which, according to the Louisiana State University study, was tied for the second most discussed topic among employers

interviewed about their perceptions of internship programs (Chern, 2018). By reaching out to universities, recruiters can develop relationships with department heads, professors, and career placement staff which can be essential for organizations such as the Maria Mitchell Association who wish to share their mission and attract interns outside of Nantucket (Willison, 2012).

3.0 Methodology

The goal of this project was to compile a digital database of interns' experiences during their time at the MMA and assess the interns' impact on science. To achieve this goal, we identified the following objectives.

1. Collect data through independent research, surveys, and interviews on how the MMA internship shaped the interns' career choices, and professional and academic accomplishments.
2. Develop a comprehensive database of intern information, as well as instructions for how the MMA can update and maintain the database.
3. Create detailed profiles of a select group of MMA interns that the organization can use for fundraising and promotional purposes.
4. Design infographics to highlight historical trends and display the measurable impact of the MMA internship program on the scientific community.

3.1 Objective 1: Data Collection

The study involved three core components:

- Independent research into the careers of former MMA interns
- A survey distributed to former MMA interns
- In-depth interviews conducted with select former MMA interns

The survey included both quantitative responses, aimed at assessing specific components of the internship program and participants' careers, and qualitative responses for more open-ended topics. The in-depth interviews and research primarily focused on qualitative data that was used to generate profiles of individual interns.

Independent Research

To identify participants in our study, we used annual reports from the Maria Mitchell Association (MMA). As shown in Figure 4, these annual reports contained lists of that year's interns with their names, college or university names, and intended graduation years. From these reports, we then created an initial spreadsheet of former interns for use only in developing the sample population for our survey. To assist in identifying the current contact information of former interns, we researched using three main avenues: social media, university web pages, and MMA files. Some also had contact information available through academic publications, such as journal articles, that they have been part of. To ensure that we were able to get a useful intern sample given the time constraints, we started by looking at the annual report for the year 2000 and working our way outward.

NSF-REU Astronomy Interns

Devon Barros, Bridgewater State University, Class of 2022

Kiana Burton, Temple University, Class of 2021

Sarah Graber, Columbia University, Class of 2021

Alex Granados, Wellesley College, Class of 2021

Andrea Mejia, Hunter College - City University of New York, Class of 2021

Natalia Villanueva, Harvard University, Class of 2023

Figure 4. An excerpt from the [2020 Annual Report](#) showing the NSF-REU Astronomy Interns for that year (Maria Mitchell Association, 2023)

Independent research was also used throughout the study to supplement information found in annual reports, interviews, and surveys. Research into the careers of former interns was used to identify potential interviewees and allowed the researchers to request interviews from certain interns prior to their completion of the survey. This research also helped to identify relatives of deceased former MMA interns that could have stories to share for the creation of profiles.

Survey

For our survey sample set, we attempted to reach as many former MMA interns as was feasible out of the estimated 1000 total former interns. A survey response deadline was set to three weeks after sending out initial surveys, to allow participants time to complete the survey while also giving us time afterward to conduct interviews and populate the database.

Once we identified a former intern and found a current email for them, we sent them an initial email (found in Appendix E) explaining who we are and the goal of our study and asked them to complete an attached survey with questions about their experience at the MMA, their career, and their educational background. This email announced the start of the survey, as well as its end date, and will henceforth be referred to as the “Introductory Email.” We sent one more email, the “Reminder Email,” roughly one week after the Introductory Email was sent to any interns who did not yet complete the survey. This reminder email again explained the goal of our study and included a polite reminder to complete the attached survey. All emails pertaining to this project were sent using the Maria Mitchell Association’s standards for formatting and visual design, as well as a Maria Mitchell Association email address. This was to help us increase the likelihood of responses from participants, who were more familiar with these emails and would have been less likely to ignore them or send them to spam.

An electronic survey (found in Appendix A) allowed us to send out standardized questions to gather more general information about as many interns as possible in preparation for in-depth analysis (Sheppard, 2020). The electronic survey could also be distributed via email, without requiring the time, money, or labor that a phone or mail survey would need. An electronic survey also helped us gather both quantitative and qualitative data into a shared data set automatically, rather than phone or mail options which would have required us to transcribe that information into an online format. We tested our survey instrument by having professors, WPI students, and current MMA employees preview it to check for content, question clarity,

and survey length. These checks helped us improve our survey and avoid questions that would have negatively affected our data or participant confidentiality (*Avoid Bad Survey Questions*, 2023).

The survey was broken down into the following sections:

- During Internship
- After Internship
- Demographics

Questions falling under the “during internship” category included statements about the intern’s enjoyment of Nantucket, satisfaction with the support and training provided, and the value of the internship overall. These questions had five answer options ranging from strongly disagree to strongly agree. This section additionally included open-response questions prompting interns to detail their favorite memory of the MMA and why they chose the internship.

The “after internship” section included short answer questions regarding employment after the internship and rated scale questions asking respondents to indicate whether their internship helped them acquire employment. This section also included open-response questions prompting respondents to detail their proudest career achievements.

The “demographics” section of the survey included multiple choice questions regarding the socio-demographic characteristics of the interns, in addition to short answer questions asking which schools the intern attended.

Survey questions were selected by importance to data collection, and to fit within a 10-minute time frame, following guidance from the literature that suggests that short surveys under 30 minutes help maintain interest and attention (Sharma, 2022). A degree of depth in the survey was sacrificed to shorten the contents and increase response rates. As the purpose of the study was to collect a high volume of data in a short period of time, all interns who could be conveniently found and contacted received a survey. Surveys were conducted using [Qualtrics](#).

Interviews

In contrast to the convenience sampling used for our survey, our in-depth interview sample set was a purposive sample chosen specifically to represent a cross-sectional set of interns. This cross-section was meant to showcase stories from across the long history of the internship program, and from across the various different internships currently offered. To ensure that we could represent this full range of perspectives, we made sure to distribute our interviewees in different fields across a range of years.

While recommendations for qualitative sample sizes can vary from 5 to 50, the size of the sample is ultimately based on the number of people that researchers can study within the given time constraints (Dworkin, 2012). Given that this entire study was conducted in 7 weeks, we decided on 22 interviews at a length of roughly 30 minutes each. Interviewing multiple people from each internship group ensured that we have different perspectives for each bucket, without oversaturating our interview data set with too many responses from any one subgroup of interns. We also balanced the gender of interview participants to roughly match the overall gender makeup of the survey response set.

We identified and contacted intended interview participants on a rolling basis upon completion of the survey based on intern interest, field, and career achievement to ensure that we had adequate time for interviews

before we devoted our time to data analysis and the formation of the profiles. As the survey included questions about preferred contact information, we were able to easily reach out to those interns we were interested in interviewing. Emails to potential interviewees established the purpose of in-depth interviews in our study and discussed the general structure these interviews would follow in terms of duration and methodology.

Interviews were open-ended and narrative-driven, where researchers provided a general question guide (found in Appendix B) and invoked more detail based on interviewee responses. Questions were tailored to the survey responses of each participant, but covered the general topics of career journey, expectations, and reality of the MMA experience, and what they would like the MMA and future interns to know. For example, if an intern indicated that they worked at Company A immediately after their internship, we asked them specifically about their time at the company and how skills learned in their internship may have applied. Interviews, being qualitative and anecdotal, require precision in administration and collection (Schmitz, 2012). Interviews were conducted on the MMA premises, in person if the interviewee was still local, and over zoom if not. Interviews were also conducted by pairs of interviewers to provide continuity between different interviews. These strategies worked to minimize the interviewer effect, which can cause respondents to answer in a certain way based on the interviewer, environment, and question order (Schmitz, 2012).

3.2 Objective 2: Database Creation

All intern names, contact information, and survey responses were kept in a temporary Excel workbook for use by the researchers for the duration of the project. This initial workbook was divided into separate sheets for each of the six fields the MMA offers internships in. The workbook also contained sheets with information about interview and profile candidates. At the conclusion of the project, two final Excel workbooks were created; these workbooks were given to the MMA along with a brief guide on how to navigate and update them.

The first workbook contained the raw data obtained through our research, organized by internship field. All information contained in this sheet was either publicly available or given to us by the MMA itself. Any interns who, through survey responses, did not consent to having their contact information shared had any emails, phone numbers, or social media information removed from this workbook. This workbook was shared directly with the MMA for use in future iterations of this project.

The second workbook contained two sheets, with all information taken from responses to the survey. The first sheet in this workbook contained personally identifiable intern information and allowed for navigation and sorting by name, year of internship, and internship field. The second contained all opinion-based survey responses that could not be directly linked to any one intern. The MMA will upload both workbooks into their Blackbaud Altru database system to aid in maintaining accurate information on all future interns.

3.3 Objective 3: In-Depth Profiles

The individual in-depth interviews were used to develop qualitative profiles of intern experiences that were then given to the MMA for use in marketing and recruitment. To create the profiles, the researchers compiled notes and audio recordings to pull out quotes and specific stories for each individual interviewee. A total of 12 profiles were created to highlight former interns who are diverse in their accomplishments and reflect the characteristics of the overall intern population. To identify trends among interview responses, we also completed a thematic analysis; while reading through interview transcripts, we took note of sections

pertaining to repeating ideas, assigning each repeating idea a code (i.e., color highlight, keyword in notes, etc.). We then sorted all the key takeaways into a series of overall themes, which were then used in the reporting of these interviews. This system was chosen based on the system used in an honors thesis at Louisiana State University, which identified themes such as “Applying Academics” and “Build Connections/ Networking” for benefits of internships mentioned by interviewed students (Chern, 2018).

3.4 Objective 4: Infographics and Historical Trends

To develop descriptive statistics of the overall intern population based on survey responses in the spreadsheets, we focused on the year of internship, type of internship, and socio-demographic characteristics of interns. Identifying how each of these factors correlates with intern satisfaction, achievements, and perceived effectiveness of their internship overall provided a good starting place for deeper analysis. We identified how trends in intern success and socio-demographic characteristics have changed over time, and how these changes could relate to alterations in the structure of the program itself, such as adding additional topics and locations. The built-in functionalities of Excel were used to develop charts, timelines, and other visuals illustrating the identified trends for MMA fundraising and promotional purposes, as well as calculating statistics drawn from the survey results. Final infographics combining much of this information were created using [Canva](#), with formatting modeled after standard MMA fonts and colors.

3.5 Data Management and Ethical Considerations

The goal of this project was to reflect on positive experiences and achievements, therefore there was minimal risk involved. Participants may have benefitted from this study by having the opportunity to reflect on their time at the MMA and reconnect with the organization. The goal of the profiles was to represent a diverse subset of interns with experiences that are unique from one another, so respondents were told that not being selected for a profile does not indicate that they are any less successful or interesting than others.

Through consent forms and survey questions, respondents had the opportunity to learn about the study, decide whether they wished to participate, and select how they would like their responses used. No question on the survey was required, so respondents could also choose to not provide specific information. Respondents were asked if they consent to having their contact information and other personally identifiable information shared with the MMA for future communication. If they did not consent to this, their contact information was deleted from the database at the conclusion of the study prior to the MMA receiving the data. Survey responses from participants who wished to remain anonymous were reflected in overall statistics given to the MMA but were not connected in any way to their identity.

Study participants were made aware that all profiles created would be public facing and not anonymous. If the interviewee consented, the interview was audio recorded using Zoom’s internal recording function. The recordings were not shared with the MMA. Some profiles also included quotes from interviewees, provided that the interviewee consented to the quote being used. Each profile was sent to the intern being featured for their approval prior to publication to ensure that all information was accurately represented. Participants were made aware that they can opt out of the study at any point in the survey or interview process.

In order to maintain confidentiality, survey data and interview recordings and raw transcriptions were held on the password and fingerprint protected computers of the researchers. Once the final Excel spreadsheets were passed to the MMA, all preliminary databases were deleted and cleared from the trash of each researcher’s computer.

4.0 Results

This section will discuss the data collected throughout the study and the deliverables of the project for each of the four project objectives.

4.1 Objective 1: Data Collection

Utilizing MMA annual reports and an Excel workbook of astronomy intern names and contact information provided by [Regina Jorgenson, director of the Maria Mitchell Observatory](#), the research team was able to identify the names and internship types of 859 former interns. Of the 859 interns identified in this study, 430 were in the field of astronomy, 247 were education, 89 were marine science, 64 were natural science, 16 were historic preservation, and 13 were administration. Through independent research and available MMA records, contact information was obtained for 511 of these interns in the form of either email, LinkedIn, or Facebook.

Survey

The survey was open to responses from November 6 to December 1. In this time, we received 190 responses (a response rate of 37%). On November 13 and November 14, reminder emails were sent to interns who had not yet completed the survey. Figure 5 displays the spike in survey responses generated from these reminder emails. Although the number of survey responses remained low after November 16, at least one survey response was received every day from November 6 to November 29.

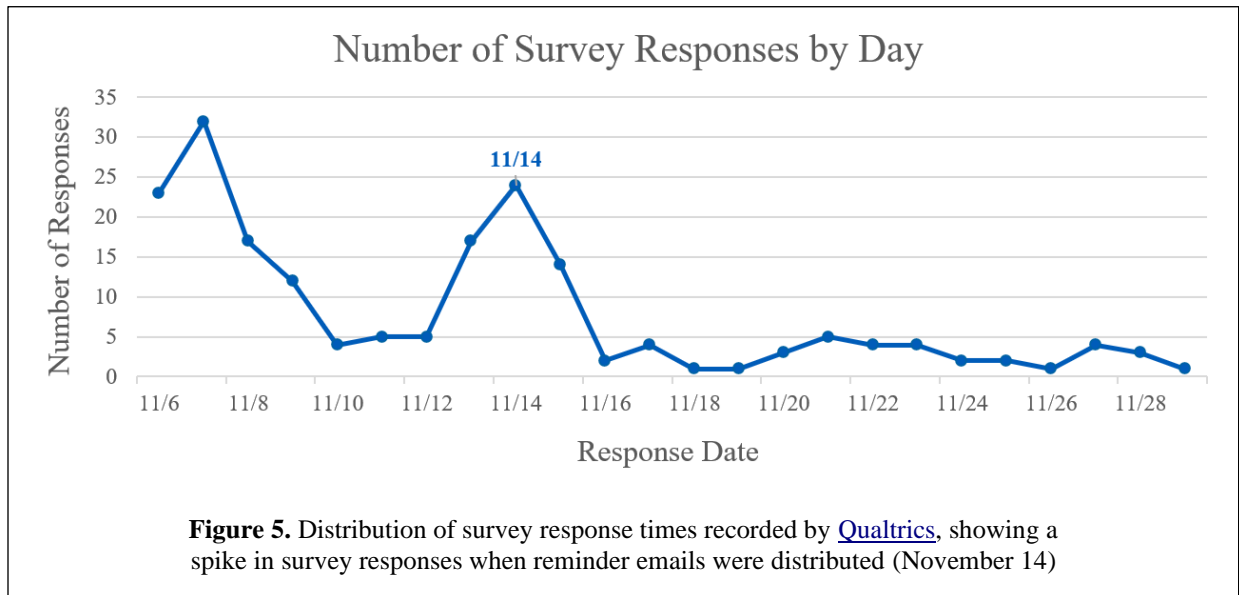


Figure 5. Distribution of survey response times recorded by [Qualtrics](#), showing a spike in survey responses when reminder emails were distributed (November 14)

73% (122 or 167) of survey respondents who provided a gender self-identified as female. This high percentage is likely due to the MMA's emphasis on female representation in the STEM field. As shown in Figure 6, the breakdown of survey respondents by field is representative of the total internship population with astronomy being the highest percentage of respondents and historic preservation and administration being the lowest. Respondents were able to select multiple internship fields if they participated in multiple internships. When survey response rate was broken down by field, there was a 34% (93 of 270) response rate for astronomy, 32% (40 of 125) for education, 42% (22 of 52) for marine science, 49% (19 of 39) for

natural science, 83% (10 of 12) for historic preservation, and 46% (6 of 13) response rate for administration. As shown in Figure 7, the age breakdown of survey respondents is fairly spread with at least 20 responses received from each age category aside from 16-20 (which is a smaller age range than the others). Any survey respondent who did not provide their age or did not consent to this information being public is not included in the graph.

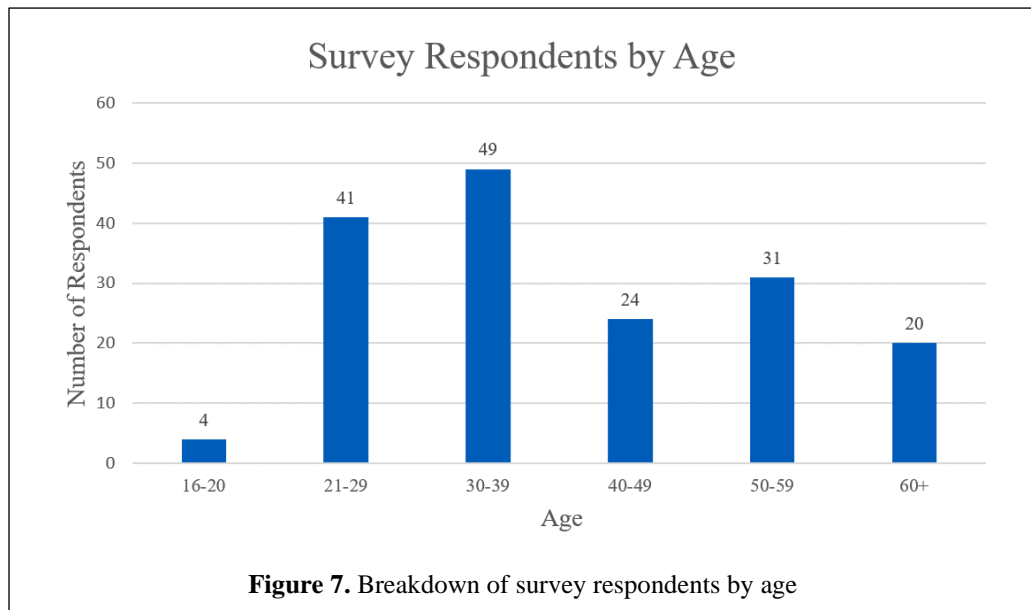
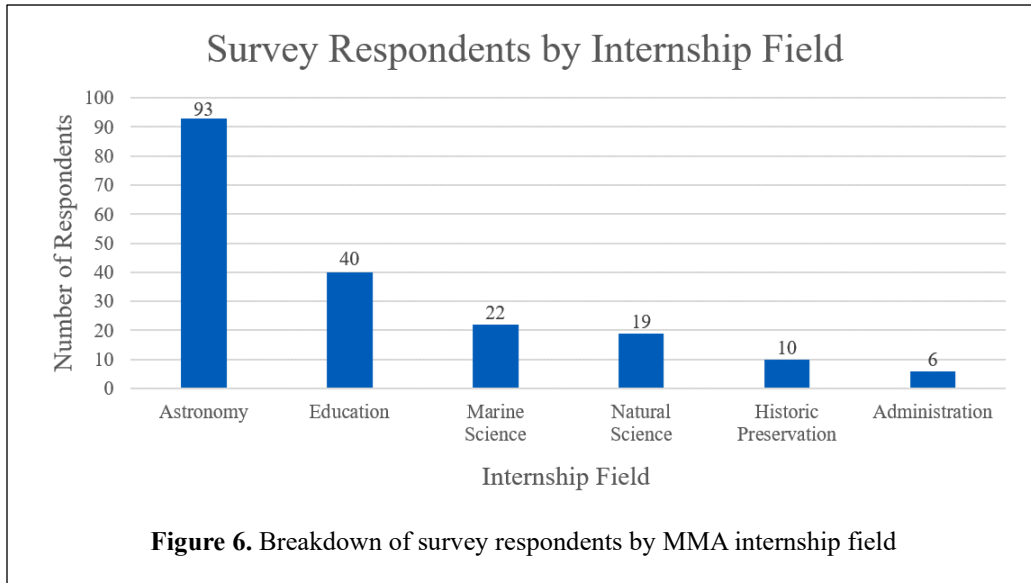
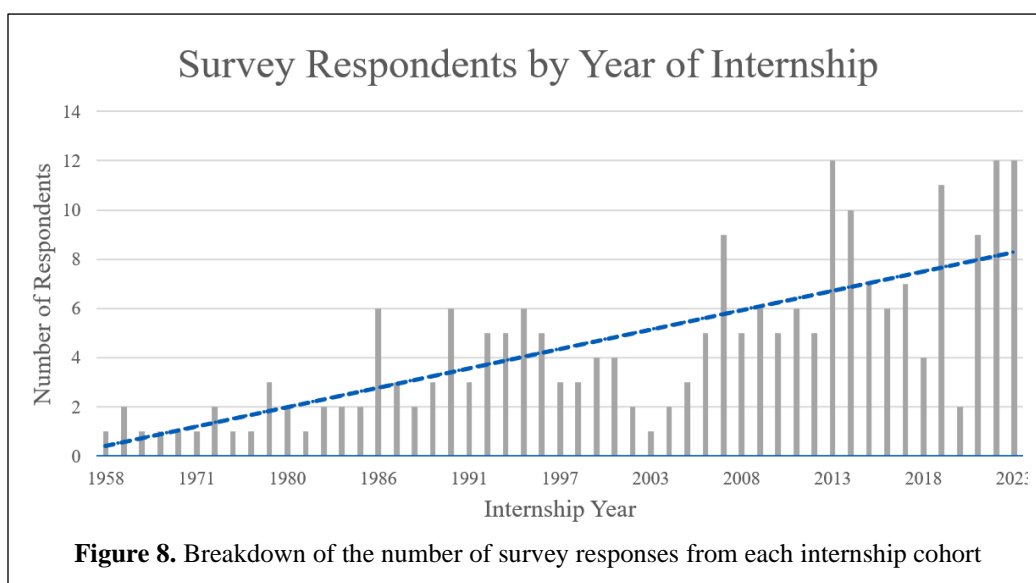


Figure 8 provides a breakdown of the number of survey respondents from each internship year. If an intern completed multiple internships, they are included in the count of total interns for each year that they participated in an MMA internship. The oldest internship cohort that responded to the survey was 1958 while the most recent was 2023. In general, the rate of survey responses increased for more recent years. This was expected by the researchers, as the MMA was more likely to have up to date information on more recent interns. Additionally, the younger generation of interns tended to have a greater online presence, making their contact information easier to identify.



Interviews

All interviews were conducted between November 13 and December 7, with the first interview requests being sent out on November 9. A total of 24 interview requests were sent out, with 22 interns responding and accepting the offer (a 92% response rate). At least one intern from each internship type was interviewed, with 10 interviewees in the field of astronomy, 4 in natural science, 4 in marine science, 2 in education, 1 in historic preservation, and 1 in administration. Interviewee internship years ranged from 1964- 2022. A full list of interviewees along with their internship field and year(s) can be found in Appendix H.

Interviewees were ultimately chosen based on their enthusiasm for the MMA and career accomplishments indicated in their survey responses. While there was a higher proportion of interviewees in the field of astronomy than others, many of the interviewees chose to pursue careers outside of the discipline in which they did their internship. For example, interviewee Ann McMahon, a 1977 astronomy intern, went on to a successful career in engineering, education, and public speaking. While her passion for astronomy remained strong throughout her career, her family, education, and career led her to new opportunities that she had not originally considered for herself.

4.2 Objective 2: Intern Database

As outlined in section 3.2, two Excel workbooks were created in this study and given to the MMA to be implemented into their pre-existing Altru database system. The first workbook contains raw data from our research, with publicly available information about former interns. The primary purpose of this workbook was to enable the MMA to update this project in the future without needing to replicate all of our initial research. The second workbook contains information taken from survey responses; to maintain the confidentiality of survey respondents, all identifiable information was kept separate from opinion-based survey responses, resulting in two separate sheets.

In the “Intern Identifiable Data” sheet of the second Excel workbook, the intern’s name, internship type, university name, age, and contact information (phone number, email, and home address) were kept. Any survey respondent who did not consent to having their identifiable information included in the database does not appear in this sheet. This sheet also includes a column indicating the interns’ interest in being

contacted by the MMA for updates and future events, such as an intern alumni reunion. The “Intern Identifiable Data” sheet of the second workbook allows for easy navigation and can be organized by internship type in the event that different MMA departments wish to contact their former interns specifically. Figure 9 shows an example of the “Intern Identifiable Data” sheet that was submitted to the MMA. The columns in this example do not appear in the order that they do in the actual database, as columns were hidden to maintain the confidentiality of select interns.

	E	F	G	H	I	J
1	Year	Internship	Current Position	Gender	Age	Race
2	2022	Aquarium Internship	Substitute Teacher	Female	21-29	White
3	2022	Natural Science Museum Internship	Vet student	Female	21-29	Asian,White
4	2021	NSF-REU Internship in Astronomy	Language Assistant	Male	21-29	White
5	2021	NSF-REU Internship in Astronomy	PhD Student	Female	21-29	White
6	2018	NSF-REU Internship in Astronomy	Postdoctoral Researcher	Female	21-29	White
7	2017	Aquarium Internship	PhD student/marine biology advisor	Female	21-29	White
8	2017	NSF-REU Internship in Astronomy	Research Analyst	Female	21-29	Asian,White
9	2017	Natural Science Museum Internship	Lead clinical laboratory specialist	Female	21-29	White
10	2016	Environmental Education Intern	Lead Editor	Female	21-29	White
11	2016	NSF-REU Internship in Astronomy	Associate Program Officer	Female	21-29	Asian
12	2015	Environmental Education Intern	Resilience & Sustainability Analyst	Female	30-39	White
13	2015	NSF-REU Internship in Astronomy	Data Scientist	Female	21-29	White
14	2015	NSF-REU Internship in Astronomy	Postdoc	Male	21-29	White
15	2015	NSF-REU Internship in Astronomy	Senior Research Assistant	Female	21-29	American Indian
16	2014	Environmental Education Intern	Communications Specialist	Female	30-39	White
17	2014	NSF-REU Internship in Astronomy	Lead Quantum Scientist	Female	21-29	White
18	2014	NSF-REU Internship in Astronomy	Postdoctoral Teaching Fellow	Male	30-39	White

Figure 9. Sample screenshot of “Intern Identifiable Data” spreadsheet that was given to the MMA

The other sheet of the second workbook, titled “Intern Non-Identifiable Data” includes all results from opinion-based survey questions such as “The training I received during my MMA internship is applicable to my current job.” This data is stored in a randomized order and can in no way be linked to the results on the previous sheet. Any survey respondent who did not consent to having their non-identifiable data included in the database does not appear in this sheet. The purpose of the “Intern Non-Identifiable Data” sheet is to ensure that the MMA staff has access to the results of the survey if they wish to conduct their own analysis in the future.

4.3 Objective 3: Intern Profiles

Using data collected through the survey and interviews, 12 profiles were created to highlight interns from across a variety of internship fields. A full list of profile names can be found in Appendix I of this report. Each profile includes a picture of the featured intern along with a page-long description of their interests and career highlights. The goal of these profiles was to illustrate the impact that the MMA has had on the lives of their interns and in turn, the impact that these interns have had on the world of science through their work, research, mentorship, and community service. One of the profiles, featuring 1977 Maria Mitchell Observatory intern Ann McMahon, is shown below in Figure 10. All profiles can be found in Appendix I of this report.

Ann McMahon



As a rising senior in high school, Ann McMahon spent the summer at the Maria Mitchell Observatory (MMO) studying variable stars. Utilizing historical research and real-time data taken through the MMA's telescopes on Nantucket, Ann was able to classify a star that had never been classified before. This work led to the publication of a paper released in the journal of the American Association of Variable Stars.

Following the completion of her MMA experience, Ann used her research and published paper to enter local and national science fairs. Her hard work paid off as she was awarded two \$4000 scholarships that helped her pay for an education that otherwise may have not been financially feasible for her family. Ann wrote

in an email to the team that “the research [she] did at MMO, by virtue of the funds and opportunities awarded to [her] in the subsequent science competitions, paid for [her] undergraduate education and launched [her] career.” She continued in her interview, adding that the MMA “truly opened up college opportunities that [she] never would have had.”

Following her education in engineering, Ann began working as an engineer at McDonnell Douglas (now The Boeing Company) “designing electronics packaging and performing thermodynamic analyses.” With her family growing, Ann decided to shift her career toward education and found her passion for teaching youth about the natural world. For the remainder of her career, Ann would devote herself to educating others and training teachers in the best practices to support and inspire students. Among many other achievements, Ann wrote and won a National Science Foundation grant to “revamp the science and math program” at the school district where she had been working, allowing her to be recognized by other organizations. Ann has made her mark on a variety of communities through her work at the Pacific Science Center, Smithsonian Science Education Center, University of Washington, and her own education company (Ann P McMahon, LLC). Ann's education career was also supplemented with a variety of public speaking events relating to science, education, and her own life experiences. In 2016, Ann was featured in the TEDx Talk “Empathy in engineering,” where she discussed her career journey.

In addition to her work as an engineer, educator, and public speaker, Ann is also committed to giving back through community service. In her interview, Ann stated that “serving organizations that help other people understand nature has always been important to [her].” Ann continued, adding that “because of the opportunity that the Maria Mitchell Association gave to [her], [she] has always felt passionate about paying it forward.”

Following her retirement, Ann is still an avid amateur astronomer, maintaining the curiosity for the sky that she has had since she was a young girl. She shared in her interview that she and her husband enjoy chasing aurora borealis when the conditions are right. Looking back on her career, Ann encourages others to “ask a lot of questions” and “be curious about the people that are introduced to you, what they're doing, and why they are doing it.”

Figure 10. Sample profile of Ann McMahon (All other profiles contained in Appendix I)

4.4 Objective 4: Historical Trends and Infographics

History of MMA Internships

An important aspect of this project was how the survey and interviews can reveal information about the history of the MMA that current staff may not have been aware of. The team found through survey responses that interns in the early 1980s and prior were working in astronomy but were not associated with the National Science Foundation's Research Experience for Undergraduates program. Interestingly, 11 interns in 1984 and prior identified other organizations that their MMA astronomy research experience was associated with. These organizations include the [American Association of Variable Star Observers](#), the [Earthwatch scholarship](#), and the [NSF's Division of Astronomical Sciences](#). While the MMA's current NSF-REU astronomy internship offers learning opportunities in exoplanets, star formation, variable stars, galaxies, dark matter, and more, three former MMA interns indicated in their interviews that prior to the 1980's, the MMA interns focused only on variable stars.

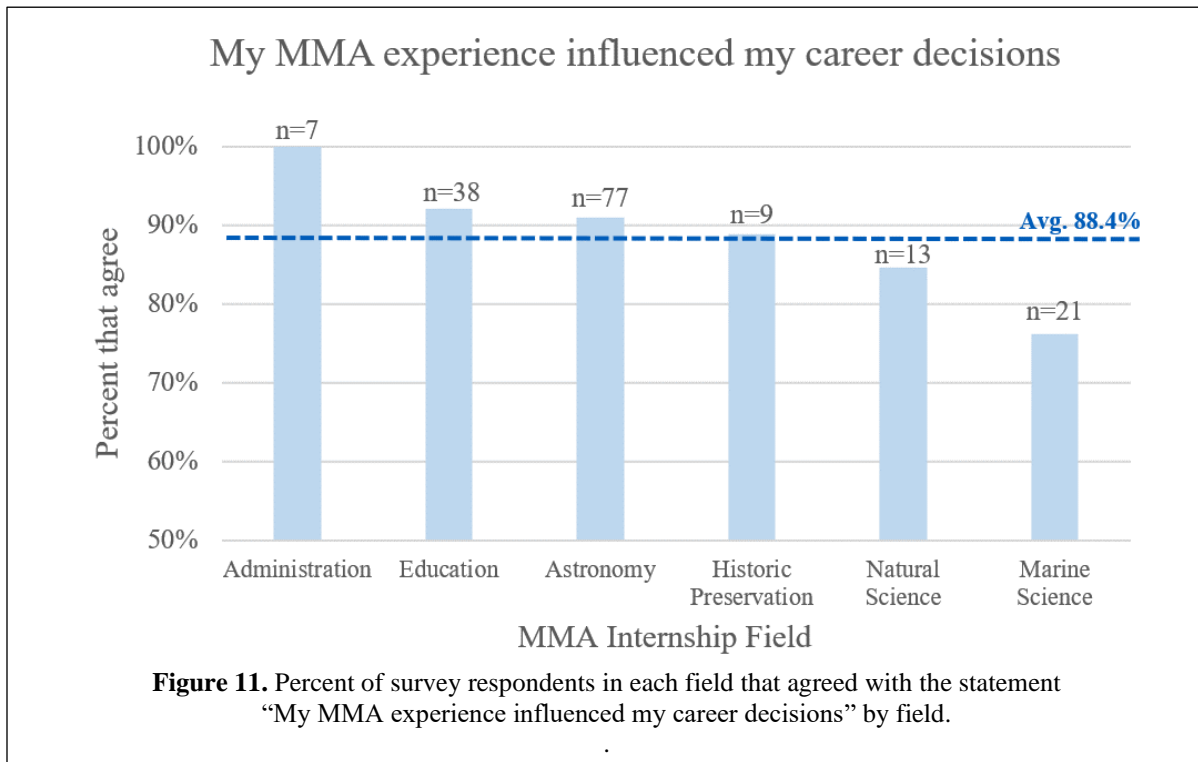
The earliest non-astronomy intern in the survey population was from 1985. While the MMA began offering opportunities in natural science, administration, and education around this time, the internships were not classified in the way they are today. One survey respondent, who began interning with the MMA in the 1990s, stated that "there wasn't a distinction between all the science internships previously." It was also discovered through this study that the first male intern, John Briggs, was introduced to the Maria Mitchell Association in 1977 under the directorship of Dorrit Hoffleit in the field of astronomy. Briggs recounted his experience as the first male intern in an interview with the research team, stating that while his acceptance to the program was initially controversial, he felt fortunate to have such a unique opportunity.

Intern Satisfaction

Survey questions asking interns to rate their agreement with statements on a scale from strongly disagree to strongly agree were used to generate infographics relating to intern satisfaction with their MMA experience. The actual infographics generated can be found in Appendix J of this report, but the numbers used in these visuals will be discussed in this section. When discussing percentages found from the survey, it is important to mention that the sample size for each department varies greatly. While the sample sizes for certain internship categories are below the threshold on $n=30$, the researchers will still discuss these findings, as they can still provide valuable insight. The exact number of responses for each department varies by question, as some survey respondents chose to leave questions blank. Statistics on overall intern satisfaction are as follows:

- **98%** (179 of 182) of respondents indicated that their **experience on Nantucket was positive**
- **98%** (174 of 177) of respondents indicated that their **overall MMA experience was positive**
- **99%** (180 of 182) of respondents felt that their **MMA internship was valuable** to them
- **96%** (171 of 179) of respondents indicated that they would likely **recommend the MMA internship to others**
- **66%** (120 of 182) of respondents indicated that their **satisfaction with their MMA experience became more positive** as they furthered their career
- **88%** (160 of 181) of respondents indicated that their **MMA internship influenced their career decisions**

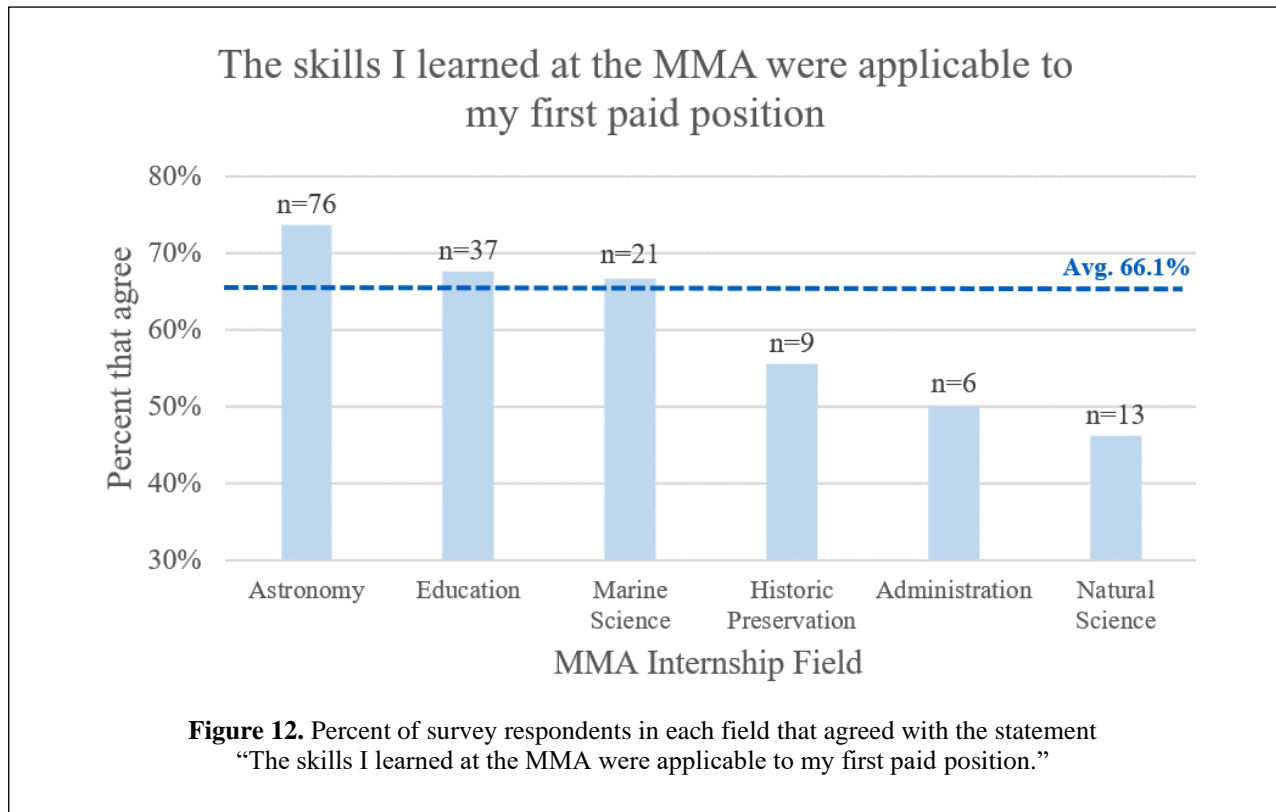
As shown in Figure 11, the number of respondents that agreed that their MMA internship influenced their career decisions varied between departments, with astronomy and education having over 90% of respondents agree with this statement (70 of 77 and 35 of 38 respectively) while marine science only had 76% (16 of 21) agree.



In terms of skills learned in the MMA internship, there was a variety of different responses:

- **94%** (167 of 177) of respondents indicated that they learned **transferable skills** at the MMA
- **59%** (105 of 178) of respondents indicated that the **skills** they learned at the MMA are **applicable to their current job**
- **66%** (117 of 177) of respondents indicated that the **skills** they learned at the MMA were **applicable to their first paid position**

As shown in Figure 12, the number of respondents who agreed that the skills they learned at the MMA were applicable to their first paid position varied across departments, with 73% (56 of 76) of astronomy respondents agreeing with this statement compared to only 46% (6 of 13) of natural science respondents.



Measurable Impact

In order to display the measurable impact of the Maria Mitchell Association internship program on science, a variety of targeted questions were asked on the survey that were used to generate the following statistics:

- **85%** (142 of 168) of survey respondents have **conducted research** of some kind
- **65%** (108 of 165) of survey respondents have **worked for a non-profit organization**
- **64%** (109 of 169) of survey respondents have **published at least one paper**
- **42%** (70 of 167) of survey respondents have **won a prize** for their professional achievements
- **38%** (64 of 168) of survey respondents earned a **doctoral degree**
- **23** survey respondents have **contributed to books**, resulting in a total of **148 book publications**
- **9** survey respondents have held patents, totaling **39 patents**
- **5** survey respondents have **given a TED talk**

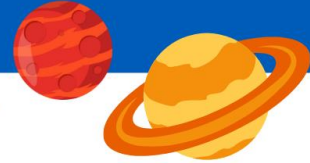
These statistics were used to generate four infographics displaying overall intern success. To gain more insight into the success of specific departments, these numbers were also broken down by field. Figure 13 shows an example infographic highlighting former MMA astronomy interns. All infographics are available in Appendix J of this report.

Curiosity can Change the World

Astronomy



Of the 93 astronomy survey respondents...



99%

of astronomy interns agree their **MMA experience was valuable**

56%

of female astronomy interns went on to receive a **doctorate degree**

40%

of former astronomy interns currently work as **educators**

95%

of astronomy interns have **conducted research** in their career

51%

of astronomy interns have **worked at a non-profit**

38

patents held by former astronomy interns

58

books/ co-authored **books published** by former astronomy interns

2

former astronomy interns have given **TED Talks**



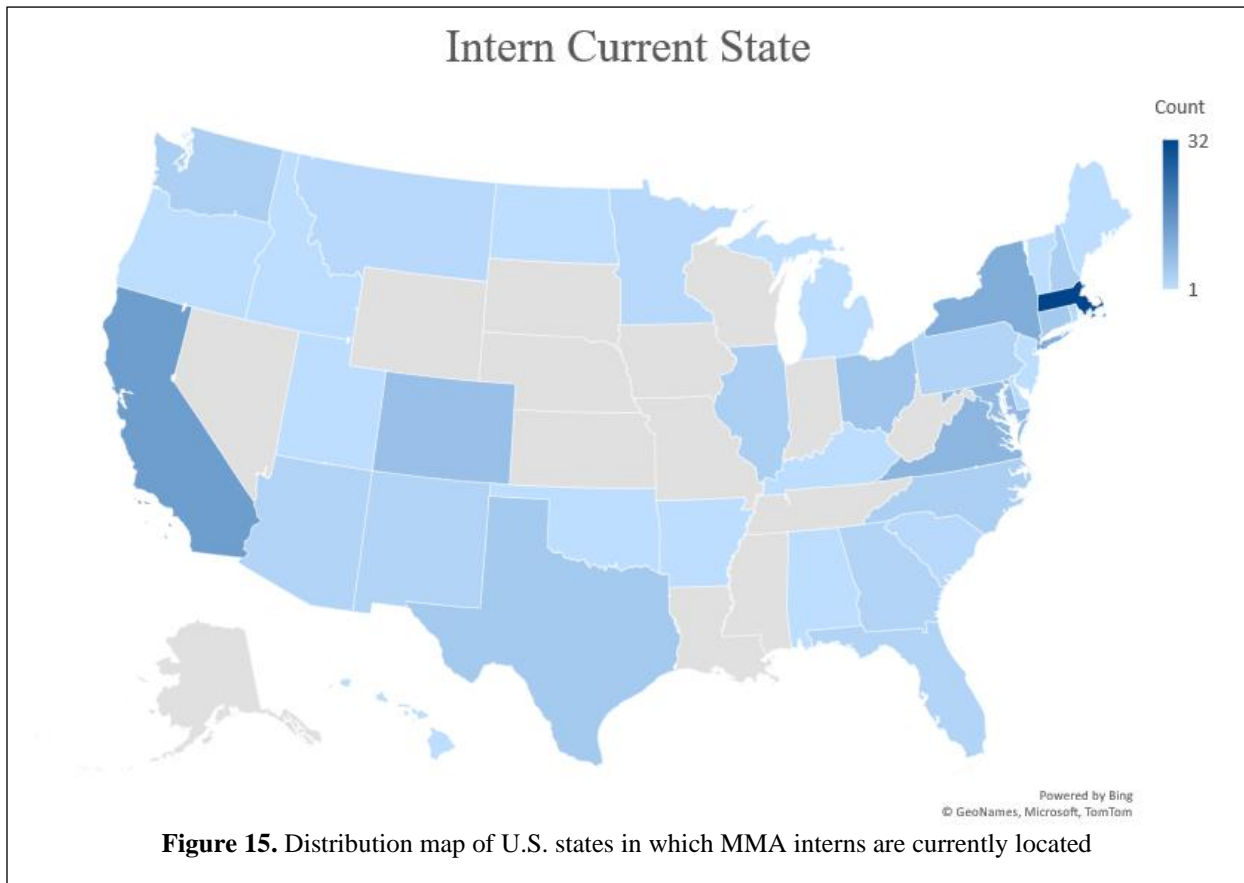
"My proudest career achievement is doing what the MMA taught me to love."

-Tess Jaffe, 1992 MMA Astronomy Intern

"My favorite part of the MMA is the amazing people and a strong sense of belonging."

-Kim-Vy Tran, 1993 MMA Astronomy Intern

Figure 13. Sample infographic highlighting the success of MMA astronomy interns, generated using [Canva](#)



One of the most notable impacts of the Maria Mitchell Association interns on science is their work as educators. 25% of all survey respondents (41 of 164) are currently working as educators, with positions ranging from professor at a university to elementary school science teacher. When asked about their proudest career achievements, survey respondents provided answers such as “the successes of the diverse students I have mentored,” “training and mentoring more than 250 new science journalists,” and “making an impact in the lives of students.” Also, when asked about their definition of success in their field, survey responses included “mentoring young scientists and leaving a legacy,” “encouraging students to build a healthy relationship with science and learning,” and “teaching science in a way that makes everyone feel excited.” Through the survey responses, it is shown that former Maria Mitchell Association interns see the value in educating the next generation of scientists, much like Maria Mitchell herself.

5.0 Conclusions and Recommendations

This section will discuss conclusions drawn from the survey and interviews on intern satisfaction and success of the MMA internship. This section will also detail recommendations for the MMA on how to continue improving their internship program and engaging the MMA community.

5.1 Conclusions

Intern Satisfaction

The survey results reflect a generally positive outlook on the MMA internship program amongst former interns. As discussed in section 4.0, the majority of survey respondents reported to agree or strongly agree with each of the opinion statements such as “My MMA internship experience influenced my future career decisions,” “I learned transferrable skills at my internship,” and “My overall MMA experience was positive.” This supports the idea that the Maria Mitchell Association’s internship program has had a positive effect on its participants for years after their participation.

This satisfaction is further reflected in the interviews conducted with former interns. All interviewees showed enthusiastic support for the Maria Mitchell Association, even after up to 50 years since their internships. One former intern stated that their internship was “the first place where [they] did something in line with what [they] were studying” and was the first domino to fall that led to their current career.

Intern Success

Along with opinions on the internship from former interns, the survey shows that many alumni of the program moved on to successful careers in their field, which led to their positive impact on science. With cumulatively hundreds of research papers published, 5 TED Talks given, and 148 published books², former MMA interns have many examples of their success to point to.

Many MMA interns hold prominent positions in their fields; MMA alumni have gone on to be heads of observatories, presidents of companies, and university professors. Other interns went on to become elementary, middle, or high school teachers, and some even wrote novels and children’s books about astronomy and science fiction, helping continue Maria Mitchell’s legacy of science education for all.

5.2 Recommendations for Future Work

Due to the time constraints of this project, the research team was not able to conduct as comprehensive of a study as we could have given more time. This section provides some recommendations on how to continue and improve this project going forward.

Recommendation 1: Interview and Profile Additional Former Interns

One of the areas most impacted by the limited duration of this project was the number of interviews and profiles we were able to complete. There were many more former interns who had impressive career accomplishments who we were unable to speak with by the end of our project. Future projects on the internship program may also be able to uncover additional information on interns from non-astronomy

² For the 190 survey respondents

fields, allowing for profiles presenting new and unique perspectives. The following is a list of interns who we believe would be strong profile candidates for a future project:

- [Mark Bell](#) (1995 MMA intern)
- [Andrea Dupree](#) (1958 MMA intern)
- [Tess Jaffe](#) (1992 MMA intern)
- [Jennifer Lotz](#) (1994 MMA intern)
- [Melissa McGrath](#) (1975 MMA intern)
- [Melanie Mitchell](#) (1979 MMA intern)
- [Maritza Tavaréz-Brown](#) (1994 MMA intern)
- [John Weirich](#) (2001 MMA intern)

Recommendation 2: Update Survey for Future Use

After analyzing our survey results, we determined multiple areas where future surveys could change or add questions. These changes would seek to expand the scope of the current questions while also making data collection easier for investigators. Some changes we would recommend if the Maria Mitchell Association chose to use the survey again in the future are listed below:

- Change questions regarding career achievements (papers published, books published, etc.) to ask for the number of the given item created by that intern, rather than a list of titles. This would speed up the process of analyzing the overall measurable achievements of MMA interns. Questions asking for a list of titles could still be included if desired, to assist in creating profiles or highlighting individual accomplishments.
- Ask participants about all talks they have given rather than simply the number of TED Talks. Many former interns, especially those working in academia, have given talks or presentations outside the TED organization, and it would be a strong addition to this project to include those talks in future reports.
- When asking interns if they have stayed in contact with other interns, encourage them to provide the contact information of these interns or supply an easy way for the survey respondent to share the survey with others. This will work to increase the survey response rate by leveraging the networks of each survey respondent.
- Change all questions pertaining to location to use a standard drop-down list format for country and state to allow for easier analysis and comparison of data.
- Make all consent questions mandatory to ensure that the data of all participants is being used accurately and ethically, as accidentally skipped consent questions can result in unusable data.

5.3 Recommendations for Alumni Engagement

Based on the team's methodology and responses from the survey, the team has created a list of recommendations for the Maria Mitchell Association to be able to keep up to date on the contact information of former interns and retain interest from program alumni. These recommendations are:

1. Update intern alumni database with each year's interns
2. Reach out to update information on a regular basis
3. Hold regular alumni events
4. Leverage social media

Recommendation 1: Update Alumni Database

Because this project stemmed from a lack of proper documentation of the MMA internship program alumni, we strongly recommend that the MMA continue updating the intern contact information database each year when new interns join the program. This is a simple update to the program's management system that would provide strong dividends in maintaining connectivity with former interns. Ensuring that the MMA has an accurate record of relevant information for all interns, including their name, email and phone number, internship field, age, education history, and address, would help ensure the MMA's ability to engage with intern alumni. These continuous updates would also make future iterations of this project more successful, as they would allow for more time to be spent on data analysis rather than research and contact information collection.

Recommendation 2: Continuously Updating Intern Information

While adding new entries into the intern database will ensure that all former MMA interns are categorized in a central location to be referenced at later times, as the team discovered through this project, contact information will not always remain consistent for someone's entire life. Over time many people will get different phone numbers or new email addresses, leaving the information used during their internship out of date. To avoid this problem, the team recommends that the MMA regularly reach out to interns requesting updated contact information if applicable. This could be done on a basis of 1-2 years; this allows for the requests to catch any change in contact information before the old information is too far out of date. By doing this, the MMA can ensure that the information contained in the database will always be as up to date as possible and any messages sent out to interns are successfully delivered. These updates should also cover any changes to interns' names, ensuring that the MMA is correctly and respectfully corresponding with former interns.

Recommendation 3: Host Alumni Events

With a comprehensive database of all the Maria Mitchell Association's former interns, the MMA will now be able to reliably contact alumni of the program; because of this, it will be important to keep engagement with former interns. To keep former interns engaged with and informed of the MMA, we recommend that alumni events are hosted by the MMA and advertised to all interns. For example, a yearly reunion could be hosted on Nantucket each summer in which former interns can reunite and learn of the MMA's new ventures, as well as offer advice to that year's current interns. Along with annual reunions, smaller events could be advertised to interns, such as sending out invites to the opening of new facilities or conferences

where important research is being presented. Some former interns have also returned to the MMA to give talks to summer interns; expanding this program with more frequent talks would also provide a way to connect former interns to each summer's new cohort. By consistently inviting former interns to stay involved with the MMA in their own ways, a community of Maria Mitchell interns can be created and upkeep throughout the years.

Recommendation 4: Leverage Social Media

It has become clear to the research team that many former MMA intern alumni are active on social media and excited to reconnect with the association. In the duration of this study, the number of active members in the Maria Mitchell Association Intern Alumni LinkedIn group has increased from 31 to 84. This increase displays the interest of intern alumni to stay in contact with the organization through social media. All interns were provided links to connect with the MMA via LinkedIn, Facebook, Instagram, Twitter, YouTube, Pinterest, and the MMA newsletter on the survey. We recommend that the MMA staff begin posting content targeted at internship alumni to encourage social media engagement at this time when so many new members have joined. Posts prompting interns to respond with their favorite MMA memories or polls about current career interests and hobbies can provide alumni a chance to reflect and reconnect. Active social media sites also provide an additional venue for posting information about alumni events, which can help improve attendance.

5.4 Recommendations for Internship Programs

Portions of the survey asked questions pertaining to issues that former interns had with their internship and how they would have liked to see it changed. These responses were used to offer insight into what recommendations we could give to the Maria Mitchell Association to make the internship program as successful as possible in the future. These recommendations are as follows:

1. Further opportunities for research in other internship fields
2. More interaction between interns of different fields
3. Increased oversight and guidance throughout the internship

Recommendation 1: Offer Further Research Opportunities for Non-Astronomy Fields

The most common critique of the MMA internship program was that the non-astronomy internships did not have as many research-based responsibilities as were hoped for or anticipated by the interns before coming to Nantucket. Mostly occurring amongst former aquarium, natural science, and Mitchell House interns, 10 respondents believed that their time would have been more enjoyable and productive if, along with the day-to-day duties that were their main focus, there were also chances to perform research in their field. One intern who shared this view stated that they wanted the MMA to “foster more research. Consider Nantucket a living laboratory; I feel like there are so many opportunities to do research on the island.”

Recommendation 2: Increase Interaction Between Internship Fields

The most common comment amongst astronomy interns was the mention of a lack of integration and interaction between the different internship fields. Respondents reported that the level of separation between interns of different fields hindered social interaction throughout the summer. Interns reported feeling isolated and distanced from other interns. One respondent even reported that they “did not know

about [the other internships] until deep into the summer.” Further integration of the different internships with each other, through consistent events and social gatherings open to all interns, would allow people in different programs to interact more and network with interns outside of their immediate work group.

Recommendation 3: Increase Oversight and Guidance

Another common critique given was a lack of guidance throughout the process of the internship, particularly for those involved in research and education. Respondents reported that while they enjoyed the freedom of independently working, they sometimes felt lost and unsure of how to move forward. One intern responded, “because this was my first experience with a research advisor, I was unsure of how often I should have been meeting with them . . . and how much progress I should have been making.”

However, it is must also be noted that other interns recounted that what made them enjoy their internship was the independence and lack of overbearing guidance; it is important to act on these critiques of not enough guidance without creating an environment that would be unenjoyable for those that like independence. Because of this, a possible solution would be to have advisors and mentors guide interns along the way and, early in the internship, discuss with each intern to what degree they would like assistance, allowing everyone to have the level of guidance and oversight that works best for them.

Recommendation 4: New Internships

One question that was asked to former interns was what type of internship they believed the MMA should add to their program. Based on survey responses, we recommend exploring internships in the following areas:

- **Non-profit Financials:** Interns in this field would learn about how a non-profit accumulates and allocates funding and assist the MMA with managing their funding and budgeting over the summer.
- **Indigenous History and Natural Practices:** Interns in this field would research the history of indigenous people on Nantucket and could develop exhibits on their research to be incorporated into the Hinchman House museum space.
- **Geological Studies:** Interns in this field would study Nantucket’s natural spaces and geologic resources. To help maximize success, this program could also be developed in partnership with conservation groups on Nantucket such as the Linda Loring Nature Foundation.

6.0 Summary

This project sought to evaluate the impact of the Maria Mitchell Association interns on science and publicize their successes. We created an initial list of all former MMA interns and their available information and distributed a survey to them to gather information about each intern's experiences. We also completed interviews with a small group of former interns, which were used to develop in-depth profiles highlighting their journeys and accomplishments. Data from the survey, interviews, and our initial research was used to develop a large database of former interns, as well as infographics and intern profiles to aid in publicizing the internship program. To help ensure that the program is maximally successful in the future, we analyzed the survey results and created a series of recommendations to the MMA regarding the intern program's structure and administrative procedures.

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