Cover Page for Proposal Submitted to the National Aeronautics and Space Administration

NASA Proposal Number

TBD on Submit

NASA PROCEDURE FOR HANDLING PROPOSALS

This proposal shall be used and disclosed for evaluation purposes only, and a copy of this Government notice shall be applied to any reproduction or abstract thereof. Any authorized restrictive notices that the submitter places on this proposal shall also be strictly complied with. Disclosure of this proposal for any reason outside the Government evaluation purposes shall be made only to the extent authorized by the Government.

SECTION I - Proposal Information

Principal Investigator	E-mail Address	Phone Number
Jarrett Byrnes	**jarrett.byrnes@umb.edu**	**401-529-4104**

Street Address (1)	Street Address (2)
100 William T Morrissey Blvd	

City	State / Province	Postal Code	Country Code
Boston	**MA**	**02125-3300**	**US**

Proposal Title : **Using Citizen Science to Understand Thirty Years of Change in Global Kelp Cover by Expanding the Zooniverse to NASA Satellite Imagery Final Report**

Proposed Start Date	Proposed End Date	Total Budget	Year 1 Budget	Year 2 Budget	Year 3 Budget
03 / 01 / 2018	**02 / 28 / 2021**	**789,577.68**	**279,201.68**	**281,222.00**	**229,154.00**

SECTION II - Application Information

NASA Program Announcement Number	NASA Program Announcement Title
NNH16ZDA001N-CSESP	**Citizen Science for Earth Systems Program**

For Consideration By NASA Organization *(the soliciting organization, or the organization to which an unsolicited proposal is submitted)*

NASA , Headquarters , Science Mission Directorate , Earth Science

Date Submitted	Submission Method	Grants.gov Application Identifier	Applicant Proposal Identifier
	Electronic Submission Only		

Type of Application	Predecessor Award Number	Other Federal Agencies to Which Proposal Has Been Submitted
New		

International Participation	Type of International Participation
No	

SECTION III - Submitting Organization Information

DUNS Number	CAGE Code	Employer Identification Number (EIN or TIN)	Organization Type
808008122	**9B961**		**2A**

Organization Name (Standard/Legal Name)	Company Division
University Of Massachusetts, Boston	**UNIVERSITY OF MASSACHUSETTS BOSTON**

Organization DBA Name	Division Number
DEPT GRANTS & ADM CONTRACTS	

Street Address (1)	Street Address (2)
100 MORRISSEY BLVD RM 80	

City	State / Province	Postal Code	Country Code
BOSTON	**MA**	**02125**	**USA**

SECTION IV - Proposal Point of Contact Information

Name	Email Address	Phone Number
Jarrett Byrnes	**jarrett.byrnes@umb.edu**	**401-529-4104**

SECTION V - Certification and Authorization

Certification of Compliance with Applicable Executive Orders and U.S. Code

By submitting the proposal identified in the Cover Sheet/Proposal Summary in response to this Research Announcement, the Authorizing Official of the proposing organization (or the individual proposer if there is no proposing organization) as identified below:

- certifies that the statements made in this proposal are true and complete to the best of his/her knowledge;
- agrees to accept the obligations to comply with NASA award terms and conditions if an award is made as a result of this proposal; and
- confirms compliance with all provisions, rules, and stipulations set forth in this solicitation.

Willful provision of false information in this proposal and/or its supporting documents, or in reports required under an ensuing award, is a criminal offense (U.S. Code, Title 18, Section 1001).

Authorized Organizational Representative (AOR) Name	AOR E-mail Address	Phone Number

AOR Signature *(Must have AOR's original signature. Do not sign "for" AOR.)*	Date

PI Name : **Jarrett Byrnes**	NASA Proposal Number
Organization Name : **University Of Massachusetts, Boston**	TBD on Submit

Proposal Title : **Using Citizen Science to Understand Thirty Years of Change in Global Kelp Cover by Expanding the Zooniverse to NASA Satellite Imagery Final Report**

SECTION VI - Team Members

Team Member Role	Team Member Name	Contact Phone	E-mail Address
PI	**Jarrett Byrnes**	**401-529-4104**	**jarrett.byrnes@umb.edu**
Organization/Business Relationship: **University Of Massachusetts, Boston**		Cage Code: **9B961**	DUNS#: **808008122**
International Participation: **No**	U.S. Government Agency		Total Funds Requested: **0.00**

Team Member Role	Team Member Name	Contact Phone	E-mail Address
Co-I/Institutional PI	**Kyle Cavanaugh**	**703-489-4671**	**kcavanaugh@geog.ucla.edu**
Organization/Business Relationship: **REGENTS UNIVERSITY OF CALIFORNIA LOS ANGELES**		Cage Code: **67NC6**	DUNS#: **830637687**
International Participation: **No**	U.S. Government Agency		Total Funds Requested: **0.00**

Team Member Role	Team Member Name	Contact Phone	E-mail Address
Co-I/Institutional PI	**Alison Haupt**	**805-705-5231**	**ahaupt@csumb.edu**
Organization/Business Relationship: **California State University, Monterey Bay**		Cage Code: **1GMS5**	DUNS#: **082412920**
International Participation: **No**	U.S. Government Agency		Total Funds Requested: **0.00**

Team Member Role	Team Member Name	Contact Phone	E-mail Address
Co-I/Institutional PI	**Laura Trouille**	**312-322-0820**	**trouille@zooniverse.org**
Organization/Business Relationship: **Adler Planetarium**		Cage Code: **33EH9**	DUNS#: **083081802**
International Participation: **No**	U.S. Government Agency		Total Funds Requested: **0.00**

PI Name : **Jarrett Byrnes**	NASA Proposal Number
Organization Name : **University Of Massachusetts, Boston**	TBD on Submit

Proposal Title : **Using Citizen Science to Understand Thirty Years of Change in Global Kelp Cover by Expanding the Zooniverse to NASA Satellite Imagery Final Report**

SECTION VII - Project Summary

In Floating Forests, we seek to harness to power of Landsat data and citizen science to understand how and why giant kelp forests have changed around the planet over the past thirty years. Moreover, we hope to use our citizen science project as a test case for the development of a user-friendly interface for the creation of online Landsat-based citizen science projects at The Zooniverse (http://zooniverse.org). Last, we seek to enhance engagement for this and future projects via the development of accessible visualization tools and curricula for university and high school students.

During the prototype phase we completed a total overhaul of our Landsat image processing pipeline for creating imagery for citizen science classification. We conducted a beta and complete relaunch of our platform at http://floatingforests.org, which included the development of a new smartphone app. This has seen tens of thousands of classifications and over one thousand unique users since the launch on December 13, 2017. We developed and tested a university level set of lab exercises with Floating Forests at its core at a primarily undergraduate and minority serving institution. We made available all of the data from version 1.0 of our platform, which consisted of ~750,000 classifications. Last, we used this data to validate our citizen science based approach to Landsat classification, and found that our consensus based classification approach agreed very well with expert classifications.

In the implementation phase, we will expand Floating Forests to map change in global kelp cover from the 1980s to the present. We will identify trends in global kelp cover, examine whether kelp range limits have shifted, and assess the degree to which these shifts are related to climate change. We will build and deploy a user friendly generalized interface for creating a Landsat- based citizen science project and demonstrate it at scientific meetings to facilitate its adoption. We will build additional visualization tools for Landsat-based projects to allow citizen scientists to quickly and easily work with our data. We will couple this with iterated versions of high school and university-level curricula that grow with these tools. Last, we will maintain a consistent data pipeline so that kelp forest citizen and professional scientists have easy direct access to our data.

PI Name : **Jarrett Byrnes**	NASA Proposal Number
Organization Name : **University Of Massachusetts, Boston**	TBD on Submit

Proposal Title : **Using Citizen Science to Understand Thirty Years of Change in Global Kelp Cover by Expanding the Zooniverse to NASA Satellite Imagery Final Report**

SECTION VIII - Other Project Information

Proprietary Information

Is proprietary/privileged information included in this application?

Yes

International Collaboration

Does this project involve activities outside the U.S. or partnership with International Collaborators?

No

Principal Investigator	Co-Investigator	Collaborator	Equipment	Facilities
No	**No**	**No**	**No**	**No**

Explanation :

NASA Civil Servant Project Personnel

Are NASA civil servant personnel participating as team members on this project (include funded and unfunded)?

No

Fiscal Year	Fiscal Year	Fiscal Year	Fiscal Year	Fiscal Year	Fiscal Year
Number of FTEs	Number of FTEs	Number of FTEs	Number of FTEs	Number of FTEs	Number of FTEs

PI Name : **Jarrett Byrnes**	NASA Proposal Number
Organization Name : **University Of Massachusetts, Boston**	TBD on Submit

Proposal Title : **Using Citizen Science to Understand Thirty Years of Change in Global Kelp Cover by Expanding the Zooniverse to NASA Satellite Imagery Final Report**

SECTION VIII - Other Project Information

Environmental Impact

Does this project have an actual or potential impact on the environment?	Has an exemption been authorized or an environmental assessment (EA) or an environmental impact statement (EIS) been performed?
No	**No**

Environmental Impact Explanation:

Exemption/EA/EIS Explanation:

PI Name : **Jarrett Byrnes**	NASA Proposal Number
Organization Name : **University Of Massachusetts, Boston**	TBD on Submit

Proposal Title : **Using Citizen Science to Understand Thirty Years of Change in Global Kelp Cover by Expanding the Zooniverse to NASA Satellite Imagery Final Report**

SECTION VIII - Other Project Information

Historical Site/Object Impact

Does this project have the potential to affect historic, archeological, or traditional cultural sites (such as Native American burial or ceremonial grounds) or historic objects (such as an historic aircraft or spacecraft)?

No

Explanation:

SECTION IX - Program Specific Data

Question 1 : Short Title:

Answer: Observing Thirty Years of Floating Forests with Citizen Science

Question 2 : Type of institution:

Answer: Educational Organization

Question 3 : Will any funding be provided to a federal government organization including NASA Centers, JPL, other Federal agencies, government laboratories, or Federally Funded Research and Development Centers (FFRDCs)?

Answer: No

Question 4 : Is this Federal government organization a different organization from the proposing (PI) organization?

Answer: N/A

Question 5 : Does this proposal include the use of NASA-provided high end computing (HEC)?

Answer: No

Question 6 : HEC Request Number

Answer:

Question 7 : Research Category:

Answer: 2) Data analysis/data restoration/data assimilation/Earth System modeling (including Guest Observer Activities)

Question 8 : Flight Services

Answer: No

Question 9 : Data Management Plan (Part 1)

Answer:

1. Overview
Our project will generate multiple forms of data in the process of citizen science classification of giant kelp forests. PI Byrnes will coordinate data management. Broadly, code for the Project Builder and derived images from Landsat scenes will be hosted at Zooniverse and mirrors on Amazon web services. Everything is open source and made freely available via GitHub (https://github.com/zooniverse). Data derived from the project will be publically available via Temperate Reefbase (http://temperatereefbase.imas.utas.edu.au/) on a

monthly update cycle and mirrored at the NASA Ocean Biology Distributed Active Archive Center (https://earthdata.nasa.gov/about/daacs/daac-obdaac). Code will be freely available via GitHub repositories.

1.1 Project & Science Objectives

Our project seeks to use citizen science efforts to categorize giant kelp forests globally from Landsat imagery for use in scientific investigations. We will use these classifications to build global consensus maps of giant kelp forests over thirty years. Using these maps, we will assess the effect of climate drivers assessed via different NOAA and NASA data products on kelp populations.

2. Project Science Data Generation and Flow

Both the current Ouroboros and future Project Builder platforms begin by downloading Landsat scenes from the US Geological Survey Landsat server. Scenes are cut into smaller images (~131 km2 per image), color corrected, and checked against coastline shapefiles and for excessive cloudiness. Images failing to meet clarity and coastal criteria are discarded. The remaining subjects are retained and shown to users for classifications. Image metadata is saved in a MongoDB database along with information about user classifications.

Monthly, the Floating Forest team downloads and reprocesses the MongoDB into 1) a simpler flat comma separated value database, 2) a NetCDF raster file with each cell containing the number of users classifying kelp in that cell, and 3) cleaned ESRI Shapefile format of kelp beds based on calibration thresholds of the number of users required to classify a cell as kelp. These three data sources will then be archived for use by project scientists and others.

2.2 Science Operations

The Zooniverse will handle all Landsat data downloading, reprocessing, and recording of image metadata. The Zooniverse will also host the Floating Forests project website and record all user classifications. Project PI Byrnes's lab will handle all data reprocessing and archiving. Co-Investigator Cavanaugh's lab will handle all the acquisition of other environmental data sets

2.3 Project Data and Code Storage and Distribution

All code for the project - both for Project Builder and analysis code - will be made available via GitHub. Zooniverse's code can currently be found at https://github.com/zooniverse and analysis code is located at https://github.com/jebyrnes/floatingForests. Analysis code can be merged to NASA's GitHub code repository upon the completion of each project analysis.

All images used by the Floating Forests website as well as the database of classifications will be hosted by Zooniverse via Amazon Web Services. Zooniverse provides an API that allows any interested party to read from the data or database directly.

Processed data products - including a cleaned CSV, NetCDF consensus classifications, and quality-controlled shapefile of kelp beds over time will be hosted by the Australia Ocean Data Network's Temperate Reefbase (TRB). After meta-data generation, we will submit the data and metadata to the NASA Ocean Biology Distributed Active Archive Center (OBDAAC) as a secondary mirror in order to ensure data longevity and to ensure that the data becomes part of NASA's public catalogue.

Question 10 : Data Management Plan (Part 2)

Answer:

3. Access and Stewardship

3.1 Transition to Science Data Center

Derived data products from Floating Forests classifications will be generated monthly. After establishment of the data pipeline during the prototype phase, data will be archived at TRB. If possible TRB and OBDAAC will be updated on the same cycle. Otherwise, OBDAAC will be updated annually for the lifetime of the project. Code will be archived on GitHub, and analysis code will be archived under NASA's account as requested.

3.2 Directories and Catalogs

Launched in June of 2016, TRB is a joint project of the AODN, the University of Tasmania, the Institute for Marine & Antarctic Studies, and the Kelp Ecosystem Ecology Network (PI Byrnes, Network coordinator) and is supported by the Australian National Data Service. TRB is a public data portal for access to tabular, raster, and other forms of data about temperate rocky reefs. It is supported by AODN funding and is planned to run as a long-term archival solution. TRB is currently exploring membership in Data One (http://dataone.org) so that data catalogs are accessible both via AODN as well as Data One's search engine.

3.3 Standards and Policies for Access

Upon archiving materials at TRB, we will generate metadata for all data products. TRB requires project scientists to generate metadata using the ISO19115 compliant Marine Community Profile 2.0 metadata schema via an intuitive user interface on intitial data creation. Metadata is maintained through data update cycles and can be edited as needed.

All Floating Forests data products and analysis code will be made available under a Creative Commons attribution required license. Data will be made freely available upon upload to TRB, and users will be requested to cite either the data product of subsequent first publications by the science team using the data set as a reference. All Zooniverse code is publically accessible under their own license which is available at https://www.zooniverse.org/privacy?lang=en.

3.4 Associated Archive Products

Associated code for Floating Forests and analysis products will all be available via GitHub. Analysis code can be forked and archived by NASA as requested.

Question 11 : Team Members Missing From Cover Page:

Answer:

Isaac Rosenthal, University of Massachusetts Boston, Boston, MA: Graduate Student on project with PI Byrnes
Unnamed Postdoctoral Researcher, University of California, Los Angeles, CA: Climate analysis researcher with Co-I Cavanaugh
Unnamed Undergraduates, California State University Monterey Bay, Monterey Bay, CA: Education interns with Co-I Haupt

Question 12 : Does this proposal contain information and/or data that are subject to U.S. export control laws and regulations including Export Administration Regulations (EAR) and International Traffic in Arms Regulations (ITAR)?

Answer: No

Question 13 : I have identified the export-controlled material in this proposal.

Answer: N/A

Question 14 : I acknowledge that the inclusion of such material in this proposal may complicate the government's ability to evaluate the proposal.

Answer: N/A

Question 15 : Does the proposed work include any involvement with collaborators in China or with Chinese organizations, or does the proposed work include activities in China?

Answer: No

Question 16 : Are you planning for undergraduate students to be involved in the conduct of the proposed investigation?

Answer: Yes

Question 17 : If yes, how many different undergraduate students?

Answer: 2

Question 18 : What is the total number of student-months of involvement for all undergraduate students over the life of the proposed investigation?

Answer: 6

Question 19 : Provide the names and current year (1,2,3,4) for any undergraduate students that have already been identified.

Answer:

Currently unnamed.

Question 20 : Are you planning for graduate students to be involved in the conduct of the proposed investigation?

Answer: Yes

Question 21 : If yes, how many different graduate students?

Answer: 1

Question 22 : What is the total number of student-months of involvement for all graduate students over the life of the proposed investigation?

Answer: 36

Question 23 : Provide the names and current year (1,2,3,4, etc.) for any graduate students that have already been identified.

Answer:

Isaac Rosenthal, 3rd year graduate student University of Massachusetts Boston with PI Byrnes.

PI Name : **Jarrett Byrnes**	NASA Proposal Number
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SECTION X - Budget

Cumulative Budget

Budget Cost Category	Funds Requested ($)			
	Year 1 ($)	Year 2 ($)	Year 3 ($)	Total Project ($)
A. Direct Labor - Key Personnel	**4,566.00**	**4,703.00**	**4,844.00**	**14,113.00**
B. Direct Labor - Other Personnel	**31,648.00**	**31,648.00**	**31,648.00**	**94,944.00**
Total Number Other Personnel	**1**	**1**	**1**	**3**
Total Direct Labor Costs (A+B)	**36,214.00**	**36,351.00**	**36,492.00**	**109,057.00**
C. Direct Costs - Equipment	**0.00**	**0.00**	**0.00**	**0.00**
D. Direct Costs - Travel	**4,491.00**	**4,491.00**	**4,491.00**	**13,473.00**
Domestic Travel	**4,491.00**	**4,491.00**	**4,491.00**	**13,473.00**
Foreign Travel	**0.00**	**0.00**	**0.00**	**0.00**
E. Direct Costs - Participant/Trainee Support Costs	**0.00**	**0.00**	**0.00**	**0.00**
Tuition/Fees/Health Insurance	**0.00**	**0.00**	**0.00**	**0.00**
Stipends	**0.00**	**0.00**	**0.00**	**0.00**
Travel	**0.00**	**0.00**	**0.00**	**0.00**
Subsistence	**0.00**	**0.00**	**0.00**	**0.00**
Other	**0.00**	**0.00**	**0.00**	**0.00**
Number of Participants/Trainees				**0**
F. Other Direct Costs	**205,418.00**	**218,938.00**	**166,655.00**	**591,011.00**
Materials and Supplies	**0.00**	**0.00**	**0.00**	**0.00**
Publication Costs	**1,500.00**	**0.00**	**0.00**	**1,500.00**
Consultant Services	**0.00**	**0.00**	**0.00**	**0.00**
ADP/Computer Services	**0.00**	**0.00**	**0.00**	**0.00**
Subawards/Consortium/Contractual Costs	**203,918.00**	**218,938.00**	**166,655.00**	**589,511.00**
Equipment or Facility Rental/User Fees	**0.00**	**0.00**	**0.00**	**0.00**
Alterations and Renovations	**0.00**	**0.00**	**0.00**	**0.00**
Other	**0.00**	**0.00**	**0.00**	**0.00**
G. Total Direct Costs (A+B+C+D+E+F)	**246,123.00**	**259,780.00**	**207,638.00**	**713,541.00**
H. Indirect Costs	**33,078.68**	**21,442.00**	**21,516.00**	**76,036.68**
I. Total Direct and Indirect Costs (G+H)	**279,201.68**	**281,222.00**	**229,154.00**	**789,577.68**
J. Fee	**0.00**	**0.00**	**0.00**	**0.00**
K. Total Cost (I+J)	**279,201.68**	**281,222.00**	**229,154.00**	**789,577.68**
Total Cumulative Budget				**789,577.68**

PI Name : **Jarrett Byrnes**	NASA Proposal Number
Organization Name : **University Of Massachusetts, Boston**	TBD on Submit

Proposal Title : **Using Citizen Science to Understand Thirty Years of Change in Global Kelp Cover by Expanding the Zooniverse to NASA Satellite Imagery Final Report**

SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
03 / 01 / 2018	**02 / 28 / 2019**	**Project**	**1**

A. Direct Labor - Key Personnel

Name	Project Role	**Base Salary ($)**	Cal. Months	Acad. Months	Summ. Months	Requested Salary ($)	**Fringe Benefits ($)**	Funds Requested ($)
Byrnes, Jarrett	**PI**	**0.00**			**.5**	**4,494.00**	**72.00**	**4,566.00**
							Total Key Personnel Costs	**4,566.00**

B. Direct Labor - Other Personnel

Number of Personnel	Project Role	Cal. Months	Acad. Months	Summ. Months	Requested Salary ($)	Fringe Benefits ($)	Funds Requested ($)
1	**Graduate Students**				**31,500.00**	**148.00**	**31,648.00**
1	Total Number Other Personnel					Total Other Personnel Costs	**31,648.00**
						Total Direct Labor Costs (Salary, Wages, Fringe Benefits) (A+B)	**36,214.00**

PI Name : **Jarrett Byrnes**	NASA Proposal Number
Organization Name : **University Of Massachusetts, Boston**	TBD on Submit
Proposal Title : **Using Citizen Science to Understand Thirty Years of Change in Global Kelp Cover by Expanding the Zooniverse to NASA Satellite Imagery Final Report**	

SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
03 / 01 / 2018	**02 / 28 / 2019**	**Project**	**1**

C. Direct Costs - Equipment

Item No.	Equipment Item Description	Funds Requested ($)
	Total Equipment Costs	**0.00**

D. Direct Costs - Travel

	Funds Requested ($)
1. Domestic Travel (Including Canada, Mexico, and U.S. Possessions)	**4,491.00**
2. Foreign Travel	**0.00**
Total Travel Costs	**4,491.00**

E. Direct Costs - Participant/Trainee Support Costs

		Funds Requested ($)
1. Tuition/Fees/Health Insurance		**0.00**
2. Stipends		**0.00**
3. Travel		**0.00**
4. Subsistence		**0.00**
Number of Participants/Trainees:	Total Participant/Trainee Support Costs	**0.00**

PI Name : **Jarrett Byrnes**	NASA Proposal Number
Organization Name : **University Of Massachusetts, Boston**	TBD on Submit
Proposal Title : **Using Citizen Science to Understand Thirty Years of Change in Global Kelp Cover by Expanding the Zooniverse to NASA Satellite Imagery Final Report**	

SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
03 / 01 / 2018	**02 / 28 / 2019**	**Project**	**1**

F. Other Direct Costs

	Funds Requested ($)
1. Materials and Supplies	**0.00**
2. Publication Costs	**1,500.00**
3. Consultant Services	**0.00**
4. ADP/Computer Services	**0.00**
5. Subawards/Consortium/Contractual Costs	**203,918.00**
6. Equipment or Facility Rental/User Fees	**0.00**
7. Alterations and Renovations	**0.00**
8. Other:	**0.00**
9. Other:	**0.00**
10. Other:	**0.00**
Total Other Direct Costs	**205,418.00**

G. Total Direct Costs

	Funds Requested ($)
Total Direct Costs (A+B+C+D+E+F)	**246,123.00**

H. Indirect Costs

	Indirect Cost Rate (%)	**Indirect Cost Base ($)**	Funds Requested ($)
UMB Indirect Cost, subcontractors included only to first 25K	**52.40**	**63,007.00**	**33,078.68**
Cognizant Federal Agency: **DHHS, Darryl W Mayes, 212-264-2069**		Total Indirect Costs	**33,078.68**

I. Direct and Indirect Costs

	Funds Requested ($)
Total Direct and Indirect Costs (G+H)	**279,201.68**

J. Fee

	Funds Requested ($)
Fee	**0.00**

K. Total Cost

	Funds Requested ($)
Total Cost with Fee (I+J)	**279,201.68**

PI Name : **Jarrett Byrnes**	NASA Proposal Number
Organization Name : **University Of Massachusetts, Boston**	TBD on Submit

Proposal Title : **Using Citizen Science to Understand Thirty Years of Change in Global Kelp Cover by Expanding the Zooniverse to NASA Satellite Imagery Final Report**

SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
05 / 01 / 2019	**02 / 29 / 2020**	**Project**	**2**

A. Direct Labor - Key Personnel

Name	Project Role	Base Salary ($)	Cal. Months	Acad. Months	Summ. Months	Requested Salary ($)	Fringe Benefits ($)	Funds Requested ($)
Byrnes, Jarrett	**PI**	**0.00**			**.5**	**4,629.00**	**74.00**	**4,703.00**
							Total Key Personnel Costs	**4,703.00**

B. Direct Labor - Other Personnel

Number of Personnel	Project Role	Cal. Months	Acad. Months	Summ. Months	Requested Salary ($)	Fringe Benefits ($)	Funds Requested ($)
1	**Graduate Students**				**31,500.00**	**148.00**	**31,648.00**
1	Total Number Other Personnel					Total Other Personnel Costs	**31,648.00**
						Total Direct Labor Costs (Salary, Wages, Fringe Benefits) (A+B)	**36,351.00**

PI Name : **Jarrett Byrnes**	NASA Proposal Number
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SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
05 / 01 / 2019	**02 / 29 / 2020**	**Project**	**2**

C. Direct Costs - Equipment

Item No.	Equipment Item Description	Funds Requested ($)
	Total Equipment Costs	**0.00**

D. Direct Costs - Travel

	Funds Requested ($)
1. Domestic Travel (Including Canada, Mexico, and U.S. Possessions)	**4,491.00**
2. Foreign Travel	**0.00**
Total Travel Costs	**4,491.00**

E. Direct Costs - Participant/Trainee Support Costs

	Funds Requested ($)
1. Tuition/Fees/Health Insurance	**0.00**
2. Stipends	**0.00**
3. Travel	**0.00**
4. Subsistence	**0.00**
Number of Participants/Trainees: Total Participant/Trainee Support Costs	**0.00**

PI Name : **Jarrett Byrnes**	NASA Proposal Number
Organization Name : **University Of Massachusetts, Boston**	TBD on Submit
Proposal Title : **Using Citizen Science to Understand Thirty Years of Change in Global Kelp Cover by Expanding the Zooniverse to NASA Satellite Imagery Final Report**	

SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
05 / 01 / 2019	**02 / 29 / 2020**	**Project**	**2**

F. Other Direct Costs

	Funds Requested ($)
1. Materials and Supplies	**0.00**
2. Publication Costs	**0.00**
3. Consultant Services	**0.00**
4. ADP/Computer Services	**0.00**
5. Subawards/Consortium/Contractual Costs	**218,938.00**
6. Equipment or Facility Rental/User Fees	**0.00**
7. Alterations and Renovations	**0.00**
8. Other:	**0.00**
9. Other:	**0.00**
10. Other:	**0.00**
Total Other Direct Costs	**218,938.00**

G. Total Direct Costs

	Funds Requested ($)
Total Direct Costs (A+B+C+D+E+F)	**259,780.00**

H. Indirect Costs

	Indirect Cost Rate (%)	**Indirect Cost Base ($)**	Funds Requested ($)
UMB Indirect Cost, subcontractors included only to first 25K	**52.40**	**40,842.00**	**21,442.00**
Cognizant Federal Agency: **DHHS, Darryl W Mayes, 212-264-2069**		Total Indirect Costs	**21,442.00**

I. Direct and Indirect Costs

	Funds Requested ($)
Total Direct and Indirect Costs (G+H)	**281,222.00**

J. Fee

	Funds Requested ($)
Fee	**0.00**

K. Total Cost

	Funds Requested ($)
Total Cost with Fee (I+J)	**281,222.00**

PI Name : **Jarrett Byrnes**	NASA Proposal Number
Organization Name : **University Of Massachusetts, Boston**	TBD on Submit
Proposal Title : **Using Citizen Science to Understand Thirty Years of Change in Global Kelp Cover by Expanding the Zooniverse to NASA Satellite Imagery Final Report**	

SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
03 / 01 / 2020	**02 / 28 / 2021**	**Project**	**3**

A. Direct Labor - Key Personnel

Name	Project Role	**Base Salary ($)**	Cal. Months	Acad. Months	Summ. Months	Requested Salary ($)	**Fringe Benefits ($)**	Funds Requested ($)
Byrnes, Jarrett	**PI**	**0.00**			**.5**	**4,768.00**	**76.00**	**4,844.00**
							Total Key Personnel Costs	**4,844.00**

B. Direct Labor - Other Personnel

Number of Personnel	Project Role	Cal. Months	Acad. Months	Summ. Months	Requested Salary ($)	Fringe Benefits ($)	Funds Requested ($)
1	**Graduate Students**				**31,500.00**	**148.00**	**31,648.00**
1	Total Number Other Personnel					Total Other Personnel Costs	**31,648.00**
						Total Direct Labor Costs (Salary, Wages, Fringe Benefits) (A+B)	**36,492.00**

PI Name : **Jarrett Byrnes**	NASA Proposal Number
Organization Name : **University Of Massachusetts, Boston**	TBD on Submit
Proposal Title : **Using Citizen Science to Understand Thirty Years of Change in Global Kelp Cover by Expanding the Zooniverse to NASA Satellite Imagery Final Report**	

SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
03 / 01 / 2020	**02 / 28 / 2021**	**Project**	**3**

C. Direct Costs - Equipment

Item No.	Equipment Item Description	Funds Requested ($)
	Total Equipment Costs	**0.00**

D. Direct Costs - Travel

	Funds Requested ($)
1. Domestic Travel (Including Canada, Mexico, and U.S. Possessions)	**4,491.00**
2. Foreign Travel	**0.00**
Total Travel Costs	**4,491.00**

E. Direct Costs - Participant/Trainee Support Costs

		Funds Requested ($)
1. Tuition/Fees/Health Insurance		**0.00**
2. Stipends		**0.00**
3. Travel		**0.00**
4. Subsistence		**0.00**
Number of Participants/Trainees:	Total Participant/Trainee Support Costs	**0.00**

PI Name : **Jarrett Byrnes**	NASA Proposal Number
Organization Name : **University Of Massachusetts, Boston**	TBD on Submit

Proposal Title : **Using Citizen Science to Understand Thirty Years of Change in Global Kelp Cover by Expanding the Zooniverse to NASA Satellite Imagery Final Report**

SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
03 / 01 / 2020	**02 / 28 / 2021**	**Project**	**3**

F. Other Direct Costs

	Funds Requested ($)
1. Materials and Supplies	**0.00**
2. Publication Costs	**0.00**
3. Consultant Services	**0.00**
4. ADP/Computer Services	**0.00**
5. Subawards/Consortium/Contractual Costs	**166,655.00**
6. Equipment or Facility Rental/User Fees	**0.00**
7. Alterations and Renovations	**0.00**
8. Other:	**0.00**
9. Other:	**0.00**
10. Other:	**0.00**
Total Other Direct Costs	**166,655.00**

G. Total Direct Costs

	Funds Requested ($)
Total Direct Costs (A+B+C+D+E+F)	**207,638.00**

H. Indirect Costs

	Indirect Cost Rate (%)	**Indirect Cost Base ($)**	Funds Requested ($)
UMB Indirect Cost, subcontractors included only to first 25K	**52.40**	**40,983.00**	**21,516.00**
Cognizant Federal Agency: **DHHS, Darryl W Mayes, 212-264-2069**		Total Indirect Costs	**21,516.00**

I. Direct and Indirect Costs

	Funds Requested ($)
Total Direct and Indirect Costs (G+H)	**229,154.00**

J. Fee

	Funds Requested ($)
Fee	**0.00**

K. Total Cost

	Funds Requested ($)
Total Cost with Fee (I+J)	**229,154.00**

Using Citizen Science to Understand Thirty Years of Change in Global Kelp Cover by Expanding the Zooniverse to NASA Satellite Imagery

Proposal Number (i.e., project number): 16-CSESP16-0024
Co-Operative Agreement Number: NNH16ZDA001N-CSESP
Name of PI(s), Co-Is and collaborators: Jarrett Byrnes, Kyle Cavanaugh, Alison Haupt, Laura Trouille
Name of Institution(s): University of Massachusetts, Boston. University of California, Los Angeles. California State University Monterey Bay. Adler Planetarium
Report Type: Final
Submission Date: 1/26/18

Executive Summary

In Floating Forests, we seek to harness to power of Landsat data and citizen science to understand how and why giant kelp forests have changed around the planet over the past thirty years. Moreover, we hope to use our citizen science project as a test case for the development of a user-friendly interface for the creation of online Landsat-based citizen science projects at The Zooniverse (http://zooniverse.org). Last, we seek to enhance engagement for this and future projects via the development of accessible visualization tools and curricula for university and high school students.

During the prototype phase we completed a total overhaul of our Landsat image processing pipeline for creating imagery for citizen science classification. We conducted a beta and complete relaunch of our platform at http://floatingforests.org, which included the development of a new smartphone app. This has seen tens of thousands of classifications and over one thousand unique users since the launch on December 13, 2017. We developed and tested a university level set of lab exercises with Floating Forests at its core at a primarily undergraduate and minority serving institution. We made available all of the data from version 1.0 of our platform, which consisted of ~750,000 classifications. Last, we used this data to validate our citizen science based approach to Landsat classification, and found that our consensus based classification approach agreed very well with expert classifications.

In the implementation phase, we will expand Floating Forests to map change in global kelp cover from the 1980s to the present. We will identify trends in global kelp cover, examine whether kelp range limits have shifted, and assess the degree to which these shifts are related to climate change. We will build and deploy a user friendly generalized interface for creating a Landsat-based citizen science project and demonstrate it at scientific meetings to facilitate its adoption. We will build additional visualization tools for Landsat-based projects to allow citizen scientists to quickly and easily work with our data. We will couple this with iterated versions of high school and university-level curricula that grow with these tools. Last, we will maintain a consistent data pipeline so that kelp forest citizen and professional scientists have easy direct access to our data.

Using Citizen Science to Understand Thirty Years of Change in Global Kelp Cover by Expanding the Zooniverse to NASA Satellite Imagery

1. INTRODUCTION

Long-term, global data sets are necessary to understand the impact of climate change. Remote sensing of earth systems has expanded understanding of planetary change (*1*). However, the utility of these data are limited by a processing bottleneck: automated classification is not possible for many applications (*2*) and small teams of researchers have limited manpower. Citizen science fills a key gap in the use of remote sensing data to understand long-term, large-scale shifts to ecosystems globally while communicating the importance of satellite data to the public. **Here we propose to use citizen science to analyze Landsat data to examine patterns and drivers of change in the global abundance of the foundation species giant kelp, *Macrocystis pyrifera*. In the process, we will expand an existing Citizen Science project-building tool from the Zooniverse enabling any scientist to freely and easily create a project using NASA Landsat data.**

Climate change is already impacting ecosystems (*3*). For example, rising temperatures have shifted the abundance and distributions of hundreds of plant species towards higher latitudes and elevations (*4*). Climate-related impacts to foundation species that provide food and habitat for communities are likely to be especially consequential (*5*). Giant kelp is a widely distributed foundation species (Fig. 1) that supports one of the most productive and valuable coastal ecosystems on earth (*6*). Giant kelp is particularly sensitive to changes in the environment (*6-12*); climate change has already impacted the abundance and distribution of giant kelp forests in some regions (*13*) including drastic declines in abundance in Tasmania (*13-16*).

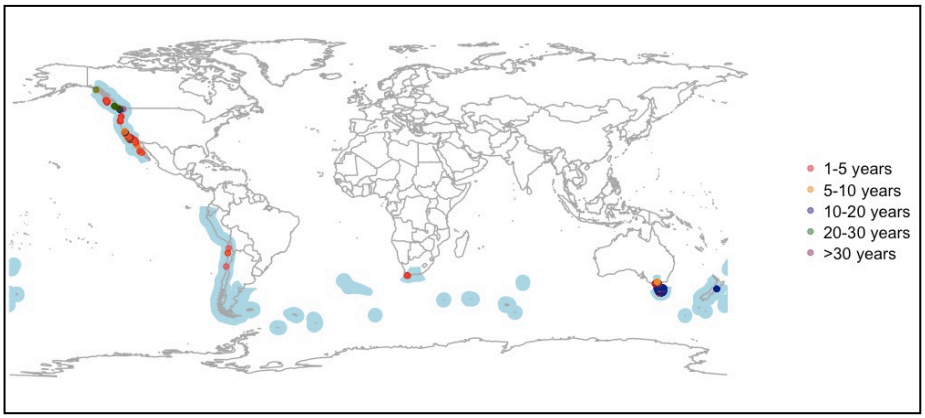

Figure 1: Distribution of the giant kelp, *Macrocystis pyrifera*, and location of all sampling efforts >3 years to date. Shaded blue regions are Ecoregions (*sensu* Spalding et al. 2008) that contain giant kelp. Points represent areas (typically <80m2) where kelp has been sampled for >3 years with color denoting times series length.

Have climate-change related phenomena changed the global abundance and distribution of kelp forests uniformly across the planet? Kelp is highly dynamic at regional scales (100s of km) and shows high variability at seasonal, interannual, and decadal scales, so we can see large fluctuations in giant kelp distribution and abundance in response to climate forcing events at short timescales (*17*). However, this variability also makes it difficult to identify the impacts of long-term climate change on kelp. Observing fluctuations in kelp abundance at a monthly time-scale over large spatio-temporal scales is difficult because of the vast range and the difficulty of underwater monitoring. Understanding the magnitude of this variability is key to derive a clear signal of climate-driven shifts in kelp's global distribution.

Characterizing changes in giant kelp on regional to global scales is impractical using field sampling techniques: only 0.03% of giant kelp's range has ever been sampled[1] (*18, Fig. 1*). Fortunately, long-term satellite global imagery make it possible to observe kelp forest surface canopies on larger space and time scales (*17*), but mapping giant kelp from remote sensing data cannot yet be fully automated and manual classification is highly time intensive. To address this issue we have worked with the Zooniverse to create Floating Forests (http://floatingforests.org), an online citizen science project. In less than two years, citizen science has enabled us to map thirty years of giant kelp forest dynamics from Point Reyes to San Diego, CA and around the entirety of Tasmania. It has provided a roadmap for expanding Floating Forests globally and a framework for coupling citizen science and remote sensing data.

1.1 Online Citizen Science and The Zooniverse

The Zooniverse is the world's largest and most successful platform for citizen science online with a workforce of 1.6 million volunteers worldwide. It supports more than seventy active projects across disciplines, producing data that has been used in more than 120 peer reviewed papers. Zooniverse is unique among the open source, free, crowdsourcing options as a result of its 1) shared software, experience, expertise, and input from users across disciplines, 2) reliable, flexible, and scalable back-end, 3) free, do-it-yourself (DIY) 'Project Builder' (also known as Panoptes) capabilities as described below, and 4) the scale of its existing audience. With this proposed effort, Zooniverse hopes to expand the scope of 'Project Builder' to enable scientists working with remote sensing data to easily create their own online citizen science projects.

1.2. Floating Forests

In 2013, our research team and the Zooniverse collaborated to create Floating Forests, an online citizen science project to classify kelp forests from Landsat imagery. We split each Landsat scene into 400 images of equal size, which were then served to users via an online classification platform (see below). After a brief tutorial, users circled any kelp beds they saw in randomly selected images. At the initiation of the prototype phase, we had completed our California and Tasmania datasets through 2012, and were ready to examine those results to redevelop and expand the program. In the proposal we refer to this initial version as Floating Forests 1.0 and the prototype phase as 2.0.

2. Prototype Phase

During the prototype phase, we laid out four major goals. 1) To use the data we had acquired thus far to validate the citizen science approach to mapping kelp forests. Related to this, we would publically release of all 1.0 classification data. 2) To redevelop the Floating Forests image pre-processing pipeline to improve image quality, ease of image acquisition, and develop the framework for a generalized NASA Landsat imaging pipeline integrated into the Zooniverse's free Project Builder interface. 3) To build a demonstration Floating Forests site with the new Zooniverse Project Builder interface. 4) To develop prototype curricula for high school and college levels that links the Floating Forests platform, kelp forest ecology, and global climate change. These goals necessitated increased communication and partnership between project scientists, the Zooniverse, and our citizen scientists. We have met or exceeded all of these goals.

2.1 Validation of Online Citizen Science to Map Kelp Distributions from Landsat

[1] http://temperatereefbase.imas.utas.edu.au/portal/search?uuid=ecbe5cc3-3fbf-4569-b5e8-07c2201fcb9c

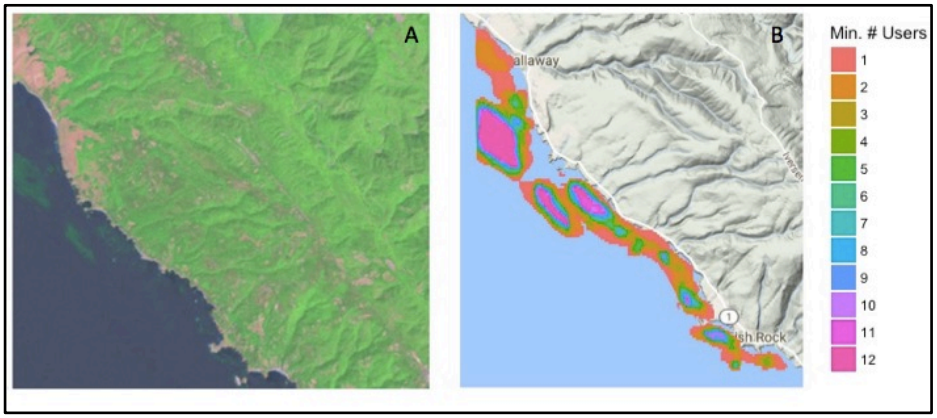

Figure 2: Consensus classifications work for a single image. A) Image taken from Landsat scene served to individual citizen scientists. B) The consensus classifications of 15 users. Color indicates the number of users who jointly agreed that a pixel contained kelp.

We created consensus results from user classifications from Floating Forests 1.0 and validated those consensus results against extant expert classifications. Consensus-based classification ensured that we accurately detected kelp. *Every image was classified by at least four different users* to determine if kelp is present. If one or more users observed kelp in the image then it was *classified by a total of 15 users*. We overlaid all the classifications and generated a consensus map of kelp (Fig. 2). We determined 1) how many users that identify a pixel as kelp are needed to confidently classify it and 2) how consensus results compared to expert classifications.

To validate citizen science as a robust way to classify kelp forests, we compared classifications at different thresholds of minimum number of users selecting a pixel as kelp (Fig. 2a) to expert classifications of Landsat kelp in California from 1983-2011 (*17*, *19*). To assess accuracy, we used Matthews Correlation Coefficient (*20*, *21*), a method to evaluate the fit between observed and predicted classifications. This method takes into account true and false positives and negatives when the classes are of very different sizes. We used MCC as our images contain only a small percentage of kelp. A score of 1 means perfect fidelity and -1 means perfect failure, and 0 is a coin flip. We found that across all images assessed, an optimum threshold of 4.2 users per image maximized MCC at ~0.6 for Landsat 8 and 0.4 for Landsat 5 and 7, indicating a strong concordance (see *22* for preprint and more results).

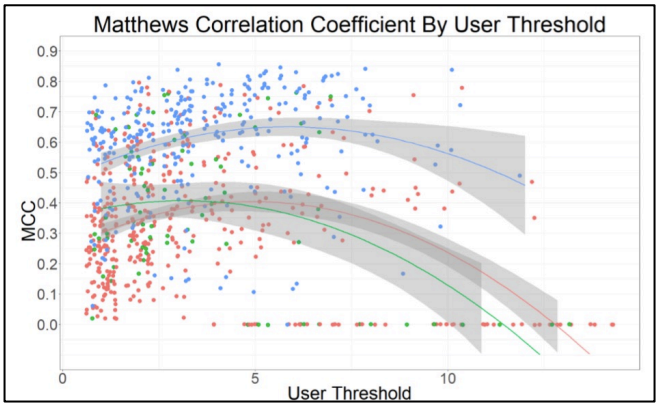

Figure 2: Model output displaying correlation between user threshold and MCC for each satellite (Landsat 5, 7, and 8). Landsat 5 (green) and 7 (red) did not differ in optimal user threshold (4.2) or MCC (0.400, SE: 0.023). Landsat 8 (blue) had the same optimal user threshold), but a higher MCC (0.639, SE: 0.246.

2.2 Redevelopment of Landsat Processing Pipeline for the Floating Forest Platform

We changed our image-processing pipeline in response to feedback from our citizen scientists. These changes enabled us to better filter out images that do not contain coastline and improve the quality of the images that we provide to the users. We now use atmospherically corrected Landsat Surface Reflectance (LSR) products as our imagery source, improving the radiometric consistency of our images and allowing us to use the same color corrections across different scenes. We also changed the scale of our subset images to 10.5km on a side. This results in a

slightly more zoomed in image subset, making it easier for users to identify small kelp beds. We decided not to allow users to manually adjust the zoom as it could add a large amount of variability. However, we plan to run an experimental zoom trial to validate this choice. Each image subset is displayed with the short-wave infrared band as red, the near infrared band as green, and the red band as blue. The high near infrared reflectance of kelp canopy causes it to stand out as bright green with this band combination. Green values (near infrared reflectance) are enhanced using a custom contrast stretch. The reflectance values that correspond to kelp canopy are boosted using a nonlinear lookup table that was determined empirically from a subset of images from Tasmania and California. Since kelp is the only feature in the ocean with significant near infrared reflectance, this non-linear stretch increases the contrast between kelp and water.

We implemented a two-stage process to filter out images that do not contain any coastline. This improvement has greatly reduced the number of "bad" images that users see. First, we utilize the LSR pixel quality assessment (QA) band to identify images that are covered by land or clouds. We then apply a band ratio filter to remove open ocean images that do not contain any coastal kelp habitat. Land pixels tend to have high reflectance in the red relative to blue, so we calculate red/blue ratios and remove images where all pixels are below a threshold.

2.3 Project Builder Floating Forests Platform

In the prototype phase, we proposed to build a rough prototype of the Floating Forest 2.0 website to solicit feedback from our citizen scientists and improve our design: we far exceeded this goal. Rather than just build a prototype, we used the Zooniverse's Project Builder interface to create a fully functional Floating Forest 2.0 website with a freehand selection tool (http://FloatingForests.org), ran a beta review, iteratively revised the design in collaboration with the Zooniverse team, and fully launched the project to the public. Despite best efforts, stringent image filtering in our pipeline produced a false-negative rate (removed images incorrectly) that was too high. On co-PI Trouille's suggestion, we implemented a second 'swipe' workflow for smartphones: users 'swipe right for kelp' when beds were present in an image (i.e., no circling, just presence/absence). This workflow was ideal for smartphones, broadening our available audience while improving early-stage image filtering of images without kelp. We also developed a more comprehensive Field Guide and Tutorial to ease user confusion. We launched the beta in April with 154 registered volunteers generating 3,156 classifications. We then requested feedback from citizen scientists that we used to make changes to our processing pipeline.

With these modifications, we launched our Floating Forest 2.0 site in December 2017 to coincide with the American Geophysical Union (AGU) meeting. We focused the Falkland Islands, a relatively small and manageable data set. In the first week, we had 5,306 classifications. At time of submission, we have classified half of the data set. The smartphone workflow was enormously successful, with 8,359 classifications in the first week. The entire filtering process took only three weeks, suggesting that the swipe workflow is viable method to improve image quality for the classification-marking interface.

2.4 Initial Development of Curricula for High School and University Students using Floating Forests

We proposed to create prototype curricula for high school and college-level classes through the Recruitment In Science Education (RISE) high-school program and a class at CSUMB. Inquiry-based curricula have been shown to be a high-impact teaching practice and retain students within the science discipline. PI Haupt worked with the curriculum coordinator at Zooniverse to develop and implement a module based on Floating Forests in her CSUMB Marine Ecology

class with the three main objectives: apply knowledge of kelp forest ecology to generate questions and hypotheses, practice principles of data analysis, and place results in a broader ecological context. First students were introduced to the importance of kelp as a foundational species and the ecology and biodiversity of kelp forests through an interactive lecture. Second, students engaged with the Floating Forest platform: they created profiles for the site, went through the tutorial, and classified images. Third, students were introduced to the different types of data available to them (kelp biomass levels, sea surface temperature, upwelling indices, various human impact data) and asked to generate hypotheses about how these different types of data might impact kelp. Students were asked to draw on what they had learned and to support these hypotheses with scientific articles. Fourth, students took the data they were given and looked for patterns and relationships. Finally, students wrote a scientific paper-style lab write-up to communicate their results and place them in a larger ecological context. Due to scheduling issues, the high school curricula, will be implemented in the RISE program in Spring 2018.

2.5 Citizen Scientist Engagement and Data Distribution

Throughout the prototype phase, we focused on keeping our citizen scientists engaged through social media and our project blog. Floating Forests 1.0 completed its run with 7,155 users contributing 2,918,625 classifications and fully classifying 758,504 images and 7,314 exchanges in the interactive talk section of the site. On January 15th, our new site, launched in December 2017, had 951 unique users contributing 25,130 classifications thus far and 204 unique interactions in Talk discussion forum. Further, in the Talk section, we have already engaged with citizen scientists to develop ideas for future mini-projects (e.g., a zoom functionality), we have developed a challenge to track seasonality of Falklands kelp forests using hashtags, and are now collaborating with a middle school teacher to bring Floating Forests into her classroom. Since launch, we have also re-dedicated ourselves to regularly posting within our Floating Forest blog, a key method for keeping our citizen scientists engaged and informed. We have not implemented Google hangouts yet, as our plan was to use them in concert with our new platform in the Spring.

As mentioned above, project PIs have also begun making these data freely available to citizen scientists and the broader scientific community and discussed the data and results to date through our project blog. We have deposited the data at Temperate Reefbase[2] (TRB), a public data portal for temperate rocky reef data. This site allows for the dissemination of tabular and geospatial data sets from anyone. The data is catalogued using the ISO 19115 compliant Marine Community Profile 2.0 (*23*) as a metadata standard and is freely available for use in any GIS platform, including Google Earth.

2.6 Products and Deliverables

During the prototype phase, we produced the following products that are all publically available.

Deliverable	Completion status	Results/Artifact of completion (If completed)	Reason for lack of completion (If incomplete)
FF Validation Manuscript	Yes	https://arxiv.org/abs/1801.08522	
Data Deposition from FF 1.0	Yes	http://temperatereefbase.imas.utas.edu.au/portal/search?uuid=554ef3f6-4f05-4e40-bbf5-1e6dd31d920c	

[2] http://temperatereefbase.imas.utas.edu.au/portal/search?uuid=554ef3f6-4f05-4e40-bbf5-1e6dd31d920c

Image Processing Pipeline	Yes	https://github.com/zooniverse/ff-import https://github.com/jebyrnes/ff-import-pipeline/	
Curricula for University and High School students	Partly	Implemented at CSUMB.	High school partner scheduling conflicts in fall.
Project Builder FF Platform	Yes	http://floatingforests.org	
Blogs to engage citizen scientists	Yes	http://blog.floatingforests.org	
Ongoing Twitter Presence	Yes	http://twitter.com/floatingforests	
Freehand selection tool on Zooniverse	Yes	See http://floatingforests.org	

3. Implementation Phase

While we have achieved much in the prototype phase, our implementation phase will 1) enable us to examine changes in the global distribution and abundance of giant kelp forests, 2) integrate the NASA Landsat data processing pipeline into Zooniverse's free Project Builder, providing a user-friendly tool and interface for any scientist to build and run a Landsat-based citizen science project, 3) add tools to increase citizen science access to Floating Forest data, and 4) build-out curricula to bring Floating Forests into classrooms from high school through university.

3.1. OBJECTIVE 1 – Evaluate Links Between Climate Change and Giant Kelp Populations

The sensitivity of giant kelp forests to changes in environmental conditions suggests that these systems may be a bellwether for the climate change effects. As discussed above, we have already witnessed significant climate change impacts on giant kelp distributions in Tasmania but these studies span only a small portion of giant kelp's range. We do not know how the abundance and distribution of giant kelp has changed in globally or if changes might be due to climate. To address this knowledge gap, **we will use the dataset produced by Floating Forests to (1) examine spatiotemporal variability in giant kelp range limits and abundance globally, and (2) identify the primary drivers of this variability.**

3.1.1 Documenting trends in giant kelp range limits abundance on global scales

The prototype phase has enabled us to more accurately estimate the time needed for a region to be classified. We estimate that 6,000 images will take roughly 2-3 months for citizen scientists to classify. The Falklands Islands dataset used for the relaunch is 10,000 images alone, with an estimated time to completion of 4 months. We therefore will split our analysis of climate drivers into two pieces. First an analysis of changes in kelp distributions at their range limits, which we will launch as "Kelp on the Edge" upon completion of the Falklands test run. Second a full-scale analysis of global kelp distributions and climate drivers as we move towards a full global dataset. For both, we will separate kelp distributions into 7 regions: northeast Pacific (Aleutian Islands to Baja California), southeast Pacific (Peru and Chile), Argentina, South Africa, Southern Australia (including Tasmania), New Zealand, and the sub-Antarctic Islands (Fig. 1).

For the range limit analysis, we will acquire Landsat imagery from the reported equatorward range boundaries of giant kelp (*24*) to 400 km towards the poles. We will run processed imagery through the swipe interface to identify the equatorward range limit each year. We will use the time series to document changes in range limits around the world from 1984-present. Images with kelp will be moved to the classify interface so we can ask if the abundance of kelps in the specified range edge has changed over time.

As regions are classified, we will perform regional analyses of change before a global analysis of changes in kelp abundance. This will allow us to maintain citizen scientist excitement as we launch and complete smaller projects and generate pulses of user activity with each

regional launch. For analyses we will bin the kelp data into 10.5 km alongshore segments –the size of a Zooniverse image – by assigning each kelp canopy observation to the closest coastline segment and calculating the composite canopy area. Giant kelp populations are variable on intra-annual timescales due to seasonal cycles of environmental factors (*19*) and inter-annual timescales due to longer scale variability in environmental conditions and biotic processes (*8*, *17*). We are interested in variability that might affect the long-term persistence of giant kelp, so we will concentrate on characterizing variability on annual to decadal timescales. We will calculate yearly maximum canopy area for each coastline segment from 1984-2016 to remove seasonal variation to assess long-term annual trends.

We will use generalized linear mixed models to estimate proportional rates of change per year for the entire time series (1984-2016) as well as each decade. This analysis will enable us to characterize long-term trends in giant kelp abundance on local (kms) to regional (100s to 1000s of kms) to global scales. These analyses will represent the most comprehensive analysis of spatiotemporal variability in kelps to date.

3.1.2. Identifying environmental and climatic controls of giant kelp range limits and abundance
There has been a large amount of research into the environmental factors that control dynamics of giant kelp populations (*6*, *17*, *19*), but most of these studies have focused on the west coast of California. It is unclear how the roles of these drivers vary on regional to global scales and whether long-term trends in temperature and wave energy match trends in kelp abundance, as we hypothesize. We expect the relative importance of those drivers to vary a great deal, as they do *within* California (*19*). We must identify environmental drivers associated with changes in kelp abundance and the variability in their local importance in order to understand how climate change will impact giant kelp distributions.

We will compare our time series of kelp distributions and abundances to variables that are anticipated to control giant kelp dynamics and evaluate how their importance changes regionally. We will focus on macroclimatic controls of kelp growth and survival - waves, SST, nutrients, and photosynthetically available radiation - as well as local-scale anthropogenic drivers such as nutrient pollution and coastal development. For each drivers, we identified available data layers or modeling techniques to generate them (*25*-*35*) (Table 2). Not all of the environmental data sets will be available for the entire period of our proposed Landsat time series of kelp dynamics (1984-present). Thus, some analyses will be necessarily regional, restricted in time, or variables will be incorporated into hierarchical models. We will use a variety of statistical techniques to assess the relationships between kelp dynamics and environmental variables including regression approaches comparing trends in kelp to trends in drivers, Empirical Orthogonal Function analyses (*19*, *36*), hierarchical Bayesian models of time series data (*37*), and generalized additive models GAMS to identify thresholds of predictor variables (*19*, *38*). These relationships will identify tipping points where a small environmental change may have a significant impact on kelp forests ecosystems and identify regions that might be sensitive to small changes.

Table 2. Environmental predictor datasets and their sources.

Parameter	**Source**	**Spatiotemporal extent**
Sea surface temperature	MODIS/AVHRR data products, Coastal Zone Color Scanner, SeaWiFS	Global; 1984-present
Surface nitrate	Modeled using *in situ* measurements of temperature, chlorophyll *a*, and nitrate from the World Ocean Database and MODIS and MODIS level 3 imagery of SST and chlorophyll *a*; Silió-Calzada et al. 2008	Global; 1997-present
Chlorophyll *a*	MODIS/VIIRS data products, SeaWiFS data products	Global; 1997-present
Wave disturbance	WAVEWATCH III, SWAN; Tolman 2009, Chawla et al. 2012, Tolman et al.	Global; 1984-present

	2014, Booij et al. 1999, Ris et al. 1999	
Surface/bottom PAR	Modeled using MODIS/VIIRS, MERIS, and SeaWiFS surface PAR and kd 490 data products; Saulquin et al. 2013	Global; 1997-present
Substrate	California Seafloor Mapping Program; Cochrane and Lafferty 2002	California
Bathymetry	NOAA ETOPO1 Global Relief Model; Amante and Eakins 2009	Global
Coastal development	VIIRS city lights groundtruthed against population densities; Miller et al. 2008	Global; 2011-present
Coastal Nutrient Runoff	Marine Cumulative Impacts Map; Halpern et al. 2008	Global; Static

3.2. OBJECTIVE 2: Develop a general platform for creating Landsat-based Citizen Science projects

Floating Forests provides an excellent example for how Landsat data can be incorporated into a citizen science program to answer transformative research questions. Other potential Landsat projects include mapping terrestrial land cover change, urbanization, and changes in surface water abundance (e.g. lake areas). During our implementation phase effort, we will **optimize the Zooniverse Project Builder to support members of the Earth Science community working with Landsat satellite data to rapidly launch online citizen science projects for free.** We will make available the needed annotation and marking tools, a user-friendly data pipeline for uploading Landsat data into the Project Builder, and data visualizations for citizen scientists and researchers to contextualize the images and their results. Our efforts will focus on Landsat, but this work will lay the foundation for future efforts to provide pipelines for other satellite datasets (e.g. Sentinel 2, MODIS, or high resolution commercial imagery).

3.2.1 A Landsat-based Project Builder for Rapid Remote Sensing Citizen Science

In July 2015 Zooniverse launched a new version of its platform using a free, DIY Project Builder. The Project Builder is a Ruby on Rails application supporting a powerful Application Programing Interface (API) that creates and manages projects, passes subjects to the Javascript front-end, records classifications, aggregates the results, tracks project statistics, etc. Data is saved in a JSON format in a PostgreSQL database to maximize flexibility by avoiding the need to define a rigid structure for classifications, while still providing easy search. The Project Builder is transformative; prior to its development a typical project required professional web development and months to years of development time. Now anyone can build and deploy a project within hours, using browser-based tools. The Project Builder supports the most common types of interaction including classification, multiple-choice questions, comparison tasks, and marking and free-hand drawing tools. All Project Builder projects come with a landing page, classification interface, discussion forum, 'About' pages for content about the research and the research team, a 'Talk' forum, and blog. Before public launch, all Project Builder built projects go through a beta review process in which several hundred Zooniverse volunteers provide feedback about usability and clarity through a standardized form. Since the launch of the Project Builder in July 2015, over 2000 DIY projects have been created, 150 have been serious attempts generating classifications, and over 35 have had public launches with promotion through Zooniverse.org. Each week, ~1 new Project Builder built site requests review.

Through this implementation phase, we will generalize our Landsat image pre-processing pipeline created in the prototype phase to support the range of parameters that other Landsat based projects might require. The Zooniverse team will develop a user-friendly data management interface and integrate this Landsat data pipeline into their free Project Builder interface. Through the interface, researchers will identify regions and time periods of interest. We have

prototyped a version[3] of this using the Google Map API, in which a researcher marks out the area on a Google map, the coordinates are stored in a KML file, and are used to kickstart a query to the NASA API. Researchers will review different choices for the size of their sub-images before deciding on the size for their project. Researchers will have the ability to toggle whether to include or remove images with only ocean or land; functionality developed during the prototype phase. The interface will also include the ability to select the spectral bands to use, adjustments for brightness and contrast, and provide filtering tools based on those values and cloud masks. If filtering produces too many false positives, we will give users the option to create a swipe workflow as a first layer of filtering, as has proven beneficial in the prototype phase of Floating Forests. The filtered processed images will be uploaded into the researcher's project. An important aspect of the data pipeline is the ability to scale with use. With this in mind, the pipeline will be loaded in a Docker container and hosted on Amazon Web Services, mirroring the architecture for Zooniverse as a whole. The Floating Forests research team will work closely with Zooniverse as they develop and implement the data pipeline, with Floating Forests serving as the test case for the fully automated pipeline.

3.2.2 Best Practices and Facilitating the Spread of a Landsat-based Project Builder

Zooniverse created a 'Best Practices Guide' for research teams to use the Project Builder to build their site as well as successfully engage with their online volunteer communities. This 'Best Practices Guide', which was developed collaboratively with Zooniverse volunteers, research team members, and Zooniverse team members, thoughtfully addresses the recommendations from the Federal Crowdsourcing and Citizen Science toolkit. Through this proposed effort, we will add information about our new NASA Landsat data pipeline tools within the Project Builder and best practices for their use. ***To spread these best practices and get more scientists to implement citizen-science based Landsat projects, PIs will host a Project Builder workshop at the annual American Geophysical Union meeting.*** There, we will introduce scientists to the Project Builder and the Landsat data pipeline and help them begin to create their own projects. We will also lead a discussion around best practices for online citizen science.

3.3. OBJECTIVE 3 - Improve Citizen Science access to and interaction with Floating Forests

As part of the Floating Forests project, we want to allow citizen scientists and stakeholders to access our data and results in contexts they find most meaningful. During the prototype phase, this took the form of data release and a series of posts detailing what the data said. This was still too esoteric. During the implementation phase, we are interested in providing dynamic visualizations of change in local kelp beds to students and citizen scientists. We want people to easily get to know the kelp forest in their backyard.

3.3.1. Data visualization

During the prototype phase, we began building visualization tools within scientific computing environments. While the code for these efforts is freely and publicly accessible, it is not something we expect the broader public to dive into. Rather, we seek to work with the Zooniverse to develop more robust, accessible, and user-friendly interactive data visualizations for citizen scientists and researchers to contextualize the Floating Forest images, data, and results. This will include an interactive map in which the user can toggle on and off the presence

[3] See https://www.youtube.com/watch?v=7dqJa9ZdZrs&feature=youtu.be

of kelp, and animate change over time. We will also include tools to overlay and toggle on and off other layers of information from the climate analysis and compare climate variables and kelp abundance through time. The code supporting these interactive data visualizations will be built into the Zooniverse infrastructure. This will enable the Zooniverse team to provide interactive data visualizations for other Zooniverse projects with similar data and metadata as Floating Forests, thus broadening the impact of this data visualization development effort.

3.3.2. Retain citizen scientists via interaction with project scientists

We want Floating Forests to retain interested citizen scientists by being as interactive with the research team and data as possible. First, to retain citizen scientists, we are shrinking the spatial extent of 'rounds' to keep in contact with them when new data is uploaded. Second, as part of the current and future project websites, we have a Talk section where citizen scientists can discuss and ask questions about the images they are classifying. There were 7,230 comments in 1.0. We have a weekly schedule for project scientists to check into Talk threads, which will continue in the future. To strengthen interaction, we are also adopting a suggestion of Zooniverse and setting up mini-challenges. For the Falklands, we are ask users to tag images that are #sokelpy with a month hashtag. We then return that data to them weekly. Future mini-projects include noting urban structures, harbors, beaches, and more to let users see if kelp is abundant or not around coastal features. We are also implementing a citizen science suggestion to contrast classifications with or without pan and zoom features after our current Falklands round completes.

To reach beyond the project website, we also use social media outlets. We maintain a project blog to discuss Floating Forests and kelp forest science. Posts typically get 100-200 hits. Information is also disseminated via our project Twitter feed, @FloatingForests, and re-disseminated by PI Byrnes to his 3.3K followers of @jebyrnes with the hashtag #kelp. The use of this hashtag allows for broader dissemination to Twitter users interested in kelp biology, ecology, tourism, and farming; it currently has an estimated reach of 643Kusers[4].

3.3.3 Recruitment of New Citizen Scientists

While Floating Forests has built a large audience, we will pursue multiple avenues to recruit new citizen scientists. We will build new partnerships to expand our user base. We will target existing ocean and climate change podcasts such as Thank You Ocean, Warm Regards, and others to promote our project. We will pitch a story to Public Radio International's Living on Earth, currently hosted at UMB. We are also currently engaged in discussions with the Long Beach Aquarium to work with them to add some element of Floating Forests to their kelp forest exhibit.

3.4. OBJECTIVE 4 - Bringing kelp forest citizen science into the classroom

A key value in this proposal is a partnership between citizen science, research, and science education and outreach. Research has underscored that hands-on learning in courses is a high-impact teaching practice inspiring lasting interest in science. Through educational partnerships, we will create curricula that can be available via the Floating Forests website for use in high school and college classrooms. These curricula will expose students without access to the marine environment to the importance of kelp forests through hands-on inquiry-based projects that will address science practices and cross-cutting concepts in line with Next Generation Science Standards (*39*). At CSUMB, funding will benefit a primarily undergraduate institution (PUI), an early career female PI (Haupt), and underrepresented undergraduates who are primarily first-

[4] As estimated by http://keyhole.co/ on January 9, 2018

generation college students. During the prototype phase PI Haupt developed a sample curriculum that she integrated into an upper division marine ecology course at CSUMB and being implemented this spring with the RISE program.

The implementation phase will take prototype curricula and iterate each year to improve and make it useable to a broad audience of students and instructors. At the end of the implementation phase we will have a set of curricula for the high school and college levels that can be used by any interested teacher. These curricula developed during the prototype year, were primarily exploratory and for the college-level class relied on R-based analysis. One lesson learned, is that the curricula itself needs to be more proscriptive for instructors and students. To do this, we will first create a curated data set from the Floating Forests data that is cleaned up and includes metadata attributed to each location and date in the dataset: e.g. sea surface temperature, available rocky habitat, El Niño indices, human impact levels. This data sheet will be integrated into a Google sheets platform, which is a platform many classrooms are already using, is free to use, and easy to operate. The Google sheets platform will have macros for analysis already built into it, so students can choose different factors to compare kelp biomass changes over time to examine relationships quantitatively and visually. Instructors will be provided with complete notes about how to use the Google sheets format, common problems, and expected results, so they don't have to already be experts. This will allow students the flexibility to explore the data while enabling instructors to guide them and check their work.

In year one of the implementation phase, PI Haupt will revisit the curricula developed for the CSUMB and RISE courses and will identify specific sample data sets that instructors can use to lead their students through a series of exercises using a Google sheets platform. In year two of the implementation phase, we will make these curricula available to a small group of faculty and teachers beyond CSUMB and RISE so that we can get feedback about ease of use and applicability to other institutions. In year three of implementation we will incorporate this feedback, re-implement curricula in more institutions, and make these curricula public at the end of the implementation phase. All lesson plans will be uploaded to Zooteach, Zoonivere's teacher resource center, SciStarter's citizen science curriculum collection[5], and Curriki[6] for long-term access. University curricula will be disseminated to the Kelp Ecosystem Ecology Network[7], an international group of kelp forest scientists working to understand kelp global change biology.

Additionally, two CSUMB undergraduates will be selected to conduct independent research projects on kelp biomass changes over time and potential anthropogenic effects. The Marine Science program at CSUMB specifically focuses on geospatial tools and undergrads at CSUMB are particularly well prepared to participate in this project. CSUMB's Undergraduate Research Opportunities Center (UROC), which hosts several minority participation programs, will provide students guidance, professional development, and financial support.

4. PLAN FOR PROJECT AFTER THE CONCLUSION OF THE AWARD

The science, public implementation of Project Builder, and educational curriculum will continue after the completion of the award. First, Floating Forests itself will continue in perpetuity and will be updated on an annual basis with new imagery unless tools are implemented to generate automated kelp classification from Landsat images. If that happens, we will work with those researchers to merge our data sets, and maintain a unified global giant kelp data set that is freely

[5] http://scistarter.com/page/Educators.html

[6] http://www.curriki.org/

[7] http://kelpecosystems.org

available. As the time series grows, so will its utility to kelp forest researchers around the world. Second, Zooniverse will continue to maintain the Landsat data pipeline for their free Project Builder. The broad research community will continue to benefit as they can create new remote-sensing citizen science projects as needed. Last, educational materials will continue to be hosted at Zooteach, SciStarter and Curriki. PIs will use and expand on these materials and the relationships they build in future proposals to NOAA SeaGrant, NSF Biological Oceanography, and NASA as a key building block for their broader impacts.

5. PERSONNEL AND PROJECT MANAGEMENT PLAN

Jarrett Byrnes will serve as lead PI and be responsible for overall project coordination, management, and reporting. He will coordinate and direct regular meetings of all PIs to assess progress and conformance to timelines. All team members already interact daily to weekly on a shared Slack channel. PI Byrnes will also hold an annual "all-hands" in-person meeting or workshop to distribute responsibilities, share results, review progress, plan manuscripts, and establish deadlines. He will supervise a graduate student Isaac Rosenthal whose dissertation will focus on urban kelp forests in Floating Forests data and who was responsible for data validation during the Prototype Phase. PI Byrnes will manage the data pipeline for Floating Forests, coordinate the project blog and social media efforts, and perform additional data validation and dissemination. Co-PI-Cavanaugh will lead the tasks associated with analysis of long-term change in global giant kelp range limits, abundance, and impacts of climate. He will contribute to the activities associated with the data pipeline creation. PI-Cavanaugh will supervise a postdoc student at UCLA whose will focus on the analysis of environmental and human impacts on global kelp forests. Co-PI Alison Haupt will lead all of the curriculum development and teacher outreach activities. She will supervise two undergraduate interns each year. Co-PI Laura Trouille from Zooniverse will lead the development of the Landsat data pipeline integrated with the Zooniverse Project builder, as well as the suite of data visualization tools.

6. PROJECT TIMELINE

During the implementation phase we will continue to release new content onto Floating Forests at 3-6 month intervals, depending on completion time. In year one, we will complete a Zooniverse Project Builder Landsat data pipeline and begin work on the Project Builder Landsat user interface. We will implement the high school curriculum. In year two, we will continue generating new Floating Forest data, begin the spatiotemporal analysis of kelp abundance and distribution with the project postdoctoral fellow, and develop visualization tools through Zooniverse. We will also revise and expand our curricula. In year two and three, we will hold Landsat Project Builder workshops at AGU. In year three, we will complete analysis of climate drivers on global kelp forests as well as publishing a manuscript on Floating Forests in the classroom. Throughout, we will continue user retention and acquisition plans to maintain a large and active citizen scientist user base.

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(a) Appointments

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(b) Professional Preparation

1997-2001 Brown University, Providence RI Bachelor of Science in Biology
2002-2008 UC Davis, Davis CA Population Biology, M.S. Ph.D.
2008-2010 Santa Barbara Long Term Ecological Research Project, Postdoctoral Fellow
2010-2012 National Center for Ecological Analysis and Synthesis, Postdoctoral Fellow

(c) Products

(i) List of Five Relevant Products

1. Krumhansl, K.A., Okamoto, D.K., Rassweiler, A., Novak, M., Bolton, J.J., Cavanaugh, K.C., Connell, S.D., Johnson, C.R., Konar, B., Ling, S.D., Micheli, F., Norderhaug, K.M., PÈrez-Matus, A., Sousa-Pinto, I., Reed, D.C., Salomon, A.K., Shears, N.T., Wernberg, T., Anderson, R.J., Barrett, N.S., Buschmann, A.H., Carr, M.H., Caselle, J.E., Derrien-Courtel, S., Edgar, G.J., Edwards, M., Estes, J.A., Goodwin, C., Kenner, M.C., Kushner, D.J., Moy, F.E., Nunn, J., Steneck, R.S., Vásquez, J., Watson, J., Witman, J.D., **Byrnes, J.E.K.,** 2016. Global patterns of kelp forest change over the past half-century. Proceedings of the National Academies of Sciences. 113, 13785–13790.

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(d) List of Five Synergistic Activities

1. Coordinator for the international Kelp Ecosystem Ecology Network. http://kelpecosystems.org

2. Contributing Developer to *piecewiseSEM*, *lavaan*, *sem*, and *semTools*- Libraries for the analysis of Structural Equation Models in R http://lavaan.org, https://github.com/simsem/semTools/wiki, http://github.com/jslefche/piecewiseSEM

3. Marshlife.org http://marshlife.org - A blog part of a MIT SeaGrant on salt marsh food web structure where researchers tell stories of life in the field and current advances in salt marsh research.

4. Global Impacts of Climate Change on Kelp Forests. Leader, National Center for Ecological Analysis and Synthesis working group.

5. SciFund Challenge, co-founder and board president. SciFund Challenge is a nonprofit organization that empowers scientists to shrink the gap between science and society. We train scientists how to connect to the public, back scientists in their outreach, and crowdfund to support research.

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2012-2014 **Postdoctoral Researcher,** Smithsonian Environmental Research Center, Smithsonian Institution, Edgewater, MD
2006-2012 **Research and Teaching Assistant,** Departments of Marine Science & Geography, University of California, Santa Barbara, CA
2004-2006 **Remote Sensing/GIS Analyst,** Earth Satellite Corporation, Rockville, MD

Professional Preparation

2011 Ph.D. Marine Science, University of California, Santa Barbara
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Selected Publications

Cavanaugh K.C., Siegel D.A., Kinlan B.P., Reed D.C. (2010) Scaling giant kelp field measurements to regional scales using satellite observations. *Marine Ecology Progress Series* 403:13-27.

Cavanaugh K.C., Siegel D.A., Reed D.C., Dennison P.E. (2011) Environmental controls on giant kelp biomass in the Santa Barbara Channel, CA. *Marine Ecology Progress Series* 429:1-17

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Cavanaugh K.C, Kellner J.R., Forde A.J., Gruner D.S., Parker J.D., Rodriguez W., Feller I.C. (2014) Poleward expansion of mangroves is a threshold response to decreased frequency of extreme cold events. *Proceedings of the National Academy of Sciences* 111(2):723-727

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Leslie, H. M., Basurto, X., Nenadovic, M., Sievanen, L., **Cavanaugh, K. C.**, Cota-Nieto, J. J., ... & Aburto-Oropeza, O. (2015). Operationalizing the social-ecological systems framework to assess sustainability. *Proceedings of the National Academy of Sciences*, *112*(19), 5979-5984.

Biographical Sketch: Dr. Laura Trouille

Senior Director of Citizen Science at the Adler Planetarium, Co-Investigator for Zooniverse
312-322-0820; ltrouille@adlerplanetarium.org; trouille@zooniverse.org

A. PROFESSIONAL PREPARATION

College/University	Major	Degree &Year
Dartmouth College	Physics, Summa Cum Laude	B.A., 2003
UW – Madison	Astronomy	Ph.D., 2010

B. ACADEMIC/PROFESSIONAL APPOINTMENTS

- Senior Director of Citizen Science at the Adler Planetarium and co-Investigator for Zooniverse, 2015+
- Northwestern University CIERA Postdoctoral Fellow and Astronomer at the Adler Planetarium (joint appointment), 2013-2015
- CIERA Postdoctoral Fellow, Northwestern University, 2010-2013
- Astronomy Adjunct Faculty, Chicago State University, Spring 2011
- Research Assistant, UW-Madison, Ph.D. Thesis Advisor: Dr. A. Barger, 2004-2010
- National Science Foundation Graduate Research Fellow, UW-Madison, 2006-2009
- CIRTL DELTA Education Research Intern, UW-Madison, 2009-2010
- NASA International Year of Astronomy Outreach Ambassador, 2009
- Instructor for Undergraduate Intro to Astronomy, UW-Madison, 2007
- Computer & ESL Secondary School Teacher, Czech Republic & India, 2003-2004
- Research Assistant (Senior Thesis), SwRI, Advisor: Dr. E. Young, 2002-2003
- Research Assistant, L'Observatoire de Paris, Advisor: Dr. J. P. Zahn, 2002

C. Relevant Experience

Co-Investigator for Zooniverse. In close collaboration with the Zooniverse team at the University of Oxford and the wider Citizen Science Alliance, Dr. Trouille leads the Adler Zooniverse team of 14 staff, including 6 web developers, a designer, a postdoctoral fellow, and an educator. She has written and been awarded and managed several million dollars in federal and private foundation grants to support this team (see C&P). Over the past decade, Zooniverse has partnered with hundreds of researchers to run 100 people-powered research projects, with 1.5 million registered users around the world making over 100,000 classifications each day. Zooniverse projects have led to over 100 published papers, plus nearly 2,000 papers citing Zooniverse data. Content spans astronomy through zoology, July 2015-present

Senior Director of Citizen Science at the Adler Planetarium. In addition to her effort as co-I for Zooniverse, Dr. Trouille leads the Adler Teen Programs group comprised of the Director for Teen Programs and four education specialists. This team leads the way in innovation and impact on teen engagement in STEM and tech experiences in the Chicago area. Through web and video

game making workshops, hack labs, after-school hangouts, the Citizen Science Ambassadors program, Far Horizons high altitude balloon launches, Scopes in the City, Teen Leadership Council and more, teens build their STEM and leadership skills and grow their interest in STEM careers, July 2015-present

Teaching Certificate through the UW-Madison Center for the Integration of Research, Teaching, and Learning (CIRTL) DELTA Program. Pedagogy coursework and internships; developing and assessing STEM curricular materials for the undergraduate and K-12 level. Also attended a semester-long seminar on how to be an effective, supportive, and responsible research mentor, 2004-2010

Research Mentor, mentor for three postdocs, three graduate students, five undergraduate students, and four high school students in citizen science, astronomy, and learning sciences research projects, 2006+
Note: Trouille's mentees have won $20K college scholarships for 3rd place in the 2012 SIEMENS Team Talent Competition and first place in the 2014 Northeastern Science and Engineering Fair.

Former member of the American Astronomical Society Committee on the Status of Women in Astronomy and liaison to the AAS Employment Committee. Developing and disseminating resources to the community to provide an inclusive culture/climate and supportive practices for women and minorities at all levels (undergraduates, graduate students, postdocs, researchers, faculty, and staff), 2010-2014

D. Selected Research Products

- Wright, D., Lintott, C., Smartt, S., Smith, K., Miller, G., Trouille, L. et al. A transient search using combined human and machine classifications, MNRAS, 2(1):472, 2017
- Kuchner, M., Faherty, J., Schneider, A., Trouille, L., et. al. The First Brown Dwarf Discovered by the Backyard Worlds: Planet 9 Citizen Science Project, Astrophysical Journal Letters, 841, 2, L19, 2017
- Van Hyning, V., Blickhan, S., Trouille, L., & Lintott, C. Transforming Libraries and Archives through Crowdsourcing. D-Lib Magazine, 23, 5/6, May/June 2017
- Zevin, M., Coughlin, S., Bahaadini, S., Trouille, L. et al. Gravity Spy: integrating advanced LIGO detector characterization, ML, and citizen science. Classical and Quantum Gravity, 34, 6, 2017
- Weintrop, D., Beheshti, E., Horn, M.S., Orton, K., Jona, K., Trouille, L., & Wilensky, U., Defining Computational Thinking for Math and Science Classrooms. Journal of Science Education and Technology, 25(1), 127–147, 2016
- Hainline, K., Hickox, R. DiPompeo, M., & Trouille, L. A Spectroscopic Survey of WISE-selected Obscured Quasars w/ the Southern African Large Telescope, ApJ, 795, 124, 2014
- Trouille, L., Coble, K., Cochran, G., Camarillo, C., Bailey, J., & Cominsky. L. Investigating Student Ideas About Cosmology III: Big Bang Theory, Expansion, Age, and History of the Universe, Astronomy Education Review, 12, 1, 2013
- Trouille, L., Barger, A. J., & Tremonti, C. The OPTX Project V: Identifying AGNs, ApJ, 742, 46. 2011

ALISON J HAUPT, PH.D.
CALIFORNIA STATE UNIVERSITY, MONTEREY BAY
DIVISION OF SCIENCE AND ENVIRONMENTAL POLICY
100 CAMPUS CENTER, SEASIDE, CALIFORNIA 93955
PHONE 831.582.3682, FAX 831.582.4122, AHAUPT@CSUMB.EDU

PROFESSIONAL PREPARATION:

Undergraduate: University of California, Santa Barbara, Santa Barbara, CA, Biology, B.A., 2003.
Graduate: Stanford University, Stanford, CA, Biological Sciences, Ph.D., 2011.
Postdoctoral: West Coast Governors Alliance on Ocean Health, Sacramento, CA and Seattle,WA Sea Grant Fellow, 2011-2013; University of Massachusetts Boston, Boston, MA, community ecology of kelp forests, 2013-2015.

APPOINTMENTS:

Assistant Professor, California State University Monterey Bay, 2015-present.

5 MOST RELEVANT PRODUCTS:

Byrnes, JEK, Cavanaugh, KC, Haupt AJ, Bell, TW, Harder, B, Rassweiller, A, Pérez-Matus, A, Assis, J, and The Zooniverse. 2014. Floating Forests. http://floatingforests.org. See also http://blog.floatingforests.org/ and http://talk.floatingforests.org/ for more.

Iles, AC, TC Gouhier, BA Menge, JS Stewart, AJ Haupt, MC Lynch. 2011. Climate-driven trends and ecological implications of event-scale upwelling in the California Current System. Global Change Biology 18:783-796.

Ruttenberg, BI, AJ Haupt, A Chiriboga, and RR Warner. 2005. Patterns, causes and consequences of regional variation in the ecology and life history of a reef fish. Oecologia. 145: 394-403.

Micheli, F, AO Shelton, SM Bushinsky, AL Chiu, AJ Haupt, KW Heiman, CV Kappel, MC Lynch, RG Martone, and J Watanabe. 2008. Persistence and recovery of depleted marine invertebrates in marine reserves of Central California. Biological Conservation. 141:1078-1090.

Samhouri, JF, AJ Haupt, PS Levin, JS Link, R Shufford. 2013. Lessons learned from developing integrated ecosystem assessments to inform marine ecosystem-based management in the USA. ICES Journal of Marine Science 71:1205-1215.

5 OTHER PRODUCTS

Wood, CL, B Zgliczynski, AJ Haupt, A Guerra, F Micheli, S Sandin. In Review. Global Change Biology. Human impacts decouple a fundamental relationship – the positive association between host diversity and parasite diversity.

Haupt, AJ, F Micheli, and SR Palumbi. 2013. Dispersal at a snail's pace: historical processes affect contemporary genetic structure in an exploited marine snail. Journal of Heredity 104:327-340.

Haupt, AJ. 2013. Ocean acidification as a West Coast Governors Alliance on Ocean Health priority area. Technical Report for WCGA.

Logan, CA, SE Alter, AJ Haupt, K Tomalty and SR Palumbi. 2008. An impediment to consumer choice: overfished species are sold as Pacific red snapper. Biological Conservation. 141:1591-1599.

Woodson, B, JA Barth, OM Cheriton, MA McManus, JP Ryan, L Washburn, KN Carden, BS Cheng, J. Fernandez, LE Garske, TC Gouhier, AJ Haupt, KT Honey, MF Hubbard, A Illes, L. Kara, MC Lynch, B Mahoney, M. Pfaff, ML Pinsky, MJ Robert, JS Stewart, SJ Teck, A True. Observations of internal wave packets propagating along-shelf in northern Monterey Bay. 2011. Geophysical Research Letters. 38

SYNERGISTIC ACTIVITIES:

Project leader National Center for Ecological Analysis and Synthesis project: Evaluation of the use of cumulative impact indices as proxies for ecosystem status of the California Current ecosystem.

Science team member Floating Forests (floatingforests.org) a citizen science to quantify kelp cover globally through Landsat satellite technology through zooniverse.

Regional coordinator for California and the Pacific Northwest for the Kelp Ecosystem Ecology Network. KEEN is a global network of kelp forest ecologists created to study the response of kelps to climate change and disturbance globally.

Ocean HEROES science outreach program for underserved student groups working with the Seaside, CA Boys and Girls Club. Founder, teacher and curriculum developer.

Participant NSF-funded Baja Biocomplexity Project: active stakeholder engagement with small-scale Mexican fishermen in Baja California, Mexico.

PI Byrnes
UMB Budget Narrative and Justification

"Using Citizen Science to Understand Thirty Years of Change in Global Kelp Cover by Expanding the Zooniverse to NASA Satellite Imagery"

Overview
The following is a narrative description and justification for the grant to PI Byrnes. Justifications and narratives for the Co-Investigator subawardees/subcontractors to follow.

Senior Personnel
PI Byrnes requests half a month of summer salary in years one through three of the implementation phase.

Other Personnel
PIs Byrnes requests salary to support a Graduate Student Researcher (GSR), Isaac Rosenthal, at 50% for the duration of the grant. Standard graduate student salary at UMB is $31,500 for the year.

Fringe Benefits
Our University fringe benefit rate is 31.01% and is negotiated between Commonwealth of Massachusetts and DHHS. Fringe is calculated at 1.60% for PI Byrnes, 1.41% for the graduate student, and is only relevant for summer salary.

Travel (Domestic)

Implementation Year 1-3
We have budgeted $2000 for PI Byrnes and graduate student to travel to an all-hands team meeting in Chicago or Los Angeles. Flight costs are estimated at $1000, lodging at $1000, and food costs at standard UMB per diem rates at $491.

We have budgeted $1000 for PI Byrnes to travel to a second team meeting in Monterey, California. Flight costs are estimated at $1000 and lodging is covered. We have also budgeted $1000 for PI Byrnes to travel to the NASA Biodiversity Forecasting team meeting, with $500 for travel and $500 for lodging.

Other Direct Costs

Dissemination and Publication Costs
We budget in $1500 for year one for publication of the calibration manuscript in a high quality open access journal.

Mandatory Health Benefits and Fee Remissions
Health insurance and fee remissions are mandatory for the hiring of graduate student researcher at 25% or greater during the academic term. These fees are exempt from indirect cost.

Indirect Cost (F&A)
F&A Rate of 52.5% is negotiated between DHHS and the University of Massachusetts Boston.

Changes from Original Proposed Budget
PI Byrnes has requested additional travel funds to accommodate the Biodiversity Forecasting team meeting as well as additional publication fees based on changed submission goals. All PIs have made slight adjustments based on changing institutional rates and work requirements. Our final budget is marginally lower than in our initial proposal.

PI: Kyle Cavanaugh
UCLA BUDGET JUSTIFICATION (IMPLEMENTATION PHASE: YEARS 2-4)

"Using Citizen Science to Understand Thirty Years of Change in Global Kelp Cover by Expanding the Zooniverse to NASA Satellite Imagery"

Senior Personnel
PI Cavanaugh requests 0.5-month summer salary for Years 2-4.

Other Personnel
PI Cavanaugh requests salary to support a postdoctoral research associate at 100% time for Years 3 and 4 of the project. The postdoc will lead the analysis of the climatic drivers of giant kelp dynamics. This analysis will utilize the data produced by Floating Forests and so the work will be concentrated in the second half of the project's implementation stage.

Fringe Benefits
Fringe benefits are estimated using figures approved by the University of California Systemwide Administration. Academic summer employment is 5.1% and Postdoctoral researcher is 32.1%.

Equipment (Year 2)
We request $7,000 to purchase a high-end desktop computer. This will be used to process and analyze the global kelp canopy data derived from Floating Forests. This estimate is based on a quote for a system that includes an Intel Xeon 3.5 GHz 12 core CPU with 128 Gb of RAM and 2 Tb of storage space.

Travel (Domestic)
Year 2
We have budgeted $2,000 for PI Cavanaugh to travel to an all-hands team meeting in Chicago or Boston. Flight costs are estimated at $500, lodging at $900, and food costs at $600.

We have budgeted $1,000 for PI Cavanaugh to travel to a second team meeting in Monterey, California. Mileage costs are estimated at $300, lodging at $400, and food costs at $300.

Year 3
We have budgeted $3,000 for PI Cavanaugh and postdoc to travel to a national conference to present results from the project. Flight costs are estimated at $400/person, lodging at $700/person, and food costs at $400/person.

Year 4
We have budgeted $3,000 for PI Cavanaugh and postdoc to travel to a national conference to present results from the project. Flight costs are estimated at $400/person, lodging at $700/person, and food costs at $400/person.

Other Direct Costs
Dissemination and Publication Costs
Page charges for one publication in an open-access journal ($1,500) for each of the final two years of the project.

Technology Infrastructure Fee
The Technology Infrastructure Fee (TIF) is a consistently-applied direct charge that is assessed to each and every campus activity unit, regardless of funding source, including units identified as individual grant and contract awards. The TIF pays for campus communication services on the basis of a monthly

accounting of actual usage data. These costs are charged as direct costs and are not recovered as indirect costs. The charge is $34.82/FTE.

Indirect Cost (F&A)

On April 27, 2011, the University of California and the United States Department of Health and Human Services (the responsible Federal audit agency) entered into a new facilities and administrative (F+A) cost rate agreement for the Los Angeles campus. This agreement establishes facilities and administrative cost rates for the period of July 1,2010, through June 30, 2016. The on-campus Research rate currently in effect is 54%. Indirect Costs are calculated at 54% of Modified Total Direct Costs (total costs – minus student tuition fees, equipment, fabrication costs, subcontracts and participant supports costs.). See: http://www.research.ucla.edu/ocga/sr2/idcinfo.htm#FA1

Adler Planetarium
Budget Justification Narrative:

A. Direct Labor– Key Personnel: NONE

PI Laura Trouille will oversee the project, but requests no salary support.

B. Direct Labor – Other Personnel:

Front End Developer commits the following level of effort per year.
Year 2 – 50%, Year 3 – 50%, Year 4 – 4%
Back End Developer commits the following level of effort per year.
Year 2 – 50%, Year 3 – 0%, Year 4 – 0%
Designer commits the following level of effort per year.
Year 2 – 33%, Year 3 – 4%, Year 4 – 4%
All salaries include a 3% annual increase.

C. Direct Costs – Equipment: NONE

D. Direct Costs – Travel: NONE

E. Direct Costs – Participant/Trainee Support Costs: NONE

F. Other Direct Costs:

1. Materials and Supplies: *None*
2. Publication Costs: *None*
3. Consultant Services: *None*
4. ADP/Computer Services:

Funds are requested to cover webhosting charges for the citizen science project. Cost estimates are based on hosting of a typical citizen science project during the implementation phase at an average rate of $3,000 per year.

5. Subawards/Consortium/Contractual Costs: *None*
6. Equipment or Facility Rental/User Fees: *None*
7. Alterations and Renovations: *None*
8. Other: *None*

H. Indirect Costs:

Adler has a federally negotiated indirect cost rate. See cover page budget and Total Budget for details.

I. Total Direct and Indirect Costs:

The total cost of the award is given in the cover page budget and is included in the separately uploaded Total Budget pdf file per solicitation instructions.

J. Fee: NONE

Facilities and Equipment:

Zooniverse within the Adler Planetarium

The Adler Citizen Science department, alongside the Zooniverse team at the University of Oxford, supports the web development and education efforts for the collection of online citizen science projects known as the Zooniverse (zooniverse.org). Working in collaboration with science teams across the world, with volunteers in almost every country, the team takes large data sets that cannot be adequately analyzed by computers and puts them online. Volunteers are asked to perform simple tasks, such as counting, identification or measurement and the resulting data is fed back to science teams who use it to further their research. As well as performing a simple analysis task on behalf of the science teams, volunteers can participate in discussions with other volunteers and scientist (e.g. talk.galaxyzoo.org) or even undertake their own research (tools.zooniverse.org).

The Adler is located at 1300 S. Lake Shore Drive in Chicago. It is both a planetarium and a space science museum covering ~90,000 square feet. Within the building are the museums' exhibition galleries, collections, and all staff, including Facilities, Planning, and Operations; Human Resources; Financial; Visitor Experience (which includes Exhibits and Education); Marketing, Advancement, Astronomy, History/Collections, and Citizen Science (which includes Zooniverse and teen programs). The facility also houses museum stores, cafes, classrooms, planetarium, auditoriums, and lobbies.

The Adler Zooniverse project personnel have access to the necessary computing equipment, office space, Internet access, programming and design software, webhosting and server space necessary for this project. The Adler provides the required cloud server space to store and manage the data and to perform the computational tasks.

Administrative assistance is available to Adler project personnel to aid in grant management, as well as travel planning.

Budget Justification Details:
YEAR 2-4 (3/1/18 – 2/28/21)

1. Direct Labor

A.	Direct Labor – Key Personnel:	Not listed here
B.	Direct Labor – Other Personnel:	Not listed here
Total Direct Labor Costs (A+B):		Not listed here

Salaries and fringe benefits not included here per solicitation guidelines. See Total Budget for details.

2. Other Direct Costs

C.	Direct Costs – Equipment:	None
D.	Direct Costs – Travel:	None
E.	Direct Costs – Participant/Trainee Support Costs:	None

F. Other Direct Costs:

1. Materials and Supplies:	None
2. Publication Costs:	None
3. Consultant Services:	None
4. ADP/Computer Services:	$9,000
Year 2 – implementation project = $3,000	
Year 3 – implementation project = $3,000	
Year 4 – implementation project = $3,000	
Total = $9,000	
5. Subawards/Consortium/Contractual Costs:	None
6. Equipment or Facility Rental/User Fees:	None
7. Alterations and Renovations:	None
8. Other:	None

G. Total Direct Costs (A+B+C+D+E+F): Not listed here

3. Facilities and Administrative (F&A) Costs:

H. Indirect Costs: Not listed here

I. Total Direct and Indirect Costs (G+H): Not listed here

Indirect Costs and Total Costs are not included here per solicitation guidelines. See Total Budget for details.

4. Other Applicable Costs

J. Fee: None

5. Subtotal-Estimated Costs

K. Total Cost (I+J): Not listed here

The total cost of the project is given in the Total Budget pdf file per solicitation instructions.

6. Total Estimated Costs (YEARS 2-4) Not listed here

The total cost of the project is given in the Total Budget pdf file per solicitation instructions.

University Corporation at Monterey Bay
On behalf of California State University, Monterey Bay

Budget Justification

Personnel:

PI Dr. Alison Haupt will work 1 summer month during years 2-4 with educational partners to create curricula for K-12 and college students. Dr Haupt will also analyze data collected through the Zooniverse *Floating Forests* project to investigate the effects of urban environments on kelp forests and incorporate *Floating Forests* research into undergraduate courses at California State University, Monterey Bay. Dr. Haupt will also mentor one part-time undergraduate research assistant, sponsored by the CSUMB Undergraduate Research Opportunities Center who will be responsible for assisting with data analysis. Year 2 salary $81,578, 1/m = $9,064; Year 3 salary $83,617, 1m = $9,291; Year 4 salary =$86,126, 1m=$9,570.

Year 2 = $9,064; Year 3 = $9,291; Year 4 = $9,570; Total = $27,925

Fringe Benefits:

The University Corporation charges actual benefit rates which vary by individual. The benefits for summer work includes FICA, Medicare, SUI and Workers' Compensation. Fringe benefits are estimated at current average benefit rate of 9.1%; the grant will be charged at the rate in effect at the time the salary is charged.

Year 2 = $825; Year 3 = $845; Year 4 = $871; Total = $2,541

Travel:

Year 2
Funds are requested for PI Haupt to travel to an all-hands team meeting in Chicago or Boston. Flight costs are estimated at $500, lodging at $800, per diem and incidentals at $700 = $2,000.

Year 3
We have also budgeted for PI Haupt to travel to a national conference to present results from the project. Flight costs are estimated to be $475, lodging $750, per diem and incidentals at $636 = $1,861

Year 4
We are requesting funds for PI Haupt to travel to a national conference to present results from the project. Flight costs are estimated to be $475, lodging $750, per diem and incidentals at $636 = $1,861

Year 2 = $2,000; Year 3 = $1,861; Year 4 = $1,861; Total = $5,722

Total Direct Costs:

Year 2= $11,889; Year 3 = $11,997; Year 4 = $12,301; Total = $36,188

Indirect Costs:

The federally negotiated indirect cost rate for the University Corporation at Monterey Bay is 46% Modified Total Direct Costs (MTDC). This is a predetermined rate through 6/30/16 and provisional though 6/30/2017. The cognizant agency for the campus is the U.S. Department of Health & Human Services. As this proposal/award is a continuation of the initial prototype Award, the indirect included is the original as outlined in Uniform Guidance.

Year 2 = $5,469; Year 3 = $5,519; Year 4 = $5,659; Total = $16,646

Total Amount of this Request: $52,834 for Years 2-4

Jarrett Byrnes
Current and Pending

Current
PI: Jarrett Byrnes
MIT Sea Grant
Feedbacks between coastal New England kelp beds and wave disturbance
02/15/2015-01/31/2018
$150,000

PI: Jarrett Byrnes
Mass Biological Labs (MBL) sub award
LTER National Science Foundation
LTER-Plum Island Ecosystems: Dynamics of coastal ecosystems in a region of rapid climate change, sea-level rise, and human impacts
10/01/2016-09/30/2022
$363,520

PI: Jarrett Byrnes
Woods Hole Oceanographic Institution
Evaluating the relationship between kelp forest ecosystems and water termperature in the Southern Gulf of Maine
01/17/2017-06/30/0218
$89,571

PI: Jarrett Byrnes
National Aeronautics and Space Administration (NASA)
Using citizen science to understand thirty years of change in global kelp cover by expanding the Zooniverse to NASA satellite
01/15/2017-02/28/2018
$163,972

Pending
PI: Jarrett Byrnes
National Aeronautics and Space Administration (NASA)
Using citizen science to understand thirty years of change in global kelp cover by expanding the Zooniverse to NASA satellite
03/01/2018 – 02/28/2021
$785,014

CURRENT AND PENDING SUPPORT – KYLE CAVANAUGH

Current

Title: Scalable Aquaculture Monitoring System - SAMS
PI: Dr. David Siegel
Agency: ARPA-E
Agency Contact: Dr. Marc von Keitz, arpa-e-co@hq.doe.gov
Award Period: December 2017 – November 2020
Award Amount: $277,831
Person-Months Per Year Committed to the Project: 1.0

Title: Using HyspIRI to Identify Benthic Composition and Bleaching in Shallow Coral Reef Ecosystems (NNX15AT98G)
PI: Dr. Kyle Cavanaugh
Agency: NASA
Agency Contact: Woody Turner, 202-358-1662, woody.turner@nasa.gov
Award Period: August 2015 – August 2018
Award Amount: $260,589
Person-Months Per Year Committed to the Project: 1.0

Title: Integrating Physiological Threshold Experiments, Remote Sensing, and Climate Modeling to Characterize the Sensitivity of Coastal Ecosystems to Climate Change (NNX16AN04G)
PI: Dr. Kyle Cavanaugh
Agency: NASA
Agency Contact: Ming-Ying Wei, 202-358-0771, mwei@nasa.gov
Award Period: July 2016 – July 2019
Award Amount: $280,954
Person-Months Per Year Committed to the Project: 1.0

Title: Using Citizen Science to Understand Thirty Years of Change in Global Kelp Cover by Expanding the Zooniverse to NASA Satellite Imagery
PI: Dr. Jarrett Byrnes
Agency: NASA
Agency Contact: Kevin Murphy, 202-358-3042, kevin.j.murphy@nasa.gov
Award Period: March 2017 – February 2018
Award Amount: $12,434 (Total: $296,706)
Person-Months Per Year Committed to the Project: 0.5

Title: Examining Trends and Variability in Giant Kelp Abundance and Distribution Near Its Southern Range Limit in North America
PI: Dr. Kyle Cavanaugh
Agency: University of California MEXUS
Agency Contact: Andrea Kaus, 951-827-3586, andrea.kaus@ucr.edu
Award Period: July 2017 – December 2018
Award Amount: $11,198
Person-Months Per Year Committed to the Project: 0.5

Pending

N/A

Current and Pending Support
DR. LAURA TROUILLE
Director of Citizen Science, Adler Planetarium

CURRENT SUPPORT

Title: Bringing Wildlife Management into Focus: Integrating Camera Traps, Remote Sensing and Citizen Science to Improve Population Modeling
Type: Supplemental Funding, Federal Subaward
Program/Sponsoring Agency: ROSES 2012 Earth Science Applications: Ecological Forecasting for Conservation and Natural Resources Management/NASA
Lead Organization/Point of Contact: University of Wisconsin/Phil Townsend, 608-622-7445, ptownsend@wisc.edu
Adler PI: Laura Trouille
Performance Start: 1/6/15 **Performance End:** 1/5/18
Adler Award Amount: $121,715 ($139,821 exp) **Adler PI Budget:** $6,480
Cal-Months: 0.28 Year 2, 0.14 Year 3, 0.09 Year 4

Title: Collaborative Research: ABI Development: Notes from Nature: Advancing a Next Generation Citizen Science Platform for Biocollection Transcription
Type: Federal Subaward
Program/Sponsoring Agency: Advancing Digitization of Biodiversity Collections/NSF
Lead Organization/Point of Contact: University of Florida/Florida Museum of Natural History /Robert Guralnick, 352-273-1980, rguralnick@flmnh.ufl.edu
Adler PI: Laura Trouille
Performance Start: 7/15/15 **Performance End:** 6/30/18
Adler Award Amount: $145,560 **Adler PI Budget:** $1,835
Cal-Months: 0.05/year

Title: Broadening Participation in a Computational Future: Casting a wide net
Type: Foundation Subaward
Program/Sponsoring Agency: Lyle Spencer Research Awards/The Spencer Foundation
Lead Organization/Point of Contact: Northwestern University/Michael Horn, 617-803-5501, michael-horn@northwestern.edu
Adler PI: Laura Trouille
Performance Start: 8/1/15 **Performance End:** 7/31/18
Adler Award Amount: $0 **Adler PI Budget:** $0
Cal-Months: 0.0

Title: ADBC Proposal: Digitization TCN: Collaborative Research: The Key to the Cabinets: Building and sustaining a research database for a global biodiversity hotspot
Type: Federal Subcontract
Program/Sponsoring Agency: Advancing Digitization of Biodiversity Collections/NSF
Lead Organization/Point of Contact: Appalachian State University/Zack Murrell, 828-262-2674, murrellze@appstate.edu
Adler PI: Laura Trouille
Performance Start: 8/15/15 **Performance End:** 7/31/18
Adler Award Amount: $40,000 **Adler PI Budget:** $0
Cal-Months: 0.0/year

Title: Collaborative Research: Engaging Introductory Astronomy Students in Authentic Research through Citizen Science
Type: Federal Award
Program/Sponsoring Agency: Improving Undergraduate STEM Education (IUSE: EHR)/NSF
Agency Point of Contact: Miles G. Boylan, 703-292-4617, mboylan@nsf.gov
Adler PI: Laura Trouille
Performance Start: 10/1/15 **Performance End:** 9/30/18
Adler Award Amount: $137,513 **Adler PI Budget:** $7,656
Cal-Months: 0.2/year

Title: Collaborative Research: Engaging Introductory Astronomy Students in Authentic Research through Citizen Science
Type: Federal Subaward
Program/Sponsoring Agency: Improving Undergraduate STEM Education (IUSE: EHR)/NSF
Lead Organization/Point of Contact: Northwestern University/ David M. Meyer, 847-491-4516, davemeyer@northwestern.edu
Adler PI: Laura Trouille
Performance Start: 10/1/15 **Performance End:** 9/30/18
Adler Award Amount: $139,730 **Adler PI Budget:** $0
Cal-Months: 0.0/year

Title: INSPIRE: GlitchZoo: Teaming Citizen Science with Machine Learning to Deepen LIGO's View of the Cosmos
Type: Federal Subaward
Program/Sponsoring Agency: INSPIRE/NSF
Lead Organization/Point of Contact: Northwestern University/Vicky Kalogera, 847-491-5669, vicky@northwesern.edu
Adler PI: Laura Trouille
Performance Start: 10/1/15 **Performance End:** 9/30/18
Adler Award Amount: $195,819 **Adler PI Budget**: $8,600
Cal-Months: 0.2/year

Title: Expanding the Zooniverse: Citizen Science Platforms
Type: Foundation Grant Subaward
Program/Sponsoring Agency: The Leona M. & Harry B. Helmsley Charitable Trust Grant
Lead Organization/Point of Contact: University of Oxford/Chris Lintott, 1865 (2) 73638, cjl@astro.ox.ac.uk
Adler PI: Laura Trouille
Performance Start: 3/1/16 **Performance End:** 2/28/19
Adler Award Amount: $452,875 **Adler PI Amount:** $16,969
Cal-Months: 0.6/year

Title: CHS: Small: Collaborative Research: Optimizing Human-Machine Systems for Citizen Science
Type: Federal Award
Program/Sponsoring Agency: Information and Intelligent Systems (IIS): Core Programs/NSF
Agency Point of Contact: William S. Bainbridge, Cyber-Human Systems, 703-292-8930, wbainbri@nsf.gov
Adler PI: Laura Trouille
Performance Start: 7/1/16 **Performance End:** 6/30/18
Adler Award Amount: $139,914 **Adler PI Budget:** $0

Cal-Months: 0.0

Title: Transforming Libraries and Archives Through Crowd Sourcing
Type: Federal Award
Program/Sponsoring Agency: National Leadership Grants for Libraries/IMLS
Agency Point of Contact: Trevor Owens, 202-653-4654, tjowens@imls.gov
Adler PI: Laura Trouille
Performance Start: 12/1/16 **Performance End:** 11/30/19
Adler Award Amount: $1,214,780 **Adler PI Budget:** $0
Cal-Months: 0.6/year

Title: Using Citizen Science to Understand Thirty Years of Change in Global Kelp Cover by Expanding the Zooniverse to NASA Satellite Imagery
Type: Federal Subaward
Program/Sponsoring Agency: Citizen Science for Earth Systems Program (CSESP)/NASA
Lead Organization/Point of Contact: University of Massachusetts, Boston/Jarrett Byrnes, 401-529-4104, Jarrett.Byrnes@umb.edu
Adler PI: Laura Trouille
Performance Start: 3/10/17 **Performance End:** 2/28/18
Adler Award Amount: $33,806 **Adler PI Budget:** $0
Cal-Months: 0.0

Title: Exploratory Pathways: Leveraging Citizen Science for Informal STEM Learning
Type: Federal Award
Program/Sponsoring Agency: Advancing Informal STEM Learning (AISL)/NSF
Agency Point of Contact: Daniel P. McEnrue, 703-292-8386, dpmcenru@nsf.gov
Adler PI: Laura Trouille
Performance Start: 7/1/17 **Performance End:** 6/30/19
Award Amount: $299,899 **Adler PI Budget:** $0
Cal-Months: 0.0

PENDING SUPPORT

Title: Streamlining Embedded Assessment to Understand Citizen Scientists' Skill Gain
Type: Federal Subcontract
Program/Sponsoring Agency: Advancing Informal STEM Learning (AISL)/NSF
Lead Organization/Point of Contact: University of Maryland/Cathlyn Stylinski, 301-689-7272, cstylinski@al.umces.edu
Adler PI: Laura Trouille
Performance Start: 9/1/17 **Performance End:** 8/31/19
Award Amount: $40,000 **Adler PI Budget:** $0
Cal-Months: 0.0

Title: Backyards World: Finding Nearby Brown Dwarfs through Citizen Science
Type: Federal Subaward
Program/Sponsoring Agency: ROSES 2017 Astrophysics Data Analysis Program/NASA
Lead Organization/Point of Contact: Goddard Space Flight Center/Marc J. Kuchner, 301-286-5165, marc.kuchner@nasa.gov
Adler PI: Laura Trouille

Performance Start: 1/1/18 **Performance End:** 12/31/18
Award Amount: $49,702 **Adler PI Budget:** $0
Cal-Months: 0.0

Title: EHR-Polar DCL 2017: IceCube in 4D: Improving Spatiotemporal Learning for Discovery
Type: Federal Subaward
Program/Sponsoring Agency: Advancing Informal STEM Learning (AISL)/NSF
Lead Organization/Point of Contact: University of Wisconsin – River Falls/James Madsen, 715-425-4390, james.madsen@uwrf.edu
Adler PI: Laura Trouille
Performance Start: 9/1/18 **Performance End:** 8/31/21
Award Amount: $202,752 **Adler PI Budget:** $8,481
Cal-Months: 0.25 Year 1 and 2

Title: 21St Century Workforce Development: Diabetes Research and Community Health Activism through Citizen Science
Type: Federal Award
Program/Sponsoring Agency: Science Education Partnership Award (SEPA)/NIH
Agency Point of Contact: Tony Beck, 301-480-4623, beckl@mail.nih.gov
Adler PI: Kelly Borden
Performance Start: 9/1/18 **Performance End:** 8/31/23
Award Amount: $1,317,338 **Dr. Trouille Budget:** $0
Dr. Trouille Cal-Months: 0.0

Title: Engaging Non-Majors in Authentic Research through Citizen Science
Type: Federal Award
Program/Sponsoring Agency: Improving Undergraduate STEM Education: Education and Human Resources (IUSE: EHR)/NSF
Agency Point of Contact: Myles G. Boylan, 703-292-4617, mboylan@nsf,gov
Adler PI: Laura Trouille
Performance Start: 9/1/18 **Performance End:** 8/31/21
Award Amount: $599,385 **Adler PI Budget:** $5,166
Cal-Months: 0.1/year

Title: NSF AISL: ALL HANDS: Astronomy Leveraged in Libraries and Highschools Across the Nation to engage students in Data Science
Type: Federal Subaward
Program/Sponsoring Agency: Advancing Informal STEM Learning (AISL)/NSF
Lead Organization/Point of Contact: Northwestern University/Vicky Kalogera, (847) 491-5669, vicky@northwesern.edu
Adler PI: Kelly Borden
Performance Start: 1/1/19 **Performance End:** 12/31/23
Award Amount: $214,242 **Dr. Trouille Budget:** $0
Dr. Trouille Cal-Months: 0.0

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator:	Other agencies (including NSF) to which this proposal has been/will be submitted.
Alison Haupt	

Support: ☐ Current ■ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Engaging Non-Majors in Authentic Research through Citizen Science

Source of Support: National Science Foundatoin

Total Award Amount: $ 44,679.00 Total Award Period Covered: 9/1/18 - 8/31/21

Location of Project: California State University, Monterey Bay

Person-Months Per Year Committed: Cal: Acad: Sumr: 1.00

Support: ☐ Current ■ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Modernizing Undergraduate Biology Education through the Integration of Genomics and Bioinformatics

Source of Support: W.M. Keck Foundation

Total Award Amount: $ 350,000.00 Total Award Period Covered: 8/1/17 - 7/31/20

Location of Project: California State University, Monterey Bay

Person-Months Per Year Committed: Cal: Acad: 0.54 Sumr:

Support: ■ Current ■ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Using Citizen Science to Understand Thirty Years of Change in Global Kelp Cover by Expanding the Zooniverse to NASA Satellite Imagery - Year 2 -4 Request

Source of Support: University of Massachusetts, Boston (flow through from NASA)

Total Award Amount: $ 52,834.00 Total Award Period Covered: 10/1/18 - 6/30/21

Location of Project: California State University, Monterey Bay

Person-Months Per Year Committed: Cal: Acad: Sumr: 1.00

Support: ■ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Research Based Interventions to Increase STEM Degree Attainment

Source of Support: U.S. Department of Education

Total Award Amount: $ 5,622,465.00 Total Award Period Covered: 10/1/16 - 9/30/21

Location of Project: California State University, Monterey Bay

Person-Months Per Year Committed: Cal: Acad: 0.67 Sumr: 0.37

Support: ■ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Response to Kelp Forest Communities to Disturbance

Source of Support: University Corporation at Monterey Bay

Total Award Amount: $ 8,893.00 Total Award Period Covered: 4/11/17 - 5/31/18

Location of Project: California State University, Monterey Bay

Person-Months Per Year Committed: Cal: Acad: 0.54 Sumr: 0.12

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

PI Byrnes Project Budget

Period of Performance: March 1, 2018 to Feb 28 2021				
Budget Period:	**Year 1**	**Year 2**	**Year 3**	
Start Date:	3/1/18	3/1/19	3/1/20	
End Date:	2/28/19	2/28/20	2/28/21	**Total**
A. Senior/Key Personnel	$4,494.00	$4,629.00	$4,768.00	$13,891.00
PI Byrnes, 0.5 mo summer				
B. Other Personnel				
Graduate Student - Isaac Rosenthal	$31,500.00	$31,500.00	$31,500.00	$94,500.00
Fringe Benefits				
Faculty (1.60%)	$72.00	$74.00	$76.00	$222.00
Graduate Student(1.41%)	$148.00	$148.00	$148.00	$444.00
Total Fringe Benefits	$220.00	$222.00	$224.00	$666.00
Total Salaries & Fringe Benefits	**$36,214.00**	**$36,351.00**	**$36,492.00**	**$109,057.00**
C. Equipment Description	$0.00	$0.00	$0.00	$0.00
D. Travel	$3,491.00	$3,491.00	$3,491.00	
Travel for PI & Grad Student to Chicago/LA Team Meeting	$1,000.00	$1,000.00	$1,000.00	
Hotel for GS & PI in Chicago/LA	$1,000.00	$1,000.00	$1,000.00	
Per Diem for GS & PI in Chicago/LA	$491.00	$491.00	$491.00	
Travel for PI to Monterey Team Meeting	$1,000.00	$1,000.00	$1,000.00	
Travel for PI to Biodiversity Forecasting Meeting	$500.00	$500.00	$500.00	
Lodging for PI for Forecasting Meeting	$500.00	$500.00	$500.00	
Total Travel	$4,491.00	$4,491.00	$4,491.00	$13,473.00
E. Participant/Trainee Support Costs				
F. Other Direct Costs				
Materials and Supplies/Publications	$1,500.00			
Subcontractors/Subawardees (see additional budget details)	$203,918.00	$218,938.00	$166,655.00	$589,511.00
Total Other Direct Costs	$203,918.00	$218,938.00	$166,655.00	$589,511.00
Total Direct Costs (A through F)	**$246,122.00**	**$259,780.00**	**$207,638.00**	**$713,540.00**
MTDC (Base Rate for Indirect Cost calculation)	**$63,007.00**	**$40,842.00**	**$40,983.00**	**$144,832.00**
Indirect Costs at 52.5%	$33,078.68	$21,442.00	$21,516.00	$76,036.68
Total Direct and Indirect Costs	**$279,200.68**	**$281,222.00**	**$229,154.00**	**$789,576.68**

UCLA Summary Proposal Budget

Principal Investigator: Kyle Cavanaugh

Project Title: Using Citizen Science to Understand Thirty Years of Change in Global Kelp Cover by Expanding the Zooniverse to NASA Satellite Imagery

Period of Performance: 3/10/2017 - 2/28/2021

			Year 1	Year 2	Year 3	Year 4	TOTAL
A. Senior/Key Person							
Cavanaugh	PI	0.5/9th	5,779	5,953	6,250	6,563	24,546
Total Senior Personnel:			**5,779**	**5,953**	**6,250**	**6,563**	**24,546**
B. Other Personnel:							
TBN - Postdoc					55,000	56,650	111,650
Total Other Personnel:			**-**	**-**	**55,000**	**56,650**	**111,650**
Fringe Benefits							
Faculty (5.1%)			295	304	319	335	1,252
Postdoc (32.1%)			-	-	17,655	18,185	35,840
Total Fringe Benefits:			**295**	**304**	**17,974**	**18,519**	**37,091**
Total Salaries & Fringe Benefits:			**6,074**	**6,256**	**79,224**	**81,732**	**173,287**
C. Equipment**			-	-			-
12 core desktop computer				7,000	-		7,000
Total Equipment:			**-**	**7,000**	**-**		**7,000**
D. Travel							
Domestic (incl. Canada, Mexico)			2,000	3,000	3,000	3,000	11,000
Total Travel:			**2,000**	**3,000**	**3,000**	**3,000**	**11,000**
F. Other Direct Costs							
Publication Costs					1,500	1,500	3,000
TIF (Technology Infrastructure Fee)			-	-	418	418	835
Total Other Direct Costs:			**-**	**-**	**1,918**	**1,918**	**3,835**
TOTAL DIRECT COSTS:			**8,074**	**16,256**	**84,142**	**86,650**	**195,123**
MTDC (Base Rate for Indirect Cost calculation)			**8,074**	**9,256**	**84,142**	**86,650**	**188,123**
Indirect Costs @ 54%			**4,360**	**4,998**	**45,436**	**46,791**	**101,585**
TOTAL PROJECT COSTS:			**12,434**	**21,254**	**129,578**	**133,440**	**296,706**

**Equipment - Items with a cost of $5000 or greater is exempt from overhead

NASA ROSES CSESP FF Proposal Budget									
Using Citizen Science to Understand Thirty Years of Change in Global Kelp Cover by Expanding the Zooniverse to NASA Satellite Imagery									
Adler Planetarium Budget									
Revised 1/5/18					**Implementation Phase**				
					YEAR 2	**YEAR 3**	**YEAR 4**	**CUMULATIVE**	
					3/1/18 - 2/28/19	**3/1/19 - 2/28/20**	**3/1/20 - 2/28/21**		
A. Direct Labor - Key Personnel		**Unit**	**Calendar Months**	**Salary**				**Total**	**Description**
	Laura Trouille Salary			$ -	$0.00	$0.00	$0.00	$0.00	3% annual increase
	Laura Trouille Fringe	21.0%			$0.00	$0.00	$0.00	$0.00	
	Total Number Key Personnel	**0**		**Subtotal**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	
B. Direct Labor - Other Personnel		**Unit**	**Calendar Months**	**Salary**					
	Front End Developer Salary	50% 50% 4%	6/6/0.5 months	$ 65,000	$32,500.00	$33,475.00	$2,873.27	$68,848.27	3% annual increase
	Front End Developer Fringe	21.0%			$6,825.00	$7,029.75	$603.39	$14,458.14	
	Back End Developer Salary	50% 0% 0%	6/0/0 months	$ 65,000	$32,500.00	$0.00	$0.00	$32,500.00	3% annual increase
	Back End Developer Fringe	21.0%			$6,825.00	$0.00	$0.00	$6,825.00	
	Designer Salary	33% 4% 4%	4/0.5/0.5 months	$ 65,000	$21,666.67	$2,789.58	$2,873.27	$27,329.52	3% annual increase
	Designer Fringe	21.0%			$4,550.00	$585.81	$603.39	$5,739.20	
	Total Number Other Personnel	**3**		**Subtotal**	**$104,866.67**	**$43,880.15**	**$6,953.32**	**$155,700.13**	
	Total Direct Labor Costs (A + B)				**$104,866.67**	**$43,880.15**	**$6,953.32**	**$155,700.13**	
C. Direct Costs - Equipment									
	None				$0.00	$0.00	$0.00	$0.00	
				Subtotal	**$0.00**	**$0.00**	**$0.00**	**$0.00**	
D. Direct Costs - Travel		**Unit**	**People**	**Cost**					
	Domestic				$0.00	$0.00	$0.00	$0.00	
					$0.00	**$0.00**	**$0.00**	**$0.00**	
	Foreign				$0.00	$0.00	$0.00	$0.00	
					$0.00	**$0.00**	**$0.00**	**$0.00**	
				Subtotal	**$0.00**	**$0.00**	**$0.00**	**$0.00**	
E. Direct Costs - Participant/Trainee Support Costs									
	None				$0.00	$0.00	$0.00	$0.00	
	Number of Participants/Trainees	**0**		**Subtotal**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	
F. Other Direct Costs									
	1. Materials and Supplies				$0.00	$0.00	$0.00	$0.00	
	2. Publication Costs				$0.00	$0.00	$0.00	$0.00	
	3. Consultant Services				$0.00	$0.00	$0.00	$0.00	
	4. ADP/Computer Services				$3,000.00	$3,000.00	$3,000.00	$9,000.00	
	5. Subawards/Consortium/Contractual Costs				$0.00	$0.00	$0.00	$0.00	
	6. Equipment or Facility Rental/User Fees				$0.00	$0.00	$0.00	$0.00	
	7. Alterations and Renovations				$0.00	$0.00	$0.00	$0.00	
	8. Other:				$0.00	$0.00	$0.00	$0.00	
				Subtotal	**$3,000.00**	**$3,000.00**	**$3,000.00**	**$9,000.00**	
G. Total Direct Costs (A+B+C+D+E+F)									
					$107,866.67	**$46,880.15**	**$9,953.32**	**$164,700.13**	
H. Indirect Costs		**Base**		MTDC	$107,866.67	$46,880.15	$9,953.32	$164,700.13	
		Rate		53.25%	**$57,439.00**	**$24,963.68**	**$5,300.14**	**$87,702.82**	
I.Total Direct and Indirect Costs (G+H)					**$165,305.67**	**$71,843.82**	**$15,253.46**	**$252,402.95**	
	Cognizant Agency:	National Science Foundation							
	Negotiator:	Meghan A. Benson, (703) 292-4884							
J. Fee					**$0.00**	**$0.00**	**$0.00**	**$0.00**	
K. Total Cost (I+J)					**$165,305.67**	**$71,843.82**	**$15,253.46**	**$252,402.95**	
Project Total					**$165,305.67**	**$71,843.82**	**$15,253.46**	**$252,402.95**	

University Corporation at Monterey Bay
PI: Alison Haupt

BUDGET SUMMARY

Budget Items Requested	**Year 2 2018-2019**	**Year 3 2019-2020**	**Year 4 2020-2021**	**Total**
A. Direct Costs:				
1. Salaries & Wages (professional & clerical employees, temporary and student support, etc.)	$ 9,064	$ 9,291	$ 9,570	$ 27,925
2. Fringe Benefits	$ 825	$ 845	$ 871	$ 2,541
3. Travel	$ 2,000	$ 1,861	$ 1,861	$ 5,722
4. Participant Support Costs				
5. Equipment				
6. Software				
7. Materials and Supplies				
8. Publications & Printing (brochures, announcements, etc.)				
9. Consultants and Contracts				
10. Other (telephone, subscriptions, etc.)				
Total Direct Costs (add 1-10 above):	$ 11,889	$ 11,997	$ 12,302	$ 36,188
B. Indirect/Administrative Costs: Negotiated Federal rate is 46% MTDC)	$ 5,469	$ 5,519	$ 5,659	$ 16,646
TOTAL PROJECT FUNDS:	$ 17,358	$ 17,516	$ 17,961	$ 52,834