Interdisciplinary Research (IDR) Origination Awards

Project Title: CORAL-MRAITK: Catalyzing Original Research and Learning using Marine Robotics, Artificial Intelligence, and Traditional Knowledge

Principal Investigators

Name (PI listed first)	Department	College
Joshua Mangelson	Electrical and Computer Engineering	Fulton College of Engineering
Richard Gill	Biology	Life Sciences
Liz Bailey	Biology	Life Sciences
Ryan Jensen	Geography	Family, Home, and Social Sciences
Geoff Wright	Technology & Engineering Studies	Fulton College of Engineering
G.E. Kawika Allen	Counseling Psychology and Special Education	McKay School of Education

Track: Track One

Abstract: Coral reefs are among the most threatened global biome due to global change. However, the ability of coastal communities in the developing tropics to monitor and respond to reef changes is hampered by (a) the lack of scale-appropriate monitoring platforms and (b) insufficient number of STEM-educated community members. Here, we propose three interrelated aims that will catalyze the development of monitoring tools and student engagement in STEM: 1. Develop an AI/machine learning system that enables automatic and efficient collection of scientifically relevant imagery and reef structure/health data from aerial and underwater drones; 2. Test and apply the proposed system in two disparate reef ecosystems including the north shore of Oahu and the southern fringing reef of Molokai, Hawaii to verify our system's ability to quantify global change impacts on coral communities and health; and 3. Promote Native Hawaiian/Pacific Islander (NHPI)-oriented STEM participation by developing and testing an educational module that links low-cost marine robotics with ethno-scientific examples from traditional Polynesian Voyagers. Our interdisciplinary team links expertise in remote sensing, marine robotics, machine learning, global change biology, STEM education, and psychology to address the complexity of novel remote sensing and classroom approaches to understanding coastal ecosystems. Funds will be used to support graduate and undergraduate students who will be trained in an integrated interdisciplinary environment, leading to nine external funding applications and an anticipated ten peer-reviewed publications as well as a model to increase NHPI participation in STEM fields.

Summary of Plans for External Funding: Our plan for securing external funding includes pursuing large, whole-team interdisciplinary grants that link technology and education as well as core disciplinary grants that will be enhanced by cross-disciplinary participation. Interdisciplinary programs include the NSF *CAREER*, NSF *Foundational Research in Robotics*, and the NSF *Partnerships for International Research and Education*. Disciplinary grants enhanced through interdisciplinary participation include NASA Utah Space Grant, NSF *Racial Equality in STEM Education*, and other smaller sustaining grants from federal or foundation sources. Each PI will take the lead/co-lead in at least one proposal. Our team has already had one small interdisciplinary grant funded (Sant Foundation) and has already submitted one large proposal (NSF-NRI) and one small seed funding proposal. We will continue to submit, revise, and resubmit proposals until all elements of the project are sustainably funded. This work leverages BYU's breadth in research and strong connection to the Pacific Islands.

Overview

Human quality of life is, in part, determined by access to critical services provided by the ecosystems in which humans reside [1-5]. Climate change and changes in land use pose an emerging threat to human quality of life by compromising ecosystem services [3,6], human health [5,7], biodiversity [3,4,8,9], and economic sustainability throughout the world, with certain human-environmental systems more vulnerable than others [5]. The ability to manage and conserve coastal ecosystems for essential ecosystem services is critical as the world works to alleviate poverty and create sustainable economies while experiencing diverse global changes [6]. The tsunami in Tonga illustrates the critical protection provided by coral reefs for communities and infrastructure in the small island nation states of the Pacific. There has never been a more important time to monitor coral reef status and trends to provide actionable and accurate data to address the projected collapse of reef systems [10,11]. However, monitoring these systems is hampered by (a) technical challenges, including the ability to efficiently and regularly monitor underwater ecosystems [11-13], and human resource challenges, where many communities lack local technical expertise to acquire and analyze monitoring data [14]. These challenges are particularly relevant for Native Hawaiians and Pacific Islanders (NHPI)[15-17]. Addressing problems associated with reef sustainability requires interdisciplinary teams that can simultaneously address environmental, technical, and educational needs.

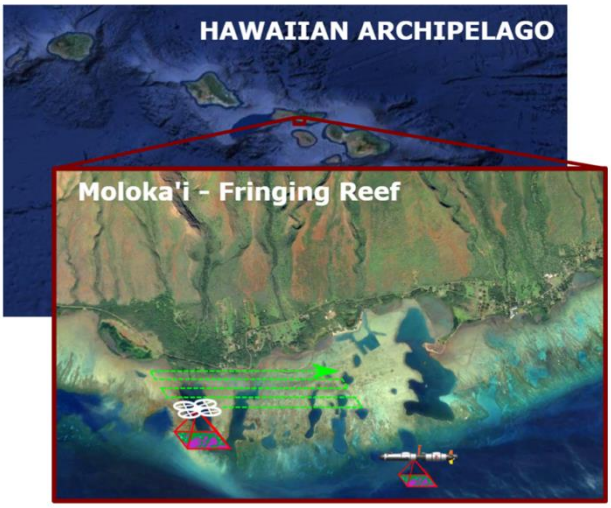

Figure 1 – Coral reefs are intimately connected with the quality of life of island populations. However, they are also among the most vulnerable of ecosystems and are in need of regular inspection/monitoring. Furthermore, NHPI populations have proportionately lower participation in STEM disciplines. In this project, we propose interdisciplinary goals in marine robotics, remote sensing, biology, and education to address these problems. We will deploy and evaluate these techniques on the island of Moloka'i, Hawaii – home to the largest fringing reef in the United States.

The goal of this application, which is a step toward our long-term goals of global reef conservation and increased NHPI participation in STEM, is to develop new approaches to monitor reef health using robotics, which then can inform the development of educational approaches that link robotics navigation tools to Polynesian Voyager knowledge in a unique NHPI/Robotics curriculum. To achieve these goals, we have developed three specific aims:

Specific Aim 1: Develop an AI/machine learning system that enables automatic and efficient collection of scientifically relevant imagery and reef structure/health data from aerial and underwater drones.

Specific Aim 2: Test and apply the proposed system in two disparate reef ecosystems including the north shore of O`ahu and the southern fringing reef of Molokai, Hawaii to verify our system's ability to systematically quantify global change impacts on coral communities and ecosystem health.

Specific Aim 3: Promote Native Hawaiian/Pacific Islander (NHPI)-oriented STEM participation by developing and testing an educational module that links low-cost marine robotics with ethnoscientific examples from traditional Polynesian Voyagers.

Interdisciplinary Plan: The success of this project hinges on the linked disciplinary expertise of our entire team. Aim 1 will be led by Mangelson, with expertise in marine robotics, perception, navigation, and field testing. This will be supported by Jensen's skill in aerial remote sensing, hyperspectral image analysis, and interpretation and Gill's knowledge of reef ecology. Gill and Mangelson will co-lead Aim 2 because of Gill's background in reef ecology and long-term work with NHPI collaborators on Oahu and Molokai and Mangelson's experience with marine robotic field testing. Success on this aim requires the successful completion of Aim 1 by Mangelson and Jensen and will be a focus of both Biology and ECEn graduate students. Aim 3 will be co-led by Bailey (STEM Education), Wright (Marine Robotics Education), and Allen (NHPI Education Psychology and Belonging). Aim 3 will be supported by

connections to Aim 1 and 2 as examples of application of STEM projects that apply navigational approaches originally applied by Polynesian Voyagers. Gill has long-term collaborations with NHPI researchers, teachers and community members that will contribute to cultural models.

Background and Challenges

Challenges of Aerial Marine Remote Sensing: Sensing and monitoring of underwater ecosystems is complex and challenging[11,18,19]. *Aerial drone and satellite-based remote sensing through the water surface,* while providing high-level understanding of the environment, often provides insufficient detail due to the refraction, diffusion, and absorption of commonly used wavelengths. Furthermore, the general lack of light at depths larger than a few meters severely limits passive aerial observations in regions deeper than <15 m in clear water [20,21]. These drawbacks often necessitate sub-surface sensing when detailed observations at the scale of individual coral heads is required.

Challenges of Autonomous Subsurface Marine Sensing: Underwater marine sensing is either conducted manually using divers or using autonomous sensing platforms such as autonomous underwater vehicles (AUVs) or autonomous surface vessels (ASVs)[22,23]. Manual inspection via diving is expensive, dangerous, limited in scope, and often subject to bias and human error[24]. Autonomous platforms on the other hand, can cover much larger areas quickly, provide accurate GPS positioning information, and can systematically collect high accuracy measurements and high-resolution imagery. However, due to limited communication underwater, AUVs are typically pre-programmed with a static trajectory that must be specified before the mission begins often resulting in data collection that is suboptimal and insufficiently targeted towards the specific scientific questions of interest[25,26]. Moreover, because of limited communications underwater, the scientist requesting the data has minimal feedback from the system during the multiple-hour survey process and thus has little influence on the data-collection process other than the initial decision of the survey area.

AI and Machine Learning Guided Exploration and Data Collection: Recent advances in artificial intelligence and machine learning have the potential to enable automatic data collection that is directly targeted to scientific questions of interest, however various research challenges would need to be addressed to enable this ambitious goal. Existing research leveraging techniques such as topic modeling allow autonomous systems to interpret and model the observations they collect in real-time; however, they often fail to categorize data in ways that are directly analogous to human scientific knowledge and interest[27,28]. Other techniques provide a potential framework for utilizing hard-coded human knowledge to guide robotic exploration; however, because the knowledge must be hard coded, this technique results in limited application[29]. Recent success of large language models such as ChatGPT have publicized advances in knowledge representation and natural language processing techniques[30]. With these successes, there is potential to extract useful knowledge from human readable sources such as textbooks. As an interdisciplinary team, we propose to develop multiple machine learning, AI, and perception solutions that integrate combinations of these paradigms resulting in efficient autonomous exploration and scientific data-collection.

NHPI Participation in STEM: NHPI students are among the most underrepresented ethnic groups to participate in STEM, leading to a profound lack of the human resources needed to recognize, analyze, and mitigate global change impacts in their home communities[16]. However, there are opportunities to increase participation and feelings of inclusion by linking western STEM training to ethnoscientific examples that support positive identity in STEM fields. The ancestors of NHPI have long been regarded as seafaring navigators throughout the Pacific Ocean[16]. Knowledge of ancient NHPI history gives meaning and a sense of identity that motivates many NHPI to continue this legacy of sea wayfinding navigators and may reduce barriers to participation in fields such as engineering, remote sensing, and biology[31,32]. Through highlighting the scientific accomplishments of Polynesian navigators and aligning their approaches with western engineering, we hypothesize that we can reduce psychological and psychosocial barriers to participation in STEM fields and increase long-term participation by NHPIs in STEM fields.

Research Plan

Specific Aim 1 – AI/Machine Learning-Guided Autonomous Survey of Coral Reef Ecosystems

The goal of this to develop a platform that can autonomously collect relevant data from coral reefs prioritizing areas of monitoring and scientific interest. This requires linking multiple autonomy and artificial intelligence frameworks. Recent advances in machine learning (ML) and artificial intelligence (AI) have the potential to enable intelligent on-the-fly survey planning by the autonomous system that could improve the efficiency and effectiveness of underwater surveys. ***Our long-term goal is to enable autonomous robotic systems to automatically perform data-collection and marine surveys while acting intelligently and utilizing modern scientific knowledge (and scientist input) in the survey decision making process.*** This aim and IDR submission is a first step towards that long-term goal and seeks to address two overarching research questions.

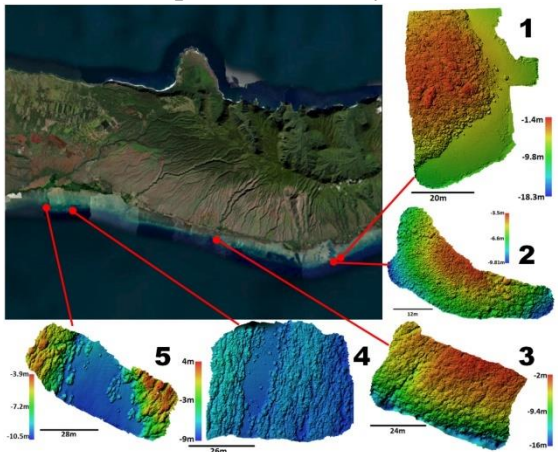

Figure 2 – Initial 3D reconstruction results from five survey sites off the coast of Molokai, Hawaii collected by Mangelson and Gill in Nov 2021.

Research Question 1: *How can we fuse information from combinations of aerial and underwater survey platforms to improve the autonomous survey planning and execution process?* As described in the background and challenges section, aerial (UAV) and underwater (AUV) platforms each provide unique and complimentary pictures of the area surveyed. We propose to develop an autonomous planning and perception framework that fuses information across these domains and enables aerial and underwater platforms to work together to support the data collection and planning process. This novel framework will enable improved efficiency and increased usefulness of marine coral reef surveys. Preliminary results from initial[33,34] experiments off the coast of Molokai, Hawaii are shown in Figure 2.

Research Question 2: *How do we enable autonomous systems to utilize the body of modern scientific knowledge and focus autonomous exploration on observations of scientific interest?* Modern natural language processing techniques can extract knowledge bases from normal human language. Moreover, these techniques can be extended to visual information in addition to textual information. We propose to develop techniques that extract marine ecology scientific knowledge (both visual and semantic) from commonly available textbooks and translate it into a form that is useful for robotic exploration/data-collection. These cues could include taxonomy, health, or structure. For example, we envision a use-case where a marine ecologist may desire to collect information about the distribution and community characteristics of a threatened species of coral. We hope to develop a framework whereby the autonomous system will then search its knowledge base and extract useful information such as the fact that the requested coral species tends to grow nearby other coral of a specific type, requires a sheltered environment, and is found in a particular depth range. After querying this information, the vehicle would then use this information to inform its exploration process as it seeks to obtain imagery of the requested coral species. These techniques would result in fully autonomous, focused, and targeted data collection, specific to the scientific question of interest . We already have preliminary results towards this goal[35].

Specific Aim 2 – Field Testing and Evaluation in Two Disparate Reef Ecosystems

The goal of this aim is to test and evaluate the frameworks developed in Aim 1 in the context of multiple reef ecosystems. To accomplish this goal, we will leverage a combination of autonomous underwater vehicles (AUVs) and autonomous surface vessels (ASVs) developed in Mangelson's lab, including 2x IVER3 AUVs outfitted with RGB stereo and hyperspectral cameras, 1x Marine Advanced

Figure 3 – Our 20ft x 30ft x 6ft AUV test tank, 1x Marine Advanced Robotics WAM-V ASV, and 2x OceanServer IVER3 AUVs.

Robotics ASV outfitted with multibeam sonar (shown in Figure 3). Aerial data will be collected using various unmanned aerial vehicles (UAVs) provided by Mangelson, Gill, and Jenson's labs. These assets are already owned and operated at BYU and in total amount to about $1M dollars in capital equipment value. Access to this fleet of autonomous aerial, surface, and underwater vehicles is a unique capability available to very few research teams and will give us an upper edge in applying for external funding.

We plan to test the proposed techniques via real-world field testing. These experiments will be dual focused. First, we will focus planning for these experiments on the collection of real data of scientific interest to coral reef health as determined by Dr. Gill and local community collaborators. The data we collect will be directly focused on research problems that improve our understanding of the health of the reef and the effects of local land management decisions on these ecosystems. Second, we will use this context as a case study to evaluate and develop the autonomy frameworks described in Aim 1.

Test Site #1: The first test site will be off the northeastern coast of Oahu, Hawaii near Laie, where BYU Hawaii is based. For this test, we will work with BYU Hawaii faculty and students who are focused on marine ecology and oceanography. In particular, we plan to investigate how proximity to estuaries influences the distribution of coral species and the balance between branching and encrusting coral species and the cover of coral rubble from damaged coral. This is particularly important in this region because of the seasonal swell that brings damaging waves during the winter season.

Test Site #2: The second test site will be off the southern shore of Moloka'i, Hawaii. Moloka'i is home to the largest fringing reef in the United States. However, this reef is threatened due to erosion-induced sedimentation, bleaching from warming oceans, and historical land management decisions. On Moloka'i, we will coordinate with our long-standing collaborator 'Aina Momona, a native Hawaiian nonprofit based on Moloka'i and dedicated to achieving environmental health and sustainability.

Specific Aim 3 – Increased Native Hawaiian and Pacific Islander Participation in STEM

The goal of this Aim is to work towards increased Native Hawaiian and Pacific Islander (NHPI) participation in STEM by leveraging the marine robotics and ocean ecology aspects of the proposed research in connection with NHPI traditional knowledge in sailing and navigation. In particular, we propose to leverage a marine robotic outreach competition started at BYU to enable a hands-on marine robotics experience for middle and high school students on Molokai and Oahu.

Figure 4 – Utah Underwater Robotics participants testing their hand built underwater robots.

The Utah Underwater Robotics (UUR) program (led by Wright) was started at BYU over 9 years ago. The program involves BYU technology and engineering students providing training to K12 teachers to help them incorporate underwater robotics into their classrooms. Here we propose to expand the UUR program and associated competition to Molokai, HI. We have long-established collaborative relationships with Kumu Kā'eo Kawaa, the Molokai Middle School STEM instructor and Emilio Macalalad, the Molokai High School Environmental Science/ Chemistry/Biology teacher. We will work with them, as well as with our collaborator Mark Ellis—the educational outreach specialist on *Hokulea*, the reconstructed ocean-going canoe operated by the Pacific

Voyaging Society—to develop integrated enthoscience-underwater robotics lessons. We anticipate that 100 middle school and 50 high school students on Molokai will be part of our initial cohort.

To evaluate the effectiveness of the proposed outreach activity, we will administer evaluations both before and after the outreach experience to assess the participants' self-efficacy, science identity, and identification with values of the scientific community[36]. In addition, we will administer the MEIM-R, developed by Phinney and Ong,[37] to assess the participants NHPI ethnic identity levels for comparison.

Expected Project Outcomes

- **Planned External Funding:** We have identified six large external grant competitions and Mangelson and Gill will revise/resubmit a previously submitted NSF grant ($1.35M). Each PI has at least one proposal that they will lead/co-lead and details on specific programs are detailed in the plan for external funding.
- **Scholarly Articles (journal/conference in italics, lead/senior author in parentheses):** Community composition and complexity of Moloka'i, Hawai'i's southern coral reef – *Journal of Ecology* (Gill); Active semi-supervised visual topic modeling for autonomous exploration – *IEEE International Conference on Robotics and Automation* (Mangelson); Autonomy Guided Coral Reef Monitoring via Hierarchical Hyperspectral Topic Monitoring – *Remote Sensing* (Jensen); Cross-Domain UAV-AUV Hyperspectral imaging for Coral Reef Monitoring – *IEEE Transactions on Robotics* (Mangelson); Automatic Scientific Knowledge-based Marine Sampling – *International Journal of Robotics Research* (Mangelson); Spatial variability in the deposition of terrigenous sediment on Moloka'i, Hawai'i southern coral reef – *Oecologia* (Gill); Hawaiian Middle School Student STEM Self Efficacy – *Journal of Technology Education* (Wright); Polynesian and STEM identity promoted through STEM/ethnoscientific activities – *CBE-Life Sciences Education* (Bailey); Using UAV-AUVs in Classrooms to Promote STEM Interest – *Journal of Technology and Engineering Teacher* (Wright); Racial Identity and Overcoming Barriers to STEM participation – *Cultural Diversity & Ethnic Minority Psychology* (Allen).
- **Interdisciplinary Mentoring Environment:** We are committed to interdisciplinary training and have already had several shared graduate students (G) and undergraduate students (UG): (Mangelson-Gill 4G/1UG; Jensen-Gill 2G; Bailey-Gill 1G/7UG). We will continue to build on this model and incorporate a large cohort of students from the service club of the Technology and Engineering Studies major (Wright), students in Geography's remote sensing courses (Jensen) as well as graduate students from Counseling Psychology and Special Education. We anticipate >20 undergraduate students will participate.
- **STEM-NHPI Ethnoscience Module:** We will produce lesson plans and a Youtube™ channel that will house "build" tutorials for the underwater robots, as well as supporting videos for the various lesson plans. This will be uploaded to the *Hawaii Online Portal for Education*.

Project Plan and Timeline

Task	Aim	Lead	2023 Su	2023 F	2024 W	2024 Su	2024 F	2025 W	2025 Su
Continued Development of Aim 1 Research Question 1	1	Mangelson/ Jensen							
Initial Investigation of Aim 1 Research Question 2	1	Mangelson/ Gill							
Field Test and Data Collection #1 Oahu, Hawaii	2	Gill/Mangelson/ Jensen							
Iteration on Solutions for Aim 1 Both Research Questions	1	Mangelson/ Jensen/Gill							
NHPI Ethnoscience Module Development	3	Wright/Allen/ Bailey							
Field Test and Data Collection #2 Molokai, Hawaii	2	Gill/Mangelson/ Jensen							
Testing of Ethnoscience/Robotics Module at Molokai Middle	3	Allen/Bailey/ Wright							
Revision of Module and Submission to Hawaii Online Portal for Ed.	3	All							
External Funding Submissions	1-3	All	P3-P4	R1-P5	P6	P7			
Publication Submissions	1-3	All	1	2		3,4	5,6	7-9	10

Budget

Purpose/Item	**Amount**
Overall Project	
ECEN PhD Student (50% Effort for 24 Months)	$25,000
BIO MS Student (50% Effort for Summer Months)	$14,000
Undergraduate student wages (1 ECEN, 1 Geography, 1 Tech/Education Student)	$15,000
Field Testing (Aims 1 + 2) – Years 1 and 2	
Travel (6 People to Oahu or Moloka'i, HI, $15,000/trip)	$30,000
Shipping Freight (2x AUVs and 2x ASVs, $5,000/trip)	$10,000
Boat time for Field Operations ($1,000/day for 5 days for 2 trips)	$10,000
Aim 1 – Specific Costs	
Supplies (Electronics, Hardware, etc, needed to support the proposed project)	$6,000
Aim 3 – Specific Costs	
Marine Robotic ROV Kits for Hands-on Activity	$5,000
Travel for Implementation of Marine Robotics/Ethno-Scientific Module (Year 2)	$5,000
Year 1 Total: $60,000 & Year 2 Total: $60,000 **Total**	**$120,000**

Budget Narrative

Graduate Student Wages: To support this project, we request funding to cover the wages of one Electrical and Computer Engineering PhD student (under the guidance of PI Mangelson) and one Biology MS student (under the guidance of PI Gill). The ECEN PhD student will devote 50% of their effort to this project until future external funding is obtained. Primary responsibilities of this PhD student include the development of the autonomous sampling framework defined in Aim 1 as well as field testing of the developed system via trials. The Biology MS student will be supported at 50% effort of the summer months for both Years 1 and 2. This student will be responsible to support the accomplishment of Aims 2 and 3 as well as supporting field experiments, co-advised by Bailey and Gill. Both graduate students will also help lead in the implementation of Aim 3 under the direction of PIs Wright, Bailey, and Davis.

Undergraduate Student Wages: We further request undergraduate student wages for 1 student each in Electrical and Computer Engineering, Geography, and Technology/Education. These students will work directly with the PIs and graduate students on the project to support all three aims. We feel strongly that experiential learning is an essential part of the learning process, and this project will provide multiple opportunities for interdisciplinary hands-on learning to take place. We will further supplement these funds with college/department available funds for additional undergraduate experiential learning. In addition, the Utah Underwater Robotics program already has over 60 volunteer students who we will involve in this process.

Field Testing/Travel Costs: Funds to support field testing off the coast of Oahu in Year 1 and on Moloka'i in Year 2, will first, enable the initial data collection needed to support the development of the proposed framework, and second, allow us to deploy and evaluate the resulting system. We have included a request for travel funds for 6 people to attend field testing in both Years 1 and 2. Further costs associated with field testing include shipping of the necessary marine robotic systems to/from Hawaii and boat time to support water operations during testing. Travel in Year 2 includes funds for implementation of the proposed marine robotics/ethno-scientific module.

Supplies: Additional funds to support supplies needed for system development and field testing including electronics, wire, hardware, raw material, o-rings, enclosures, etc. are included.

Marine Robotics ROV Kits: Finally, we include funds for purchase and assembly of ROV kits for the hands-on activity/competition to be implemented in coordination with the Moloka'i middle and high schools.

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Plans for Securing External Funding

Our team has already begun applying for external funding. In mid-February 2022, Mangelson and Gill submitted a $1.3M proposal to the NSF *National Robotics Initiative 3.0*, with a focus on Aim 1 – Research Question 1 and Aim 2 of this application. While our submission was not awarded, we received positive reviews and plan to resubmit a revised version of the proposal to NSF *Foundational Research in Robotics (FRR)*. In January 2023, Mangelson and Gill received a Sant Grant for $14k to support initial investigations towards the Aims of this proposal and also submitted a College of Engineering Seed Grant in February 2023. We have also utilized startup funds to support initial data gathering in Nov. 2021.

We believe the ideas we present in this proposal have the potential to be ground-breaking and plan to submit multiple grants to prestigious venues including NSF, NASA, NOAA, and the US Department of Education. In particular, PI Mangelson plans to submit an NSF ***CAREER*** award in July 2023 focused on topics related to Aim 1 - Research Question 2. Later in 2023, we will revise and resubmit our previous NRI proposal to the NSF FRR program. Results from these projects will prepare us to submit to NSF *Partnerships for International Research and Education (PIRE)* in Mar 2024. In addition to these large-scale, sustaining grants, we propose to pursue some smaller grants that would support testing and refinement, as well as local surveys, including a Utah NASA Space Grant.

We also see enormous potential to expand our research and outreach associated with NHPI/STEM education. NSF has recently released its first RFP on *Racial Equity in STEM*. We assert that our pilot program on Molokai, along with ongoing collaborations with BYU-Hawaii, would make us competitive for this large grant. With our collaborators in the Hawaiian K-12 system, we believe we would also be competitive for the US Department of Education *Native Hawaiian Education* fund, where we could work with our colleagues to expand the STEM/Ethnoscience approach to teaching about engineering, biology, and mathematics. In nearly all submissions, the success of the proposal depends on the broad, diverse interdisciplinary team, connecting engineers, geographers, life scientists, and educators.

Grant Program	Proposal Number (See Timeline) and Potential Title	Funding	Target	Lead PIs
Sant Grant	Award 1: Linking Modalities to Understand Reef Ecosystems	$14,000	Jan 2023	Gill/ Mangelson
CoE Seed Funding	Submitted 1: Artificial Intelligence Techniques for Automatic Underwater Scientific Data Collection	$12,500	Feb 2023	Mangelson/ Gill
Utah NASA Space Grant	Proposal P3: Linking Aerial and Underwater Remote Sensing in Vulnerable Coastal Zones	$35,000	Apr 2023	Jensen/Gill/ Mangelson
NSF FRR **CAREER**	P4: CAREER: FRR: Scientific Knowledge-Guided Coral Reef Sampling via NLP and Bayesian Inference	$600,000	Jul 2023	Mangelson
NSF FRR	Resubmission R1: Cross-Domain Hyperspectral Topic-Modeling for Reef Monitoring	$1,300,000	Oct 2023	Mangelson/ Gill
NSF Racial Equity in STEM	P5: Addressing Persistent Racial Inequalities by Linking Traditional and STEM Knowledge Systems	$500,000	Oct 2023	Bailey/ Allen/ Gill/ Wright
NSF PIRE	P6: PIRE: Monitoring and Educating on Climate Change in South Pacific Coastal Systems	$1,500,000	Mar 2024	Gill/Bailey/ Mangelson
US Dept ED Native Hawaiian Ed	P7: Linking Cultural Education and STEM Activities to Prepare Students for Postsecondary Education.	$500,000	May 2025	Allen/ Bailey/ Wright
Total:		**$4,461,500**		

BIOGRAPHICAL SKETCH

NAME: Joshua Mangelson

POSITION TITLE: Assistant Professor

EDUCATION/TRAINING: Professional Preparation

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
Brigham Young University	BS	04/2014	Electrical Engineering
University of Michigan	MS	05/2016	Robotics
University of Michigan	PhD	03/2019	Robotics
University of Michigan	Post-Doc	07/2019	Marine Robotics
Carnegie Mellon University	Post-Doc	06/2020	Field Robotics

A. Personal Statement

Dr. Joshua Mangelson holds PhD and Masters degrees in Robotics from the University of Michigan. His qualifications include demonstrated expertise in robotic perception, mapping, and localization with a particular focus on marine robotics. He has extensive experience leading marine robotic field trials in various locations around the world including San Diego, Hawaii, Boston, northern Michigan, and Utah. In 2022, he traveled to Hawaii as part of the current research team to conduct preliminary testing and data collection activities in Moloka'i, Hawaii. The Field Robotics Systems Lab (FRoSt) focuses on improving scientific data collection and robotic localization for marine systems using machine learning and perceptual algorithm development. Previous funding from the Office of Naval Research enabled the acquisition of multiple industrial marine robotic vehicles which will be used in support of this research plan.

B. Positions, Scientific Appointments, and Honors

Positions

2020 – Present Assistant Professor, Brigham Young University, Electrical and Computer Engineering, Provo, UT
2019 – 2020 Postdoctoral Research Fellow, Carnegie Mellon University, Field Robotics Center, Pittsburgh, PA
2019 – 2019 Postdoctoral Research Fellow, University of Michigan, Naval Architecture and Marine Engineering, Ann Arbor, MI
2014 – 2019 Graduate Student Research Assistant, University of Michigan

Scientific Appointments

2023-Present - Associate Editor of International Journal of Robotics Research

2021-Present – Associate Editor for The IEEE International Conference on Intelligent Robots and Systems (IROS)

2022 - SLAM Session Chair, IEEE International Conference on Intelligent Robots and Systems (IROS)

Honors

2022 - BYU Presidential Innovation Award – "Y-Ride: Elevating Student's Vision of their Potential via Autonomous Driving"

2021 – IEEE ICRA Best Service Robotics Paper – Finalist, IEEE International Conference on Robotics and Automation: "Tactile SLAM: Real-time Inference of Shape and Pose from Planar Pushing", by S. Suresh, M. Bauza, K. Yu, J. G. Mangelson, and M. Kaess.

C. Contributions to Science

Products Most Closely Related to the Proposed Project

1. Suresh S, Sodhi P, Mangelson JG, Wettergreen D, Kaess M. Active SLAM using 3D Submap Saliency for Underwater Volumetric Exploration. Proceedings of the IEEE International Conference on Robotics and Automation. 2020 May.

2. Potokar E, Norman K, Mangelson JG. Invariant Extended Kalman Filtering for Underwater Navigation. IEEE Robotics and Automation Letters. 2021; 6(3):5792-5799.

3. Potokar E, Ashford S, Kaess M, Mangelson J. HoloOcean: An Underwater Robotics Simulator. Proceedings of the IEEE International Conference on Robotics and Automation. 2022 May.

4. Potokar E, Lay K, Norman K, Benham D, Neilsen T, Kaess M, Mangelson J. HoloOcean: Realistic Sonar Simulation. Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems. 2022 October.

5. Benham D, Newman A, Ellis K, Gill R, Mangelson JG. 3D Reconstruction of Reefs using Autonomous Surface Vessels and an Analysis of Chain vs. 3D Rugosity Measurement Robustness. Proceedings of the IEEE/MTS OCEANS Conference and Exhibition. 2022 October.

Other Significant Products

6. Mangelson JG, Jadidi MG, Vasudevan R, Eustice RM. Characterizing the Uncertainty of Jointly BS-1 of 2 Distributed Poses in the Lie Algebra. IEEE Transactions on Robotics. 2020 October; 36(5):1371 - 1388.

7. Mangelson JG, Dominic D, Eustice RM, Vasudevan R. Pairwise Consistent Measurement Set Maximization for Robust Multi-robot Map Merging. Proceedings of the IEEE International Conference on Robotics and Automation. 2018 May.

8. Mangelson JG, Vasudevan R, Eustice RM. Communication Constrained Trajectory Alignment of Multi-Agent Inspection via Linear Programming. Proceedings of the IEEE/MTS OCEANS Conference and Exhibition; 2018 October; Charleston, SC, USA.

9. Suresh S, Bauza M, Yu K, Mangelson JG, Rodriguez A, Kaess M. Tactile SLAM: Real-time inference of shape and pose from planar pushing. Proceedings of the IEEE International Conference on Robotics and Automation. 2021 May.

BIOGRAPHICAL SKETCH

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NAME: Richard Gill

POSITION TITLE: Professor

EDUCATION/TRAINING: Professional Preparation

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
Brigham Young University	B.S.	1993	Conservation Biology
Colorado State University	Ph.D.	1998	Ecology
Duke University	Post-Doc	2001	Biology

A. Personal Statement

Dr. Gill is a broadly trained community and ecosystem ecologist with extensive experience doing research in the South Pacific. His research on global climate change has been published in *Nature, Nature-Climate Change, Ecology, Global Change Biology,* and other top journals. He is uniquely positioned to contribute to this work because of his cultural competency in working with Native Hawaiian and Pacific Islander communities and organizations. Fluent in Samoan, he has worked for more than a decade on issues at the intersection between environmental quality and economic development in communities in Hawaii and Samoa. In addition, he has worked extensively in areas related to remote sensing and robotics, with his four most recent graduate students working on or completing projects that included both aerial and marine robotics to collect imagery for ecological analysis. This project lies at the nexus of his professional and personal interests, combining technical (robotics), ecological/environmental (climate impacts on communities), and culturally informed education innovation (NHPI and STEM) questions.

B. Positions, Scientific Appointments, and Honors

Positions

2022—Current Dean, Undergraduate Education, Brigham Young University, Provo, UT

2019 – 2022 Chair, Department of Biology, Brigham Young University, Provo, UT

2019 – Present Professor, Brigham Young University, Provo, UT

2008 – 2019 Associate Professor, Brigham Young University, Provo, UT

2007 – 2008 Associate Professor, Washington State University, Pullman, WA

2001 – 2007 Assistant Professor, Washington State University, Pullman, WA

1998 – 2001 Postdoctoral Research Fellow, Duke University, Durham, NC

Scientific Appointments

Advisory Board, Sorensen Center for Moral and Ethical Leadership, Brigham Young University

RECO-EVO: Seminars to help religious academic institutions develop models of reconciliation between faith and science (Funded by HHMI; have worked with >30 institutions)

Director and Designer, Center for Culture and the Environment, Saipipi, Samoa

Science Advisor, ‘Aina Momona, Moloka’i, HI

Faculty Advisor, Pacific Islanders in the Life Sciences (PILI) Club, Brigham Young University, Provo, UT

C. Select Contributions to Science

Bishop, T.B.B., RA Gill, BR McMillan, SB St. Clair. 2019. Fire, rodent herbivory, and plant competition: implications for invasion and altered fire regimes in the Mojave Desert. Oecologia DOI: 10.1007/s00442-019-04562-2

Bishop, T.B.B., SB St. Clair, R.A. Gill, Steve Petersen, Seth Munson. 2019. Spatiotemporal patterns of cheatgrass invasion in Colorado Plateau National Parks. Landscape Ecology 34 (4):925-941.

Colin L. Tucker, Theresa A. McHugh, Armin Howell, Richard A. Gill, Bettina Weber, Jayne Belnap, Edmund Grote, Sasha C. Reed. 2017. The concurrent use of novel soil surface microclimate measurements to evaluate CO2 pulses in biocrusted interspaces in a cool desert ecosystem. Biogeochemistry 135:239-249. DOI 10.1007/s10533-017-0372-3

Gill, Richard A. 2014. The influence of 3-years of warming and N-deposition on ecosystem dynamics is small compared to past land use in subalpine meadows. Plant and Soil. DOI 10.1007/s11104-013-1868-9. (10/3.052)

Conner, Lafe G., Ames, Daniel P., Gill, Richard A., (2013) HydroServer Lite as an Open Source Solution for Archiving and Sharing Environmental Data for Independent University Labs, Ecological Informatics, doi:10.1016/j.ecoinf.2013.08.006.

Gill, R.A., H. Wayne Polley, Hyrum B. Johnson, Laurel J. Anderson, Hafiz Maherali, and Robert B. Jackson. 2002. Nonlinear grassland response to past and future atmospheric CO2. Nature 417:279-282.

Gill, R.A., H. W. Polley, H.B. Johnson, R.B. Jackson. 2006. Potential nitrogen constraints on soil carbon sequestration under low and elevated atmospheric CO2. Ecology 87:41-52.

Gill R.A. Can we engage students in large-lecture, nonmajors environmental science courses? The Bulletin of the Ecological Society of America 90 (2), 199-204

Fay, Philip A., Jin, Virginia L., Way, Danielle A., Potter, Kenneth N., Gill, Richard A., Jackson, Robert B., Polley, H. Wayne. 2012. Soil-mediated effects of subambient to increased carbon dioxide on grassland productivity. Nature-Climate Change 2:742-746/DOI: 10.1038/NCLIMATE1573

St Clair, SB, R O’Connor, R.A. Gill, B McMillian. 2016. Biotic resistance and disturbance: rodent consumers regulate post-fire plant invasions and increase plant community diversity. Ecology 97 (7):1700-1711.

BIOGRAPHICAL SKETCH

NAME: Elizabeth Gibbons Bailey

POSITION TITLE: Assistant Professor

EDUCATION/TRAINING: Professional Preparation

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
Brigham Young University	BS	04/2008	Biophysics
Brigham Young University	PhD	08/2013	Physiology and Developmental Biology

A. Personal Statement

I conduct biology education research, with much of my work focusing on underserved populations and evidence-based practices for increasing equity. My work in this area began by investigating women's experiences in undergraduate biology courses, and I have recently moved into work on Indigenous students in STEM. I have published a review article on suggested best practices found in the literature for incorporating traditional ecological knowledge in the classroom, and I have a paper in preparation reporting on students' experiences in a biology course in which traditional ecological knowledge was integrated throughout. I also have a paper in review about the intersection between Native Hawaiian and Pacific Islander students' science identity and ethnic identity. I have experience designing evidence-based education activities, administering and analyzing psychological instruments to assess latent variables related to STEM persistence, and assessing whether educational activities meet target learning objectives. This expertise will allow me to help lead the final aim of the proposal, as we develop an education module to promote students' science identity and integration into the scientific community.

B. Positions, Scientific Appointments, and Honors

2018 – Current Assistant Professor: Biology. Brigham Young University, Provo, UT

2017 – 2018 Assistant Teaching Professor: Biology. Georgetown University, Washington, DC

2016 – 2017 Visiting Assistant Professor: Biology. Brigham Young University Hawaii, Laie, HI

2014 – 2016 Visiting Assistant Professor: Biology. Brigham Young University, Provo, UT

2013 – 2014 Adjunct Faculty: Physiology and Developmental Biology. Brigham Young University, Provo, UT

2013 – 2014 Adjunct Faculty: Biology. Salt Lake Community College, Salt Lake City, UT

C. Contributions to Science

Greenall RF, Bailey EG. "An Instructor's Guide to Integrating Traditional Ecological Knowledge in the Undergraduate Biology Classroom" CBE-LSE 2022; 21(4): 1-14; Doi: 10.1187/cbe.21-12-0340

Greenall RF, Allen GE, Nichols S, Gaspar de Alba J, Bailey EG. “Intersecting Identities: A look at how ethnic identity impacts science identity in Native Hawaiian and Pacific Islander students.” CBE-LSE (in review)

Barrett AA, Smith C, Hafen CH, Severe E, Bailey EG. “The impact of gender roles and previous exposure on major choice, perceived competence, and belonging: a qualitative study of students in computer science and bioinformatics classes.” Computer Science Education 2022. Doi: 10.1080/08993408.2022.2160144

Dewsbury B, Segura-Totten M, Lo SM, Bailey EG, Beaster-Jones L, et al. “Chronicling the journey of the Society for the Advancement in Biology Education Research (SABER) in its effort to become antiracist: from acknowledgment to action.” Frontiers in Education 2021. Doi: 10.3389/FEDUC.2021.780401

Bailey EG, Greenall RF, Baek DM, Morris C, Nelson N, Quirante TM, Rice NS, Rose S, Williams KR. “Female In-Class Participation and Performance Increase with More Female Peers and/or a Female Instructor in Life Sciences Courses.” CBE-LSE 2020; 19(3):ar30. Doi: 10.1187/cbe.19-12-0266

Nichols SC, Xia YY, Parco M, Bailey EG. “Participation and performance by gender in synchronous online lectures: Three unique case studies during emergency remote teaching.” JMBE 2022; e00281-21; Doi: 10.1128/jmbe.00281-21

Bailey EG, Greenall RF, Tullis MM, Williams K. “The retention benefits of frequent cumulative versus non-cumulative testing depend on students’ reasoning skills.” PLOS One 2021; 16(4):e0250143. Doi:10.1371/journal.pone.0250143

Bailey EG, Baek D, Meiling J, Morris C, Nelson N, Rice N, Rose S, Stockdale P. Learning Gains from Recurring ‘Teach and Question’ Homework Assignment in a General Biology Course: Using Reciprocal Peer Tutoring Outside of Class. CBE-LSE 2018; 17: ar23.

Jensen J, Bailey, EG, Kummer T, Weber K. Using Backward Design in Education Research: A Research Methods Essay. J. Microbiol. Biol. Educ. October 2017; 18(3).

Bailey EG, Jensen J, Nelson J, Wiberg HK, Bell JD. Weekly Formative Exams and Creative Grading Enhance Student Learning in an Introductory Biology Course. CBE-LSE 2017; 16(1): ar2.

BIOGRAPHICAL SKETCH

NAME: Ryan R. Jensen

POSITION TITLE: Professor

EDUCATION/TRAINING: Professional Preparation

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
Brigham Young University, Provo, Utah	BS	04/1996	Geography – Geographic Information Systems
Brigham Young University, Provo, Utah	MS	08/1997	Geography
University of Florida, Gainesville, Florida	PhD	05/2000	Geography; Botany minor

A. Personal Statement

I am a geographer interested in ecosystem problems. I conduct empirical and theoretical research using traditional biogeographic observation and measurement in conjunction with state-of-the-art GIScience techniques (cartography, geographic information systems, remote sensing, and digital image processing). A common thread in almost all of my research projects and publications is the use of these GIScience techniques to examine the human/environment interface in a variety of landscapes and areas.

B. Positions, Scientific Appointments, and Honors

Professional Appointments

2013 – Present	Professor, Department of Geography, Brigham Young University
2012 – 2021	Chair, Department of Geography, Brigham Young University
2007 – 2012	Associate Professor of Geography, Department of Geography, Brigham Young University
2005 – 2007	Associate Professor of Geography, Department of Geography, Geology, and Anthropology, Indiana State University (Tenured).
2005 – 2007	Director, Center for Remote Sensing and Geographic Information Systems, Indiana State University.
2005 – 2007	Adjunct Professor, Department of Life Sciences, Indiana State University
2000 – 2005	Assistant Professor of Geography, Department of Geography, Geology, and Anthropology, Indiana State University (Tenure track)
2002 – 2007	Associate Director for Forest Research, Center for State Park Research, Indiana State University.
2002 – 2007	Undergraduate Advisor, Department of Geography, Geology, and Anthropology, Indiana State University

C. Contributions to Science

Relevant Books

I am co-editor (with Jay D. Gatrell) of the Springer series "Geospatial Technologies and the Environment."

Jensen, R.R., E. Martin, and L. Hadfield. Under Contract. *Protected Lands in Tanzania: Land Use and Management Challenges in Complex Areas.* Springer Nature.

Gatrell, J.D., G.D. Bierly, R.R. Jensen, and R.R. Thakur. 2020. *Research Design and Proposal Writing in Spatial Science, 3rd Ed.* Berlin*:* Springer. ISBN: 978-3030600181. 265p.

Durrant, J.O., E.H. Martin, K. Melubo, R.R. Jensen, P.J. Hardin, and L.H. Weisler. 2020. *Protected Areas in Northern Tanzania: Local Communities, Land Use Change, and Management Challenges*. Springer. ISBN: 978-3-030-43301-7. 179p.

Gatrell, J.D., R.R. Jensen, M.W. Patterson, and N. Hoalst-Pullen (eds). 2016. *Urban Sustainability – Policy and Praxis*. Berlin: Springer. 266 pages.

Jensen, R.R. 2014. *Introductory Geographic Information Systems Workbook.* New York: Pearson. 164p.

Jensen, J.R. and R.R. Jensen. 2013. *Introductory Geographic Information Systems*. New York: Pearson. 400p.

Gatrell, J.D., G.D. Bierly, and R.R. Jensen. 2012. *Research Design and Proposal Writing in Spatial Science, 2nd Ed.* Berlin: Springer. 215p.

Gatrell, J.D. and R.R. Jensen (eds.) 2009. *Planning and Socioeconomic Applications* in Geotechnologies and the Environment Series. Berlin: Springer. 223p.

Jensen, R.R., J.D. Gatrell, and D. McLean (eds.) 2007. *Geo-Spatial Technologies in Urban Environments: Policy, Practice, and Pixels, 2nd edition.* Berlin: Springer. 240p.

Gatrell, J.D., G.D. Bierly, and R.R. Jensen. 2005. *Research Design and Proposal Writing in Spatial Science*. Berlin: Springer. 216 p.

Jensen, R.R., J.D. Gatrell. and D. McLean (eds.) 2005*: Geo-Spatial Technologies in Urban Environments.* Berlin: Springer. 176 p.

Relevant Peer-Reviewed Journal Articles

Howell, R.G., R.R. Jensen, S.L. Petersen, and R.T. Larsen. 2020. "Measuring height characteristics of sagebrush (*Artemisia* sp.) using imagery derived from small unmanned aerial systems(sUAS)." *Drones*, 4(1), 6. https://doi.org/10.3390/drones4010006

Burchfield, D.R., S.L. Petersen, S.G. Kitchen, and R.R. Jensen. 2020. "sUAS-based remote sensing in mountainous areas: benefits, challenges, and best practices." *Papers in Applied Geography*, https://doi.org/10.1080/23754931.2020.1716385

Martin, E.H., R.R. Jensen, P.J. Hardin, A.W. Kisingo, R.A. Shoo, and A. Eustace. 2019. "Assessing changes in Tanzania's Kwakuchinja Wildlife Corridor using multitemporal satellite imagery and open source tools." *Applied Geography* 110:102051. https://doi.org/10.1016/j.apgeog.2019.102051

Perry J. Hardin, V. Lulla, R.R. Jensen, and J.R. Jensen. 2019. "Small Unmanned Aerial Systems (sUAS) for environmental remote sensing: challenges and opportunities revisited." *GIScience & Remote Sensing*, 56(2):309-322. DOI:10.1080/15481603.2018.1510088

Boswell, A., S. Petersen, B. Roundy, R. Jensen, D. Summers, and A. Hulet. 2017. "Rangeland monitoring using remote sensing: comparison of cover estimates from field measurements and image analysis." *AIMS Environmental Science* 4(1):1-16. DOI: 10.3934/environsci.2017.1.1

Roundy, D.B., A. Hulet, S.L. Petersen, B.A. Roundy, R.R. Jensen, J.B. Hinkle, and L. Crook. 2016. "Estimating pinyon and juniper cover across Utah using NAIP imagery." *AIMS Environmental Science* 3(4):765-777. DOI: 10.3934/environsci.2016.4.765

Westover, M., R. Baxter, J. Baxter, C. Day, R. Jensen, S. Petersen, and R. Larsen. 2016. "Assessing Greater Sage-Grouse selection of brood-rearing habitat using remotely-sensed imagery: Can readily available high-resolution imagery be used to identify brood-rearing habitat across a broad landscape?" *PloS ONE* e0156290. doi: 10.1371/journal.pone.0156290

Jamison, A., E. Tuttle, R. Jensen, G. Bierly, and R. Gonser. 2015. "Spatial ecology, landscapes, and the geography of vector-borne disease: a multi-disciplinary review." *Applied Geography* 63:418-426.

BIOGRAPHICAL SKETCH

NAME: Geoffrey A. Wright

POSITION TITLE: Associate Professor – Technology and Engineering Studies

EDUCATION/TRAINING: Professional Preparation

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
Brigham Young University	B.S.	04/2001	Technology and Engineering Studies
Chapman University	M.S.	04/2003	Ed Leadership/Admin
Brigham Young University	Ph.D.	04/2008	Information Processes and Technology

A. Personal Statement

I currently serve as the chair for the Technology and Engineering Studies program at Brigham Young University. The focus of this program is to prepare technology and engineering educators – for both technical fields and K12 service. In addition, I serve as the chair of Innovation, where I oversee the design and development, and implementation of innovation pedagogy for faculty and students. I am also the director of Utah Underwater Robotics, which is the largest remote operated vehicle (ROV) program in landlocked states (we average over 1000 participants each year). The program is a K12, teacher and student inquiry based ROV experience, where teachers and students design and build ROVs embedded in a tech and engineering curriculum. An additional central tenant of my work is outreach with schools doing workshops and trainings in STEM fields, demonstrating effective pedagogical strategies while teaching STEM content. My areas of research center on computational thinking, innovation engineering, STEM teacher training, and design thinking. The courses I currently teach consist of material science – with a specific focus on composites and metals, emerging communication technologies, mixed media and UX design, and programing and game design. I believe each of the positions listed above, coupled with my teaching and technical backgrounds will bring a beneficial contribution to this dynamic group of researchers.

B. Positions, Scientific Appointments, and Honors

- 2014 – Present Associate Professor, Technology and Engineering Studies, Brigham Young University
- 2019 – Present Chair, Technology and Engineering Studies, Brigham Young University
- 2015 – 2023 Chair, Innovation, School of Technology, Brigham Young University
- 2015 – Present Director, Utah Underwater Robotics
- 2016 (Sp/Su) Visiting Professor of Education and Innovation, Cambridge University, UK
- 2007 – 2014 Assistant Professor, Technology and Engineering Studies, Brigham Young University
- 2006 – 2008 Assistant Principal – Intern, Alpine School District, OHS, MRJH, FE
- 2004 – 2008 Career and Technical Teacher, Mountain Ridge Jr. High
- 2001 – 2004 Information Communication and Technology Teacher Ramon Jr. High
- 2001 – 2004 Computer Science Teacher, Chino High School

C. Contributions to Science

1. West, R. E., Jensen, J. L., Johnson, M., Nielson, J. B., Sansom, R. L., Wright, G. A. (2022). STEM Faculty Institute: An Intensive Interdisciplinary Effort to Improve STEM Faculty Adoption of Evidence-based Instructional Practices. *Journal of College Science Teaching*. https://www.nsta.org/journal-college-science-teaching/journal-college-science-teaching- januaryfebruary-2022/stem-faculty
2. Wright, G. A., Bartholomew, S. R. (2021). What it takes to create a vaccine & biomedical engineering. *Technology & Engineering Teacher, 80*(7), 20-23. https://eric.ed.gov/?id=EJ1293614
3. West, R. E., Sansom, R. L., Nielson, J. B., Wright, G. A., Turley, R. S., Jensen, J. L., Johnson, M. E. (2021). Ideas for Supporting Student-Centered STEM Learning Through Remote Labs: A Response. *Educational Technology Research and Development, 69*(1), 263-268. https://link.springer.com/article/10.1007/s11423-020-09905-y
4. Wright, G. A., Bartholomew, S. R. (2020). Hands-on approaches to education during a pandemic. *Technology and Engineering Teacher, 80*(4). https://eric.ed.gov/?id=EJ1277603
5. Olsen, G., Wright, G. A., West, J. H., Crookston, B. T., & Walsh, T. (2020). Building Electric Bikes to Promote Student Interest in Public Health and Engineering. In Technology Engineering Teacher 79(8). Reston, Virginia, USA: ITEEA. https://www.iteea.org/Publications/Journals/TET/172463/TETMJ20TETe.aspx#publicationContent
6. Bell, M., Shumway, S., & Wright, G. (2020). An Investigation of the Impact of a Flipped Classroom Instructional Approach on High School Students' Content Knowledge and Attitude Toward the Learning Environment. *Advances in Social Sciences Research.* https://www.semanticscholar.org/paper/An-Investigation-of-the- Impact-of-a-Flipped-on-High-Bell/a5c68d420581128fdb74195bc92ee3b6c8ff7814
7. Walsh, T. & Wright, G. A. (2020). Increasing Female Enrollment in Technology and Engineering Classes: An All-Female Class. In Technology and Engineering Teacher 79(7), 13–17). Reston, VA, USA: ITEEA. https://www.iteea.org/Publications/Journals/TET/170479/170494.aspx#publicationContent
8. Weidman, J. E., & Wright, G. A. (2019). Promoting Construction Education in K-12 by Using an Experiential, Student-centered, STEM-infused Construction Unit. Technology and Engineering Teacher, 79(1). https://www.iteea.org/Publications/Journals/TET/TETSept2019.aspx
9. Hoover, B., Wright, G. A. (2019). Investigating if Multidisciplinary or Homogenous Teams Are More Innovative in a Higher Education Setting. Business Review, 25(1), 93–99. http://www.jaabc.com/JAABC25-1September2019Wright.html
10. Rytting, M., Wright, G. A., Shumway, S. L., & Jensen, J. L. (2019). Comparison of Simulation and Hands-on Labs in Helping High School Students Learn Physics Concepts. International Journal of Education, 11(1), 18-28. http://www.macrothink.org/journal/index.php/ije/article/view/14017
11. Welling, J., & Wright, G. A. (2018). Teaching Engineering Design Through Paper Rockets. Technology and Engineering Teacher, 77(8). https://www.iteea.org/Publications/Journals/TET/TETMayJune18.aspx
12. Wright, G. A. (2018). Engineering attitudes: an investigation of the effect of literature on student attitudes toward engineering. International Journal of Technology and Design Education, 28 (653-665). https://link.springer.com/article/10.1007/s10798-017-9417-0
13. https://www.iteea.org/Publications/Journals/TET/TETFeb18.aspx
14. Wright, G. A., & White, M. (2015). Using ROV (Remotely Operated Vehicles) to Promote STEM in K-12 Classrooms. In Tech Directions (1st ed., Vol. March, 13-17). http://www.omagdigital.com/publication/index.php?i=248114&m=&l=&p=13&pre=
15. Hurd, R. C., Hacking, K., Damarjian, J. L., Wright, G. A., & Truscott, T. (2015). Underwater Robotics Surface In Utah. Technology and Engineering Teacher, 74(5), 8-16. https://eric.ed.gov/?id=EJ1054838

BIOGRAPHICAL SKETCH

NAME: Allen, G. E. Kawika

POSITION TITLE: Associate Professor - Counseling Psychology PhD Program

EDUCATION/TRAINING: Professional Preparation

INSTITUTION AND LOCATION	DEGREE (if applicable)	Completion Date MM/YYYY	FIELD OF STUDY
University of Utah, Salt Lake City, UT	BS	08/1999	Speech Communication
University of Utah, Salt Lake City, UT	MS	08/2005	Counseling Psychology
University of Missouri, Columbia, MO	PhD	08/2011	Counseling Psychology
Duke University, Durham, NC	Predoctoral Internship	08/2011	Counseling Psychology

A. Personal Statement

Professor received his BS in speech/organizational communication and his MS in counseling psychology at the University of Utah. He then received his PhD in counseling psychology from the University of Missouri-Columbia (a top-ranked program) and completed his predoctoral clinical internship at Duke University. His research areas involve spiritual, cultural, and indigenous ways of healing in psychotherapy including culturally appropriate psychotherapies and interventions for underserved populations. Professor Allen is founder of and leads the Polynesian Psychology Research Team (The Poly Psi Team) research efforts involving not only Polynesian/Pasifika Psychology Research, but research across all BIPOC groups. Professor Allen has traveled with his colleagues and students across the South Pacific including New Zealand, American Samoa, Hawai'i, and Fiji conducting spiritual, cultural, and indigenous interventions in psychotherapy for psychological healing among Pacific Islanders. He has over 35 publications in top-tier scientific journals, over $4 million dollars in research grants, and over 100 professional presentations at national and international conferences. He has received awards as a graduate student and as a professor for his research. He has also held editorial board and leadership positions in Divisions 17, 36, and 45 of the American Psychological Association. Dr. Allen is an associate professor in the doctoral program of counseling psychology at Brigham Young University.

B. Positions, Scientific Appointments, and Honors

2022-present **Brigham Young University**
Associate Professor with Tenure
Department of Counseling Psychology and Special Education (CPSE)

2013-present **Brigham Young University**
Assistant Professor
Department of Counseling Psychology and Special Education (CPSE)

2010-2011 **Duke University**
Clinical Psychology Intern
Counseling and Psychological Services (CAPS)
APA-accredited Pre-doctoral Psychology Internship

C. Contributions to Science

PEER-REVIEWED JOURNAL ARTICLES RELATED TO CURRENT PROJECT
* Student-led or ** Student co-authored

*Tanner, E., **Allen, G. E. K.,** Young, E. L., Feinauer, E., & **Ure, C. (2022). Examining

psychological correlates and indirect effects of forgiveness on racial discrimination among Polynesian American emerging adults. *Journal of Ethnic and Cultural Studies*, *9, 2, 134-150*. https://dx.doi.org/10.29333/ejecs/1017

Cutrer-Parraga, B., **Allen, G. E. K.,** Conklin, H., **Hee, C., Miller, E., **Chapman, R., **Gancinia, B., **Roan, M., & **Norton, A. (2022). Culture-centered psychotherapy preferences for Polynesian Americans: An interpretative phenomenological approach. *International Journal for the Advancement of Counselling.* https://doi.org/10.1007/s10447-022-09472-2

Allen, G. E. K., Masuda, A., Griner, D., Beecher, M., **Cline, J. **Ming, M., & **Tsoi, C. (in press). Examining expectations, attitudes, and intentions to seeking psychotherapy among Polynesian Americans. *American Journal of Psychotherapy.*

*Cline, J., Larsen, R., Griner, D., Beecher, M., **Allen, G. E. K.,** Lee, Chien-Ti., **Lefrandt, J., Worthen, V. (in press). Ethnoracial comparisons in anxiety and depression outcomes among Native Hawaiian and Pacific Islander college students. *Journal of Multicultural Counseling and Development.*

Masuda, A., **Allen, G. E. K.**, Liu, C, & Tully, E. C. (2021). The role of self-concealment and perceived racial/ethnic discrimination in general psychological distress among racial and ethnic minority college students. *International Journal for the Advancement of Counselling.* https://doi.org/10.1007/s10447-021-09441-1

*Kane, D., **Allen, G. E. K.**, Smith, T.B., Griner, D., Jackson, A., Beecher, M., **Ming, M., Cutrer-Parraga, B. & Richards, P.S. (2021). Forgiveness and gratitude as mediators between religious commitment and well-Being among Latter-day Saint Polynesian Americans. *Mental Health, Religion & Culture*. https://doi.org/10.1080/13674676.2021.1875205

*Hafoka, O., Smith, T. B., Griner, D., **Allen, G. E. K.,** Beecher, M., & Young, E. (2019). Psychotherapy utilization, presenting concerns, and outcomes among Pacific Islander and Asian American students. *Counselling Psychology Quarterly*. doi.org/10.1080/09515070.2019.1699502

*Stokes, H., Griner, D., Smith, T. B., Beecher, M., **Allen, G. E. K.**, Cox, J., Hobbs, K., & Kirtley, N. (2019). Psychotherapy utilization and presenting concerns among international Asian and Asian American students in a university counseling center. *Journal of College Student Psychotherapy*. doi: 10.1080/87568225.2019.1650681.

Allen, G. E. K., Conklin, H., & **Kane, D. (2017). Racial discrimination and psychological health among Polynesians in the U.S. *Cultural Diversity and Ethnic Minority Psychology*, *23* (3), 416-424. doi: 10.1037/cdp0000133

Allen, G. E. K., Cox, J., Smith, T. B., Griner, D., Beecher, M., **Hafoka, O. (2016). Psychotherapy utilization and presenting concerns among Polynesian American college students. *The Counseling Psychologist, 44* (1), 28-49. *Major Impact Section.* doi:10.1177/0011000015617534

Allen, G. E. K., Kim, B. S. K., Smith, T. B., **Hafoka, O. (2016). Counseling attitudes and stigma among Polynesian Americans. *The Counseling Psychologist, 44* (1), 6-27. *Major Impact Section.* doi: 10.1177/0011000015618762

Allen, G. E. K., & Smith, T. (2015). Collectivistic coping strategies for distress among Polynesian Americans. *Psychological Services*, 12, 3, 322–329. doi: 10.1037/ser0000039

Allen, G. E. K., **Garriott, P. O., Reyes, C. J. & **Hsieh, C. (2014). Racial identity, phenotype, and self-esteem among biracial Polynesian/White individuals. *Family Relations*, *62*, 82-91. doi: 10.1111/j.1741-3729.2012.00743.x

***Allen, G. E. K.** & Heppner, P. P. (2011). Religiosity, coping, and psychological well-being among Latter-Day Saint Polynesians in the U.S. *Asian American Journal of Psychology, 2, 1,* 13-24. doi: 10.1037/a0023266

Current and Pending Support for IDR Research Team

Current and Pending Support – Joshua Mangelson

Current

Project Title: Center for Autonomous Air Mobility and Sensing (CAAMS)

Funding Agency: National Science Foundation

Amount Awarded: $506,622

Active Dates: Apr 2022- Mar 2027

Committed Effort: N/A

Role: Added as senior personnel. Within this center, I annually submit proposals for research funding that are approved on a yearly basis for specific projects.

Relevance to Current Project: Unrelated – mainly only covers travel to support discussion with air force and air-mobility related sponsors.

Project Title: Multi-agent localization in GPS-denied environments

Funding Agency: NSF CAAMS Center

Amount Awarded: $75,000

Active Dates: Sept 2022 – Aug 2023

Committed Effort: 0.2 Months/Year

Role: Co-PI, I am overseeing and advising graduate students on this project.

Relevance to Current Project: Unrelated.

Project Title: Precision landing localization technology for autonomous eVTOL

Funding Agency: AFOSR Agility Prime STTR Phase II with Archer Aviation

Amount Awarded: $224,602

Active Dates: Mar 2022 – May 2023

Committed Effort: 0.2 Months/Year

Role: Added as senior personnel after submission. I am currently advising students on this project.

Relevance to Current Project: Unrelated.

Project Title: Cross-Modality Localization and Mapping

Funding Agency: Office of Naval Research

Amount Awarded: $554,840

Active Dates: May 2021 – Apr 2024

Committed Effort: 1.0 Months/Year

Role: Principal Investigator- Supporting 2 Graduate RAs, 2-3 Undergrad RAs

Relevance to Current Project: Unrelated.

Project Title: DURIP: A Re-configurable Testbed for Autonomous Heterogeneous Marine Mapping, Sensing, and Search

Funding Agency: Office of Naval Research

Amount Awarded: $837,047

Committed Effort: N/A

Active Dates: Mar 2021 – Feb 2023

Role: Principal Investigator

Relevance to Current Project: Funds provided by ONR under this grant were for capital equipment only and allowed purchase of the marine robotic systems needed to support the ONR funded cross-modality project described previously. However, with the requested IDR funds we can expand the proposed project to new research areas and expand/develop novel interdisciplinary collaborations. The proposed IDR will leverage the marine robotic systems purchased under this grant.

Project Title: Linking Modalities to Understand Reef Ecosystems: Aerial, Underwater, and Cross-cultural Tools for Ecosystem Insights

Funding Agency: Roger and Victoria Sant Sustainability Research Program

Amount Awarded: $14,000

Active Dates: Jan 2023 - Dec 2024

Committed Effort: 0.1 Months/Year

Role: Co-PI

Relevance to Current Project: Seed funding to support an initial field test towards the goal of external funding as described under this IDR but does not supply sufficient funds to complete the aims described in this project. Shared with Richard Gill.

Project Title: Y-Ride: Elevating Student's Vision of their Potential via Autonomous Driving

Funding Agency: BYU Presidential Innovation Award

Amount Requested: $90,000

Proposed Dates: May 2022 – Apr 2024

Potential Committed Effort: 0.1 Months/Year

Role: Principal Investigator

Relevance to Current Project: Unrelated – This grant is a teaching grant focused on capital equipment for a new class and a capstone project.

Pending

Project Title: NEEC: Active Cooperative Terrain Aided Navigation Using Inverted-USBL

Funding Agency: Naval Surface Warfare Center – Panama City Division

Amount Requested: $448,739

Proposed Dates: Apr 2023 – Mar 2026

Potential Committed Effort: 0.5 Months/Year

Role: Principal Investigator – The sole PI on this project

Relevance to Current Project: Unrelated.

Project Title: NEEC: Mixed Simulation and Reality for Testing of Multi-agent UUV Perceptual Autonomy

Funding Agency: Naval Undersea Warfare Center – Keyport Division

Amount Requested: $449,601

Proposed Dates: Apr 2023 – Mar 2026

Potential Committed Effort: 0.5 Months/Year

Role: Principal Investigator – The sole PI on this project

Relevance to Current Project: Unrelated

Project Title: Artificial Intelligence Techniques for Automatic Underwater Scientific Data Collection

Funding Agency: College of Engineering Seed Funding

Amount Awarded: $12,500

Potential Committed Effort: 0.1 Months/Year

Proposal Dates: Mar 2023 - Feb 2024

Role: Principal Investigator

Relevance to Current Project: Seed funding to support the hire of two summer undergraduates towards goals aligned with this IDR. However, funds are insufficient to accomplish the Aims described in this IDR and are complimentary and non-overlapping.

Current and Pending Support – Richard Gill

Current

Project Title: Linking Modalities to Understand Reef Ecosystems: Aerial, Underwater, and Cross-cultural Tools for Ecosystem Insights

Funding Agency: Roger and Victoria Sant Sustainability Research Program

Amount Awarded: $14,000

Committed Effort: 0.1 Months/Year

Active Dates: Jan 2023 - Dec 2024

Role: Principal Investigator

Relevance to Current Project: Seed funding to support an initial field test towards the goal of external funding as described under this IDR, but does not supply sufficient funds to complete the aims described in this project. Shared with Joshua Mangelson.

Pending

None

Current and Pending Support – Kawika Allen

Current

Project Title: Faufautua: Exploring Best Practices for Spiritual-, Cultural-, and Indigenous-integrated Strategies for Psychological Healing with Pacific Islander clients in Fiji.

Funding Agency: BYU Scholarly and Creative Works – David O. McKay Grant

Amount Awarded: $24,000 (awarded November 2021)

Active Dates: Jan 2022-Dec 2023

Role: Principal Investigator

Relevance to Current Project: Unrelated

Pending

None

Current and Pending Support – Elizabeth G Bailey

Current

Project Title: Transforming water education to address the global water crisis

Funding Agency: Interdisciplinary Research Origination Awards (BYU Internal)

Amount Awarded: $120,000

Active Dates: May 2021 – May 2023

Role: Co-PI

Relevance to Current Project: Unrelated

Pending

Project Title: Compiling the Expert Consensus on the Water Cycle to Increase Water Literacy and Teach Systems Thinking

Funding Agency: Spencer Foundation

Amount Requested: $49,712

Role: Co-PI

Relevance to Current Project: Unrelated

Project Title: Developmental bias and inflorescence architecture convergence in leafy-stemmed gilias

Funding Agency: National Science Foundation

Amount Requested: $1,011,377

Role: Co-PI

Relevance to Current Project: Unrelated

Current and Pending Support – Geoffrey Wright

Current

None

Pending

None

Current and Pending Support – Ryan Jensen

Current

None

Pending

None