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Students as Scientists: Using Immersive Experiences and Near-Peer Mentoring to Build STEM Identity and Community

ACTIVITIES AND PROGRAM MODEL

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ABSTRACT

Giving students an opportunity to undertake field work, learn about data collection and analysis, and work and live as part of a team of diverse individuals is a unique experience that can influence and shape future careers and lives. Engagement of young science enthusiasts in a rural community is a key goal of the Journey for Aspiring Students Pursuing Ecological Research (JASPER) program run by Oregon State University's Marine Mammal Institute that focuses on gray whale foraging ecology research. This unique project integrates research with STEM education by bringing together a team of graduate students, undergraduate students, and high school students for a six-week intensive field season each year where students conduct research, hone teamwork and leadership skills, and build their STEM identity. Over the course of this internship, students learn how to use diverse technology to collect data, engage with the local community, and gain an understanding of marine ecology and the scientific process. Additionally, interns develop science communication skills in both formal and informal settings, including a community presentation and a blog post. Over seven years, JASPER has given 25 students a chance to interact with scientists and to be a real scientist for a short while. We have been able to track 88% of these students; all are in STEM-related fields and reported that this program profoundly impacted their lives and careers. Whether or not students continue STEM career paths, the experience broadens their horizons and skill sets, and helps engage the local community in current marine research.

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INTRODUCTION

Increasing diversity in science, technology, engineering, and mathematics (STEM) fields, including marine sciences, is essential for supporting the innovation needed to advance scientific discovery and address important issues (Johnson et al. 2016). Unfortunately, rural communities often face significant challenges in recruiting and retaining students in STEM because many students in these areas do not have access to the high-quality STEM opportunities that exist in more densely populated, resource-rich areas (National Science and Technology Council Committee on STEM Education 2018). Rural schools also experience higher staff turnover rates, and rural teachers tend to have a background in science at a more general level and have fewer professional development opportunities. These factors combine to lead to poorer outcomes for rural youth, as reflected in test scores, graduation rates, college going rates, and income projections (Rivera et al. 2019).

Creating and implementing mentor programs has been effective in addressing STEM inequities in certain rural areas (Rivera et al. 2019). Peer mentors, including "near-peers" (those close in age and stage), can be particularly effective at providing social support and fostering a sense of belonging. Additionally, near-peer mentors have the capacity to better understand the needs of mentees, and thus be more empathetic (Abeywardana et al. 2020). Near-peer models provide a continuum of learning, allowing students with more experience to serve as mentors. This structure yields personal, educational, and professional benefits for mentors while also increasing the interest and engagement of younger student mentees studying STEM disciplines (Sales et al. 2006). The near-peer model reinforces that learning is a continuous process and that all individuals are capable of growth and significant contribution, as it bridges the gap between pre-college, undergraduate, and graduate levels. Participants in near-peer mentoring programs gain an increased awareness of their own abilities, increased confidence, and motivation to pursue educational and career options of interest that they might not have considered otherwise (Anderson et al. 2018).

Research and STEM experiential learning by students is often separated programmatically, as it is considered difficult to successfully accomplish both simultaneously. However, the Geospatial Ecology of Marine Megafauna Lab (GEMM Lab, Marine Mammal Institute, Oregon State University (OSU)) has engaged young students in our Journey for Aspiring Students Pursuing Ecological Research (JASPER) program by integrating it closely with our Theodolite Overlooking Predators And Zooplankton (TOPAZ) research project that focuses on gray whale foraging ecology. Whales can serve as an effective gateway to an interest in, and appreciation for, marine science because they are engaging and mysterious mammals that often generate wonder in land-based humans. Gray whales feed close to shore in Oregon coastal waters, including during summer months near the small, rural community of Port Orford, which is located on Oregon's South Coast and has an estimated human population of just over a thousand residents. This proximity to shore allows cost-effective, safe, and repeatable data collection on tangible and meaningful marine research topics. To establish and continue the JASPER/TOPAZ program, we work with Port Orford community members and maintain open communication pathways, thus avoiding the perception of "helicopter science," where outside researchers only briefly visit study areas to collect data and leave without regard for long-term impacts on the community. JASPER/TOPAZ is an integrated near-peer mentoring and STEM learning program alongside data collection activities, with a team composed of a Principal Investigator (PI), the PI's graduate student who leads the on-site activities, and three to four undergraduate and local high school students. The scientific goal of TOPAZ is to better understand the environmental drivers of gray whale foraging behavior. TOPAZ research activities include non-invasively tracking whale movements using a theodolite from a cliffside location (Figure 1), photo-identification of whales using a camera, tandem kayaking to collect data on zooplankton prey and ocean properties using a GoPro, ocean sensor, and zooplankton net (Figure 2), zooplankton identification using a microscope (Figure 3), data management, and equipment maintenance. Activities associated with JASPER include teamwork, interpersonal communication, leadership, confidence building, and science communication through informal conversations with community members and tourists, and formal opportunities through a blog post and community presentation at the end of the internship (Figure 4).

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Figure 1 The team tracks a whale from a cliff top location in Port Orford using a camera for photo-identification of the whale and a theodolite (on tripod) connected to a laptop computer to track the whales' movements. Photo: Tom Calvanese. Reproduced with permission of the photographer.

Figure 2 A student intern deploys instruments from the tandem kayak to collect data on zooplankton prey availability for whales. Photo: Robyn Norman. Reproduced with permission of the photographer.

Figure 3 A student intern uses a microscope to identify zooplankton species and count individuals caught during the kayak sampling earlier in the day. Photo: Lisa Hildebrand. Reproduced with permission of the photographer.

Figure 4 Community members attend the end-of-season presentation by the students at the OSU Port Orford Field Station. Photo: Tom Calvanese. Reproduced with permission of the photographer.

PROGRAM GOALS

The integrated JASPER/TOPAZ program has multiple goals that fall into three target audience categories: Student interns, Community members, and Science (Table 1). The program aims to use the local high school student interns as a conduit to the community to build trust and knowledge through the voice of local youth. Overall, the program strives to connect the community with their local ocean ecosystem, impact the career trajectories of students, increase ocean literacy and appreciation, and gain important data to increase marine ecological knowledge.

Table 1 JASPER/TOPAZ program goals and implementation methods divided into three broad areas of impact: student interns, community members, and science.

	PROGRAM GOAL	METHODS
Student interns	Leadership skills	Opportunities to take "ownership" of project needs, large and small (e.g., cooking dinner, morale encouragement, exemplifying discipline and responsibility).
	Marine ecology knowledge	Observing and learning firsthand about trophic connections between oceanography, zooplankton prey, and whale foraging ecology. Constant opportunities for questions, dialogue, and interpretation.
	Critical thinking skills	Multiple daily decisions the team is confronted with including gear malfunctions, weather forecasts, field team logistics, application of ecological theories to field observations in study system.
	Basic computer skills	Data entry into spreadsheets, communications between sensors and computers, word processing for blog writing, presentation development for community outreach.
	Technology skills	Learn basics of camera use, theodolite use (including trigonometry), GoPro cameras, oceanographic sensors and calibration, use of dissecting microscope for zooplankton ID.
	Communication and interpersonal skills	Close team living and working conditions requires clear, transparent, and frequent communication to avoid and resolve conflicts.
	Scientific communication skills	Formal opportunities: Each intern writes a blog related to project or experience that goes through review process with grad student and PI; Team develops and delivers community presentation on project. Informal opportunities frequently occur for interns to discuss project with community members and tourists on kayak tours and cliff site.
	Teamwork experience	Working together toward project objectives, learning task assignment and follow through, understand the value of patience and clear communication.
	STEM identity and confidence	The holistic experience provides opportunities for students to see themselves as scientists and gain confidence through their own success.
Community members	Connect to local ocean	Recognize whales and other marine diversity near their community.
	Ocean literacy	Through local interns and community presentation, learn ocean and ecology concepts.
	Recognition of field station and opportunities	Host presentation at field station where other opportunities are highlighted, such as information resources, workshops, seminars, and other research projects.
	Build trust in scientists	Provide opportunities for community members to see scientists as individuals. Open two-way dialogues about issues of concern (e.g., pollution, climate change, and fisheries).
	Connect with neighbors	Community members meet each other and share concerns, ideas, and histories; opportunities to expand networks.
Science	Long-term data collection	Replicate use of standardized methods to collect data at same time and location over many years.
	Produce new findings and manuscripts	Graduate students analyze datasets, generate and publish findings for dissemination to scientific communities.
	Develop a new generation of scientists	Experience impacts career trajectory through CV building, skill development, and hands-on experience of "science".

APPROACH

In order to build trust, support, and interest in our program, we formed partnerships with a number of local groups (Figure 5). The team is housed at OSU's Port Orford Field Station that is co-located with the Port Orford Sustainable Seafood (POSS) fish processing and distribution operation. POSS is composed of local fishermen and businesspeople and offers interns opportunities to get hands-on experience, learn about local fishery issues, and connect with the community. Meanwhile, POSS employees learn about nearshore marine ecology and the science team's experiences. We also formed a strong partnership with a local tour operator, South Coast Tours, LLC., which provides the team with kayak safety training (Figure 6) and wetsuits for the program period, while the interns enhance the guides' knowledge and the customers' tour experience through direct, on-the-water engagement with scientists. The Port of Port Orford primarily serves the fishing community, and our field team's presence at the port every year has allowed for relationship development with scientists, knowledge transfer, and increased respect across marine sectors. Additionally, funding support for the program has been cultivated through local organizations, including Wild Rivers Coast Alliance, Oregon Sea Grant, the Oregon Coast STEM-Hub, and OSU, which share goals around outreach, engagement, and marine research.

Figure 5 The student teams with community members during the six-week program. Left: The team with Dave Lacy, owner of South Coast Tours, LLC. Right: The team on the cliff looking for whales with Tom Calvanese, manager of the OSU Port Orford Field Station. Photo: Marcus Mayorga (left) and Leigh Torres (right). Reproduced with permission of the photographers.

Figure 6 The team learns kayak safety, paddling methods, and self-rescue techniques (pictured here) during a kayak training course early in the six-week program. Photo: Florence Sullivan. Reproduced with permission of the photographer.

PROGRAMMATIC ACTIVITIES

INTERN RECRUITMENT AND FORMATION OF RESEARCH TEAM

All interns on the field team are paid. The amounts have varied over the years based on funding source and payment mechanism (hourly vs. stipend). Additionally, housing costs and food

are provided for the team during the six-week project period at the Port Orford Field Station, although if the high school student(s) are local they may continue to live at home but frequently join for meals and team bonding activities that occur outside of work.

A graduate student of the project PI serves as the field team leader for a three-to-four-year duration, which ensures program consistency, supports relationship development in the community, and provides ample opportunity to build leadership skills. Program continuity is enabled when the hand-off between graduate student leadership occurs with both the outgoing and incoming graduate students participating in the same transitional field season. This approach allows the incoming graduate student to learn operations and logistics directly from the outgoing graduate student, providing an additional opportunity for mentoring. The graduate student and PI must have a solid working relationship, with fluid, honest communication throughout the program to ensure the PI is fully aware and engaged in all major decisions and activities, including when not on-site (via texts, emails, phone calls, etc.). The PI guides the graduate student in navigating the many issues and challenges that arise, including personality conflicts, gear and data collection issues, community member concerns, financial aspects, and safety decisions.

One to two undergraduate interns are recruited each year through university job boards, departmental emails, and social media. These students often have a strong interest in gaining field experience in marine science but have variable prior experience. The temptation is often to select students with the most prior experience, but this can defeat the purpose of recruiting new students into STEM fields. When possible, we select one undergrad with solid prior experience that would likely bolster the research more and a second undergrad with less or no prior field experience to enhance their skill set and CV.

To recruit high school students, we communicate directly with science teachers and principals at local high schools. We develop an informational flyer with photos that clearly describes duties, benefits, and the paid employment. The graduate student also visits science classes at the schools to give an in-person presentation about the project and answer questions. We also request that high school students from the previous year recruit potential students that would be a good fit for the internship and attend these presentations.

Applicants for both the undergraduate and high school internship positions submit a one- to two- page CV, one letter of recommendation from an academic advisor or professor, and a personal statement that describes their personal, professional, and academic background, skills, and interests, as well as their career goals and how this experience would help them reach their identified goals. In-person or virtual interviews are then conducted with the top candidates and final selections are made. For high school students, it is also critical to discuss the program expectations and activities with the parents to ensure they are aware and supportive of time and labor demands. Transport to and from the field site can be an important issue to discuss if the student relies on others for transportation.

FIELD SEASON PREPARATIONS

The weeks leading up to the field season involve crucial preparations to ensure safety, effective data collection, and a positive experience for interns with benefits to the community. A key aspect during this period is communication with interns. Through email, we provide a detailed packing list and description of what to expect of daily routines and provide links to videos made by previous interns that describe the activities. We also discuss the expectation of writing a blog post and participating in the development and dissemination of the end- of-season community presentation. The PI and graduate student also host a team meeting a few weeks prior to the start of the internship and invite parents of the high school students. At this meeting, we introduce ourselves, provide additional background information on the program, explain duties and responsibilities, and address any questions or concerns. This informal yet crucial meeting is where we begin to build trust and relationships across the team members. Interns are also requested to fill out an anonymous pre-internship survey during this period to understand their attitudes toward STEM and expectations for the internship. Administrative paperwork is also handled during this period regarding liability and insurance, emergency contact information, on-water safety forms, and youth safety training

for all team members over 18 years old. Program logistics are also organized during this preparation period, including solidifying housing and food for the field team and purchasing and testing of field equipment.

TRAINING AND ONBOARDING INTERNS

Most interns arrive excited but a bit apprehensive and without much prior knowledge on the many tools and methods used in the field. Therefore, data collection is deemphasized during the first two weeks as the interns learn the needed skills and routines, while the team also builds relationships, confidence, and ecological knowledge. This process ensures safety, successful data collection, and a positive learning, living, and work environment for the team. Specific learning objectives and activities for our program during this two-week period include:

- Introductions and tour of field station
- First aid (Figure 7) and kayak training
- Learning about scientific objectives and concepts of marine and foraging ecology; research questions are discussed, and team develops hypotheses for testing
- Training on how and where to read forecasts, the importance of observing current conditions, and the importance of weather forecasts for safety and data collection
- Theodolite training and use of binoculars
- VHF radio use and communication protocols
- Camera and whale photo-ID training
- Laptop use and data management training (Figure 8)
- Zooplankton ID training, use of microscope, and data collection methods
- Training on lab protocols and equipment maintenance
- Team bonding through joint dinners, board games, and a blueberry picking trip. The team also creates a unique team name for that field season, which joins a legacy of team names over the years and provides a sense of unity and belonging.

During this period, the team engages in a couple "practice days" where they learn the routine, responsibilities, discipline, and time management required. Additionally, the PI visits the field site and has a team meeting and one-on-one discussions with each intern where each student is encouraged to voice interests, concerns, ideas, and expectations. The PI also meets with the field station manager and graduate student to assess program function, team morale, and address issues of concern.

Figure 7 Student interns learn first response techniques during training from an instructor during the first week of the program. Photo: Florence Sullivan. Reproduced with permission of the photographer.

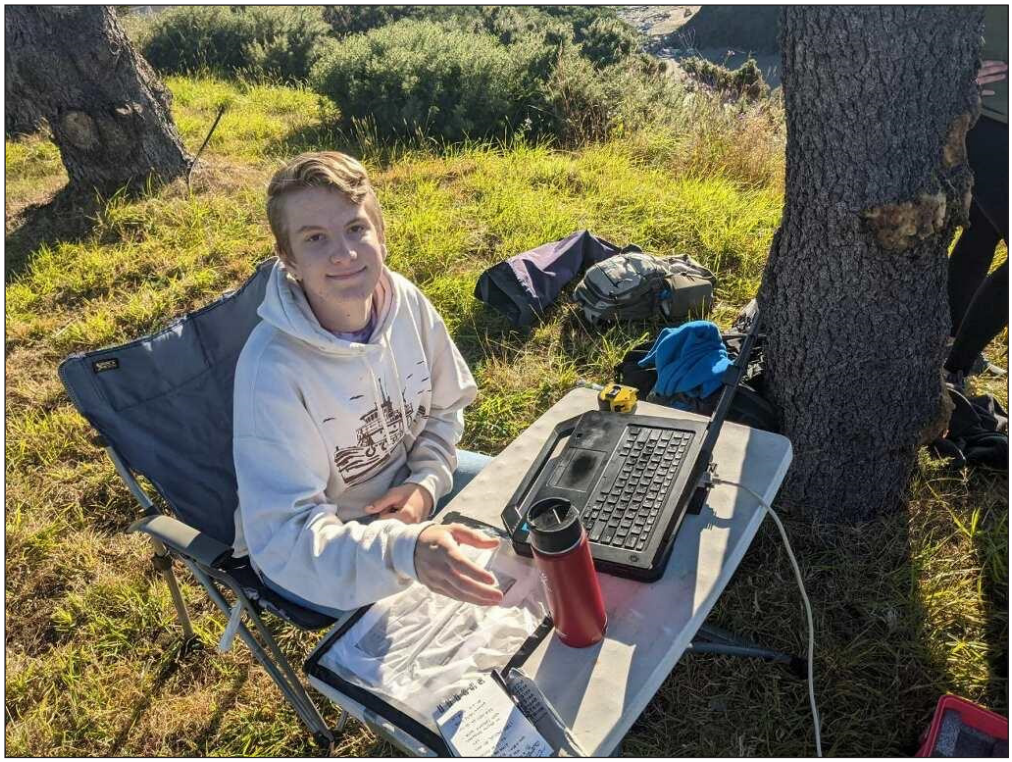

Figure 8 Student interns learn how to use computers for data collection and data management. Photo: Lisa Hildebrand. Reproduced with permission of the photographer.

DATA COLLECTION PERIOD

This four-week period is the intensive phase of the internship when interns build their confidence and STEM identity. Interns are not "going through the motions" but actually collecting real data that will be used in scientific efforts. Interns have been trained and subsequently given our trust to continue the legacy of the project. Interns build their STEM identity through intensive field work and lab work, with an emphasis on taking ownership of their duties. They are encouraged to voice their ideas, observations, and proposed project improvements, and they gain confidence through independent conversations with team and community members to practice their science communication skills. High school and undergraduate interns may also perform small independent research projects to test the waters of data analysis and synthesis. This period can be both intense and exhilarating to interns as they learn stamina, the value of commitment, and teamwork to achieve success.

The PI will also visit during this phase to engage with the team and meet one-on-one with interns to discuss scientific questions and observations, address issues, build relationships, and provide encouragement. The PI also discusses career goals and pathways with each intern, providing advice and feedback where appropriate. Each intern will also write a blog during this phase that pushes students to concisely express their independent thinking regarding their observations and feelings. Additionally, during the last week, the team will work together to develop an approximately 45-minute presentation delivered to the community regarding the program's research and their experience. While inexperience and fear are typical initial emotions of interns at the thought of public speaking, every intern has risen to the task phenomenally once they gain confidence and knowledge from the internship experience. The community appreciates and enjoys the presentation as they learn about the activities of the field station and project team, and it is a great culmination to the internship program as interns demonstrate their growth and knowledge gained. We often have a celebratory dinner or barbeque afterward to wrap up the program.

POST-INTERNSHIP

Within a week of the end of the internship, each intern is asked to fill out an anonymous post-survey with open ended questions regarding their internship experience, suggested improvements for the program, perception of STEM and researchers, and overall impact of the program on their future career plans. The PI and graduate student often provide interns with letters of recommendation for years after the internship to assist with college and scholarship applications, as well as graduate school and job applications. The PI and graduate student compile an annual program report with details on activities, participants, funders, issues, suggestions for improvement, highlights, and photos, which is distributed to all partners and funders.

Table 2 Quotes from former students who have participated in the JASPER/TOPAZ project categorized by program goals identified in Table 1. Position of student during internship and participation year are listed in parentheses after each quote. Student positions are abbreviated as follows: HS = high school student; UG = undergraduate student; MS = Master's student.

	GOAL TO ENHANCE	QUOTES
Student interns	Leadership skills	• "I often acted as [the] second-hand [for the graduate student team lead] which boosted my confidence as a leader and teacher to the high schoolers on the field team. That small team leadership experience has been helpful in every professional setting since then." (UG 2017) • "This internship taught me a lot about self-discipline, responsibility, and leadership. As the lead intern, I was required to oversee the other interns…My skills as a leader were put to the test every day in the field. Through the rough elements of the ocean and the long hours of hard work, I was required to guide the team to reach our goals. I was successful in this position and that further grew my confidence as a leader." (UG 2018)
	Marine ecology knowledge	• "This experience illustrated the feedback mechanisms by which the scientific method conducts itself. The field of science is not characterized by rigidity, but rather science is dynamic and perpetually exhilarating." (UG 2021) • "This internship helped show me an ecological issue that's been happening in my area and how it could (theoretically) be impacting some of the larger organisms in the ecosystem. I watched footage of previous years that showed how prevalent the local kelp forests used to be and saw with my own eyes how barren they are now." (HS 2021)
	Critical thinking skills	• "It taught me how flexible you need to be doing fieldwork, especially when pioneering a new project. It was not at all what we expected it to be, and we were required to brainstorm throughout the entire first season and figure out what actually worked and was practical moving forward…It taught me how important it is to think on our feet and change our processes to account for those variabilities." (UG 2015) • "The study design for this project helped me think more creatively about how to design my future projects." (UG 2017)
	Basic computer skills	• "This internship equips you with the knowledge and experience to comfortably carry out field work and data entry." (HS 2019)
	Technology skills	• "The sea kayak survival training and experience with using multiple tools in the field set me up for great success as a biological science technician and as a volunteer with the U.S. Forest Service." (UG 2017)
	Communication and interpersonal skills	• "The internship showed me first hand the importance of community and collaboration in science. I saw that collaboration with others is one of the most important things a scientist can do." (UG 2018)
	Scientific communication skills	• "While interviewing for the project, I was TERRIFIED of the public component of it. I didn't want to be talked to or asked what we were doing. I didn't want to have to explain it. By the end of the project, I enjoyed that element quite a bit. I think one of the biggest things I got from my internship was how enjoyable outreach could be." (UG 2015) • "It changed my awareness of how much policy and community engagement impacts science. Ever since the internship, I've paid more attention to how laws, regulations, and local policies impact research methods and study plans. This increased awareness has influenced what jobs I apply to and my current m aster's degree thesis project." (UG 2017) • "I think the biggest takeaway for me from this internship was that the human dimension and communication of science plays an equal part in the effectiveness of the goals we all have as professionals in the wildlife and conservation world." (MS 2020)
	Teamwork experience	• "It wasn't the only time I've been a part of a research project, but it was the most meaningful, and the one where I felt I played an important part. I really enjoyed the team aspect of it." (UG 2015) • "Working with a small but passionate group of young scientists on the beautiful southern Oregon coast for those six weeks completely changed my view of what science was. It showed me the value of teamwork and collaboration, and how important and rewarding communication of ideas and information can be." (UG 2018)
	STEM identity and confidence	• "This internship gave me confidence to push myself." (UG 2015) • "From this internship, I became more confident in my abilities and I felt like I had a place in this field. As a first generation Asian American, I am fully aware of the lack of diversity in the field of marine science and recognize that I may not have the opportunity to experience a room full of scientists like me. But the support and invaluable experience I received through this internship gave me the confidence in myself and the practical skills to prove to others that I am capable of pursuing a career in marine mammal science." (UG 2016) • "In terms of my own identity as a scientist, I feel that this internship was the first time I could really see myself in a research setting. I didn't quite know what I wanted to do at the time. However, following that experience, I knew that ecology would be a part of whatever I did somehow." (HS 2017) • "I come from a pretty low education background, so to have that experience before starting undergrad was really helpful for my confidence and also gave me a better shot at competitive internships and scholarships." (UG 2018) • "Being a first-gen college student, I never had much exposure to the scientific world outside of nature documentaries and attractions like the zoo. I was always excited about science and nature growing up, but I never knew how it really worked in a practical way and thought it to be this rather unfamiliar and gilded thing that was far out of my reach. That changed when I joined the TOPAZ/JASPER project…It was my first research experience outside of the classroom." (UG 2018) • "It was the first time in my life I have ever taken something I learned and used it in order to make a true difference in our environment. The internship gave me a sense of pride in continuing on in my STEM field, but also a sense of accomplishment that I can achieve anything I set my mind to." (HS 2019) • "It increased my confidence in my abilities and helped me to see that I can bring value to the scientific community." (UG 2020) • "My participation in the…project has most definitely had a large impact on my life. It allowed me, at 17 years old, to be a part of research affecting the ecosystem right by my home…and it helped solidify the idea that I have a future in STEM." (HS 2021)

(Contd.)

	GOAL TO ENHANCE	QUOTES
Community members	Connect to local ocean	• "This program has inspired our community to want to learn more about ocean science and whales in particular." (Local tour operator 2022) • "The GEMM Lab gray whale research has stimulated countless discussions in the community, both in person, and on social media, about the whales they are familiar with each summer. More importantly, conversations about the science they learn about from the students during their stay in the community and their science communication efforts, culminating in a very well attended seminar given at the end of the season each year – definitely a highlight among our events at the Port Orford Field Station. One charming example of this community connection was the receipt of a library card from the Port Orford Library for "Buttons," one of the gray whales that frequents the waters of Port Orford each summer." (Field station manager 2022)
	Ocean literacy	• "Members of the community, including local students who have learned about this educational opportunity, have shown a continued increase in their interest in and knowledge of the local ocean and coastal environment. Port Orford has a solid track record as an ocean aware community, in large part, due to its thriving commercial fishing port. In more recent years, this awareness and knowledge have only deepened and become more detailed due to projects like the GEMM Lab gray whale research project." (Field station manager 2022) • "The whale team has kept us up to speed on the whales that come through our area and have given us the confidence to accurately answer questions regarding the whales. Just the other day somebody asked me whether it is true that there have been fewer whales coming by here and I was able to explain to them the potential loss of kelp habitat that might be affecting that, and it felt pretty cool knowing that answer." (Local business owner 2022)
	Recognition of field station and opportunities	• "By including a local high school student in the research it shows other students what possibilities are out there and excites them to participate in science." (Local tour operator 2022) • "The peer mentor approach used, which provides opportunities for local high school students to gain experience as young field scientists and science communicators, is highly valued by the community and the students who have had the opportunity to participate. The project has been underway long enough that the community has witnessed its positive effects in the lives of local high school students who, due to their participation, were able to secure scholarships for undergraduate studies, and are now applying to graduate school." (Field station manager 2022)
	Build trust in scientists	• "It is my feeling that the whole community has embraced the program and many locals are always looking forward to the end- of- season presentation to learn how the research went this year as well as hearing about new findings." (Local tour operator 2022) • "We have always been able to count on the whale team for backup and help in the fish processing room and in turn are able to return the favor of providing new knowledge by giving the team information about what makes fishing in Port Orford unique and sustainable...We owe a lot of our summer successes to the whale team for helping us push through countless, grueling processing days of monotonous work, but have new energy, new faces, new stories, and especially stories that are locally based from what the team is studying and how that ties in to the [fishing] fleet, makes for really fun work days when there's that science and industry dynamic going on." (Local business owner 2022)
	Connect with neighbors	• "I think the community engagement portion of the project was the most impactful for me. Seeing how involved the local community is was so cool. It really highlighted how science and community can and should intersect. Being the expert in that instance but recognizing that the community members know so much more about the area was (and continues to be) a good reminder for me when I felt out of place like everyone else knows something I don't." (UG 2018)
Science	Long-term data collection	• "I have contributed to the scientific literature and been delighted to see my project grow into a long-term monitoring effort that increases our understanding of gray whale ecology and is now supporting a third generation of graduate students." (MS 2015)
	Produce new findings and manuscripts	• Two master's theses have been produced (and one is underway) based on research conducted during JASPER/TOPAZ. • Three peer-reviewed papers have been published based on data collected during JASPER/TOPAZ (Sullivan and Torres 2018; Hildebrand et al. 2021; Hildebrand et al. 2022), and one more manuscript is in review currently.
	Develop a new generation of scientists	• "The study showed me the value in using data to influence management decisions and create community engagement in marine mammal conservation. I believe it played a large role in my acceptance into graduate school." (UG 2016) • "The TOPAZ/JASPER project was critical in creating the foundation of my career as a marine biologist. I knew going into my undergraduate degree that I wanted to actively participate in marine science and marine mammal research, but I wasn't sure how to exactly achieve my end goals...I was very fortunate that those at the project were willing to mentor and support me, so that I could become the person and scientist I wanted to be." (UG 2018) • "This internship also gave me a much more dense resume, allowing me to stand out from my peers." (HS 2019)

PROGRAM OUTPUTS

To date our research program has produced three peer-reviewed published papers (with another in review), further signifying the value and capability of this integrated approach to data collection and STEM learning. Interns have presented posters and talks about the methods and results from small projects associated with this program at both regional and national conferences. Graduate students often deliver presentations to large scientific and public audiences regarding both the science and STEM learning outcomes from the program, to share

our scientific knowledge and increase awareness of the importance of student engagement and learning. Over the seven years of the program, interns have produced 24 blogs and two videos that persist as writing examples for students and outreach efforts by the program.

In addition to the scientific outputs and local-level outreach and engagement, the data collected during the JASPER/TOPAZ project has contributed to an engaging website called IndividuWhale (https://www.individuwhale.com/) that introduces visitors to the lives of individual gray whales. The website profiles the life stories of different gray whales that feed along the Oregon coast based on sighting histories of whales, including surviving major injuries, finding mates, and having calves, and feeding in specialized ways. The website also describes data collection methods used to better understand gray whale ecology and health, and explains a few of the major threats the whales face in the region. This engaging website is possible through the work of the many students involved in the JASPER/TOPAZ program and shares our knowledge across a broad audience.

IMPACTS

Since our program began in 2015, six high school students, 14 undergraduate students, and five graduate students have participated. Overall, students gained confidence, a real perspective of what science is and what a scientist does, skills and experiences to leverage future opportunities, and the value of community connections (Table 2). Of the 25 students that have participated in JASPER/TOPAZ program between 2016 and 2021, 22 responded to our request for information on their current professional status, all of which are in STEM fields (Table 3). Many of these previous interns are not in a field related to marine mammal science, highlighting that an internship about whales can effectively serve as a gateway toward professional careers in diverse STEM fields.

POSITION DURING INTERNSHIP	AFTER INTERNSHIP
High school student (n = 6)	• 3 in college pursuing bachelor's degrees in STEM fields • 1 in community college • 1 training to become an EMT • 1 unknown
Undergraduate student (n = 14)	• 3 finishing bachelor's degrees and intend to pursue graduate degrees • 1 finishing bachelor's degree and intends to attend medical school • 2 pursuing MS degree in marine science • 3 completed MS degree and working in marine mammal research • 1 completed MS degree in teaching and works as middle and high school science teacher • 1 working for biotech company • 1 working as STEM-related field tech • 2 unknown
Master's student (n = 5)	• 1 working for marine mammal NGO • 2 doing Ph.D. • 1 doing MS & currently leading TOPAZ/JASPER projects • 1 is a director of conservation NGO

Table 3 Where are they now? Of the 25 students that have participated in JASPER/TOPAZ program, 22 (88%) responded to our request for information on their current professional status, all of which are in STEM fields.

CONCLUSION

Our program has successfully integrated scientific data collection, community engagement and outreach, and career-connected STEM learning (Table 2). The six-week program is intense and truly impactful with ripple effects in the lives of interns and throughout the local community. The near-peer mentoring structure has significant value, as students at all levels can see and understand a pathway through STEM. Additionally, meeting with the PI informally, in a field setting, provides students with opportunities to see a professional scientist as a real, normal, and approachable person; no lab coat or big, sciencey words required. Students at all levels benefit from the career-connected learning environment, which often serves to jump start their careers. The community gains marine and interpersonal connections, while also building more skilled and knowledgeable youth.

Although we believe our model is successful and replicable, we have learned many lessons along the way and the program has morphed accordingly. Each year we evaluate the science and engagement aspects of the program to identify areas of improvement and adapt as needed and

as is feasible. We have learned that student interns need to be adequately paid to ensure their commitment and full participation and to open this career-growth opportunity to all students. For instance, we received this meaningful quote from an undergraduate intern in 2016:

> "Another point that I'd like to add is that during the time I was searching for internships in 2016, it was crucial for me to save up money for school. The marine mammal field is saturated with mostly unpaid internships, so I had previously always ruled myself out of ever getting an opportunity like this one…Offering paid opportunities is a very valuable way to increase inclusivity and welcome diverse backgrounds in the marine science world, and the GEMM Lab's efforts to do so are a great example."

Additionally, parents or guardians of high school students must be engaged early in the program to ensure they know what commitment is required from their child. We have also discovered that a team of five members is ideal, in case one member has to miss work. And finally, an overlapping field season with both the incoming and outgoing graduate student is important to facilitate a smooth transition and transfer of experience.

Like many others, our program has faced challenges, including variable funding sources and support. Each year requires early and thoughtful pursuit of funding to support the program, which can be stressful and requires nimbleness. However, with proof of program success, a few funding sources have become more consistent. Like most programs, there are also administrative burdens to overcome, such as insurance, human resources, and payroll.

The challenge we have been most surprised and frustrated by is the paucity of interested high school students in our internship program. Despite being a paid position to study whales and kayak, each year we struggle to recruit more than one or two high school students. This struggle is likely due to the low population size of the Port Orford region (each graduating class from the high school is only eight to 16 students per year). We continue to recruit early and often through many pathways and thus have been successful in gaining good, interested, and capable students. In the future, we plan to have previous high school interns speak with middle school students to plant the seed of this internship program early and to invite potential high school interns to visit during the field season to see the project in action and gain interest.

Overall, our program has been successful in our three focal areas. Through this unique internship, students gain STEM and "soft" skills that benefit and support career progression, regardless of their choice to pursue a STEM field. Furthermore, our program has expanded the local community's awareness of the ocean resources and biodiversity in their "backyard," as well as field station activities and services. Finally, the program has enabled important scientific gains in marine ecological knowledge, at both the local and global level. We highly encourage replication of this program in other communities, especially those where an academic field station or satellite campus exists in a small town. We believe our program has made a real and positive impact on the lives of young students and the community, both directly and indirectly, and we look forward to continuing our program in the future and watching these impacts grow and magnify.

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The authors have no competing interests to declare.

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