Thursday, April 18, 2019
3:30 p.m.
Library 1312

ORDER OF BUSINESS

1. Roll Call

2. Reports of Special Committees

Presentation of the 2018-19 Academic Senate Awards by the following committees:

Committee on the Faculty Research Lecturer
Committee on Diversity and Equity
Committee on Distinguished Teaching
Committee on Outstanding Teaching Assistants
Committee on Graduate Mentorship Awards

3. Announcements by the Chancellor

4. Announcements by the Chair and Others

5. Special Orders –

   Consent Calendar
   Approval of the minutes of the March 21, 2019 meeting (Attachment 1)

6. Reports of Standing Committees

   Graduate Council
   Action: Proposal to Establish a Masters of Environmental Data Science (Attachment 2)

   Undergraduate Council
   Action: Proposal to revise SB Senate Regulation 125. H. 3 and 115 E. (Attachment 3)

7. Petitions of Students None

8. Unfinished Business

9. University and Faculty Welfare

10. New Business

   Adjournment
The Faculty Legislature of the Santa Barbara Division met in Library Conference Room 1575 at 3:30 p.m. on Thursday, March 21, 2019, with Chair Henning Bohn presiding. The meeting was attended by 29 voting members, 5 ex officio members, and other interested parties.

Announcements by the Chancellor (from the slides presented)

Thank you to Senate Chair Henning Bohn and to all of our faculty colleagues for your commitment to shared governance. We are excited for the upcoming spring quarter!

Student Updates

UC Applications, 2018 vs. 2019
Overall freshman applications for fall 2019 dropped from the previous year in the UC system, led by Berkeley, UCLA and Santa Cruz.

+2.6% Merced
+1.2% San Diego
+1.2% Santa Barbara
+0.8% Riverside
+0.6% Irvine
+0.1% Davis
-1.3% Santa Cruz
-2.1% Los Angeles
-2.5% Berkeley
-3.0% UC-wide

UCSB Decision Day is Tuesday, March 19

Fall 2019 Freshman Admit Data

93, 342 freshman applicants
26, 827 freshman admits (4,800 expected to enroll)
29% admission rate (down from 32% last year)
Average GPA: 4.32 (up from 4.28)
64% California residents (down from 67%)
15% domestic nonresidents (no change)
21% international nonresidents (up from 18%)
23% underrepresented minorities (no change)
30% first-generation (no change)

2017-18 Freshman-to-Transfer Ratio
UCSB met the 2:1 freshman-to-transfer ratio in 2017-18, with precisely 2.0. Though several campuses did not meet the ratio, the ratio was met Universitywide. Merced is excluded from the 2:1 ratio goal that is part of the Budget Framework agreement with the governor.

UCOP Policy on Nonresident Student Tuition
Nonresident Supplemental Tuition for students whom a campus enrolled above its 18% cap will be redirected to support student basic needs programs across the system in 2019-20. However, the campus will retain an amount for the estimated cost of instructing those students.

Per-student figures:

- Extra tuition supplemented by nonresident student: $29,000
- Estimated cost of instruction retained by campus: -$11,400
- Nonresident supplemental tuition redirected: $17,600

for student basic needs UC-wide

Fall 2018 Undergraduate Nonresident Enrollment Percentages on UC Campuses
UC Santa Barbara's percentage of undergraduate nonresidents was 16.2% in Fall Quarter 2018, which is 3,736 nonresidents of the 23,070 total undergraduate students. Five campuses have exceeded the cap, while three others have not met the limit.

Nonresident Tuition

Last Thursday, the UC Regents voted to table a proposed 2.6% tuition increase for nonresident students.

2019 Regional Receptions

- San Jose: February 24
- Washington D.C.: March 9
- New York City: March 10
- Orange County: March 16
- Los Angeles: March 17

UCSB Open House 2019
Campus-wide open house welcoming admitted students, prospective students, and their families will take place on Saturday, April 13.

**Campus Updates and Highlights**

**College Admissions Scandal**

President Napolitano issues a letter of the ten UC chancellors on Monday, March 18, calling for “an independent assessment of our admission practices throughout the system.” Our internal audit department will work with the systemwide Office of Ethics, Compliance, and Audit Services on this review.

**Long-Range Planning Task Force on Enrollment**

On February 28, we announced the formation of our Long-Range Planning Task Force on Enrollment, as suggested by our Academic Senate Committee on Admissions, Enrollment, and Relations with Schools (CAERS).

Thank you to each of our faculty colleagues who have agreed to serve.

**2020 U.S. News Best Graduate Schools**

Materials ranks No. 1 among public institutions and No. 3 overall.

Chemical Engineering ranks No. 6 among public institutions and No. 10 overall.

**National Book Critics Circle Award**

Professor of English Yunte Huang’s “Inseparable: The Original Siamese Twins and Their Rendezvous With American History” is shortlisted in the biography category.

**Friedrich Wilhelm Bessel Research Award**

Professor of Chemistry and Biochemistry Trevor Hayton is awarded for his research toward the future development of high-tech materials, as well as new methods for nuclear fuel cleanup.

**2019 J. Anthony Lukas Prize Project Award**

Professor of Black Studies Jeffrey Stewart has won this prestigious nonfiction award - administered by the Columbia Journalism School and the Nieman Foundation for Journalism at Harvard - for his biography of Alan Locke.

**AAAS Lifetime Mentor Award**
Professor of Physics Beth Gwinn receives 2019 Lifetime Mentor Award from the American Association for the Advancement of Science.

2019 Plous Lecture

Associate Professor of EEMB Douglas McCauley delivered our annual Plous Lecture on March 11, examining the impact of humans and technology on our oceans.

NSF Career Award

Assistant Professor of Mechanical Engineering Bolin Liao receives the NSF Career Award - making it his third early career award since joining our faculty in July 2017.

2019 Elizabeth D. Hay New Investigator Award

Assistant Professor of Mechanical Engineering Otger Campas has received the Elizabeth D. Hay New Investigator Award from the Society for Developmental Biology.

Alfred P. Sloan Foundation Fellowships

Assistant Professor of Psychological and Brain Sciences Thomas Sprague, and Assistant Professor of Mathematics Xin Zhao are recognized for their promising early-career achievements.

Robotics Technologies of the Year

Assistant Professor of Mechanical Engineering Elliot Hawkes’ soft robot is among Science Robotics’ “Ten robotics technologies of the year.”

IEEE Electron Devices Society Fellowship

Professor of Electrical and Computer Engineering Kaustav Banerjee’s doctoral student, Junkai Jiang, receives the prestigious Ph.D. Student Fellowship from the Institute of Electrical and Electronics Engineers’ Electron Devices Society.

UCSB Reads 2019

On January 10, we helped hand out free books to our students. Author Thi Bui will give a free lecture at Campbell Hall on April 25.

El Plan of Santa Barbara’s 50th Anniversary
Last month, our campus celebrated the 50-year legacy of Chicana and Chicano Studies at UC Santa Barbara. Thanks to all of our faculty, staff, and students who helped organize and who participated!

**UCSB Advocacy Day in Sacramento**

On April 2, Chancellor Yang will be meeting with our state legislators to discuss higher education issues and funding. We will also hold a reception for our alumni.

Save the date for the All Gaucho Reunion from April 25-28, 2019. Thank you.

**Consent Calendar**

**Motion:** To approve the minutes of the January 10, 2019 meeting.

The motion was seconded and approved by unanimous voice vote.

**Announcements by the Chair**

Chair Bohn thanked Chancellor Yang for approving an interim measure to provide support for infant care for Assistant Professors. The Chancellor has agreed to make grant funding available as part of the startup packages for Assistant Professors in the amount of $5,000 for up to two years, in the event they cannot be accommodated by Early Childhood Care and Education Services. Eligible faculty must be on the waitlist for at least one month, and until their baby is three months old. Associate Vice Chancellor Hererra Sobek has agreed to manage the program.

In response to a question from the floor, Chair Bohn stated that the program is only available to Assistant Professors at this time. The Chancellor’s Advisory Committee on Childcare is also considering the issue of backup care.

Academic Council has selected its next Vice-Chair for 2021, pending Academic Assembly approval. The nominee is Mary Gauvain from UC Riverside. UCSB’s Kum-Kum Bhavnani will serve as Chair.

In response to a question from the floor, Chair Bohn reported that the recent admissions scandal reported in the news has generated debate on the campuses. The Office of the President is aware of one case at UCLA. Chair Bohn emphasized that we will continue to follow current procedures for addressing the submission of fraudulent documents. The Academic Senate will also review the related policies and procedures to determine whether modifications might be appropriate. President Napolitano has initiated a review at the Universitywide level.

In response to a related question about the admission of athletes, Chair Bohn responded that the students we are admitting are academically qualified and UCSB has one of the highest
graduation rates of student athletes.

As noted in the Academic Council’s letter, posted on the Academic Senate website, the University has reached a standstill in its negotiations with Elsevier. Access to publications have not been cut off, but may be any day. In the event that access is closed, the Library will use interlibrary loans. The University of California has been offered support from universities all over the country, who are prepared to help us access articles that may be inaccessible through Elsevier.

UC Santa Barbara has signed the OA2020 Statement of Interest, which was broadly supported by our Divisional reviewing agencies. The letter affirming our support is posted on the Academic Senate website.

Although generally identified as positive, the proposed 2019-20 State budget has a number of important drawbacks. Although the UC is expected to receive a funding increase from 2018-19, a significant amount of it will be in one-time allocations. Chair Bohn acknowledged that UC has some heavy lifting to do in its negotiations with the State.

The Regents voted to freeze undergraduate tuition for California residents for the 2019-20 academic year, and tabled the discussion related to tuition for non-resident students. There was also a long discussion regarding Self-Supporting Graduate Professional Degree Programs.

In November, the Regents assumed $30M in new revenues to cover expenses for Non-Resident Supplemental Tuition. While UC’s primary responsibility is to California residents, concerns have been raised about affordability for non-resident domestic and foreign students.

The President has endorsed recommendations from two systemwide “tiger teams” for protecting UC from potential risks from foreign entities. The Teams on 1) Vulnerabilities Associated with International Students, and 2) Sensitive Information and Materials Related to International Agreements were asked to develop recommendations for protecting UC systems and intellectual property in ways that address federal concerns about national security but also support UC’s commitment to an open and collaborative research environment. A second letter from the president provides additional guidance for UC engagements with specific Chinese network equipment companies, in anticipation of possible federal action against those companies. UCSB’s Office of Research is strictly following related policy and procedures and overseeing campus compliance.

President Napolitano has released several letters regarding foreign influence and UC engagement with Huawei and ZTE. UC is concerned about political interference in science research, which is currently under discussion by UCORP and Academic Freedom. Current issues include restrictions on climate research and stem cell research. Both the Office of the President an UCSB are holding the line, pushing back against any interference.

The Academic Council discussed the use of research information management systems, which measure faculty performance with respect to publications. The Council has asked Provost and
Executive Vice President Brown to commission a review of this issue.

The University has made an agreement with the United Auto Workers union to compensate graduate students for incorrect or delayed payments as a result of UCPath implementation issues.

The Academic Council also discussed next steps for the discussion regarding the Area D Laboratory Science admissions requirements. The recent proposal from the Board of Admissions and Relations with Schools was deemed unsuccessful because of concerns that under-resourced high schools may have problems with eligibility. The proposal may be split into separate initiatives, such as renaming “Laboratory Science” to “Science” and broadening the list of courses that can be applied toward the third science course.

The proposed revisions to Bylaw 336 were approved by the Academic Council and will be presented to the Academic Assembly for final consideration. Faculty have serious concerns about the ambitiousness of the proposed timelines, and concerns have been voiced about the need for additional resources to ensure successful implementation of the new requirements.

The Council considered the second systemwide review of the Proposed Presidential Policy on Open Access for Theses and Dissertations. The campuses have submitted many comments, and there is more work to be done. The main questions include who should have authority to embargo theses and dissertations and for how long.

2018-19 Elections Report


Assembly Representatives

The following candidates accepted nomination and received the requisite five endorsements.

Charles A. Akemann (Mathematics)
Claudio Fogu (French and Italian)
Nuha N. Khoury (History of Art and Architecture)

Because there were only three viable candidates for the three open positions, a ballot was not conducted following the nomination period.

Committee on Committees

A total of three candidates were nominated for Area C: College of Letters and Science Humanities and Fine Arts Division and College of Creative Studies. As there were three nominees for one available position, a ballot was conducted from February 20 – March 6, with
the following results:
Silvia Bermudez (Spanish and Portuguese) – 16.67% (14 votes)
Constance Penley (Film and Media Studies) – 30.95% (26 votes)
Ann Plane (History) – 50.00% (42 votes)
Abstain – 2.38% (2 votes)
Total Votes – 84 (22.22%) of 378 eligible voters

Ann Plane received the most votes for Area C: College of Letters and Science Humanities and Fine Arts Division and College of Creative Studies.

Lisa Hajjar accepted nomination and received the requisite number of endorsements for Area B: College of Letters and Science Social Sciences Division and Gevirtz Graduate School of Education. Because there was only one nominee in Area B, a ballot was not conducted for this position.

As there were no faculty nominations for the position in Area A (College of Letters and Science Mathematical, Life and Physical Sciences Division and Donald Bren School of Environmental Science and Management), this position will be filled by an appointment by the Committee on Committees according to Divisional Bylaw 90.C3.

Parliamentarian Akemann asked the legislators to remind their colleagues to be mindful of Senate elections and to please vote.

Akemann asked for additional nominations from the floor. As there were none, a motion was accepted to approve the proposed slate.

**Motion:** To approve the slate of 2019-20 Senate election candidates. The motion was seconded and approved by unanimous voice vote.

**Proposal to Revise Appendix V of the Divisional Senate Manual - Student Appeals Procedure**

Chair Bohn provided contextual information to the Legislature regarding the proposed changes to Appendix V. In Fall Quarter 2017, General Counsel approached the Academic Senate with proposed modifications to Policy 4105, the Student Grievance Procedure for Alleged Discrimination. Many campus stakeholders provided input on the proposed modifications, and after a number of revisions, General Counsel and OCR settled on an updated version of Policy 4105. OCR has asked the University to move forward with implementing Policy 4105. As the Student Grievance Procedures are connected with the Academic Senate’s Procedures for Grade Appeal (Appendix V of the Senate Manual), we must now update Appendix V for congruence.

Chair Bohn stated that the main purpose of the revisions is to clarify the process and authority for addressing formal student complaints that involve both an allegation of discrimination and a grade appeal. While decisions regarding discrimination fall under the authority of the Vice
Chancellor for Student Affairs (or designee), the decisions regarding grade changes fall under the authority of the Academic Senate (or designee).

The Academic Senate disseminated the draft of Appendix V for council and committee review over the winter quarter and received comments from the Committee on Rules, Jurisdiction, and Elections, Undergraduate Council, Graduate Council, and Faculty Executive Committees of the College of Letters and Science and the College of Engineering. The proposed language was presented for final consideration by the Legislature.

A member raised concerns about the proposed procedures, noting that grade appeals should be evaluated separately from discrimination complaints. After several varying viewpoints were expressed, Executive Vice Chancellor Marshall clarified that the main purpose of the changes to Appendix V was to maintain the integrity of the Academic Senate’s authority to adjudicate a grade appeal. If the Office of Equal Opportunity determines that a faculty member has discriminated against a student, it is possible they will suggest a grade adjustment as an appropriate remedy. The Senate will make the final determination about the grade.

Following additional discussion, a member from the floor moved to approve the proposal.

**Motion:** To approve the proposed changes to the Divisional Academic Senate Manual, Appendix V. The motion was seconded and passed with 28 in favor, 1 opposed, and 0 abstentions.

**Proposal to Establish a Standing Committee on Information Technology within CRIR**

Jianwen Su, Chair of the Council on Research and Instructional Resources (CRIR), explained the rationale for the proposed establishment of a new standing Committee on Information Technology within the Council on Research and Instructional Resources, and the associated changes to Divisional Bylaw 65, which governs CRIR. Chair Su stated that the Academic Senate would benefit from additional communication and holistic consideration of IT-related issues such as data management, cybersecurity, privacy, and network stability.

A member raised concerns about adding another committee to the Division, in the interest of maintaining a lean operation. It was clarified that the new Committee would be comprised of existing CRIR members.

**Motion:** To approve the establishment of a committee on Information Technology within CRIR. The motion was seconded and passed with 27 in favor, 0 against, and 1 abstention.

**Memorial to the Regents - Fossil Fuel Divestment**

Chair Bohn explained to the Legislature that the San Francisco Division of the Academic Senate has circulated a Memorial to the Regents calling to divest the University’s endowment portfolio
of all investments in the 200 publicly traded fossil fuel companies with the largest carbon reserves.

Under Academic Senate Bylaw 90, UCSF has notified all of the divisions of the proposed Memorial. The Santa Barbara Division has 90 days to put the issue to a vote, and may approve or not, or decline to act. It is not possible to amend or change the proposed Memorial language. If at least three divisions, constituting 35% of the membership of the Academic Senate, vote to approve the Memorial, it will be put to a mail ballot for the entire membership. None of other divisions have voted yet.

It was noted that the Memorial applies only to UC’s general endowment and not to its retirement funds. Members expressed varying viewpoints, including the Memorial’s consistency with UCSB’s status as a staunch supporter of environmental policy and sustainability. Support was also voiced regarding the need to rein in the fossil fuel industry. It was suggested that collecting additional information and pursuing greater consultation would be advisable, but a motion to move forward was eventually made from the floor, based on the discussion and the information already provided.

**Motion:** To approve the proposed Memorial to the Regents. **The motion passed with 21 in favor, 4 against, and 2 abstentions.**

The meeting was adjourned at 5:00 p.m.
April 5, 2019

TO:    Henning Bohn, Chair
       Academic Senate

FROM: Henry T. Yang

RE:   Proposal to Establish a Program of Graduate Studies with PDST in Environmental Data Science for the Master of Environmental Data Science Degree

I have had the opportunity to review a proposal from the Bren School in Environmental Science and Management to establish a Program of Graduate Studies with PDST in Environmental Data Science for the Master of Environmental Data Science degree.

The proposed degree program has gone through two reviews overseen by Graduate Council. The reviewers included Carol Genetti, Dean of Graduate Division; Rod Alferness, Dean of the College of Engineering; John Majewski, Dean of the Division of Humanities and Fine Arts in the College of Letters and Science; Pierre Wiltzius, Dean of the Division of Mathematical, Life and Physical Sciences in the College of Letters and Science; Faculty Executive Committees (FECs) of the Bren School, College of Engineering, and College of Letters and Science; and Council on Planning and Budget (CPB), Undergraduate Council (UgC), Committee on Library, Information and Instructional Resources (CLIIR), and Committee on Research Policy and Procedures (CRPP), for review and comment. The proposal was accompanied by letters of support from Steve Gaines, Dean of the Bren School of Environmental Science and Management, and Charles Hale, Dean of the Division of Social Sciences in the College of Letters and Science.

There was general support for the proposal during the initial review, but Graduate Council decided to ask the initiators of the proposal to address some questions that had been raised by reviewers. After Graduate Council conveyed those concerns to the initiators, a revised proposal was submitted to the Council on January 7, 2019, including both changes to the proposal and detailed responses to the substantive concerns that had been raised. The revised proposal was distributed to all reviewing agencies for a subsequent review. Graduate Council received revised letters of support from Dean Genetti and CPB, as well as letters of support from Dean Wiltzius and the College of Letters and Science FEC. The Council reviewed the updated documentation at its meeting of February 11, 2019, and agreed that the initiators had satisfactorily addressed all relevant issues. Graduate Council voted to approve the proposal with 14 in favor, 0 against, and 1 abstention (5 members were absent).

Executive Vice Chancellor Marshall has reviewed the proposal, the supporting materials, and budget information. He noted that the proposed Bren Master of Environmental Data Science degree, with funding from PDST, like the Master of Technology Management degree in the College of Engineering’s Technology Management Program, has the potential to play an important role in our state, leveraging Bren’s national and international stature and UC Santa Barbara’s unique ability to embed a professional degree within the context of a research university. He further noted that the proposed degree program comes forward in the context of campus-wide discussions to explore strategies for advancing both research and curricular initiatives in the area of data science.
April 5, 2019
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As a result of his review, Executive Vice Chancellor Marshall has offered his endorsement, and it is now proceeding through my office for my review. I concur with the Executive Vice Chancellor’s endorsement and offer final administrative endorsement. I thus recommend that the proposal be placed on the Agenda for a future Faculty Legislature meeting. If the proposal for the new graduate program is approved by the Faculty Legislature, it will be ready to be transmitted to the Coordinating Committee for Graduate Affairs and the Office of the President.

I would like to mention that the climate for establishing data science degree programs has matured and emerged recently as a popular trend in higher education. For example, MIT has just established a College of Computing, inspired by a leading gift from Blackstone Group CEO Stephen Schwarzman. And UC Berkeley has established a Division of Data Science and Information, coupled with a fundraising program.

I would like to recommend that our campus work with the Associate Vice Chancellor for Development along with our administrative and faculty colleagues and myself to coordinate a fundraising plan to secure additional support from private sources to add strength to the development of our data science efforts, in addition to the anonymous gift of $3 million for the establishment of this program. However, such private fundraising should not be a prerequisite to the approval of this program.

Thank you.

cc:  David Marshall
     Toby Lazarowitz
     Amr El Abbadi
     Debra Blake
February 25, 2019

To: David Marshall, Executive Vice Chancellor

From: Amr El Abbadi, Chair, Graduate Council

Re: Proposal for a Master of Environmental Data Science, with Professional Degree Supplemental Tuition

Per the policy and procedures for the Establishment of a Graduate Program Leading to a New or Existing Degree, we are forwarding for your review and consultation with the Chancellor a proposal from the Bren School of Environmental Science and Management to establish a program of professional graduate studies with PDST in Environmental Data Science for the Master of Environmental Data Science degree.

The proponents have developed a well-written proposal which presents a cogent argument for the establishment of a master’s program in this emergent discipline. The proposed Master of Environmental Data Science will be unique in the UC system and is an appropriate evolution of the Bren School’s academic offerings. This program will also form an integral component of the data science efforts at UCSB.

The proposal was distributed to Carol Genetti, Dean of Graduate Division, Rod Alferness, Dean of the College of Engineering, John Majewski, Dean of the Division of Humanities and Fine Arts in the College of Letters and Science, Pierre Wiltzius, Dean of the Division of Mathematical, Life and Physical Sciences in the College of Letters and Science; Faculty Executive Committees (FECs) of the Bren School, College of Engineering, and College of Letters and Science; and Council on Planning and Budget (CPB), Undergraduate Council (UgC), Committee on Library, Information and Instructional Resources (CLIIR), and Committee on Research Policy and Procedures (CRPP), for review and comment. The proposal was accompanied by letters of support from Steve Gaines, Dean of the Bren School of Environmental Science and Management and Charles Hale, Dean of the Division of Social Sciences in the College of Letters and Science. Chuck Haines, Assistant Chancellor for Budget and Planning, opted not to opine. The remaining reviewing agencies had mixed evaluations and provided extensive comments for the Graduate Council (GC) to consider. During the Council’s meeting on December 3, 2018, GC evaluated a first submission of all materials. There was support from all reviewing agents except the College of Letters and Science FEC and Dean Wiltzius. Concerns from GC and the reviewing agencies were conveyed to the initiators with a request for revisions and response to substantive concerns. A revised proposal, including detailed responses to each concern, was received on January 7, 2019. The revised proposal was distributed to all reviewing agencies for a subsequent review.

Graduate Council received revised letters of support from Dean Genetti and CPB, and support from Dean Wiltzius and the College of Letters and Science FEC. The Council reviewed the updated documentation at their meeting of February 11, 2019, and have agreed that the faculty have satisfactorily addressed all relevant issues. GC voted to approve the proposal with 14 in favor, 0 against, and 1 abstention (5 members were absent). The full proposal, initiator response and accompanying reviewing agency comments are attached for your review.
The Council recommends that the initiators give further thought to some of the repeated concerns from multiple reviewing agencies, especially CPB and the College of Letters and Science FEC. It will be important for the Bren School to leverage new campus space, such as additional classroom availability across campus when the approved classroom building is completed, and to continuously evaluate the coursework to ensure proper level of rigor. To this end, GC recommends a three-year review from first cohort date of entrance of the MEDS program. This review should include an internal assessment and report submitted to Graduate Council.

CC: Ben Halpern, Professor, Bren School; Director, NCEAS
    Henning Bohn, Chair, Academic Senate
    Debra Blake, Executive Director, Academic Senate
    Carol Genetti, Dean, Graduate Division
    Robert Hamm, Assistant Dean, Graduate Division
    Rickie Smith, Director, Academic Services, Graduate Division
    Toby Lazarowitz, Executive Assistant to the Executive Vice Chancellor
    Steven Velasco, Director, Institutional Research, Planning & Assessment
    Steve Gaines, Dean, Bren School
    Satie Airame, Assistant Dean, Bren School
Thank you for the opportunity to comment on the proposal for a new professional Master’s program in Environmental Data Science. It is clear that the program is innovative, timely, and meets a key societal need. The many letters of support amply demonstrate that the program is an excellent fit for UC Santa Barbara, would build on significant strengths, and would complement existing programs across campus. I find the Bren School’s arguments on projected need and student demand to be compelling and the enrollment projections seem feasible.

As the proposal makes clear, the academic program is intensive, but the workload is still reasonable for full-time students. The group project model for the capstone has been highly successful in the Bren MESM program, and I believe it will translate well within the shorter MEDS framework and provide experience that will be highly valued by employers. Due to the admissions requirements, admitted students will come into the program with relevant skillsets. The summer boot-camp classes will provide opportunities to refresh these skills, which will help students transition to the two-week summer classes and the more in-depth courses during the academic year.

As you are well aware, campus space is a significant challenge at UC Santa Barbara. This dearth will eventually be remedied, at least with regard to instructional space: the campus has received an allocation of funding from the State for a new building dedicated to instruction. That building should be ready for use by February 2023. By the time the MEDS program reaches its full size, the classroom inventory on campus will be greatly increased. There will be challenges in the short term. The proposed two-campus solution is a creative innovation. The plan is to hold classes at the Balboa building in downtown Santa Barbara and at the UCSB campus on alternate days. This arrangement will pose some challenges for faculty and students, but the program’s supporters are well-aware of these and have made a good case that it is a workable arrangement as the program gets established and new facilities are built on campus. Regarding office space, the proposal states that the program will need 17 new offices, mostly at UC Santa Barbara. The letter from Steven Gaines, Dean of the Bren School, indicates that he will take responsibility to ensure that these offices and other campus spaces are available.

The proposal lists eight current faculty members committed to teach in the program. Seven of the eight are listed as instructors in the proposed initial teaching plan (assuming the hire of an LSOE and a ninth faculty member). This suggests that there will be adequate faculty to cover sabbaticals or other leaves. Authors of the proposal also indicate that they have worked closely with Dean Gaines and Assistant Dean Airame to ensure that neither Bren’s MESM nor its doctoral curriculum will be negatively affected by teaching commitments to MEDS. The proposed request for two new faculty FTE is sufficiently modest to be accommodated through the regular process of FTE allocation. In addition to new Bren faculty, the data science initiative across campus is likely to lead to additional faculty appointments in relevant areas.

The program advances two important campus strategic goals: increasing the graduate student population; and reaching out to, admitting, and recruiting a diverse student body. I am encouraged by the Bren School’s plan to use donor funds to create diversity fellowships for the MEDS program. As you know, the Graduate Division has set an aspirational goal of having the diversity of the graduate students reflect that of our undergraduates. In setting
diversity goals, the Bren School may want to consider whether the cohorts that it admits reflect the diversity of UCSB majors in Environmental Science. Even more important from a societal perspective is whether admitted cohorts include members of minority or other under-privileged populations that are directly and disproportionately impacted by the negative effects of environmental degradation.

There are considerable staffing needs laid out in the proposal. I understand that it is important for a one-year professional program to be very well run and to provide significant support for professional development and career attainment. These costs are appropriately covered by the PDST and donor funds.

The budget overall is comprehensive and realistic. The identification of a significant philanthropic gift to launch the program will allow it to avoid deficits as it ramps up to full size, assuming enrollment and cost projections are accurate (which they appear to be). The PDST level brings the overall cost within the range of comparable programs nationally, and there is a strong plan for financial aid to ensure access.

In sum, the Bren School has put forward a compelling proposal for a professional Master’s program that is well designed, appropriately resourced, likely to have significant student demand, and will equip students with skills that can be applied to perhaps the most significant challenge of our century. I enthusiastically endorse this proposal and strongly recommend approval by the Graduate Council.
To: Henning Bohn, Chair  
Academic Senate

From: Joao Hespanha, Chair  
Council on Planning & Budget

Re: 2nd Revised proposal for Master of Environmental Data Science (MEDS)

The Council on Planning & Budget has reviewed the second revised proposal for a Master of Environmental Data Science (MEDS). CPB is now supportive of the MEDS proposal and believes that the bulk of its concerns have been addressed. The members of CPB overwhelmingly believe that the MEDS program will contribute significantly to the larger data science initiative at UCSB. In reviewing the latest version of the proposal, three primary points were raised. They do not need to be addressed in a revision, but are merely stated as factors to consider going forward.

1. One of CPB’s original concerns was what would happen if the MEDS program doesn’t reach its stated goal of +/- 90 students. Is there a “plan B” or alternative in the event that this goal isn’t met?
2. Even though CPB was favorable toward the revised proposal, there still wasn’t unanimous support of the rigor of the coursework.
3. The MEDs program will likely create numerous opportunities for collaboration across campus, with other universities, and with the larger community. This could present a good opportunity for faculty recruitment in the future.

In general, CPB is supportive of the revised MEDS proposal and believes it will bring significant visibility to campus and enhance the larger data science initiative.

cc: Debra Blake, Academic Senate Executive Director  
Kelly Erland, Academic Senate Analyst for Graduate Education
February 4, 2019

TO: Amr El Abbadi, Chair  
    Graduate Council

FROM: Ralph Armbruster-Sandoval, Chair  
      College of Letters and Science Faculty Executive Committee

RE: Proposed Master’s in Environmental Data Science

At its meeting on January 31, 2019, the Letters and Science Faculty Executive Committee (FEC) reviewed the revised (January 2019) version of a proposal to establish a Master’s degree in Environmental Data Science at UC Santa Barbara.

The FEC appreciates the efforts of Professor Halpern et al. to address the various Senate concerns and found the table of similar programs to be especially helpful. Developing a new graduate degree program is by nature a complex endeavor, and such proposals invariably benefit from broad campus review. From our perspective the adjustments, clarifications, and additional information have resulted in a much stronger proposal. The FEC voted unanimously to endorse the establishment of the degree.

We do offer the following recommendations for program and campus administration to consider as the program moves forward:

1) Location and Space. The FEC recognizes the very real lack of space on campus that makes locating the program partially at NCEAS a necessity. Because many potential participants may not be located in Santa Barbara proper, we encourage the full relocation of the program to campus as soon as is practicable.

2) Refresher Courses and Pre-Requisites. The summer refresher courses could be a vital component of student success in this fast-paced academic program, yet time [and income loss] could prove a powerful disincentive to participation. As such we recommend that program administrators consider setting a limit beyond which the refresher modules become mandatory (e.g., a certain number of years not using mathematics). Perhaps correlations between refresher module participation and overall student success could be monitored and fed into such decisions.

The FEC looks forward to the success of this new program.

cc: Pierre Wiltzius, Executive Dean of the College and Dean of Science  
    Jeffrey Stopple, Associate Vice Chancellor and Dean, Undergraduate Education
January 15, 2019

To: Rod Alferness, Dean, College of Engineering  
Ralph Armbruster Sandoval, Chair, Letters and Science Faculty Executive Committee  
Irene Beyerlein, Chair, Engineering Faculty Executive Committee  
Carol Genetti, Dean, Graduate Division  
Trevor Hayton, Chair, Undergraduate Council  
Joao Hespanha, Chair, Council on Planning and Budget  
Werner Kuhn, Chair, Committee on Library, Information and Instructional Resources  
Jianwen Su, Chair, Committee on Research Policy and Procedures  
Pierre Wiltzius, Dean, Mathematical, Life, and Physical Sciences

From: Amr El Abbadi, Chair, Graduate Council

Re: Master of Environmental Data Science – Revised Proposal

In December 2018, Graduate Council considered all reviewing agency comments on the Master of Environmental Data Science (MEDS) degree program proposal. The Council transmitted, along with its own findings, the main concerns to the proposal initiators with a request for response.

Ben Halpern, Professor in the Bren School and lead initiator of the MEDS proposal, has responded in the attached memo, submitted a revised version of the proposal and added new letters of support. We are sending his response and the revised proposal for your review and comment.

We would appreciate your response no later than February 6, so that Graduate Council can consider your comments in its discussion. Graduate Council has approval authority for graduate degree programs prior to administrative endorsement and Faculty Legislature consideration. Following campus approval, the proposal is transmitted to the Coordinating Committee on Graduate Affairs (the systemwide counterpart to Graduate Council) and the Office of the President for final review.

CC: Henning Bohn, Chair, Academic Senate  
Debra Blake, Executive Director, Academic Senate  
David Marshall, Executive Vice Chancellor  
Toby Lazarowitz, Executive Assistant to the Executive Vice Chancellor  
Steve Gaines, Dean, Bren School  
Nancy Emerson, Executive Assistant to the Dean, MLPS  
Robert Hamm, Assistant Dean, Graduate Division  
Michelle Veal, Executive Assistant to the Dean, College of Engineering  
Shasta Delp, Analyst, Undergraduate Council  
Casey Hankey, Analyst, Council on Research and Instructional Resources  
Kyle Richards, Analyst, Council on Planning and Budget  
Satie Airame, Assistant Dean, Bren School  
Barbara Gilkes, Assistant Dean, College of Letters & Science  
Tiffany Sabado, Advisor, College of Engineering Faculty Executive Committee
To: Graduate Council and Reviewing Committees  
Re: Responses to reviewer comments on the proposal for a Masters of Environmental Data Science (Meds)

Thank you for the opportunity to respond to reviewer comments and submit a revised MEDS proposal. Below we address each issue raised by reviewers and highlight places where the proposal has been revised if changes were needed, as well as include as appendices a comparison table and additional letters of support (discussed below, and included in the revised proposal). Overall, the changes were relatively minor to add clarity and are referenced in the comments below. Because there was some overlap in comments across letters, we address all comments together as a single response rather than directly addressing each letter separately.

How does MEDS fit into a larger, holistic campus strategy on data science?

We appreciate the broad interest and enthusiasm across campus for a robust and diverse vision for data science, and a coordinated strategy for implementing that vision. Indeed, both Ben Halpern and Krzysztof Janowicz (PIs on the MEDS proposal) serve on EVC Marshall’s Advisory Committee on Data Science that has spent the last year discussing and developing this vision and strategy. The letter from Prof. Ambuj Singh submitted with the proposal spoke to these efforts and MEDS integration into them; Prof. Singh has submitted an ‘addendum’ letter with this cover letter further clarifying how MEDS fits into this plan.

In brief, UCSB has launched some core undergraduate classes to help serve and develop data science undergraduate education. To address graduate education needs and opportunities, there are plans to foster a system of complementary disciplinary nodes of opportunities – initially with PSTAT’s existing MA in Statistics (Data Science emphasis), Geography’s 5th year Masters in GIS (MAGIS - to be submitted), and MEDS. Other opportunities will equally be encouraged (e.g., CS is currently focusing on PhD level graduate programs, but if they decide to pursue a Masters degree, this would fit well into the campus plan). Because Geography has not yet finalized their proposal for their degree and CS currently has no plans to, we have not had the opportunity to comment on those potential plans and their possible integration with MEDS. We look forward to that opportunity. The revised MEDS proposal speaks more directly to this broader campus wide plan and the role of MEDS in it (see updated section 1.4.a, which begins on page 11 in the revised proposal).

The letter from CPB discussed specific questions/concerns about how MEDS curriculum might overlap with PSTAT’s existing degree and any potential plans by Geography and CS and whether it would be better to integrate these existing (or potential) classes into the MEDS curriculum instead of creating new classes. Although there will be numerous opportunities for shared electives across these programs, there are several reasons why this is not an effective strategy for most of the core requirements for the MEDS degree. First, data science classes benefit enormously from a strong disciplinary focus, and departments/programs can and should teach separate classes that use and benefit from this disciplinary focus. The disciplinary focus allows for problem sets, case study examples, and general student interests, among other course attributes, to be matched. Statistics is a perfect example of this approach at work: at UCSB it is currently taught in EEMB (EEMB146, EEMB176, EEMB276), Bren (ESM206,
ESM244), Geography (GEOG172, GEOG210A,B,C) and PSTAT (many courses), at a minimum (other departments are also likely teaching statistics courses).

Second, courses in professional programs need to be relatively small to cater to the expectations of students who are paying supplemental tuition for a professional graduate degree (and to allow for more hands-on instruction). It simply would not work to fold 80 graduate students (e.g., when MEDS is fully mature) into an existing PSTAT graduate class. As noted above and below, this would not be a problem for electives that would draw a very small number of MEDS students.

Third, PSTAT faculty are already heavily impacted by existing enrollment in their classes. Asking them to add a substantial number of students into their classes and modify their instructional materials to accommodate those students (see point above) is not sustainable.

Finally, as outlined in the proposal, there are dozens of existing data science masters programs across the country that can meet the needs of students with very generic interests. MEDS will be the first program with a specific environmental focus. To draw the top national and international talent focused on bringing the tools of data science to tackling the world’s environmental challenges, the MEDS core curriculum must link the tools to the classes of environmental challenges they can solve.

We strongly believe that multiple efforts across campus around data science training and education will provide substantial positive synergies rather than any negative conflict. As noted above, this is a shared philosophy within the Data Science Advisory Committee convened by EVC Marshall. Where there is potential overlap, we see many ways these synergies can emerge. Coordinated and shared instructional materials, where appropriate, is a positive outcome. Cross-fertilization of ideas and disciplines via co-enrollment of students in elective classes is a positive outcome. Potential for shared resources (e.g., TAs) for larger classes that have enrollment from multiple programs is a positive outcome. Finally, although this program is focused on professional masters students, the faculty involved will also be advising and offering courses focused on PhD students within Bren and in other degree programs. This expands the range of educational and research interactions across campus in ways that go beyond the MEDS program. As an example, the current Bren School MESM program has cohorts that are of comparable size to the proposed MEDS program. They also take all of the core MESM classes within the Bren School. But, they take electives across campus, and the Bren school faculty also advise more than 65 PhD students. Roughly 25% of these students are getting their degrees in departments outside of the Bren School, and nearly all of the Bren School faculty have at least a 0% affiliated appointment in these other departments. We envision similar cross campus linkages growing from the campus Data Science Initiative through faculty and PhD collaborations.

Both Ben Halpern and Krzysztof Janowicz are committed to staying involved in UCSB’s efforts to develop and execute a broader initiative around data science, at a minimum by continuing to serve on the Advisory Committee but also through involvement with existing and emerging efforts within and across departments and at the Library. It is an exciting time for data science at UCSB, and we remain excited to be one important part of this broader effort.
Program breadth versus depth

When the proposed MEDS curriculum was developed, we did extensive research on what is being offered by existing Masters programs in data science and built from those examples when adapting the curriculum to the needs of environmental science and problem solving. The MEDS curriculum closely aligns with other programs - we now provide a comparison table of the curricula from a representative set of programs (N=26) to help demonstrate the similarities (table provided as an appendix to this letter, and also as Appendix H in the revised proposal). In short, MEDS is equally rigorous (i.e., in depth) as other programs offering a Masters in data science while allowing for a focus on environmental data and environmental problems.

The letter from Grad Council specifically requested further elaboration on the MEDS curriculum with respect to three issues: environmental aspects of the curriculum, expected knowledge of a graduate, and how the courses (in sequence) build on each other to develop the necessary expertise. To the first point, each class will be taught using environmental data, framed within environmental problems and solutions (e.g., case studies in lectures), and by environmental data science experts. To build on the arguments above, this integration of the deep environmental components in each class is crucial to creating a professional degree that links skills in data science to their potential for driving environmental solutions – a clear reason why these core needs cannot be met by simply taking existing data science classes with no domain specific grounding. To the second point, the proposal provides a detailed description of Program Learning Objectives (see section 1.7, which begins on page 20 in the revised proposal), as required of any degree program. These PLOs speak directly to the knowledge and skills we expect students to have at time of graduation from the MEDS program. Given how specific and comprehensive the PLOs are, we believe the details the Grad Council is seeking are covered in the PLOs, which may not have been obvious. To the final point, the classes build from core skills (summer and fall classes) to more advanced, specific skills (fall and winter classes) to application of what has been learned to a capstone project (winter and spring).

Length of program

As we noted in the original proposal (see section 2.3.g, page 29 of the revised proposal), the most full-time data science Masters programs are one year or less. However, we realize we did not support this statement with sufficient evidence. As noted above, we now include a table comparing a representative set of existing programs offering a Masters in data science, including information on the duration of the degree program (see appendix to this letter, and also as Appendix H in the revised proposal). Most full-time programs are a year in length or shorter, with the remaining full-time programs running up to 18 months.

The review from CPB noted that ‘several of the programs Bren offers as comparable are 18 and 24 months,’ referencing Table 1 (see pages 17-18 of the revised proposal). It’s important to note that this table 1) only lists other Data Science programs within the UC, not all data science programs, as required for that section of the proposal, and 2) only has one full-time 24 month program (UCB’s MIMS degree; UCSD’s 24 month program is part-time, select weekends only) and one 18 month program (UCLA’s MAS) out of 11 programs offered across the various campuses.
Feasibility of the FTE plan

It is important to note that although the request for new FTE positions is 2, the MEDS program will actually be starting with an effective 5 new positions, the 2 requested in the proposal, 1 FTE that was hired this year into Bren with a strong focus on environmental data science and the intent to be part of the MEDS program (Tamma Carleton), and 2 recent hires into Bren that had not yet begun teaching (because of first year teaching release) and have decided to have some of their teaching be part of MEDS (Scott Jasechko and Samantha Stevenson). As such, relative to the previous proposal (and the situation at the time it was submitted), the current proposal is based on 5 new FTEs in the MEDS program, with just 2 additional ones requested through the proposal. Furthermore, the proposal last year that included 8 FTE positions raised substantial concerns for requesting too many FTE. In developing the new proposal and plan, we were directly responding to this feedback to reduce the FTEs in a meaningful way (i.e., not just reducing it by 1 or 2 FTEs). As such, the current FTE request is appropriate, feasible and fit-to-need.

We have worked closely with Dean Gaines and Assistant Dean Airame at the Bren School to evaluate teaching needs within the MESM program and confirmed that all courses would be covered under the proposed plan.

Sustainability plan under a lower enrollment scenario

As we explain in our market assessment of demand (see section 3.3, starting on page 33 of the revised proposal), we believe our budgeted growth trajectory is conservative. Growth in student enrollment over the first 4 years (years 2-5 of the program, since year 1 is the year prior to matriculation of the first cohort) is projected to start at 20, then grown annually to 30, 40, and then 55 (see Table 4, page 35 of the revised proposal). From all indications, there will be substantial demand for the program.

The program will of course not simply rely on expected demand to achieve enrollment targets. Leveraging the experience of current staff at Bren who recruit for the MESM program, we will actively recruit students for MEDS. We have added a description in the proposal (see page 35 of the revised proposal) addressing our expected recruitment strategy. We will adapt this strategy as we learn what works and does not work over the first few years of the program.

Under our conservative scenario, the program remains in the black the entire initial five years and ends with roughly a $150K surplus. Assuming zero additional success at fundraising for the program, which is highly unlikely, the program thereafter would need 73 students to break even. As a back-up plan if this conservative growth trajectory is not achieved, the MEDS program would delay (or not hire) several of the staff positions that are needed when enrollment is higher - in other words, we can scale the increase in staffing to the rate of growth of enrollment to ensure the program remains in the black at all times under actual growth trajectories. Thus, we can adapt growth projections based on realized enrollment levels each year, and adjust our staff hiring plans accordingly in response. We now detail this contingency plan in the proposal (see section 6.10, page 63 of the revised proposal).

Finally, we will continue to actively fundraise for MEDS and are very optimistic about future prospects. For example, the initial donor may want to further invest to ensure the initial gift is leveraged. Preliminary conversations with other potential donors have been very promising as well.
Staff requests and requirements

We have addressed throughout the proposal (for example, see in particular section 6.2, starting on page 51 of the revised proposal) why a professional degree requires additional staff beyond what a typical department requires. The service needed (and expected) from students paying for a professional degree includes recruitment, career services, professional skills training, and more. For example, both the Bren School’s MESM program and TMP require and use similar staffing levels, as do successful professional programs at other universities. So although these staff requirements may seem high relative to those not accustomed to professional degree programs, they are needed for a successful program, expected by students, and standard operation for professional degree programs. Some of these staffing needs will be scaled to demand (see also our response to sustainability plans immediately above), such that we can streamline MEDS staff accordingly.

In CPB’s letter, the committee noted that reference to the staff position coming from the Chancellor’s Staff Enhancement program (in section 6.2 of the proposal) has not yet been approved. Please see the new memo from EVC Marshall to Dean Gaines outlining his expectations.

Elective courses

The proposal only lists 3 potential elective courses specifically, as illustrative examples, and then notes that many other classes across many departments, including the current Bren MESM curriculum, and new elective courses to be identified and developed by MEDS faculty would also be available (see section 2.3.d, starting on page 24 of the revised proposal). Given the large number of potential elective classes that would be available for MEDS students, and relatively little opportunity to take elective classes in the curriculum, the expectation is that any given elective class would only have less than 5 MEDS students when the program is fully mature (at 80-90 students), and of course fewer in the first 5 years as the program is growing. We will need to learn by doing to see which departments and which classes end up being more attractive to MEDS students, and thus potentially impacted. We recognize that faculty and departments may choose or need to give priority to students in their own programs. If any class were needed as a MEDS elective and impacted by extra MEDS students, the MEDS budget has sufficient resources to cover an extra TA for that class.

During development of the current proposal we met with Chairs of departments potentially impacted by MEDS students taking elective courses and all were supportive. In particular this includes the Chairs of Geography, Math, Computer Science, Bren, Environmental Studies and EEMB, the departments we expect will be top choices for elective classes by MEDS students (with letters from the Chairs of Math, CS, Bren, ES, and EEMB; see Appendix A of the proposal). We also include in the revised proposal a letter of support from the Chair of PSTAT (as an individual, not representing the department; see below ‘Letters of Support’).

Letters of support

CPB noted their interest in additional letters of support from the Deans of Engineering and MLPS. We note that Dean Alferness provided a letter of support in response to the submitted proposal (letter now included in Appendix A of the revised proposal), and Dean
Wiltzius has provided a letter of support along with this response letter (this letter is also now included in Appendix A of the revised proposal). We note also that Dean Genetti provided a strong letter of support in response to the submitted proposal.

We have also included an addendum letter of support from Ambuj Singh explaining how MEDS fits into the larger campus initiative around Data Science (also described above in our response to how MEDS fits into the broader campus initiative), as well as a letter of support from Mike Ludkovski, Chair of PSTAT (on behalf of himself, not as a representative of the department).

Off-campus instruction and space
As we noted in the proposal, a key reason for hosting some of the instruction at NCEAS is the current limitation of instructional space on campus. Furthermore, using NCEAS for instruction is intended as a temporary solution until more instructional space is built on campus (see pages 57-58 of the revised proposal, and memo from EVC Marshall, included in Appendix A); once those buildings are finished and space becomes available, we can move MEDS fully onto campus if it makes sense at that time to do so.

The letter from L&S FEC states that the program ‘is housed primarily off campus’, yet a majority of the program will be on campus (see pages 58-60 of the revised proposal for the narrative on a typical ‘day in the life’ of a MEDS student). Students will have a strong, regular connection to campus throughout their degree program.

The letter from CPB asserts that having part of the program downtown will be ‘very difficult for students’, but the only reason given is that ‘free parking is almost impossible for more than 75 minutes’ (but the letter also acknowledges that there is a free, direct express bus). The letter from the Chair of the Committee on Research Policy and Procedures also states concern about the ‘roundtrip travel time of at least an hour.’ As Director of NCEAS, Ben Halpern regularly commutes between NCEAS and UCSB by bus - it is very easy and almost as fast as driving (and more environmentally friendly. There is also unlimited street parking just a few blocks from NCEAS. Importantly, many graduate students who live downtown (or anywhere that requires commuting to UCSB) have to pay for parking on campus (or use public transport) and have equal commute times yet are able to accommodate this into their education and study schedules. Thus, all of these same concerns are equally challenging for students who must come to the UCSB campus for instruction.

Source of donor funds
The donor who has committed $3 million to MEDS has requested to remain anonymous. Please see the memo from Nicole Klanfer, Managing Senior Director, UCSB Development, noting the commitment of these funds.

Plans/use of donor funds
The donor has specified strong interest in supporting student fellowships, so the structure and use of the funds is designed to meet this request. We note that fellowships are an excellent way to structure support for the program as they 1) provide a mechanism to recruit top students and support diversity, 2) are further leveraged because the supplemental fees paid by
these fellowship funds are invested ($\frac{1}{3}$ of the fees) in financial aid to support additional students, and 3) support staffing needs through the remainder ($\frac{2}{3}$) of the supplemental fees.

A suggestion was made in the reviews that MEDS save more of these funds through the end of Year 5 to have a larger pool of unspent funding in case enrollment growth is slower than anticipated. For several reasons, we believe this is not a good strategy: 1) the donor has requested we use these funds to pursue excellence in the program as quickly as possible, and providing as many fellowships as possible is one of the best ways to attract and support top students, 2) UCSB Development and our own experience at the Bren School have indicated that future development fundraising is better served if the initial gift is spent down faster to build the stature and visibility of the program more quickly and to create a clear need for subsequent donor support, and 3) we have a number of other ‘back-up’ plan strategies in case enrollment growth does not meet the conservative projections we use (see ‘sustainability plan’ response above). See also the memo from Nicole Klanfer (included in Appendix A) that speaks to these same points.

**Admissions criteria**

The review from the College of Letters and Science FEC notes that its concerns with the proposal submitted in 2017 regarding admission criteria were resolved in the current proposal, but request evidence that the optional 2-week refresher modules (offered prior to formal course work, as described in section 2.1 on page 22 of the revised proposal) are sufficient to bring students up to speed. We believe the committee misinterpreted our intent for these optional courses. The point of a prerequisite requirement is that, if it is met, it is sufficient. Nonetheless, particularly in a professional school that can attract students across a wide age range, there may have been significant gaps in time since the student fulfilled the prerequisite and when they matriculate in the program. The refresher modules simply help those students who elect to participate jump into the degree program more prepared and confident.

We have used exactly this type of approach with great success in the Bren School’s MESM program for several years. For example, like the MEDS program, this program is also extremely quantitative in its focus and has prerequisites in calculus and statistics. Since the average incoming student is about 5 years post undergraduate education, these prerequisites may have been met many years before. Although the math boot camp refresher course is optional for these students, it is taken by nearly all students for two weeks prior to the start of regular courses and is widely appreciated by both students and Bren faculty, who anecdotally say it makes a notable difference for students as they enter into their first courses.

**Suitability of the name**

The letter from CPB, and echoed in the Grad Council’s summary, suggested that the degree name be switched to ‘Data Analytics’ rather than ‘Data Science’. As noted above (see also Appendix H of the revised proposal), the MEDS curriculum is on par with other Data Science Masters degrees. In order to accurately communicate what the program is to prospective students, and to employers who will hire MEDS graduates, we strongly feel the name needs to remain Masters of Environmental Data Science.
Who ‘owns’ data science?

The letter from CPB noted that no one department or school should ‘own’ data science. We fully agree with this sentiment and point out that it argues that the Bren School, like any other department or school, can have a data science program. We believe the cross campus initiative in data science is greatly strengthened by multiple programs that complement each other rather than compete.

There is very strong support from across campus, at all levels, for the MEDS program. Along with the 52 letters of support submitted with the proposal, the Deans of Graduate Division and Engineering submitted strong letters of support during the review process, and we have secured additional letters to accompany the revised submission (including from the Dean of MLPS; see above for our direct response to the request for additional letters of support).

MEDS and LRDP

The LRDP speaks generally to the campus goal of increasing the number and percentage of graduate students, based on many different benefits provided by a larger graduate student population. MEDS would help make progress towards this goal in many ways. As the L&S FEC points out, though, the nature of this fit is not a reason to oppose the MEDS program.

Teaching assistantships

Dean Wiltzius expressed some concern about the potential role of MEDS students as TAs. Although we anticipate that MEDS students will have both sufficient time and capacity to serve as TAs (as do many current MESM students – MESM students TA about 140 classes across 19 departments per year), growth of a professional Masters degree program is not predicated on providing this function, nor should it be expected to. We have revised the proposal to minimize discussion of TAships to reflect this shift in emphasis. Dean Wiltzius has included a letter of support with this letter and revised proposal (included in Appendix A).

Industry participation

The letter from the College of Engineering FEC states an interest in seeing stronger indication in the proposal of ‘support from industry in the form of recruitment, investment, and sponsorship of employees in the program.’ We can use the past 23 years of experience at Bren with the MESM degree as a reasonable indication of this kind of support. We note that with environmental data science, ‘industry’ is both corporate and NGO, as conservation NGOs play a substantial role in the science and application of environmental data science.

Graduating MESM students have an extremely high placement rate (98% are employed within 6 months of graduation, most in their ‘ideal’ job). On average, graduates primarily end up in corporate (13%), consulting (29%), or nonprofit organizations (20%). The remaining graduates end up in academic (18%), government (17%), or other (3%) positions.

MESM group projects have been financially supported almost entirely by corporate and NGO industry partners, in a highly competitive market (fewer than 40% of all industry proposals are selected). On average, each year 2-3 of the 15 chosen proposals are from corporations and 10 are from NGOs (the remaining few are from government agencies).
Industry sponsorship of students (i.e., paying their tuition and fees) is rare within the MESM program, although partial funding is more common (e.g., Deckers has provided funds for cover some costs for students for the last decade), and just this year SoCalGas committed funds to sponsor two fellowships (all expenses paid). It is fairly common for industry to pay for summer internships for students (roughly 25 students per year). We anticipate that MEDS, with its focus on data science training and a 11 month duration, will have higher likelihood of industry sponsorship of students.

Undergraduate instruction
The letter from the Undergraduate Council stated concern about ‘any potential shift of resources away from undergraduate teaching. As noted above and in the proposal, the FTE request for MEDS is very modest, and importantly is not a zero-sum game with FTE allocations for undergraduate education. UCSB has planned on growth in graduate education, not instead of undergraduate growth but in addition to it.

Prerequisite Coursework
The letter from CPB states that ‘the pre-requisite course requirements are too vague to be meaningful.’ We disagree for two key reasons: first, the requirements are very specific (calculus, basic statistics, basic programming, and a class in environmental science), and second, they are equivalent to or exceed pre-requisite requirements for most other masters programs (MEDS additionally requires the environmental science class). For example, UC Berkeley’s MIDS program has pre-requisites that do not include any coursework but instead focus on a bachelor’s degree (any discipline), high quantitative GRE scores, a ‘problem solving mindset’, a working knowledge of math (a ‘bridge’ course can be taken to refresh concepts), and programming efficiency (see details on their website).

NCEAS role supporting the academic program
The final comment/question in the letter from Grad Council asked if ‘discussions have taken place with the relevant administrators regarding the protocol for NCEAS to shift a piece of its activities, resources and staff time to support an academic program.” Ben Halpern, the lead of the MEDS proposal, is also the Director of NCEAS and has worked in very close consultation with EVC David Marshall, Dean Genetti, Dean Gaines and VCR Incandela throughout the development of the MEDS proposal, and all are supportive of this role for NCEAS -- NCEAS’s role is essentially as a facility that is helping address the extremely limited instructional space on campus. Modest additional staff at NCEAS will facilitate this role, but all instruction and administration of MEDS will be via faculty and staff at the Bren School.

Online/evening coursework
In one of the comments from the CPB, the question was raised as to whether there will be some coursework online (as is done at Berkeley) or as night classes (as is done for some part-time professional degrees that are targeting people who continue working full time while getting their degree). The MEDS curriculum is designed to be very hands-on, a format that is not amenable to online instruction; in general, online instruction is used for part-time degree programs. Similarly, night time courses are generally used for part-time professional degree
programs. The MEDS degree is designed to be full-time and so classes are fit into the regular instructional schedule at UCSB.

We look forward to your consideration of these responses and revisions to the proposal, and ultimately the chance to launch an exciting and impactful new degree program.

Sincerely,
Ben Halpern, on behalf of all proposal authors
# Appendix

A list and attributes of comparable Masters programs in data science. The list is not comprehensive but is instead a selection of programs at major universities within North America. Courses listed are sometimes a sample from a larger list of courses. When applicable, information about full-time programs is reported. This table is also included in the MEDS proposal as Appendix H.

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<th>Program</th>
<th>University</th>
<th>Duration</th>
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<th>Foundation/Core Courses</th>
<th>Advanced Courses</th>
<th>Electives / Concentration Areas</th>
<th>Capstone Project / Courses</th>
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<td>Master of Environmental Data Science (MEDS)</td>
<td>UC Santa Barbara</td>
<td>11 months (full time)</td>
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<td></td>
<td>- Data integration and infrastructures</td>
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<td>- Introduction to bioinformatics</td>
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<thead>
<tr>
<th>Program</th>
<th>Institution</th>
<th>Duration</th>
<th>Units</th>
<th>Core Courses</th>
<th>electives</th>
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<tr>
<td>Master in Data Science &amp; Engineering (DSE)</td>
<td>UC San Diego</td>
<td>24 months (part time)</td>
<td>40</td>
<td>12 units - Python for data analysis - Data management systems - Probability and statistics using python</td>
<td>16 units - Machine learning - Data analysis using Hadoop and Spark - Data integration &amp; ETL</td>
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<td>Master of Science in Business Analytics (MSBA)</td>
<td>UC San Diego</td>
<td>12 months (full time)</td>
<td>50</td>
<td>16 units - Business analytics in marketing, finance, and operations - Collecting and analyzing large data - Business analytics</td>
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<td>32 units - Customer analytics - Business intelligence systems - Experiments in firms - Business forecasting - Technology and innovation strategy</td>
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<tr>
<td>Master of Information and Data Science (MIDS)</td>
<td>UC Berkeley</td>
<td>20 months or less (part time; online)</td>
<td>27</td>
<td>12 units - Python for data science - Research design and application for data and analysis - Statistics for data analysis - Fundamentals of data engineering - Applied machine learning</td>
<td>12 units - Experiments and causal inference - Behind the data: humans and values - Deep learning in the cloud - Statistical methods for discrete response, time series, and panel data - Machine learning at scale - Natural language processing with deep learning - Data visualization</td>
<td>No</td>
<td>Yes (3 units)</td>
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<tr>
<td>Master of Computer Science (MCS)</td>
<td>UC Irvine</td>
<td>16 months (full time)</td>
<td>48</td>
<td>12 units (3 courses) - Principles of data management - Data structures with applications</td>
<td>No</td>
<td>24 units (6 courses) - Introduction to artificial intelligence - Data compression</td>
<td>Yes (12 units from 2 courses)</td>
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<td>Program</td>
<td>Carnegie Mellon University</td>
<td>Master of Data Science (DSC)</td>
<td>Rensselaer Polytechnic Institute</td>
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<td>Other Programs</td>
<td>Master of Information Technology Strategy (MITS)</td>
<td>12 months (full time)</td>
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<td>- Machine learning and data mining</td>
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<td>36 units</td>
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<tr>
<td>- Advanced programming and problem solving</td>
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<td>120 units</td>
<td>Include in core courses</td>
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<td>- Machine learning in practice</td>
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<td>- Software architecture and systems</td>
<td>No</td>
<td>18 months (full time)</td>
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<td>- Distributed systems</td>
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<td>- Data science</td>
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<td>- Data structures for programming</td>
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<td>- Time series analysis &amp; forecasting</td>
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<tr>
<td>- Causal inference</td>
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<td>- Geospatial data analysis</td>
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<td>- Cloud computing</td>
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<td>30 credits</td>
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<tr>
<td>- Big data policies</td>
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<tr>
<td>Master of Science in Data Science</td>
<td>Columbia University</td>
<td>9-13 months (2-3 semester full time)</td>
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<td>12 credits</td>
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| Master in Information Systems | Johns Hopkins University | 12 months (full time) | 36 credits | None specified | None specified | No | 24 credits | - Probability & statistics for data science - Algorithms for data science - Data analytics - Operations management - Business communication | No | 21 credits | - Introduction to statistics - Data mining - Applied machine learning - Data visualization |

| Master of Science in Computer Science (Data Science) | University of Southern California | Not specified | 32 units | None specified | None specified | No | 12 units | - Analysis of algorithms and data structures - Database systems - Information systems management - Business communication | No | 30 units | - Introduction to statistics - Data mining - Applied machine learning - Data visualization |

| Master in Data Science | Indiana University | 12-15 months (full time) | 36 credits | None specified | None specified | Yes | 18 credits | - Security for networked systems - Machine learning in bioinformatics - Advanced database concepts - Big data applications - Multivariate data analysis | No | 18-22 units | - Geospatial information management - Advanced big data analytics - Probabilistic reasoning - Applied probability - Machine learning for data science |

| Master of Science in Data Science | University of Southern California | Not specified | 32 units | None specified | None specified | No | 12 units | - Analysis of algorithms and data structures - Database systems - Information systems management - Business communication | No | 30 units | - Introduction to statistics - Data mining - Applied machine learning - Data visualization |

<p>| Master in Data Science | Indiana University | 12-15 months (full time) | 36 credits | None specified | None specified | Yes | 18 credits | - Security for networked systems - Machine learning in bioinformatics - Advanced database concepts - Big data applications - Multivariate data analysis | No | 18-22 units | - Geospatial information management - Advanced big data analytics - Probabilistic reasoning - Applied probability - Machine learning for data science |</p>
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<thead>
<tr>
<th>Program Name</th>
<th>Institution</th>
<th>Duration (full/part time)</th>
<th>Credits</th>
<th>Core Courses</th>
<th>Additional Courses</th>
<th>Specialization Options</th>
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<tbody>
<tr>
<td>Master of Data Science</td>
<td>Illinois Institute of Technology</td>
<td>12 months (full time); 24 months (part time)</td>
<td>33 credits</td>
<td>18 credits</td>
<td>- Big data technologies - Applied statistics - Machine learning - Statistical learning - Data preparation and analysis</td>
<td>No</td>
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<td>Master of Information Systems (MIS)</td>
<td>University of Arkansas</td>
<td>12 months (full time)</td>
<td>30 credit hours</td>
<td>9-credit hours</td>
<td>- Data management systems - Seminar in systems development - Management of information technology seminar</td>
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<tr>
<td>Master of Information Systems and Technology (MSIST)</td>
<td>Claremont Graduate University</td>
<td>12-18 months (full-time) (also offered part-time &amp; online)</td>
<td>36 units</td>
<td>Not specified</td>
<td>- Data analytics &amp; information visualization - Data mining practicum - Databases &amp; big data - CS insights via Python programming</td>
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<tr>
<td>Masters of Science in Computational &amp; Data Sciences</td>
<td>Chapman University</td>
<td>24 months (full time). Part time enrollment also possible</td>
<td>At least 31 credits</td>
<td>16-22 credits</td>
<td>- Statistical methods - Applied methods in mathematics - Computing for scientists - Data mining - Multivariate data analysis</td>
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<td>Master of Science in Data Science</td>
<td>George Washington University</td>
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<td></td>
<td></td>
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<td>- Introduction to data science</td>
<td>- Machine learning I: Algorithm analysis</td>
<td>- Data science applied research</td>
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<td>- Data warehousing</td>
<td>- Machine learning II: data analysis</td>
<td>- Geographical information systems I</td>
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<td>- Introduction to data mining</td>
<td>- Visualization of complex data</td>
<td>- Applied linear models</td>
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<td>- Data science capstone</td>
<td>- High performance computing and parallel computing</td>
<td>- Modern regression analysis</td>
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<tr>
<th>Master of Science in Analytics</th>
<th>Georgia State University</th>
<th>12-18 months</th>
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<td></td>
<td></td>
<td>12 months (full time)</td>
<td>36 credit hours</td>
<td>- Data programming for analytics</td>
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<td>- Analytical tools</td>
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<td>- Machine learning for analytics</td>
<td>- Image analytics</td>
<td>- Business analytics</td>
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<td>- Statistical foundations for analytics</td>
<td>- Image and text analytics</td>
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<td>- Econometric modelling for analytics</td>
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<table>
<thead>
<tr>
<th>Master of Science in Analytics</th>
<th>Georgia Institute of Technology</th>
<th>12 months (full time)</th>
<th>36 credit hours</th>
<th>15 credits</th>
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<th>15 credits</th>
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<td>24 months (online)</td>
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<td>- Big Data analytics in business</td>
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<td>- Data and visual analytics</td>
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<td>- Operations research</td>
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<td>- Statistics (2 courses)</td>
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<th>Master of Science in Data Science</th>
<th>University of Michigan</th>
<th>18 months (full time). Also offered online</th>
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<td>- Introduction to combinatorics</td>
<td>- Database management systems</td>
<td>- Probability and distribution theory</td>
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<td>- Programming for scientists and engineers</td>
<td>- Data science analytics using python</td>
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<td>- Data structures for scientists and engineers</td>
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<td>- Statistical computing</td>
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<td>University of Washington</td>
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<td>Cornell University</td>
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<td>Master of Science in Data Science</td>
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<td>- Linear models with matrices</td>
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| Data Science | s) | - Probability models and inference  
- Applied statistics data project  
- Professional development | statistics  
- Data mining and machine learning  
- Big data management and analysis  
- Econometrics  
- Monte carlo simulation | Master of Science in Data Science  
Stanford University  
18 months  
45 units  
12 units  
- Numerical linear algebra  
- Discrete mathematics and algorithms  
- Optimization  
- Theory of probability  
6 units  
- Distributed algorithms and optimization  
- Parallel computing  
- Parallel methods in numerical analysis  
21 units  
- Introduction to statistical inference  
- Introduction to regression models and analysis of variance  
- Modern applied statistics: Learning  
- Modern applied statistics: Data mining  
- Computing for data science  
Yes (6 units) | Master of Science in Data Science  
University of San Francisco  
12 months (full time)  
35 units  
Unspecified  
- Relational databases  
- Computation for analytics  
- Review of probability and statistics  
- Linear regression analysis  
No  
Unspecified  
- Introduction to machine learning  
- Distributed computing  
- Advanced machine learning  
- Problem solving with Python  
No | Master of Science in Data Science  
University of Virginia  
11 months  
31 credits  
23 credits  
- Programming and systems for data science  
- Statistical computing for data science  
- Linear models for data science  
- Data mining  
No  
6 credits  
- Theory of computation  
- Data visualization  
- Econometrics II  
- Longitudinal analysis  
- Advanced use of Geographical Information Systems  
Yes (2 credits) |
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<tr>
<th>Master of Science in Statistics – Data Science</th>
<th>University of Wisconsin</th>
<th>12 months</th>
<th>30 credits</th>
<th>15 credits</th>
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<tr>
<td>- Machine learning</td>
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<td>- Statistical methods I and II</td>
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<td>- An introduction to sample survey theory and methods</td>
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<td>- Introduction to computational statistics</td>
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<td>- Professional skills in data science</td>
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<td>- Statistical methods for spatial data</td>
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</table>
January 3, 2019

To: Dean Steve Gaines, Bren School of Environmental Science and Management

From: David Marshall, Executive Vice Chancellor

Re: Bren Masters of Environmental Data Science Proposal

I am pleased to see that the proposal for a new Master’s program in Environmental Data Science submitted by the Bren School of Environmental Science and Management is in the final stages of campus review. Graduate Council has indicated that it is “generally supportive of this initiative” and Dean Genetti has given her endorsement. Graduate Council has requested some clarifications and revisions to ensure that the campus can put “the strongest possible proposal forward.” At this point, after seeing the comments conveyed in Graduate Council’s December 13, 2018 memo to you and Professor Halpern, it seems appropriate for me to make some observations from the perspective of my office that will help reviewing agencies assess the final proposal.

- **Data Science:** I agree that the proposal should be seen in the context of a “holistic campus strategy for data science initiatives.” I have convened several faculty discussions, and an advisory committee chaired by Professor Ambuj Singh, to make recommendations and explore strategies for advancing both research and curricular initiatives in the area of data science. Our academic disciplines are being transformed by the availability of large data sets and data management techniques, as well as new methods, systems, processes, and theoretical insights. At the same time, interdisciplinary and cross-disciplinary collaborations are opening up new opportunities. I have asked the committee to consider comprehensive and connected approaches that could help us think about future directions in data science, both within individual departments and disciplines and across campus. Although I anticipate opportunities for shared curriculum and collaborative projects, I believe that each area should be free to pursue its own initiatives, preferably in dialogue with other programs in order to leverage resources and develop partnerships. In the years ahead, I expect that what we today call data science will be developed in individual disciplines and domains, while also opening up new possibilities for new degrees and interdisciplinary and interdepartmental initiatives. In any case, I do not believe that the proposed Bren program will preclude developments elsewhere on campus, and I expect that the synergies of our interdisciplinary and collaborative culture will strengthen this and other individual programs.

- **FTE:** The deans, the Council on Planning and Budget, and I have identified data science as an important area of focus in reviewing FTE plans and authorizing new searches. Last spring CPB identified some 25 positions requested by departments that could be seen in the general area of data science, and many of these positions were authorized. I have asked the deans to work with faculty and departments over the course of the year to develop strategies to advance data science, building on departmental requests and some special opportunities that might follow the Q-Bio or IGPMs models. I see some parallels with the current planning for a Bioengineering department within the College of Engineering. That being said, numerous relevant recruitments have been approved in individual departments in every discipline, and some new recruitments that were not originally identified as data science positions have ended up recruiting new faculty who have expertise in this area. This has been true in Bren, as you know. In the future, I anticipate positions in various departments that will be resources for Bren, like faculty in Marine Science and Environmental Studies, to take two examples. Again, the modest growth proposed by Bren in relation to enrollment growth will not preclude new faculty appointments elsewhere on campus, and I expect that the synergies of our interdisciplinary and collaborative culture will provide added support. New FTE for Bren will depend on enrollment growth, as with programs elsewhere on campus.
- **Staffing:** Like the Technology Management Program in the College of Engineering, the Bren proposal plans for a level of specialized staffing that is closer to a professional school than to the average UCSB graduate program. This is one of the justifications for assessing a Professional Degree Supplemental Tuition. We have recently completed the second year of a five-year Chancellor’s staff enhancement program. The Chancellor’s Coordinating Committee on Budget Strategy has agreed on the principle that some future positions should be held for the development of new academic programs. In this context, I have indicated that I expect to be able to allocate a new staff FTE to support this new Bren program, assuming appropriate enrollment growth and ongoing need. That being said, the revenue projected from the supplemental tuition, as well as the $3 million gift made on the condition that the new program be established, should ensure that the program will be able to afford the staffing that it anticipates. Regardless of the funding source, any increase in staffing will need to be justified by enrollment growth and programmatic need.

- **Space:** I agree with reviewing agencies that it would be best to accommodate the program on campus as much as possible, although I see the synergies with NCEAS and its downtown research facilities. As you know, an ambitious new classroom building has been approved, which will provide approximately 53,940 assignable-square-feet (ASF) and 95,250 gross-square-feet (GSF) of new space to expand the campus’s general assignment classroom inventory. With 32 general assignment classrooms, the building will increase the campus’s classroom inventory by 35 percent and its seating capacity by 40 percent, or approximately 2,290 seats. It is currently projected that the building will be ready for occupancy in February 2023. This will free up other space on campus, as well as supplement our instructional capacity. We are also hopeful that the new Governor and Legislature will support a resumption of capital projects for the University of California. Another alternative we are actively exploring is the development of existing buildings on our Devereux campus. I expect that by the time the proposed Bren program reaches full capacity, the campus will be able to accommodate the additional students.

The University of California Office of the President has stated: “Professional Degree Supplemental Tuition (PDST) plays a key role in the University of California’s ability to provide students with high-quality graduate professional degree programs in both traditional and emerging disciplines.” Like the Master of Technology Management degree offered by the College of Engineering’s Technology Program, the proposed Bren Master of Environmental Data Science degree, with funding from PDST, has the potential to play an important role in our state, leveraging Bren’s national and international stature and UC Santa Barbara’s unique ability to embed a professional degree within the context of a research university. If the proposal is approved, I assume that more details of the specific curriculum and requirements will be reviewed by the appropriate Bren and Academic Senate faculty committees. At this point, the proposal seems more than viable to me. It is expected that the campus will help launch a new PDST program, with the understanding that the program will be able to pay back any loans and attain self-sufficiency within a specified period of time. Every PDST program ultimately must have a business plan that will achieve solvency and self-sufficiency if it is to continue. If the new Environmental Data Science Master’s program is approved and launched, I believe that the modest campus investments that will be justified in proportion to enrollment growth, along with the projected Professional Degree Supplemental Tuition income and the currently committed and projected donor funding, will be more than adequate to make the program successful.

I hope that these clarifications and comments will be helpful as the campus completes its final review of the revised proposal. Thank you.
Dear Ben:

I would like to reiterate my support of the proposed Master of Environmental Data Science (MEDS) degree program. The proposed program is an important piece of our campus’s response to the growing importance of data science nationally and internationally. Many universities are scrambling to adapt to this fast-changing area by creating new programs at the undergraduate and graduate levels, research centers, and new schools and colleges. The UCSB Data Science Initiative was launched in summer 2018 to address this need. We are already a few years behind a number of other universities (including sister UC campuses at Berkeley and San Diego) and have been playing catch-up for the past year.

The campus working group on the data science initiative has met multiple times in order to coordinate the different ongoing campus efforts and develop an agenda for the future. Our charter includes the development of a sequence of undergraduate and graduate courses that lead to emphases, minors, and degree programs, the development of focused areas that build on UCSB’s strengths, and the recruitment of faculty members that can be situated across multiple departments in order to establish interdisciplinary bridges. Our main undertaking currently has been the offering of undergraduate and graduate courses. We offered a new undergraduate course (INT 5) for freshmen last Fall and will be offering an undergraduate and a graduate course in Spring. We plan to offer more courses in the 2019-20 academic year and follow up with an undergraduate major. While the working group has focused on these courses, it welcomes complementary efforts such as the MEDS program. For UCSB’s data science effort to stand out nationally, there need to be prominent and visible areas of strength. Bren, NCEAS, and the broader environmental science research at UCSB undoubtedly provide this. The MEDS program emphasizes our strengths through a unique graduate level training program. It has the potential of building new cross-disciplinary efforts between Bren and rest of the campus.

I thank you for your leadership in developing the MEDS program and support it wholeheartedly. We need to act on this quickly and in parallel with other activities in data science.

Sincerely,

Ambuj K. Singh
Professor
Dept. of Computer Science
Biomolecular Science and Engineering
Lead, Data Science Initiative
2 January 2019

To: Amr El Abbadi, Chair Graduate Council  
Kelly Erland, Academic Senate Analyst  
UCSB Academic Senate

From: Pierre Wiltzius, Dean  
Division of Mathematical, Life and Physical Sciences

Re: Addendum to Comments on the Proposal to establish a Master of Environmental Data Science

In response to the December 13, 2018 memo from Graduate Council, Prof. Halpern discussed with me my main concerns with the proposal. He also shared with me a draft of the letter in response to reviewing agency comments that responds to the most recent concerns.

Prof. Halpern provides more detail regarding the teaching load of Bren faculty. In particular, he makes it clear that the MEDS program will actually be starting with an effective five new positions; the two requested in the proposal, one FTE that was hired this year into Bren, and two recent hires into Bren that had not yet begun teaching. This makes the feasibility of delivering the curriculum of the MEDS program much more plausible.

The use of MEDS students as Teaching Assistants also had been one of my previous concerns. I am glad to see that in the revised proposal, the discussion of TAships has been reduced and its importance minimized.

Finally, I am happy to hear that Prof. Ambuj Singh has submitted a letter addressing the efforts to integrate the MEDS program with the broader discussion of a cross-campus effort in Data Science.

Overall, I think the MEDS proposal is in much better shape and will be a powerful addition to and UCSB/Bren. This degree would be of great interest to both recent graduates and mid-career professionals. I do strongly support moving forward with this proposal and look forward to its great success.

cc: Dorothy Satomi, Assistant Dean, MLPS
January 1, 2019

TO: Ben Halpern  
   Director, National Center for Ecological Analysis & Synthesis  
   Professor, Bren School  

FR: Mike Ludkovski  
   Professor, Department of Statistics and Applied Probability  

I am pleased to support the establishment of the Master’s degree in Environmental Data Science. The unique focus of the MEDS program enhances the national prominence of UCSB as an education and research hub in environmental science. Augmenting such areas of strength is critical to building the UCSB brand of Data Science. As a member of the Faculty Advisory Committee on Data Science, we have been discussing the creation of both core DS degrees, as well as domain-centered “Data Science + X” initiatives like this one. A Master’s program is a natural sweet spot for bringing in significant numbers of graduate students to UCSB and building an alumni network of applied data scientists.

Leveraging the existing reputation of the Bren School, MEDS is a timely new interdisciplinary program that complements other campus efforts. In particular, the proposals for a series of data science boot camps and for distinguished visitor series of public lectures and targeted workshops are fantastic initiatives that would be highly valuable for a wide spectrum of graduate students across campus, not least Statistics. The Global Summit on Environmental Data Science would also be a great research catalyst that I would love to participate in. My own research touches upon environmental data science in the context of quantitative analysis of natural commodity markets and environmental finance, such as cap-and-trade regulation and transition to renewable energy, and I look forward to collaborations and discussions with envisioned new MEDS hires and distinguished long-term visitors. Overall, the potential to strengthen cross-disciplinary ties between Bren and multiple other departments is immense and is a major strength of the proposal.

Sincerely,

Michael Ludkovski  

Professor and Chair, Department of Statistics & Applied Probability  
Co-Director, Center for Financial Mathematics and Actuarial Research  
ph: (805)893-5634  
e-mail: ludkovski@pstat.ucsb.edu
January 2, 2019

To: Ben Halpern, Director, National Center for Ecological Analysis and Synthesis, Professor of the Bren School of Environmental Science and Management; Steve Gaines, Dean, Bren School of Environmental Science and Management

From: Nicole Klanfer, Managing Senior Director, Development

RE: Support for proposed Master of Environmental Data Science (MEDS) Program

I am writing to inform the review process of the proposed Master of Environmental Data Science (MEDS) Program, specifically regarding donor support for the program:

- This is to confirm receipt of a $3 million donation from an anonymous donor to support the proposed Master of Environmental Data Science program. Pledge payment in full was received on December 11, 2018 and is being held in cash at the UC Santa Barbara Foundation. As the donor indicated in memo dated May 17, 2018,

  “I would like . . . $3 Million . . . be directed to support new curriculum and programs in association with the establishment of a new Master’s degree, the Master of Environmental Data Science (MEDS) in the Bren School of Environmental Science and Management . . . I understand that any new degree program requires approval by the UC Santa Barbara administration and Academic Senate, by UC Office of the President, and by the UC Regents.

  Funds may be held in an account at the UC Santa Barbara Foundation and not expended until such time that MEDS is formally approved. . . You may utilize my commitment in the best way to maximize the approval and success of the Master in Environmental Data Science.”

- It is important for donor stewardship that the campus demonstrates the maximum impact of this philanthropic investment and that these funds are used to pursue excellence in the program as quickly as possible. While funds can be used flexibly to launch and implement the master’s degree, it is prudent to direct a meaningful portion of this gift to provide as many fellowships as possible as one of the best ways to attract and support top students.

Furthermore, it is in the experience of UC Santa Barbara Development that our ability to maximize future fundraising for MEDS is better served if the initial gift is spent down in a timely manner to build the stature and visibility of the program and to create a clear need for subsequent donor support. We are optimistic that if the program launches effectively and we can illustrate the impact of the gift, the donor has indicated their inclination to make additional significant future investment in MEDS. Additionally, we have confidence in our ability to develop a strategic plan to leverage this gift and identify and cultivate additional donors who will have an interest in supporting MEDS.

Please let me know if you or the review committee have any additional questions or needs additional documentation. Thank you very much.
Graduate Council (GC) has considered the revised proposal to establish the professional Master’s degree in Environmental Data Science (MEDS), along with the requisite reviewing agency comments. GC agreed that the proposal has improved significantly and that the initiators have provided thorough responses to many of the concerns raised in response to the previous iteration. The Council appreciates the amount of time and effort involved in this exercise. Nevertheless, several of the reviewing agencies have persisting concerns or remain unconvinced by aspects of the new proposal. While none of the groups rejected the proposal outright, the critical comments and tepid endorsements are such that the proposal is unlikely to be successful at the higher levels of review (Faculty Legislature, Coordinating Committee on Graduate Affairs, the Office of the President). GC would like to send the strongest possible proposal forward, and to that end, GC suggests that the MEDS proponents review the attached responses and respond appropriately. A timely response will minimize disruption of the review timetable.

While it would not be productive to discuss all of the council and committee concerns in this memo, Council has identified those that are common to several of the responses: a holistic campus strategy for data science initiatives, the feasibility of the FTE plan in relation to teaching needs, enrollment projections and program sustainability, off-campus instruction and space, teaching assistantships, student housing, and staff support. As you will recall, some of these concerns were among the issues raised in our March 12 memo, and many of them have been addressed to GC’s satisfaction in the new proposal. However, it would be prudent for the proponents to consider how further revision might respond to remaining concerns and strengthen the proposal. Several of these issues will likely be easy for the initiators to address, while others may necessitate larger discussions between the deans, the Executive Vice Chancellor, and other campus stakeholders.

One issue within the purview of Graduate Council (and also discussed by other reviewing agencies) is breadth of the program at the expense of depth given the compact timeline. GC would like to see a more comprehensive description of the proposed curriculum, specifically: 1) the environmental aspects of the data science curriculum, 2) the expected knowledge of a graduating MEDS student, and 3) how the summer supplements and required courses build on each other to develop the necessary expertise to be successful in the field. Likewise, the Council requests that the initiators address reviewing agency queries about the suitability of the name of the program as it relates to the curriculum.
GC felt that the initiators could have gone further to explain the sustainability of the program with respect to FTE and the instructional plan, specifically regarding the contributions of the faculty recently hired by the School. Were they hired primarily to participate in MEDS, or also in MESM? Will the allocation of Bren teaching resources negatively impact the MESM or Ph.D. programs? Which faculty are capable of teaching each of the core courses? What is the Bren School’s plan during leaves and sabbaticals? Have discussions taken place with the relevant administrators regarding the protocol for The National Center for Ecological Analysis and Synthesis (NCEAS) to shift a piece of its activities, resources, and staff time, to support an academic program?

In sum, GC is generally supportive of this initiative and would like to offer an opportunity for further dialogue and refinement of the proposal before moving forward. GC unanimously voted to send forward this memorandum.

CC:  
Henning Bohn, Chair, Academic Senate  
Debra Blake, Executive Director, Academic Senate  
Pierre Wiltzius, Dean, Mathematical, Life, and Physical Sciences  
Carol Genetti, Dean, Graduate Division  
Robert Hamm, Assistant Dean, Graduate Division  
Joao Hespanha, Chair, Council on Planning and Budget  
Kyle Richards, Analyst, Council on Planning and Budget  
Ralph Armbruster Sandoval, Chair, Letters and Science Executive Committee  
Barbara Gilkes, Assistant Dean for Policy and Academic Administration, College of Letters and Science
10 October 2018

To: Kelly Erland, Academic Senate Analyst
   UCSB Academic Senate

From: Pierre Wiltzius, Dean
       Division of Mathematical, Life and Physical Sciences

Re: Comments on the Proposal to establish a Master of Environmental Data Science

Thank you for giving me the opportunity to comment on the updated version of the proposal to establish a Master of Environmental Data Science. Overall, I think there are many appealing aspects in this proposal—I can see the argument for creating such a program and UCSB/Bren is a natural place to establish it. I trust that such a degree would be of great interest to both recent graduates and mid-career professionals. The proposed degree is intended to be a one-year-long course, with a 'group capstone' project similar to what has been offered by the Bren School in MESM. I agree with the assessment that MEDS would be in line with our broader goal to grow research and education in Data Science.

The biggest change between the first version of the proposal and the current one is the significant reduction in the number of faculty FTE requested to support the teaching and research components. As you write in an accompanying email: “FTE request: The new proposal requests only two new FTE lines, one as a ladder faculty and one as a LSOE position. This substantially lower request is possible because of new hires in the past year and some new synergies in Bren curriculum.”

Without knowing the details of the newly hired faculty, which in part were most likely connected with separating or retiring faculty, I am uneasy about the numbers. The fundamental problem is that I cannot see how Bren will be able to deliver the full program without additional faculty commitment. The suggestion that other faculty currently associated with Bren and other programs will cover the rest seems unrealistic. There are going to be 15 required classes of which 3 will be covered by the new LSOE. In the normal program, you note that Bren faculty typically teach one or maybe two core classes. So at the very least, this program requires the commitment of six full-time faculty—probably more. Yet, you ask for one. Some of the teaching may be covered by Unit 18’s and more by existing faculty, but then how will that impact these people’s current teaching and programs? Who will fill in?

I had an additional discussion with Ben Halpern and he was adamant that the Bren faculty would be able to handle the teaching. It would at most require a few extra seats in courses already taught by other faculty for other graduate programs.

Another issue is student-related. I read that the program will support undergraduate education because MEDS students will be “available to TA”, but then I also read that "students will have limited ability to take elective courses” because the core, required program is already so full. How would they ever have time to TA? In addition, past experience with students from the MESM
How would they ever have time to TA? In addition, past experience with students from the MESM program has shown mixed results in their ability to be teaching assistants. Maybe this is a matter of lack of time to devote to the teaching or a lack of training and preparation. We have to be careful not to expect too much from masters students.

The broader question of how this Master's degree program connects with other emerging campus-wide Data Science initiatives is still unanswered. Emerging efforts in several departments (Statistics and Applied Probability, Geography, Computer Science) are mentioned in the proposal, but it is clear that this Master's degree was developed without considering those other, "complementary" efforts.

The goal of growing the cohort size to 80 -100 by years six or seven seems achievable, which would, as is mentioned in the proposal, increase the number of graduate students at UCSB significantly, an explicit goal of the campus. I need to point out, however, that from my perspective as the Dean of MLPS, these master’s students will not fill a crucial need of more TAs for our highly impacted science classes. Growing the number of Ph.D. students in the sciences that can take on the role of teaching assistants has, in my view, higher priority.

In conclusion, while I see and appreciate the local allure for establishing MEDS within Bren, the possibility of missed opportunities is significant. I encourage the campus to have a larger discussion around data science, in general, and new master’s programs, in particular. Reluctantly, and with trepidation, I do support moving forward with this proposal, hoping that it will not come at the expense of other campus activities.

cc: Dorothy Satomi, Assistant Dean, MLPS
November 13, 2018

TO: Amr El Abbadi, Chair
Graduate Council

FROM: Carol Genetti, Chair
Graduate Division

RE: Proposal for a Master’s Degree in Environmental Data Science

Thank you for the opportunity to comment on the proposal for a new professional Master’s program in Environmental Data Science. It is clear that the program is innovative, timely, and meets a key societal need. The many letters of support amply demonstrate that the program is an excellent fit for UC Santa Barbara, would build on significant strengths, and would complement existing programs across campus. I find the Bren School’s arguments on projected need and student demand to be compelling and the enrollment projections seem feasible.

As the proposal makes clear, the academic program is intensive, but the workload is still reasonable for full-time students. The group project model for the capstone has been highly successful in the Bren MESM program, and I believe it will translate well within the shorter MEDS framework and provide experience that will be highly valued by employers. Due to the admissions requirements, admitted students will come into the program with relevant skillsets. The summer boot-camp classes will provide opportunities to refresh these skills, which will help students transition to the two-week summer classes and the more in-depth courses during the academic year.

As you are well aware, campus space is a significant challenge at UC Santa Barbara. This dearth will eventually be remedied, at least with regard to instructional space: the campus has received an allocation of funding from the State for a new building dedicated to instructional instruction. That project is in the final stage of Regental approval and is entering the design phase. In addition, discussions regarding another new building to support the environmental sciences have been initiated. By the time the MEDS program reaches its full size, the classroom inventory on campus would be greatly increased. There will be challenges in the short term. The proposed two-campus solution is a creative innovation. The plan is to hold classes at the Balboa building in downtown Santa Barbara and at the UCSB campus on alternate days. This arrangement will pose some challenges for faculty and students, but the program’s supporters are well-aware of these and have made a good case that it is a workable arrangement as the program gets established and new facilities are built on campus. Regarding office space, the proposal states that the program will need 17 new offices, mostly at UC Santa Barbara. The letter from Steven Gaines, Dean of the Bren School, indicates that he will take responsibility to ensure that these offices and other campus spaces are available.

The proposal lists eight current faculty members committed to teach in the program. Seven of the eight are listed as instructors in the proposed initial teaching plan (assuming the hire of an LSOE and a ninth faculty member). This suggests that there will be adequate faculty to cover sabbaticals or other leaves. Given the enthusiastic support of MEDS from Bren faculty, I assume that the allocation of five or six courses annually will not negatively impact either the MESM or the doctoral curriculum within the Bren School. The proposed request for two new faculty FTE is sufficiently modest to be accommodated through the regular process of FTE allocation. In addition to new Bren faculty, the data science initiative across campus is likely to lead to additional faculty appointments in relevant areas.

Both the intensity of the one-year program and the two-campus solution will make it challenging for MEDS students to serve as TAs in other departments, although perhaps some will do so. Whether or not MEDS in fact generates a large pool of TAs, the underlying strength of the proposal remains. More important to campus strategic goals is the program’s ability to increase the graduate student population, as well as its commitment to reach out to, admit, and
recruit a diverse student body. The Graduate Division has set an aspirational goal of having the diversity of the graduate students reflect that of our undergraduates. In setting diversity goals, the Bren School may want to consider whether the cohorts that it admits reflect the diversity of UCSB majors in Environmental Science. Even more important from a societal perspective is whether admitted cohorts include members of minority or other under-privileged populations that are directly and disproportionately impacted by the negative effects of environmental degradation.

There are considerable staffing needs laid out in the proposal. I understand that it is important for a one-year professional program to be very well run and to provide significant support for professional development and career attainment. These costs are appropriately covered by the PDST and donor funds.

The budget overall is comprehensive and realistic. The identification of a significant philanthropic gift to launch the program will allow it to avoid deficits as it ramps up to full size, assuming enrollment and cost projections are accurate (which they appear to be). The PDST level brings the overall cost within the range of comparable programs nationally, and there is a strong plan for financial aid to ensure access.

In sum, the Bren School has put forward a compelling proposal for a professional Master’s program that is well designed, appropriately resourced, likely to have significant student demand, and will equip students with skills that can be applied to perhaps the most significant challenge of our century. I enthusiastically endorse this proposal and strongly recommend approval by the Graduate Council.
The Council on Planning & Budget has reviewed the revised proposal for a Master of Environmental Data Science (MEDS). There are several aspects of the revised proposal that have improved since the original. Overall, CPB is now supportive of the MEDS proposal. However, some previous concerns raised by CPB remain in this second iteration. These issues are outlined below:

1. The request for campus resources is more reasonable in this revised proposal. However, the funding mechanism to support the MEDS program needs additional clarification. Bren asked for eight FTE in last year’s proposal, which CPB thought was too many and did not support. This revised proposal reduced this request to one ladder faculty position and one LSOE. The Chancellor’s Staffing Initiative might also provide Bren with one staff line (but it is important to note that this line has not yet been approved). The remaining staff will be supported by the fee upon entry to the program ($20,000 per student) and a $3 million private donation. However, there is a lack of clarity regarding the source of the private donation. It is also unclear why Bren needs nine staff to run the MEDS program. This seems like a large number of staff for the number of students. In addition, even though the proposal indicates that no other FTE other than those requested will come from the university, the proposed coursework suggests that other existing FTE resources will be taken up by the MEDS program (see below). If these existing lines are absorbed, it seems likely that Bren will be asking for future FTE to support the MEDS program.

2. Regarding the enrollment, it appears that the MEDS program begins with 20 students, then proposes to increase by about 10 students each of the first 5 years. It is not clear what the basis is for actualizing the proposed +/- 90 student enrollment (noted on page 34). CPB has concerns over the risk involved in investing in a program that might not be able to realize this many students. What if Bren cannot secure 90 students? What is the plan for recruiting this many students? Is there a “back up plan” in the event that the proposed number of students cannot be recruited? Finally, it seems like there also needs to be a plan to better determine how to distribute the donated money for fellowships (giving fellowships only to those students who need help) and saving some of it to ensure the future of the MEDS program. Essentially, CPB is
concerned about the sustainability of the MEDS program. It does not seem like the MEDS program could run with a small number of students.

3. CPB also continues to believe that an 11 month program is too short and that the proposed course work does not match the rigor necessary to obtain a degree in Data Science. Several of the programs Bren offers as comparable are 18 and 24 months instead of 11 months. In spite of sprinkling phrases like “coalesce existing strengths” and “leverage these strengths,” the proposal also does not take advantage of, or efficiently integrate with, existing courses in Statistics and/or Computer Science. Instead, it proposes an altogether new set of 15+2 courses using existing faculty resources—the equivalent of which would be 5 (open-rank) FTE. Existing degrees like the MA in Statistics (Data Science emphasis) in PStat, and the proposed GIS in Geography are mentioned only in passing (p.12). The pre-requisite course requirements are too vague to be meaningful. In general, the proposed coursework does not meet the depth and rigor required for a degree in Data Science (as mentioned by CPB and Grad Council in the previous responses). Perhaps, as CPB suggested last time, the degree should be in Data Analytics instead of Data Science?

4. CPB noted in its response last year that no one department or school should “own” data science and that it seemed odd that other departments/areas were not included in the proposal (including letters of recommendation). Letters from Computer Science are now included in the revised proposal (including a letter of support from Ambuj Singh, who is leading the campus-wide Data Science working group), although CPB would have liked to have seen a letter of support from the Dean of MLPS and/or the Dean of Engineering. Even though there are now letters of support, it is still unclear how this new Master’s program would intersect, compliment, coordinate, or compete with the MA program in Data Science in the Statistics department [http://www.pstat.ucsb.edu/graduate/ma](http://www.pstat.ucsb.edu/graduate/ma), which was mentioned in the previous CPB comments. The proposal also does not discuss larger efforts to embed the MEDS program with other existing data science initiatives on campus, like that of Computer Science. As it is rightfully noted in the MEDS proposal, data science is a rapidly growing field attracting many students. It is important to have a vision for how the various programs on campus might interact in order to make the whole greater than the sum of the parts.

5. As CPB noted in its original response, dividing a program between the UCSB campus and downtown Santa Barbara will be very difficult for students. There is a free bus between UCSB and downtown but free parking is almost impossible for more than 75 minutes. Perhaps the program can be brought back to UCSB after the new classroom building is finished. Also, is there a plan to have some of the coursework online to attract students? (CPB specifically referenced the Berkeley program as a model.) Will night classes be offered so that professional students can attain the degree while working?

cc: Debra Blake, Academic Senate Executive Director
    Kelly Erland, Academic Senate Analyst for Graduate Education
November 14, 2018

TO: Amr El Abbadi  
Chair, Graduate Council

FROM: Ralph Armbruster-Sandoval  
Chair, College of Letters and Science Faculty Executive Committee

RE: Proposed Master’s Degree in Environmental Data Science

The College of Letters and Science Faculty Executive Committee (FEC) has reviewed the revised proposal to establish a Master’s Degree in Environmental Data Science. The 11-month professional degree would be administered by the Bren School and would charge supplemental tuition.

When considering the initial proposal in fall 2017 the FEC expressed concerns relating to

- curriculum, primarily the program’s tradeoff of breadth for depth
- admissions criteria that did not seem to mesh with the academic program and timeline
- potential impact on L&S courses in areas that are over-subscribed
- impacts on the broader campus initiative in data science

The FEC remains highly supportive of a data science strategy on campus and sees value in connecting environmental data analysis to that initiative. However, the committee found that the revised proposal did not adequately address our stated concerns.

In terms of curriculum, the FEC does not perceive significant change. It still appears that the curriculum sacrifices depth for breadth in such a way that the graduates would not be adequately prepared for the types of professional jobs the proposal indicates. The FEC allows that we are not experts in this area; therefore, a comparison of the proposed curriculum to existing data science programs would be helpful in demonstrating that the MEDS program would in fact offer sufficient training for the desired outcomes.

Further to curriculum, the FEC notes that the majority of electives are L&S graduate courses. We would expect to see written assurance from the chairs of those departments that (a) there is existing capacity in the courses to accommodate MEDS students, and (b) that this would not negatively impact those departments’ own data science training plans.

FEC recognizes adjustment in the admissions criteria, with additional relevant coursework being required of candidates. We appreciate that the authors are no longer relying exclusively on highly impacted L&S undergraduate courses to compensate for candidates’ deficiencies, although we would like to see evidence that the two-week summer modules are sufficient to bring all students up to speed on the areas of calculus, coding, and statistics.

The FEC is unconvinced by arguments that the MEDS program dovetails with the campus long range development plan (LRDP). MEDS graduate students would be enrolled in an intensive 11-month professional training program that is housed primarily off campus and they would be admitted under criteria that do not ensure adequate preparation for TAing in impacted undergraduate areas. This does not fit the primary goal of the campus LRDP. While this is not a reason to oppose establishment of the MEDS program, we feel compelled to point out this disconnect.

Throughout the document the authors indicate that the proposed program aligns with the campus data science initiative. Not having access to that campus plan, the FEC is at a disadvantage in assessing this. The committee recommends that the campus should first determine and make known its priorities.
for data science. Is the priority to establish a technical unit that can assist faculty with large data analysis needs, is it to develop an emphasis and core curriculum that can serve a variety of graduate programs, is it to develop a cross-cutting undergraduate option? Absent this information, the FEC is unable to assess whether the MEDS program indeed fits into the larger campus data science initiative. We refer back to our earlier statement of not knowing the opportunity costs of establishing the MEDS program as the first step in the campus plan.

Overall, we could be supportive of this proposal if a stand-alone masters in environmental data science fits with the campus data science strategy, if the proposers can demonstrate that the curriculum can in fact produce the desired outcomes, and if the chairs of impacted L&S departments can confirm the feasibility of relying on their courses.

One final note, judging from existing campus staff:student ratios, 9 staff members seems excessive, even for a program charging supplemental tuition.

Thank you for the opportunity to comment.

cc: Pierre Wiltzius, Executive Dean of the College and Dean Science
    Jeffrey Stopple, Associate Vice Chancellor and Dean, Undergraduate Education
November 13, 2018

To:    Kelly Erland  
Senate Analyst, Academic Senate

From:  Rod C. Alferness  
Dean, College of Engineering

Re: Comments on the Proposal to establish a Professional Master’s degree in Environmental Data Science

First, I would like to thank the Graduate Council for offering me the opportunity to comment on the proposal from the Bren School and the National Center for Ecological Analysis and Synthesis to establish a Master’s degree in Environment Data Science (MEDS). The authors are to be commended for a comprehensive proposal. As I have previously indicated the concept of a Master's degree in the field of Data Science applied in the field of environmental science is a very reasonable one that would leverage the Bren's strength in environmental science and would be an early entry into this space. It is also clear that data science technologies are being aggressively applied in many areas of industry. We have seen that vividly in the demand for our computer science and engineering graduates.

I would like to commend Ben Halpern and the entire proposal committee for their creative and substantial efforts to make significant changes from their original proposal. I appreciate that they have creatively addressed the concerns that were raised with the previous proposal, I believe that using the professional Master’s degree model is an appropriate one for this program. There is clearly high demand for employees trained in Data Sciences. The Bren School is a top tier, highly prestigious institution for Environment Sciences and Management and this field is rich in data and well suited to reap valuable information and insight from data mining. Therefore, I believe that graduates from this program will be highly sought after in industry making a professional Master’s degree with the additional fee appropriate. I want to commend and congratulate the Bren School for their success in fundraising for this program. It is great that donor funding will be available to help support the program, eliminating upfront debt and providing some fellowships for students for whom the extra fees are a major burden.

This approach with a portion of the extra fee to be used to provide most of the necessary staff mitigates my concern relative to the earlier proposal that required a significant number of campus funded staff while now my understanding is that only one will be required. I appreciate that the new proposal is more reasonable with respect to new faculty FTE needs. I note and appreciate that the new proposal has also added prerequisites that will help to ensure that incoming students are prepared and motivated
for the rigorous program to be completed in one year. Such prerequisites were viewed as necessary by several of our faculty.

As I indicated in my comments on the previous proposal, I strongly believe that it is important for UCSB to have a campus wide strategy for Data Science and my major concern with the earlier proposal was that the resources requested were so large that the program would preclude future Data Science programs in other areas. For reasons indicated above I am less concerned about that problem with the new proposal. Nevertheless, I do strongly believe that UCSB needs to have a more holistic campus strategy on data science, that includes a strategic vision and high-level resource allocation, in Data Science and its application to other disciplines. That goal is being addressed in the EVC’s Data Science initiative committee chaired by Ambuj Singh. I am pleased to see Bren representation on this committee which has already launched an undergraduate course on Data Science that requires no prerequisites.

So, with the caveat that strong collaborative participation of this program’s leadership continues on the EVC’s Data Science Committee including sharing of best practice and learnings, I am pleased to support this new proposal to establish a professional Master’s degree in Environmental Data Science.
November 19, 2018

TO: Henning Bohn, Academic Senate Chair

FR: Steve Gaines, James Salzman, Mark Buntaine, Sarah Anderson, and Frank Davis
Bren School of Environmental Science & Management, Faculty Executive Committee

RE: Master of Environmental Data Science (MEDS) degree proposal

The Bren School of Environmental Science & Management enthusiastically supports the creation of a new professional Master of Environmental Data Science (MEDS) degree. The MEDS degree offers a new direction to expand the strengths of UCSB in data science and environment. Many UCSB departments and research units already have expertise in these fields. Faculty from a number of departments across campus, including the Bren School, Geography, Economics, Computer Science, and NCEAS have contributed to the refinement of the MEDS proposals. Professionals in environmental data science are needed to address persistent and emerging environmental challenges. While some universities offer Data Science degree programs, the proposed program would be the first Environmental Data Science master’s degree program in the United States. This will position UCSB, the Bren School and collaborating departments at the forefront of innovation in this rapidly expanding field with tremendous potential for positive impact to society.

UCSB is the right place to launch the new MEDS degree program for many reasons. UCSB is home to the first Environmental Studies undergraduate degree program, which emerged from the collective faculty response to the tragic oil spill in Santa Barbara in 1969. Since then, research linked to environment (across all disciplines) has been a priority for more than a third of UCSB faculty. Building on this interdisciplinary expertise in environmental science, UCSB was selected as the location for a graduate school in environmental science and management (now the Bren School) in 1996. In the intervening years, technology has made it possible to gather vast amounts of data about the environment. Professionals must be trained to harness, manage, analyze, interpret and apply the data to inform research, management, policy, business, education, and other sectors of society. The new MEDS degree program will address this urgent need for research and training in environmental data science.

The MEDS degree program is a one-year professional program. The MEDS program will attract recent college graduates who are interested in jobs in environmental data science, graduate students who wish to pursue a second graduate degree, and mid-career professionals seeking advanced training. The one-year timeline for the program makes it possible for students to efficiently complete the program and seek employment or return to the job market with additional professional skills, and matches the one-year length of every other master's program in data science. To ensure that students have the right preparation to succeed professionally, the MEDS proposal has been revised to include a more complete set of prerequisites in environmental sciences for admission. The MEDS degree program offers a new opportunity for UCSB to grow graduate enrollment, consistent with the goals of the Graduate Division and UCSB administration.
Given the applied nature of the MEDS degree program, MEDS students will be assessed professional degree supplemental tuition (PDST), like similar data science programs at other universities. At least 33% of the PDST revenue will be returned to students as financial aid to recruit top students with financial need and contribute to diversity of the student body. Remaining PDST revenue will be used to support program operations and staffing. The combination of state funds and PDST is needed to develop, deliver and sustain high-quality graduate training commensurate with the students’ investment in their education. Because of recent faculty hires who would play a role in the proposed MEDS program, the faculty FTE requested for the program have been reduced to two. We emphasize also that a recent philanthropic gift, a staff augmentation as part of the Chancellor’s Staff Initiative, and the PDST revenue mean that centrally-funded staff positions are not requested in the proposal. We also emphasize that the recent gift to establish the program means that there will be zero accrued debt even under very conservative assumptions about enrollment.

The new MEDS degree program offers opportunities for UCSB faculty across campus to be involved with research as well as graduate teaching and mentoring in environmental data science. Faculty from many UCSB departments, including the Bren School, Computer Science, Earth Research Institute, Ecology, Evolution and Marine Biology, Environmental Studies, Geography, Mechanical Engineering, Media Art and Technology, National Center for Ecological Analysis and Synthesis (NCEAS), and Statistics and Applied Probability, have expressed interest in collaborating on research related to environmental data science. Several faculty have expressed interest in teaching for the MEDS program, including Olivier Deschenes (Economics), James Frew (Bren School), and Christina (Naomi) Tague (Bren School). Currently, Earth Research Institute is leading a search for a new faculty member in the field of environmental data science and other departments, including the Bren School, have expressed interest recruiting additional faculty in this field. Collectively the efforts across campus are likely to coalesce around an interdepartmental Data Science initiative. Given the broad interest among current faculty and anticipated faculty growth, UCSB is positioned to support new directions in research and teaching in environmental data science.

The MEDS degree proposal builds on faculty expertise cultivated over 20 years of work with the Master of Environmental Science and Management (MESM) program in the Bren School. Currently there are 26 Bren faculty, 160 MESM students and 55 PhD students in the Bren School. We anticipate that the MEDS program would begin with cohorts of about 20 students with the goal to eventually grow to 80-100 master’s students per cohort. We anticipate some synergies between the MEDS and MESM programs, including opportunities for MEDS students to take classes in the MESM program and vice versa, and/or to add the MEDS degree after completing the MESM program.

Growth in the number of faculty and students in environmental data science will require additional space for faculty offices, classrooms, and teaching labs. Some space needs may be addressed in Bren Hall through sharing classrooms and teaching labs with the MESM program. Some classroom and office space also is available at NCEAS in downtown Santa Barbara. Direct express MTD bus connections make this commute easy and free for students. Efforts should be made to house MEDS faculty in Bren Hall and, as much as possible, provide MEDS courses within or near Bren Hall and at NCEAS. This will contribute to synergistic interactions between the new MEDS program and existing MESM and Environmental Studies undergraduate programs, both currently housed in Bren Hall, and the environmental data science research and training occurring at NCEAS. With growth of the MEDS program, additional space will need to be considered, though the needs are less than required in the initial proposal, since careful consultations with Bren faculty identified efficiencies in teaching between the existing MESM program and the proposed MEDS program that reduce the total FTE request.

Founders of the Bren School recognized the importance of integrating natural and social sciences for environmental problem solving at a time when few schools pursued this interdisciplinary approach. Since
then, other universities have adopted the Bren School’s research and teaching model. Building the campus strengths in environment and data science, UCSB is well-positioned to catalyze this exciting proposal into the leading Environmental Data Science master’s degree program in the nation. We strongly encourage you to support this proposal for a new professional master’s degree in Environmental Data Science. Please feel free to contact us if you have any questions. Thank you for your consideration.
November 14, 2018

TO: Amr El Abbadi  
    Graduate Council Chair

FROM: Irene Beyerlein, Chair  
    College of Engineering, Faculty Executive Committee

RE: Proposal for Professional Masters in Environmental Data Science

The College of Engineering Faculty Executive Committee was asked to review and comment on the new proposal for a Professional Masters in Environmental Data Science (MEDS). Two comments arose. First, the committee recognizes that some of the members of the MEDS proposal are currently participating in campus-wide initiatives in Data Science. Provided the program is approved, the committee feels that this connection with campus efforts, via membership and coordination with campus-level committees and groups, should continue after the program is implemented and grows in the coming years. A second comment concerns industrial participation. The committee felt the proposal could highlight support from industry in the form of recruitment, investment, and sponsorship of employees in the program.
October 19, 2018

To: Henning Bohn, Divisional Chair
    Academic Senate

From: Werner Kuhn, Chair
       Committee on Library, Information, and Instructional Resources

Re: New Proposal to Establish a Masters in Environmental Data Science

CLIIR reviewed the New Proposal to Establish a Masters in Environmental Data Science during its October 19 meeting. Committee members agreed that the new proposal was much improved from the original one that CLIIR reviewed last year. One of CLIIR’s concerns from the previous proposal was how MEDS would impact library resources and staff. This is addressed in the new proposal and University Librarian Antelman confirmed that the new resources that the MEDS program would require are resources that the Library is already investing in. Similarly, staff impact should be minimal as funding for two new data curation positions has been approved. The main concern expressed was whether there is a back-up plan for students who may fall behind in the program and are unable to complete it in the one-year timeframe. Overall, CLIIR approves the new proposal, but hopes that a back-up plan is in place or will be developed for students who are unable to complete the coursework during one year.

Cc: Debra Blake, Executive Director, Academic Senate
November 15, 2018

To: Henning Bohn, Chair
   Academic Senate

From: Jianwen Su, Chair
       Committee on Research Policy and Procedures

Re: Proposal to Establish a Master of Environmental Data Science

The revised proposal is a significant improvement with regard to several major concerns including in particular the impact on the research missions of the campus and support letters. The Committee on Research Policies and Procedures endorses the proposal, but notes the following concerns/issues:

First, the program has a nontrivial component for statistical methods and techniques but the proposal failed to include a letter from the Department of Statistics and Probability.

Second, the use of the NCEAS facility in downtown Santa Barbara remains a concern since the roundtrip travel time is at least an hour. In spite of scheduling considerations (e.g., alternating days) sketched in the proposal, the commute will chip into the students study times. An alternative could be to identify rooms on campus that are under-utilized, due to various issues, and renovate them, possibly with the program funds.

Cc: Debra Blake, Executive Director, Academic Senate
To: Henning Bohn, Chair
    Academic Senate

From: Trevor Hayton, Chair
    Undergraduate Council

Date: November 14, 2018

Re: Proposal to Establish a Master of Environmental Data Science (MEDS)

The Undergraduate Council (UgC) has considered the revised proposal to establish a master’s degree program in Environmental Data Science. With the Council’s purview in mind, members identified two remaining issues related to the proposed program.

The Council anticipates that current ladder faculty will be involved in offering courses toward the MEDS degree, in lieu of other teaching responsibilities. Members reiterated their concerns regarding any potential shift of resources away from undergraduate teaching given our limited resources and increasing student numbers. The Council also expressed concern with regard to classroom space, when the time comes for the program to vacate its temporary location at the downtown offices of the National Center for Ecological Analysis and Synthesis (NCEAS). Members felt strongly that the initiators of the proposal, in coordination with campus administrators, should ensure that the MEDS program minimizes any adverse effects on undergraduate course access and well as classroom space.

Thank you for the opportunity to comment.

CC: Debra Blake, Executive Director
    Academic Senate
A Proposal for a Program of Graduate Studies in pursuit of the degree of

Master of Environmental Data Science

Submitted: January 7, 2019

Proposed by: Ben Halpern, Professor, Bren School; Director, NCEAS (lead)*
Krzysztof Janowicz, Associate Professor, Geography
Olivier Deschenes, Professor, Economics
Naomi Tague, Professor, Bren School
James Frew, Associate Professor, Bren School

*contact: halpern@nceas.ucsb.edu; 805.893.7527
Executive Summary

Environmental problems are becoming increasingly complex, requiring multi-disciplinary approaches to address them. These problems can no longer be solved solely with a disciplinary focus, and they increasingly demand data-driven solutions. The rise of big data and new technologies for observing earth systems and the human actions that rapidly change and respond to the environment demand that resource management and conservation decisions be informed by data in a fully transparent and repeatable way. These demands are shifting the landscape of the skills that are needed to tackle environmental problems.

This proposal for a Master of Environmental Data Science (MEDS) degree directly addresses these converging needs. The MEDS program will provide students with broad, practical training in the knowledge and skills needed to bring data to bear on environmental science questions, creating a pipeline of interested and talented students into key positions within business, non-profit, agency and academic institutions and organizations. It will be the first such program in the United States.

As with the current and analogous UCSB Master of Environmental Science and Management (MESM) degree, MEDS-affiliated faculty will also be global leaders in their fields, such that the MEDS program will add data science research strength to the campus. Indeed, the program builds upon the globally recognized strengths in environmental informatics and science housed in many different departments and centers at UC Santa Barbara. MEDS will help coalesce these existing strengths into a coordinated degree, drawing expertise from and serving the needs of departments and faculty in over a dozen departments across every School.

The MEDS program will create significant synergies with other emerging data science research initiatives at UCSB. These broader data science initiatives will help MEDS recruit top faculty into the program, and MEDS will provide a powerful lens through which to apply data science research and a mechanism for translating data science tools and knowledge into practical, professional training. Together with existing and emerging data science initiatives at UCSB, MEDS will be a key component of what will make UCSB the global leader in environmental data science.

Specifically, the MEDS program will:

● be a one-year stand-alone master’s program administered by the Bren School of Environmental Science & Management (Bren) and integrated with the National Center for Ecological Analysis & Synthesis (NCEAS), with engagement of faculty from departments across campus. It will start with a summer quarter to build core coding, computational and statistical skills, followed by a rigorous curriculum for the three academic quarters.

● focus on the background, perspectives and tools used by different disciplines to analyze data, with an emphasis on environmental data and problem solving, and an aim to build competency across a range of data science topics.

● include a group capstone project spanning winter and spring quarters which will embed groups of 3-4 MEDS students in client-driven projects. The MEDS projects and their
administration will be modeled on the highly-successful MESM group projects in Bren, but will be smaller in scope given the shorter duration of the MEDS program.

- incorporate practical training in science communication and data visualization, an emerging and critical skill across all disciplines.
- build on the infrastructure and capacity of Bren staff that provide world-class student support and career development to support placement of graduates in key positions across the full spectrum of employers. These staff and services will be integral to the professional aspects of the MEDS degree program and will be supported by a supplemental fee.

The Bren School offers a globally unique and efficient home for a professional-targeted environmental data science program. Two decades of experience at Bren running an analogous environmental science and management (MESM) degree means the existing staff, client network, infrastructure and faculty can be leveraged by new MEDS faculty and staff to launch a world-class program on day one. The partnership with NCEAS offers the Center’s international reputation in eco-informatics and past experience in short courses in environmental data science, available space when little exists on the main campus, and a key way to build UCSB’s presence in downtown Santa Barbara.

The MEDS program will help significantly grow the graduate student population at UCSB at a time when this is a key priority and in a way that serves and benefits from a wide range of departments across campus. It will also provide valuable additional visibility to data science at UCSB in support of the broader data science initiatives being pursued by faculty in Computer Science, Statistics, Geography and other departments.
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Section 1. Introduction

Data science comprises computational paradigms and techniques that focus on the collection, management, exploitation, communication, and preservation of information\(^1\). It is one of the fastest growing professions, spanning disciplines as varied as medicine, business, art, engineering and genetics. In the last 10 years, hundreds of programs and training courses have launched around the country and the world focused on areas such as bioinformatics, software engineering, and data science in general\(^2\). Almost entirely missing from this list of disciplines is environmental science, despite recognition in the field that data science should and will play a critical role in solving increasingly complex and global-scale environmental problems. The proposed one-year professional master’s degree in Environmental Data Science will be one of the few such programs in the world, filling a critical educational and training gap and helping produce the next generation of environmental problem solvers. The new program will leverage the strengths of many departments across campus and help position UCSB as a global leader in this emerging field.

1.1 Aims and Objectives

The Bren School of Environmental Science & Management (Bren), in coordination with the National Center for Ecological Analysis and Synthesis (NCEAS) and faculty from Bren, Geography and Economics, and with consultation and support from faculty in an additional 15 programs and departments across a range of Schools, Colleges and Divisions\(^3\), proposes a new professional Master’s degree, the Master of Environmental Data Science (MEDS)\(^4\). The program will combine and leverage existing, globally-recognized strengths of these many departments, will help coalesce and expand the international leadership of UCSB in environmental science and informatics, and will focus on providing courses and hands-on training needed by professionals in businesses, government agencies and environmental organizations at local to global scales. The program will be modeled on the highly successful Master’s in Environmental Science & Management (MESM) at Bren (described in more detail in Section 1.4 Relationship to Campus Academic Plan and Existing Programs), but will span 11 months instead of 2 years and will produce a distinct but complementary type of student from the MESM program, one that both understands the many practical complexities of collaborative data processing and analysis within environmental sciences and is familiar with environmental science. The aim is to fill current and growing market needs for broadly-trained environmental

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\(^2\) The top 23 data science degree programs are ranked and reviewed at www.mastersindatascience.org

\(^3\) These include the College of Engineering; College of Letters & Science, Division of Social Science and Fine Arts and Division of Mathematical, Life and Physical Sciences; and the Bren School of Environmental Science & Management; and includes Departments of Geography, Statistics and Applied Probability, Political Science, Computer Science, Communication, Art, Environmental Studies, History, English, Mechanical Engineering, Electrical and Computer Engineering, Mathematics, Ecology Evolution and Marine Biology, Media Arts and Technology, and the UCSB Library.

\(^4\) A short glossary of acronyms and shorthand used in the proposal follows Section 9 of the proposal.
data scientists who can transform the way corporations, organizations and institutions address and solve environmental problems. In particular, the program will:

- be a one-year stand-alone master’s program offered by Bren and integrated with NCEAS, with engagement of faculty from departments across campus. It will start with a summer quarter focused on getting all students up to speed on basic coding, computational, statistical and team science skills, followed by a rigorous curriculum for the three academic quarters.
- focus on the background, perspectives and tools used by different disciplines to analyze data, with an emphasis on environmental data and problem solving, and an aim to build competency across a range of data science topics.
- include a group capstone project spanning winter and spring quarters which will embed groups of 3-4 master’s students in client-driven projects. The projects and their administration will be modeled on the highly-successful MESM group projects in Bren, but will be smaller in scope given the shorter duration of the MEDS program.
- incorporate practical training in science communication and data visualization, and emerging and critical skill across all disciplines.
- build on the infrastructure and capacity of Bren staff that provide world-class student support and career development to support placement of graduates in key positions across the full spectrum of employers. These staff and services will be an integral part of the professional degree program and will be supported through a supplemental fee.

Our goal is to give students who enter with prior environmental, computational and statistical experience a broad overview of environmental data processing tools and the practical experience with those tools needed to be effective in environmental data science careers. We recognize that students cannot be expected to become experts in any one area within this broad, one year program. The focus is on breadth of exposure, with greater depth in a chosen sub-area of data processing provided within the capstone projects and tailored to individual skill sets.

The target audience for this program includes recent graduates and early career researchers with varied backgrounds wanting to launch a career that leverages environmental data science, as well as mid-career professionals looking to augment their skills and resumes (see Section 3.3 Student Demand for further details). Based on experience with the MESM program, we expect much higher application and enrollment rates for out-of-state and international students compared to most graduate departments and programs on campus. From the inception of the program we will invest significant effort in marketing, outreach, and (through philanthropy) financial support to underrepresented communities. The supplemental fee and fellowships supported by funds already committed from a donor will help provide financial aid to many students while also supporting the staff necessary for a service-oriented professional degree.

Data science is a rapidly expanding discipline and profession. At the same time, environmental problems and the need for solutions are becoming ever more challenging and pressing. The intersection of these needs and opportunities makes the timing ripe for a program in environmental data science.
1.2 Background and Historical Development

Many threads have contributed to the emergence of data science as a discipline in the last decade. The Turing-award-winning computer scientist Jim Gray observed the broad trend in modern science towards a “fourth paradigm” of data exploration or “e-science”, unifying the previous three paradigms of empirical description, theoretical modeling, and computational simulation\(^5\). Data science is, in effect, an instantiation of this fourth paradigm.

First, exponentially decreasing costs for online digital storage, coupled with voluminous data sources (environmental sensors, web searches, social media linkages, etc.), have led to an explosion of tools and techniques for dealing with big data; that is, datasets so large that copying them is prohibitively expensive and processing them is infeasible without massive parallelism. Many of the computational techniques associated with data science have emerged as specific responses to the challenges of big data\(^6\). Second, the collaborative infrastructure enabled by the Web has led to a proliferation of high-quality open source tools for high-level programming, collaboration, and data management. Data science is built on these technologies, formerly restricted to specialists and large computing centers but now accessible to scientists on their personal computers. Finally, an increasing emphasis on the reproducibility of published science has led to the development and adoption of techniques and platforms for sharing both the data and the computational workflows supporting scientific publications. These hybrid publications will be the currency of data science.

Data science comprises computational paradigms and techniques that focus on the collection, management, exploitation, communication, and preservation of information\(^7\). As such, key components of data science include:

- **data mining and analytics** - extracting information from large, complex multidimensional datasets.
- **data modeling** - designing schemas and ontologies that adequately capture the structure and meaning of information.
- **data curation** - documenting, packaging, and managing information to assure its long-term availability.
- **data visualization** - preparing visual (and possibly other sensory modalities) representations of information to help discover and communicate its structure and content.

Data science techniques are primarily drawn from statistics, computer science, geography and earth sciences. In many institutions, these departments provide homes for (and inevitably lend their emphases to) data science programs. However, data science necessarily involves the interaction of these techniques with application disciplines. Environmental data science lies at

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the intersection between environmental problems and the data needed to analyze them. The challenges and opportunities of environmental data science are thus: to understand environmental problems, to know how to frame and interpret analyses, to have experience with environmental data, to know how to use (and not use) the data, and to have the skills to do the analyses.

Environmental data science as a discipline is relatively new but combines many antecedents. In particular, the environmental component of environmental data science owes its origins in part to the development and rise of geographic information science (GIScience, widely credited to Mike Goodchild and others from the Geography Department at UCSB) that tracks, processes and analyzes often very large spatially-explicit data; the development and growth of ecological synthesis science and the concomitant development of ecological informatics (widely credited to NCEAS); the enormous growth in ‘big data’ from satellites and other remote sensors that are widely used in earth sciences; and the diffusion of big data into almost every allied discipline, including social sciences such as economics and political science that are fundamentally important to environmental problem solving. Environmental policy makers and the general public are demanding more accountability and transparency in environmental decision making and the environmental science that (ideally) underpins those decisions. Data science provides the tools for this transparency and repeatability.

By bringing quantitative approaches to environmental problem solving, most Bren faculty and students have already been involved in environmental data science. Although such approaches are not unique to the Bren School, the caliber and the interdisciplinary nature of the research being conducted, and the team science approach to graduate education, make the Bren School stand out globally.

1.3 Proposed Timetable

Following successful completion of campus and UC-wide approval processes, program implementation would begin immediately, including hiring new faculty and staff, implementing any necessary space renovation, and marketing and recruiting for the program. We anticipate beginning these processes in fall 2019, with an initial cohort of 20-25 students enrolled and starting late summer 2020. Initial teaching needs will be met primarily by existing faculty from campus, one of the two initial faculty hires, and a few part-time lecturers, with the second additional new faculty hire within the following year or two as the program grows (see 6.1 Faculty FTE for further details).

We anticipate strong interest in the degree (see 3.3 Student Demand below in support of this assessment), and thus the potential for rapid growth of the program. However, we will deliberately grow enrollment slowly to allow for learning and adaptation of the program. We conservatively project enrolling 20 students in the first year (2020-2021), 30 students in the second year (2021-2022), 40 students in the third year (2022-2023), and then grow more quickly to a maximum enrollment of 80-90 students by year six or seven. It is likely that demand will be high enough that the program could grow faster than this. We will keep enrollment below...
100, as experience with the MESM degree in Bren has shown this to be an optimal cohort size for program administration, student cohesiveness, and alumni networking.

This anticipated growth in the new professional degree program helps implement the approved Long-Range-Development Plan (LRDP) for UC Santa Barbara, which has already seen an increase in campus enrollment of over 4000 (of the projected 5000) students, nearly all of which have been undergraduates. As such, this program will help address a key but unmet target of the LRDP to increase the number of graduate students, by up to 80-90 students per year once the program reaches maturity. The program will also provide an initial, high-visibility pillar in a potential Data Science Initiative being discussed for UCSB.

1.4 Relationship to Campus Academic Plan and Existing Programs

1.4.a Relationship to Broader campus initiatives

Growth in graduate enrollment has been a key target for UCSB since the development and launch of the Long Range Development Plan (LRDP). Notably, the rapid increase in undergraduate enrollment has left little room for growth in graduate enrollment. Informal discussions among the Executive Vice Chancellor (EVC) and various Deans and faculty have been ongoing since 2014 about the potential for an environmental data science graduate degree. Adding a new degree-granting program focused on environmental data science thus addresses these campus plans and offers a means to substantially grow the graduate student community.

More recently, there have been several bottom-up initiatives that are exploring how UCSB will address data science from both curricular and research perspectives. These bottom-up initiatives have led to broad interest across campus for campus-level data science initiatives. For example, in 2018 the first ever data science FTE proposal was submitted from the Faculty Working Group on Data Science, and a new campus wide Advisory Committee was initiated by EVC Marshall. Many involved in this MEDS proposal have contributed to or serve on these efforts.

The FTE plan proposed by the Faculty Working Group (including MEDS lead proposer Ben Halpern) is an initial effort to coordinate data science at the campus level, and will help EVC Marshall with his efforts to make strategic decisions across campus related to data science FTE allocations (see memo from EVC Marshall in Appendix A). The plan emphasizes the need for hires both within the “Theory of Data Science” and within “Domain-specific data science areas”. We anticipate that any additional hires as part of the MEDS program will be part of the Domain-specific Data Science group. Hires within MEDS will contribute to fulfilling this identified need for linking data science with environmental sciences - one of the largest data-science domains on campus.
MEDS will also contribute to emerging recommendations from EVC Marshall’s Advisory Committee on Data Science, which has spent the past year developing a strategic plan for cross-campus data science (see addendum letter from Ambuj Singh, Appendix A). Ben Halpern and Krzysztof Janowicz (PIs on this proposal) currently serve on the Committee and will continue to do so, and we anticipate other MEDS faculty to play an active role in this committee in the future, as needed. Initial plans for a campus wide initiative include the development of cross-departmental undergraduate courses in data science, which have already been implemented, and disciplinary nodes of graduate programs. The MEDS program fits into this graduate-level focus of the cross-campus initiative.

MEDS will also build on a new data-science related Crossroads project that will begin in Fall 2018. Crossroads is a Graduate Division initiative that supports interdisciplinary research and teaching at UCSB (http://www.graddiv.ucsb.edu/financial/crossroads). This new Crossroads project is led by Naomi Tague and James Frew, both of whom are actively engaged in the MEDS program. The project entitled “Watch Them Work: Visualizing Environmental Models” also involves faculty from Computer Science (Höllerer) and statistics (Meiring). One of the goals of the project is to develop a graduate level curriculum around human-computer interfaces for environmental data science and modeling. This curriculum development will directly support the MEDS program, and in particular the MEDS courses environmental modeling (EDS 230: Modeling Environmental Systems) and visualization (EDS 240: Data Visualization and Communication).

Furthermore, substantial opportunities exist to interact with, leverage and amplify related research and instruction in other departments and centers (discussed in more detail in Section 3.5. Relationship to Research Interests of Faculty). In particular, with respect to educational and curriculum objectives, the Statistics and Applied Probability (PSTAT) Department has an MA in Statistics with a Data Science specialization and Geography is developing a proposal for a 5th year master’s in Geographic Information System (GIS) science, both of which are complementary to this proposed MEDS degree. Synergies between MEDS and these other initiatives include the potential to share curriculum resources (such as software carpentry modules) TAs, and guest lecturers; cross-fertilization of disciplinary ideas through shared enrollment of students in elective classes; and interdisciplinary research initiatives among data science faculty in different departments, among others. The MEDS program, however, will be distinctive in its focus on the intersection between environmental science and data science. MEDS will help students gain familiarity with state-of-the art environmental data sets and how these can be leveraged to monitor, analyze and model a changing environment. For MEDS students, data science tools that evaluate change over space and time are essential. They need tools that can deal with datasets that cross-scales (from local to global) and vary in quality, and tools that integrate emerging indices of environmental health, predictions from global climate models and results from both social and natural science perspectives. These tools will be informed by advances in computer science, statistics and other programs, but a key component of this program will be education that strategically identifies and teaches advances that are most relevant to the environmental domain.
There will be ample room for additional master's programs in data science at UCSB, both general and domain-specific. Just as research in data science benefits substantially from domain-specific perspectives and research problems (and associated unique data sets and analytical approaches), education and curricula often need to be tailored to specific domain(s) and case studies. Together these different and complementary initiatives would elevate the caliber of each and provide colleagues and opportunities across diverse departments on campus.

Because MEDS faculty will maintain active research programs and groups and be leaders in their fields, there will also be substantial opportunity for research collaborations and synergies across campus. Such opportunities include, but are not limited to, collaborations with faculty from departments across campus (see list of interested faculty in Section 4.2 Faculty with Potential Research Involvement, and letters of support in Appendix A), focused programs such as the Crossroads Initiative described above on environmental data visualization, and faculty and projects affiliated with campus Centers and Institutes, including the Center for Spatial Studies, the Earth Research Institute (ERI), the Marine Science Institute (MSI), Media Arts and Technology (MAT), the Natural Reserve System (NRS), and the Broom Center for Demography, among likely others.

The MEDS program may also indirectly support undergraduate education through MEDS students being available to TA in undergraduate classes across a range of departments, although this role is not expected of Masters students and may ultimately be limited. MEDS students will likely have a breadth of backgrounds similar to current MESM students, who in 2017/18 TAed for 135 classes in 19 departments across campus, including Anthropology, Black Studies, Chicana/o Studies, Communication, Earth Science, Economics, EEMB, Environmental Studies, Feminist Studies, French and Italian, Geography, Global Studies, History, MCDB, Probability and Applied Statistics, Physics, Sociology, Spanish/Portuguese, and the Technology Management Program. MESM students currently take equal or greater credit unit loads as to the proposed MEDS degree, suggesting that MEDS students will likely be able to take all classes and TA. Therefore, the addition of this large new graduate program could benefit undergraduate education on campus, including providing a candidate pool of TAs for the expected data science core curriculum (being discussed by the EVC’s Executive Committee).

The proposed professional degree program is thus unique from other departments and programs, yet complement and supports growth directions and future programs being considered by other departments. Most importantly, we have met with departmental chairs for CS and PSTAT, Deans from the respective colleges, and EVC Marshall, and there is strong enthusiasm for a broad initiative at UCSB around data science research. The focus in MEDS on professional training will thus be highly complementary to this campus-wide research and curriculum initiative.
1.4.b MEDS contributions to data science initiatives across campus

Many components of the MEDS program will directly or indirectly benefit a wide range of departments across campus and their planned and existing data science initiatives.

Annual campus symposium on environmental data science: The MEDS program will host an annual one-day symposium to showcase and share ongoing research and activities at UCSB on or related to environmental data science. Although hosted by the MEDS program, the symposium will be open to anyone on campus (undergraduate, graduate, postdoctoral, faculty, or researchers).

Biannual Global Summit on environmental data science: Every other fall, beginning in the fall of the first cohort of MEDS students, the MEDS program will convene a global summit at UCSB on environmental data science that brings together experts, thought leaders and visionaries from academia, industry and practitioner organizations. The two-day summit will explore the boundaries of environmental data science, including the science, practice, tools and influence of EDS, across disciplines.

Coordinated series of data science boot camps: A number of informal and ad-hoc data science training efforts have emerged in recent years at UCSB, such as the Data Science at UCSB club, the eco-data-science group, and trainings offered by the Library’s Interdisciplinary Research Collaboratory, that together demonstrate significant demand across disciplines for practical training and experience in data science tools. MEDS will augment these offerings, providing regular free trainings of different lengths and on different topics each quarter and over the summer. MEDS staff will work with other data science training staff and personnel to coordinate these various workshops.

Distinguished Visitor Series: For several years, the Bren School has run a Distinguished Climate Science visitors program that brings national or international leaders in Climate Science to give a public seminar and to teach a short (1-week) course in their field of expertise. We will model a MEDS Distinguished Visitor Series on this highly successful program. Each year one senior and one early-career distinguished visitor will give a lecture that will be open to the public and advertised across campus, and then teach a short workshop spread over 3-4 days on an EDS topic. The workshops will be open first to MEDS students but made available to other students on campus, space permitting.

Guest lectures in other classes: As with all faculty across other departments, MEDS faculty will be available to give talks or guest lectures in related classes across campus. In particular, if the core data science curriculum is approved and launched, MEDS faculty would provide valuable domain-specific lectures in these classes.
1.4.c Building on Bren and NCEAS experience

The MEDS program builds on two decades of leadership and expertise in environmental science at Bren and environmental data science at NCEAS. The Bren School has become one of the premier environmental science research and educational departments in the country, and the MESM program pioneered the highly successful and influential group capstone project. In the age of team science, Bren leads the way in providing this training at the graduate level. The experience of the staff and faculty in developing and teaching the MESM curriculum (and the unique style of teaching this content that students demand from a professional degree) offers a strong foundation on which to build the new but similar MEDS program. Indeed, the MEDS program will benefit greatly from having its faculty and staff integrated into the existing Bren School.

The mission of the Bren School is to develop interdisciplinary solutions to environmental problems, train environmental leaders, and work for a sustainable future. It pursues this mission by educating and training large (80-90 person) cohorts of master’s students to be interdisciplinary, broadly-trained practitioners of environmental science. The Bren School consistently ranks in the top three environmental science master’s programs in the country. The MESM program is structured around a core curriculum and a range of possible specializations, and the signature year-long group capstone project. In 2015 the Bren School awarded its 1000th MESM degree, and on average places 98% of its graduates in a job within 6 months after graduating, with up to 60% stating the job was their ideal position. Faculty within the Bren School are global leaders in their fields, conducting cutting edge, innovative multidisciplinary research.

Collaborating with NCEAS offers at least three distinct benefits to the MEDS program and UCSB in general. First, NCEAS has a global reputation for ecological and environmental data science. Since its inception, NCEAS⁸ has been leading the way in addressing the challenge of interfacing with and analyzing extremely heterogeneous environmental data. NCEAS has done this in two key ways, first by constituting and leading a broad community of scientists and technologists to develop the infrastructure and tools needed for the preservation and discovery of environmental data, and then training researchers and students in the use of these technologies to enable the synthetic research critical to understanding today’s complex environmental issues. NCEAS has extensive experience training environmental scientists in the use of existing and emerging technology tools, as well as in the foundational computational and data-wrangling skills necessary for environmental researchers to efficiently and reproducibly conduct integrative, interdisciplinary scientific investigations.

Second, NCEAS has available space (by expanding its footprint in the downtown office building), at a time when UCSB has extremely limited space, and strong infrastructural support for and experience with environmental data science. NCEAS is located in the heart of downtown Santa Barbara and has been an active research center for 23 years, hosting over 6000

⁸ See also NCEAS website: www.nceas.ucsb.edu
scientists from around the world for working group meetings and over 120 resident post-doctoral fellows. The space is designed to support multiple groups of up to 25 people each and has a large classroom (up to 120 people). Administrative and computer support staff are very experienced at hosting and supporting dynamic and changing groups of scientists and students.

Third, engaging NCEAS in the MEDS program provides a highly visible way to build stronger connections between campus and downtown Santa Barbara. Both NCEAS and UCSB administrators have been actively pursuing ways to build these stronger connections and for NCEAS to integrate more deeply into activities and programs across campus. The MEDS program offers a vibrant, dynamic and unique opportunity to dramatically grow these connections while also creating a stronger presence for UCSB in the heart of downtown Santa Barbara.

To confirm that the proposed MEDS program would not overlap or conflict with the MESM degree, Bren staff and faculty met to discuss the fit and potential synergies between the two programs and the existing and likely new faculty. There was strong support for both the value of the independent MEDS program and the potential for exciting synergies between the programs. The potential for some students to complete both programs was particularly compelling.

The breadth of disciplines and departments represented in the proposal committee and the letters of support speaks to the broad interest from faculty across campus. The program is expected to build strong connections among departments interested in different aspects of environmental data science. Ultimately it will lay the foundation for a graduate focus in environmental data science and data science training options for undergraduates, graduate students, and faculty alike by creating curricula and resources that can be leveraged for these communities.

1.5 Relationship to Programs at Other UC Institutions

A basic review was conducted of existing relevant programs within the UC, across the United States, and internationally. Where this proposed degree program fits in nationally and internationally is addressed in more detail in 3.6 Program Differentiation. Based on this assessment we see essentially no competition with our sister UC institutions (nor almost any other programs nationally or internationally, as the niche for environmental data science remains unfilled). Most UC campuses have programs, centers or departments in biomedical/health informatics (UCSD, UCLA, UCD, UCM), bioinformatics (UCSC, UCR, UCB), or informatics (UCR, UCI, UCB). In general these programs focus on technology applications of informatics, primarily in service of medical, health, or genetics/genomics disciplines (see Table 1). Environmental data science (or informatics) will have some inherent overlap with these disciplines, but the focus on research, training and applied solutions to environmental problems that require highly heterogeneous, often geographic, data makes EDS very different and distinctive from these other programs.\(^9\)

\(^9\) Because of these strong differences in program focus, letters were not sent to or solicited from the chairs/heads of the programs at these campuses.
<table>
<thead>
<tr>
<th>Program</th>
<th>Program attributes</th>
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<tbody>
<tr>
<td>UCM</td>
<td>n/a Currently no programs in data science</td>
</tr>
<tr>
<td>UCD</td>
<td>Master of Science in Business Analytics and Master’s in Health Informatics Offered by Graduate School of Management and School of Medicine; Master’s of Science in Business Analytics focuses on data science with business applications and requires 30 units; Master’s in Health Informatics trains students for careers in the healthcare computing industry and requires 43 units.</td>
</tr>
<tr>
<td>UCSF</td>
<td>Institute for Computational Health Sciences Selected courses focused on big data in health sciences; mainly focused on projects building infrastructure to link health records</td>
</tr>
<tr>
<td>UCB</td>
<td>Master of Information Management Systems (MIMS); Master of Information Data Science (MIDS) On-campus 2-year MIMS degree focused on social and policy issues; On-line MIDS degree focused on building technical skills of people in business, with 1 week on-campus and weekly online classes at students own pace; see below text for further details on MIMS.</td>
</tr>
<tr>
<td>UCSC</td>
<td>Center of Excellence in Data Science Research Recently launched research center intended to coalesce research efforts across departments; no graduate-level education</td>
</tr>
<tr>
<td>UCLA</td>
<td>Master of Applied Statistics (MAS) and Master of Science in Business Analytics (MSBA) MAS launched in 2015; 18-month program with evening courses plus a thesis project with an industry partner; accepts no more than 30 students per cohort; charges regular tuition plus UCOP-approved $1000/unit fee; see below text for further details. MSBA offered by Anderson School of Business; focuses on data sciences methods for improving business decisions; 48 units required</td>
</tr>
<tr>
<td>UCR</td>
<td>Master of Science Engineering in Data Science (MDS) Online degree over 13 months; 4 possible start dates; includes 9 courses at $3,333/course ($30,000 total); run through College of Engineering.</td>
</tr>
</tbody>
</table>
It is notable that many of the data science programs offered at other UC schools focus on business analytics. Only two of these other programs have some potential overlap with our proposed MEDS program – the MIMS degree through the Berkeley Institute for Data Science (BIDS) and UCLA’s Master in Applied Statistics (MAS) – although both are focused on data science rather than environmental data science. BIDS was founded in 2013 with significant support from the Moore and Sloan Foundations. The UC Berkeley program awards a Master of Information Management Systems (MIMS) degree that is offered on-campus and has a strong concentration on social and policy issues of information. They also offer an online Master’s in Information and Data Science (MIDS) degree aimed at augmenting the data skills of individuals already occupying positions in businesses dealing with data analysis challenges; the MIDS degree at Berkeley is intended to prepare graduates to become more competent data analysts and managers primarily within the business intelligence components of their respective firms. The MIMS degree is a 2-year course based program; it is interdisciplinary with focus on social and political sciences but explicitly not environmental science. UCLA’s Master in Applied Statistics is a two-year program with 12 courses, of which 6 are core required and the other 6 are elective. There is a written thesis as a final requirement.

The MEDS program, on the other hand, will not only provide a solid basis for understanding the fundamentals of data science, but also a strong familiarity with the challenges and opportunities of applying data science to environmental problems. This domain expertise requires a clear focus on the specific types of environmental data that might be overlooked in a program aimed at creating more generalized data scientists. The disciplinary focus of the MEDS program on environmental science data, coupled with integrating instruction on environmental theory and topics, will lead to a generation of data scientists highly qualified to assist with the significant challenges of better understanding the Earth environment and biosphere, through judicious and efficient use of the growing amounts of high resolution, global scale earth science data.
Because the proposed program at UC Santa Barbara is unique, the opportunities for collaborations and synergies with other campuses will be particularly exciting and fruitful at the intersection of environmental health and human health. This is a rapidly growing (and funded) topic nationally and globally. Drafts of this proposal have been submitted to our colleagues at UC Berkeley, and through in person conversations they offer strong support for the MEDS program.

We plan to launch this program with a global summit in fall 2020, annual thereafter, that will bring in global leaders in environmental data science and allied disciplines that will include faculty from our sister institutions, and we may engage faculty and researchers from these institutions as lecturers for some of our summer (short-term) courses in the initial years of the program. The idea for this summit was proposed and encouraged by EVC Marshall. The summit will bring in keynote speakers across many environmental science disciplines that use data science in innovative ways; encourage early career scientists (graduate students and post-docs) and faculty at UCSB and other UC institutions to contribute to panel discussions and digital presentations of research (animated, video or other); and host ‘side-events’ such as problem-solving ‘hackathons’ or half-day hands-on training in new data science tools or techniques.

1.6 Program Administration

The MEDS degree program will be administered by the Bren School, in close coordination with NCEAS. The Bren faculty voted unanimously (Sept. 14, 2018) in support of this proposal and the MEDS program (24 voted in favor, 0 against, 1 abstained, 1 not voting out of a total of 26 faculty). Bren faculty and staff have over 20 years of experience administering the MESM program, providing by far the most efficient and experienced infrastructure for administering the new MEDS program. NCEAS is a research center and unit located in downtown Santa Barbara. The Center primarily houses research scientists and post-docs and hosts hundreds of scientists in dozens of working groups each year as well as numerous data science short courses. This deep experience (and associated resources) in supporting environmental data science research and instruction offers an invaluable and efficient foundation from which to launch the program.

Faculty within the MEDS program will be hired within the Bren School and housed there. Faculty with joint appointments whose other (affiliated) departments are their primary home will be given space in Bren based on availability and individual faculty preferences. MEDS faculty will be integrated into the existing governance structure of Bren as faculty of the Bren School, with the MEDS program a distinct constellation of activities from the MESM program.

Staff will be hired to support admissions, finance and administration, career development, student affairs, and computing and IT needs, and campus-wide data science boot-camp training. Staff supporting the current MESM program were consulted on the necessary additional staffing needs to support the new MEDS program. Details and rationale for staffing needs are provided in Section 6.2 Staff FTE. All staff costs will be covered by the supplemental fee, except for the single position committed from the Chancellor’s Staffing Initiative (see reference to the memo from EVC David Marshall to Dean Gaines in his letter in
Appendix A). Embedding the administration of MEDS within Bren with support from NCEAS allows for greatest efficiency and fewest resources given programmatic needs (see organizational chart, Appendix C, for details of staffing and administration), lower than what would be required to run the program through any other department or arrangement. Specific advantages of engaging NCEAS in the MEDS program are described in more detail in *Section 1.4 Relationship to Campus Academic Plan and Existing Program*. 

### 1.7 Plan for Evaluating the Program

During the first two years of program growth we will conduct quarterly reviews of the academic program with participating faculty and instructors to evaluate how well course offerings are integrated and sequenced. During subsequent years these reviews will happen annually. The reviews will also be used to modify enrollment growth and target levels. Leveraging the experience and infrastructure within Bren, we will also conduct exit surveys with students and track job-placement of graduates. Both measures allow ongoing assessment of program success. Furthermore, we propose an internal audit and review after completion of the fourth full year of the degree program, to be conducted by appointees of the Dean of Bren. Following that, we expect the program will be subject to normal periodic academic reviews every 7-9 years within a broader process of reviewing the Bren School, as with any campus program.

We will also implement a process to assess Program Learning Outcomes (PLOs), per UCSB guidelines, so that we can confirm that students graduating with a MEDS are achieving the following outcomes:

#### 1. Core Knowledge

- Demonstrate broad knowledge of the computation, mathematical and statistical foundations of data science and apply to the solution of an environmental problem.
- Demonstrate broad knowledge of the concepts in data science necessary to address environmental problems.
- Demonstrate and apply broad knowledge of programming and database languages used in environmental data science, including Python, R, and SQL.
- Demonstrate and apply a deep understanding of one of more areas of environmental data science, including data storage and management, interoperability, modeling, mining, analysis, and visualization.

#### 2. Research Methods and Analysis

- Identify and understand the range of qualitative and quantitative methodologies used in environmental data sciences, including regression analysis, simulation, big data methods, and other relevant computational methods, applying relevant methods to environmental problems.
- Review and cogently synthesize relevant academic and policy literatures
- Identify and understand the institutions and stakeholders that are relevant to current environmental problems, applying relevant methods to specific problems.
• Identify and understand policy evaluation methods that are relevant to environmental problems.

3. Independent Research
• Formulate research questions and hypotheses that are relevant to environmental problems.
• Demonstrate the ability to design, develop, and implement rigorous studies using data, methods, and techniques relevant to environmental data science.
• Analyze, organize, and visualize data using data science methods in order to solve environmental problems.

4. Communication & Dissemination
• Write research reports at a level and style appropriate for public dissemination
• Create and deliver compelling, professional-quality public presentations of research results.

5. Professionalism
• Make effective contributions to a research team.
• Formulate and follow a work plan to advance a research project or other investigation.
• Cultivate and maintain strong professional relations with colleagues, professional associates, clients, and customers.
• Create environmental data science products and reports that satisfy employer, client, and customer needs.

Section 2. The Degree Program
A terminal, 11-month professional Master’s degree in Environmental Data Science is proposed. A group capstone project will be required in lieu of an individual thesis or comprehensive examination (following the model of the MESM degree in Bren; see Section 2.3.f Description of Capstone for more detail). The program’s Classification of Instructional Programs (CIP) code is proposed to be 03.0199 (Natural resources conservation and research, other).

2.1 Admissions Requirements and Preferences
The program is intended to help students with interest and background in environmental science and data science accelerate their practical learning and skill development to help launch a career in environmental data science. We expect applicants will come from STEM-related fields such as engineering, computer science or physical/life sciences as well as social sciences and humanities, but rigorous prerequisite requirements will ensure students have sufficient background training to jump into the MEDS curriculum and thrive in the program. The breadth of environmental science disciplines required to address environmental problems needs graduates
with diverse backgrounds trained with the knowledge and skills that enable them to manage and analyze large and diverse data. This philosophy underpins the MEDS program.

The MEDS program is not intended to train disciplinary experts in, for example, computer science, mathematics or statistics. Instead, the aim of the program is to provide exposure and training in existing data science skills and tools through the lens of environmental data and environmental problem solving. Graduates of the MEDS program will become essential bridges between environmental scientists with little to no data science training and informatics experts with little to no understanding of environmental data and problems.

A Bachelor’s degree (or higher) in a discipline of environmental science, or several years of work experience in an environmental science position, will be required for admittance into the program. Additionally, applicants will need one semester or two quarters of calculus or linear algebra, one course in statistics, and one course (or equivalent experience) in programming. Students lacking some of this preparation may be accepted for admission, but it is expected that deficiencies will be made up by enrolling in full courses (at UCSB or elsewhere) the spring or summer prior to entrance. This level of prerequisites for admittance to the program exceeds those for most general data science programs (in particular because of the requirement for environmental science experience). For example, Berkeley’s Master’s in Information and Data Science (MIDS) requires linear algebra and a ‘working knowledge of fundamental computer science concepts including: data structures, algorithms and analysis of algorithms.’

Even students meeting these prerequisites may be ‘rusty’ on some of the topics, so the MEDS program will offer non-mandatory ‘boot camp’ classes at no additional cost just prior to the start of the summer quarter instruction. These short courses are intended to give a refresher overview of key topics. Such boot camp classes are currently offered for matriculating MESM students and are widely subscribed and appreciated. These refresher courses will be offered at the Bren School.

The Graduate Record Examination (GRE) General Test will be required. Official grade transcripts and degree certifications will be required from the applicant’s most recent academic institution as well as any transcripts from post-secondary education institutions where at least one full term was completed. While the minimum GPA for admission is a 3.0 at a student’s undergraduate institution, a Grade Point Average (GPA) of 3.5 or higher will be recommended for admission into the program.

Applicants whose native language is not English are required to take either the Test of English as Foreign Language (TOEFL) or the International English Language Testing System (IELTS) exam. Exemptions to this requirement will be considered for those students who have completed an undergraduate or graduate education at an institution whose primary language of instruction is English. The minimum TOEFL score for consideration is 550 for the paper-based test (PBT), or 80 for the Internet-based test (IBT). The minimum IELTS score for consideration is an Overall Band Score of 7 or higher. TOEFL and IELTS scores must not be more than two years old at the time of application to UCSB.
We anticipate that many students interested and/or enrolled in the MESM program, as well as in other degree programs through other departments, will be interested in the MEDS degree. Given the heavy course load in the MEDS program, concurrent degrees will not be allowed.

2.2 Foreign Language Requirement

There is no foreign language requirement for the MEDS degree. All MEDS courses and examinations will be delivered in English. No related graduate program in the UC system has a foreign language requirement.

2.3 Program of Study

2.3.a Specific Fields of Emphasis

Given that MEDS is a one-year intensive program, emphases or specializations will not be possible.

2.3.b Plan

The program will offer a Master's Plan II (with capstone project) that includes 56 units of required courses over 4 quarters (summer through spring). The capstone project will be administered as a course-based group project, similar to the current MESM group project. See Section 2.3.f Description of Capstone for a detailed description of the existing MESM and proposed MEDS group capstone projects.

2.3.c Unit Requirements

A total of 56 units will be required for the Master's degree. This includes 48 units of traditional coursework and 8 units for the group capstone project. Details for the structure and function of the group project are provided in Section 2.3.f Description of Capstone. Per University guidelines, students must earn a C grade or higher in required courses and a cumulative GPA of 3.0 or higher in order to graduate.

Although this unit requirement may seem high compared to traditional graduate programs, it is based on typical curriculum and course loads in other data science master's programs and is the same as or less than the typical per-quarter unit load in the current MESM program (16-18 units per quarter). The MEDS degree is a course-based, professional degree in which a higher unit load is not only possible but desired by students. Based upon two decades of experience with the MESM degree, we are confident that it is reasonable and achievable for the students, and necessary to provide them with the full spectrum of courses and instruction needed for a robust course-based degree.

A survey of >60 alumni from the Bren MESM program indicates that many graduates would likely have done a double (sequential) degree had the MEDS program been around when they were there.
2.3.d Required and Recommended Courses

The curriculum will comprise a new set of 200-level courses listed under a new EDS course code designation. Proposed course numbers and titles are listed below, with proposed catalog descriptions found in Section 5 Courses.

Priority for enrollment in all classes will be given to MEDS students. Classes with space available will be open to students from other departments where appropriate. Required courses will include the following, formatted as a graduation requirement form:

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<thead>
<tr>
<th>COURSE #</th>
<th>COURSE NAME</th>
<th>UNITS</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDS 211</td>
<td>TEAM SCIENCE, COLLABORATIVE ANALYSIS &amp; PROJECT MNGT</td>
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</tr>
<tr>
<td>EDS 212</td>
<td>ESSENTIAL MATH FOR ENVIRONMENTAL DATA SCIENCE</td>
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</tr>
<tr>
<td>EDS 213</td>
<td>METADATA STANDARDS, DATA MODELING AND DATA SEMANTICS</td>
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<tr>
<td>EDS 214</td>
<td>ANALYTICAL WORKFLOWS AND SCIENTIFIC REPRODUCIBILITY</td>
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<td>EDS 215</td>
<td>INTRODUCTION TO DATA STORAGE AND MANAGEMENT</td>
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<td>EDS 216</td>
<td>META-ANALYSIS AND SYSTEMATIC REVIEWS</td>
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<td>REMOTE SENSING AND ENVIRONMENTAL DATA</td>
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<tr>
<td>EDS 221</td>
<td>SCIENTIFIC PROGRAMMING ESSENTIALS</td>
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<tr>
<td>EDS 222</td>
<td>STATISTICS FOR ENVIRONMENTAL DATA SCIENCE</td>
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<tr>
<td>EDS 223</td>
<td>SPATIAL ANALYSIS FOR ENVIRONMENTAL PROBLEM SOLVING</td>
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<td>EDS 230</td>
<td>MODELING ENVIRONMENTAL SYSTEMS</td>
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<tr>
<td>EDS 231</td>
<td>TEXT AND SENTIMENT ANALYSIS FOR ENVIRONMENTAL DATA SCIENCE</td>
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<td>EDS 232</td>
<td>MACHINE LEARNING IN ENVIRONMENTAL SCIENCE</td>
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<td>EDS 240</td>
<td>DATA VISUALIZATION AND COMMUNICATION</td>
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<td>EDS 241</td>
<td>ENVIRONMENTAL POLICY EVALUATION</td>
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</tbody>
</table>
These core courses will provide students with a breadth of data science background and practical experience, framed within and applied to environmental questions and problem solving. The classes will have strong hands-on curricula that will encourage ‘learning by doing’. The broad diversity of disciplines represented by the faculty, LSOE position, and lecturers will provide students with many perspectives and contexts in which data science can be brought to bear on environmental problems.

Given very strong support for the program to be no longer than a single year, and the significant number of courses necessary to provide the breadth of education and training in environmental data science, students will have limited ability to take elective courses. For the most part, students will be able to take a single elective in spring quarter and potentially additional (2 or 4 unit) elective courses in fall, winter and spring quarters. We list some possible elective courses here, but students will be allowed to take classes offered by faculty in the MEDS program or any other related department, pending approval by MEDS faculty that the class meets programmatic goals.

Possible new elective classes to be taught by MEDS affiliated faculty include (full descriptions are provided in Section 5.1b Potential Elective Courses):

- EDS XXX: Bayesian hierarchical models for environmental processes, 4 units
- EDS XXX: Advanced Scientific Programming, 2 units
- EDS XXX: Data Integration and Infrastructures, 4 units

EDS elective classes would generally be taught each year. Additionally, a wide range of existing classes on campus could be taken by MEDS students as electives. The exact list of possible elective courses is still to be determined and will depend on the interests of incoming cohorts, but existing classes in Bren, CS, Geography, PSTAT, EEMB, MAT, Political Science and other departments present dozens of options. We anticipate that any given elective class would enroll 5 or fewer MEDS students; many faculty from other departments have indicated they would be happy to have MEDS students in their classes (see letters of support).
2.3.e Sample Program

Table 2 provides an overview of the program structure, with spots for various elective courses noted generally. Summer quarter classes will likely be structured as two concurrent 3-week classes for each of three 3-week sessions (i.e., summer sessions E, F, and G).

Table 2. Example curriculum and schedule for the MEDS program.

<table>
<thead>
<tr>
<th>Summer Quarter</th>
<th>Fall Quarter</th>
<th>Winter Quarter</th>
<th>Spring Quarter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units: 12 (req.)</td>
<td>Units: 16 (req.); 2-4 (elect.)</td>
<td>Units: 16 (req.); 2-4 (elect.)</td>
<td>Units: 12 (req.); 4-8 (elect.)</td>
</tr>
<tr>
<td><strong>EDS 211</strong>: Team Science, Collaborative Analysis, and Project Management (2 units)</td>
<td><strong>EDS 220</strong>: Remote Sensing and Environmental Data (4 units)</td>
<td><strong>EDS 230</strong>: Modeling Environmental Systems (4 units)</td>
<td><strong>EDS 240</strong>: Data Visualization and Communication (4 units)</td>
</tr>
<tr>
<td><strong>EDS 212</strong>: Essential Math for Environmental Data Science (2 units)</td>
<td><strong>EDS 221</strong>: Scientific Programming Essentials (4 units)</td>
<td><strong>EDS 231</strong>: Text and sentiment analysis for environmental problems (4 units)</td>
<td><strong>EDS 241</strong>: Environmental Policy Evaluation (4 units)</td>
</tr>
<tr>
<td><strong>EDS 213</strong>: Metadata Standards, Data Modeling, and Data Semantics (2 units)</td>
<td><strong>EDS 222</strong>: Statistics for Environmental Data Science (4 units)</td>
<td><strong>EDS 232</strong>: Machine Learning in Environmental Science (4 units)</td>
<td><strong>EDS 411B</strong>: Group Project (4 units)</td>
</tr>
<tr>
<td><strong>EDS 214</strong>: Analytical Workflows and Scientific Reproducibility (2 units)</td>
<td><strong>EDS 223</strong>: Spatial Analysis for Environmental Data Science (4 units)</td>
<td><strong>EDS 411A</strong>: Group Project (4 units)</td>
<td>ELECTIVE (4 units)</td>
</tr>
<tr>
<td><strong>EDS 215</strong>: Introduction to data storage and management (2 units)</td>
<td>POSSIBLE ELECTIVE (2 or 4 units)</td>
<td>POSSIBLE ELECTIVE (2 or 4 units)</td>
<td>POSSIBLE ELECTIVE (2 or 4 units)</td>
</tr>
<tr>
<td><strong>EDS 216</strong>: Meta-analysis and Systematic Reviews (2 units)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.3.f Description of Capstone

During the second half of the degree program (winter and spring quarters), students will engage in a course-based group capstone project, similar in structure and administration to the current MESM group project, albeit *smaller in scope and output and shorter in duration*\(^\text{11}\). Given the

\(^\text{11}\) The MESM capstone group project runs Spring Quarter (year 1) through Spring Quarter (year 2) and often includes a summer internship for one of the group members, and includes creating a website, poster, and policy briefing along with the main products of a written report, oral defense and public presentation. The scope of work conducted as part of MESM capstone group projects matches the year-
very strong interest from industry, agencies, conservation NGOs and others to be clients for MESM capstone projects, we anticipate similar interest for MEDS capstones. MEDS group projects will include a written report, including an executive summary, a project website and final presentation and generally involve a few analytical components. In particular, MEDS group projects will function in the following way:

*Summer quarter:* This quarter primarily involves MEDS staff and prospective clients. Clients for group projects are solicited and proposals are drafted. In general students and faculty are not involved in this process, although proposals from students will be considered. MEDS staff advise clients on scope and structure of the project to match it to the timing and expectations for graduate work. Clients can be corporations, government agencies, conservation Non-Governmental Organizations (NGOs), scientific research initiatives, or groups with similar scope and purpose (e.g., MESM group projects that need additional data science capacity, NCEAS working groups, faculty-driven research that needs focused data processing and analysis within the environmental science domain). Proposals are expected to focus on a data science application to support environmental problem solving in direct service of a specific client need; the specific topic can vary significantly depending on client interests/needs and the skills and interests of the current student cohort (see list of example topics below). Projects must be feasibly completable by a group of 3-4 students in a two-quarter time frame (one quarter for analysis, one quarter for write up and presentations). Proposals must clearly identify a data-science goal, available datasets, and how the data-science application will be used in environmental problem solving. Projects are expected to be ambitious but realistic. Project focus may include novel analysis, producing a code package, developing data science infrastructure, integrating and visualizing existing but under-analyzed data, etc.

*Fall quarter:* This quarter is when groups are assigned to projects. Client proposals are due at the start of the quarter. A MEDS faculty committee reviews and selects the top proposals, and then students rank their top choices from this list. The faculty committee then matches one group of 3-4 students per proposal, based on priority-matching algorithm. The LSOE position will mentor groups through course-based instruction during initial years when cohort size is small; as cohort size increases, MEDS faculty will engage in mentoring projects as co-instructors for the class, and additional faculty can opt to mentor a project depending on their interests and teaching load.

*Winter quarter:* This quarter is when groups begin work. In consultation with the class instructor(s) and client liaison, students a) develop a project design and management plan, which includes producing a project timeline and deliverables, b) develop a communication and outreach strategy, c) compile all data and implement a data management plan, d) finalize detailed research plans, and e) time pending, begin analyses. Students will utilize skills learned in EDS 211 (Team Science, Collaborative Analysis and Project Management), taken concurrently with EDS 411 to guide the development of the project plan.

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long (plus summer internship) timeframe, usually involving 2 or 3 analytical components, social surveys, and/or literature reviews.
**Spring quarter**: This quarter is when groups wrap up analyses and develop communication materials. In consultation with the instructor(s) and client liaison, students a) complete all analyses, b) write and submit a project report, c) develop and post online at least one data visualization product from the project, and d) prepare and give an oral presentation intended for a lay audience.

Possible group projects could include:

- Embedding within a MESM group project to augment and accelerate the data processing and analysis components of the project. Possible MESM topics are wide ranging, including but not limited to:
  - Spatial optimization of conservation plans for ocean areas or landscapes;
  - Quantifying the benefit of ecosystem service provision in different case study contexts;
  - Feasibility and cost-benefit analysis of commercial-scale solar energy in the California desert.

- Embedding within an NCEAS synthesis working group to tackle a specific data-intensive problem or analysis. Possible working group topics are wide ranging, including but not limited to:
  - Mapping the global potential for aquaculture under a changing climate;
  - Developing and implementing composite biodiversity indicators;
  - Measuring and trading-off the value of different components of natural capital;
  - Assessing wildfire risk and cost across Mediterranean landscapes.

- Working with a corporate sustainability group to pull together and analyze data on the costs and benefits of a current business practice or product.

- Working with an environmental NGO to analyze data on the economic versus biological costs and benefits of a site-specific conservation action

- Creating an R package (a stand alone bundle of code designed for specific function or analysis) in support of a large academic research initiative looking at developing indicators of biodiversity status

Grading of group projects typical course-based work, with the LSOE instructor meeting weekly with the groups to gauge progress, offer advice, and develop a sense of the performance of individual students. Projects are structured so that each student takes on at least one individual role that matches his/her specific interests (for example, one student may focus on spatial data analysis while another focuses on metadata and data archiving). At the end of each quarter, students provide confidential evaluations of the performance of each group member and themselves. The LSOE instructor then uses these evaluations to supplement her/his own assessments. Students are enrolled in 4 units for each of winter and spring quarters and grades are assigned to students individually based on the assessments above and the quality of the work produced for each quarter (see quarterly descriptions above). This operational and grading structure ensures that if a student drops out of the program, the group project can continue and individual students are graded on their own performance as it contributes to the larger group effort.
Group projects and the associated outputs are the main mechanism for achieving many of the Program Learning Outcomes (PLOs), described above in Section 1.7 Plan for Evaluating the Program. As such, the capstone group project is a fundamental component of the MEDS program.

2.3.g Rationale for one-year degree

There are several reasons why the MEDS program needs to be less than one year. Most importantly, essentially every one of the more than 100 data science master's programs in the world is less than a year. It would be very risky to offer a 2-year program, where the cost would be substantially more than all single-year programs and the duration uncompetitive for students who cannot afford (or do not want) to take 2 years to complete the degree. Any program length between one and two years (e.g., 15-month degree) would be logistically challenging and equally undesirable (to applicants).

Additionally, a 11-month program meets the expectations and constraints of people in specific and likely target applicant pools. Mid-career professionals that we surveyed indicated they would not be able to take more than a year away from their jobs to pursue this graduate degree. Although this demographic may not be a large portion of the eventual student body of the MEDS program, it is an important market to maintain. Similarly, and more specific to UCSB, many alumni from the current MESM program indicated they would have done the MEDS degree in addition to the MESM degree, but only if the MEDS degree were a single year.

2.3.h Licensing of Certification

Not applicable.

2.4 Field Examination

Not applicable

2.5 Qualifying Examination

Not applicable

2.6 Thesis/Dissertation

There is no thesis for this program; instead it will be structured as a course-based group capstone project (see 2.3f Description of Capstone), similar in design and execution to the MESM group project but of significantly smaller scope due to the shorter degree program. See Section 2.3.f Description of Capstone for a detailed description of the existing MESM and proposed MEDS group capstone projects.
2.7 Final Examination
Not applicable

2.8 Normative Time to Degree
The proposed professional degree is intended to be intensive, 11-month, and mostly course-based. Thus the normative time will be one-year. The rationale for why the degree should be completed within 12 months (rather than anything longer) is detailed above in Section 2.3.g Rationale for one-year degree. In extraordinary situations and subject to careful review and prior approval by MEDS faculty, students would be allowed to complete the degree over the course of a second year.

Single-year graduate programs always face the potential situation that students who earn a grade less than a C in a core class or do not achieve a 3.0 or higher GPA will not meet the necessary requirements to graduate. Any student in overall good academic standing will be able to repeat a course the following year, pending the careful review and approval of MEDS faculty, but this would require enrolling in the program an additional quarter. All 1-year degree programs face this challenge, but we anticipate the situation being extremely rare.

Section 3. Projected Need

3.1 Importance to the discipline
The importance of data science is evident at all levels of government and industry. In 2013 President Obama signed an Executive Order, requiring government data to be open and machine-readable. The motivation for this initiative was to make data “easily available to entrepreneurs, innovators, researchers, and others who can use those data to generate new products and services, build businesses, and create jobs.” Within this executive order, both the Energy sector and Global Development, areas frequently within the sphere of environmental management, are highlighted. All government agencies that play a key role in environmental management have programs specifically focused on the compilation, analysis and use of data (see Table 3 below for examples of data science initiatives at key national and international environmental agencies).
Table 3. Sample large-scale data science initiatives. These examples represent both likely potential clients for group projects and employers of MEDS graduates.

<table>
<thead>
<tr>
<th>National Aeronautics &amp; Space Administration (NASA)</th>
<th>Atmospheric Data Science Center</th>
<th><a href="https://eosweb.larc.nasa.gov/">https://eosweb.larc.nasa.gov/</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Protection Agency (EPA)</td>
<td>Environmental Dataset Gateway</td>
<td><a href="https://ofmpub.epa.gov/sor%E3%82%A4%E3%83%B3%E3%82%BF%E3%83%BC%E3%83%8D%E3%83%83%E3%83%88/registr">https://ofmpub.epa.gov/sorインターネット/registr</a> y/edgreg/home/overview.do</td>
</tr>
<tr>
<td>US Geologic Survey (USGS)</td>
<td>Forest Inventory and Data Analysis</td>
<td><a href="http://www.fia.fs.fed.us/">http://www.fia.fs.fed.us/</a></td>
</tr>
<tr>
<td>US Department of Agriculture (USDA)</td>
<td>Food Composition and Nutrion database</td>
<td><a href="https://ndb.nal.usda.gov/ndb/">https://ndb.nal.usda.gov/ndb/</a></td>
</tr>
<tr>
<td>United Nations Environment Program</td>
<td>Environmental Data Explorer</td>
<td><a href="http://geodata.grid.unep.ch/">http://geodata.grid.unep.ch/</a></td>
</tr>
</tbody>
</table>

As described in Section 1.2 Background and Historical Development, environmental data science draws on GIScience, ecological informatics, earth sciences, and various other environmental disciplines and combines them with analytical tools and techniques drawn from statistics and computer science. Although individuals have been doing this kind of research for decades, it is only in the last several years that all of the pieces have coalesced into a clear discipline. Indeed, data science is increasingly important for environmental research. In 2009, the National Science Foundation (NSF) founded DataONE, intended to be “the Data Observation Network for Earth, a distributed cyberinfrastructure that meets the needs of science and society for open, persistent, robust and accessible Earth observational data.” The creation of this multi-million-dollar enterprise by the NSF highlights the growing reliance of researchers in environmental science on data and software engineering. Other NSF initiatives such as the Arctic Data Center (https://arcticdata.io/), the Biological and Chemical Oceanography Data Management Office (http://www.bco-dmo.org/) and many other programs are designed to provide data and analytical tools to support environmental research.

However, the growth in need for environmental data science has not yet translated into focused educational and training programs and has been hindered by the lack of a robust work force to implement environmental data science in businesses, NGOs, agencies and academia. A just-released study of 704 PIs funded by NSF’s Directorate of Biological Sciences found the most pressing unmet needs are ‘training in data integration, data management, and scaling analyses...
for High Performance Computing\textsuperscript{12}. The MEDS program is an opportunity to directly address these needs and become a global leader in the field.

### 3.2 Meeting the Needs of Society

Solving the many environmental problems facing society, from threats to food-security and biodiversity to pollution and global climate change, will require a workforce trained in the use of data. The United Nations Secretary-General Ban Ki-moon’s High Level Panel\textsuperscript{13} recently called for a “data revolution” for sustainable development and launched Global Pulse, an innovation center for the use of data to enhance the public good. Core environmental agencies in the United States, including the National Center for Atmospheric Research (NCAR), the National Oceanic and Atmospheric Administration (NOAA), the National Aeronautics and Space Administration (NASA), the Environmental Protection Agency (EPA), the United States Geologic Survey (USGS) and a broad range of local and state government agencies, all have data-science related initiatives that require expertise in collecting, managing, interpreting and applying data to understanding the environment. The private sector also increasingly utilizes environmental data and software - from a global insurance company that relies on data-model synthesis to evaluate environmental risks, to a local manufacturing company that needs estimates of water availability during a drought.

With this widespread emergence of data science driven initiatives, there is an ever-growing need for skilled data science practitioners. While general data scientists can provide core computing skills, the compilation, analysis and application of data sets to support environmental problem solving requires a unique set of skills that combine computing and data analysis with understanding of the types of data used to monitor and assess how human and earth systems interact. There is a need for practitioners familiar with this wide range of data sources and techniques for characterizing the health of water, air, soil and ecosystems, and how these measurements can be integrated and applied to assess environmental impacts and find new solutions to environmental problems at local to global scales. Techniques such as remote sensing, Geographic Information Systems (GIS), environmental modeling, economic analyses, Cyber-Physical System (CPS), and distributed sensor networks are all components of environmental data science.

Environmental and conservation solutions can be complex, controversial, and resource intensive. As such, there is great need for transparency and effective communication to build trust, provide defensible information to policy makers, and increase stakeholder engagement. Environmental data science provides the means to these ends, and the MEDS program will help create environmental scientists trained to work collaboratively, transparently, and reproducibly, and in doing so to set an example and be leaders for others.


\textsuperscript{13} http://www.post2015hlp.org/featured/high-level-panel-releases-recommendations-for-worlds-next-development-agenda/
The field of environmental science is an area of likely substantial growth given the continued and increasing pressure humanity is placing on the planet and its ecosystems, and the increasing urgency to find solutions. As the discipline has matured, it has tackled increasingly complex and data-driven research. The future of environmental problem solving is likely to be dominated by data science approaches.

3.3 Student demand

Several trends in academic institutions and the job market indicate high demand for a master’s program focused on environmental data science. First, data science as a profession is exploding in response to the deluge of data now available across all domains and the demand by businesses and scientists for people with the skills to access and analyze these data (for more details, see Section 3.4 Placement of Graduates). Universities across the country and around the world are following suit and creating graduate programs in data science. Although such programs are focused on data science in general rather than environmental data science, they offer a useful benchmark for expected demand for the MEDS program.

Second, students and professionals across a wide range of disciplines are seeking data science training. The breadth of departments at UCSB supporting this proposal speaks to the demand in many different fields for training in environmental data science. Recent ‘open science for synthesis’ training courses (3 week course over the summer) at NCEAS have received 100-400 applicants for 25 available spots. A survey of 61 graduates of the MESM program at Bren who are now in data science careers indicated overwhelming support and enthusiasm for the MEDS program. To confirm that the proposed MEDS program would not overlap or conflict with the MESM degree through Bren, we asked what they would want in a MEDS program and if/how it would have impacted their decision to enroll in the MESM program. Nearly all those surveyed felt that it would further encourage enrollment in the MESM degree rather than discourage it due to the expected opportunities to take courses and engage in data science training. Importantly, many said they would actually want to do a double degree (over 3 years), as they saw the two programs as complementary but of unique value.

Finally, growth and demand for the MESM degree at Bren (see Fig. 1) speaks to student interest in environmental science, practical training, and the group project approach to getting a graduate degree. Since its inception, the Bren School has grown dramatically in reputation, consistently ranking in the top three environmental science programs in the country. The combination of excellent faculty, the innovative group project that focuses on team science, the international reputation of UCSB as an epicenter of environmental science, and the location of UCSB along the coast in Santa Barbara all draw students to the MESM program. The MEDS program will leverage all of these assets and add in the globally-recognized strengths in data

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14 A full list of graduate programs in data science is catalogued [here](#).
15 In spring 2016, a phone survey was conducted of 61 graduates of the MESM program spanning 15 graduating cohorts. The informal survey was designed to gauge interest and inform program structure and curriculum.
science provided by NCEAS, Computer Science and beyond to create an anticipated high demand for the MEDS program.

Figure 1. Growth in MESM applicant pool (given relatively constant enrollment) over the past 15 years.

Because there are only a few comparable environmental data science master's programs in the world (e.g., Master's in Environmental Informatics are offered at the University of Michigan, the University of Leicester (U.K.), and Cranfield University (U.K.)), we were not able to get comparable information on application and enrollment levels for established environmental data science programs.

A conservative estimate of enrollment growth in the new MEDS program over the first 5 years is shown in Table 4. A recent survey of data science graduates found that one in three were foreign born\(^\text{16}\), suggesting a strong potential interest in the MEDS program from international students. We anticipate a very small number of students who would have enrolled in the MESM program to instead enroll in the MEDS program, but we expect an equal or greater number of students will opt to do both degrees. Based on experience with the MESM program and annual discussion among Bren faculty about optimal cohort size, we plan to cap annual enrollment at +/- 90 students. We are aiming for an initial cohort of about 20 students (a smaller initial cohort allows for greater flexibility and adaptability in the course structure and content as faculty and staff learn and adapt to what best meets student needs) and use a conservative projection of growth (Table 4) for planning and budget estimates. The actual growth rate will likely be faster but will be carefully calibrated to the needs and opportunities of the faculty and students.

\(^{16}\) 'The Supply And Demand Of Data Scientists: What The Surveys Say,’ Forbes, Apr 30, 2015; full article here.
Table 4. Conservative projected enrollment in the MEDS program

<table>
<thead>
<tr>
<th></th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Projected</td>
<td>Initial staffing: (no students)</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>55</td>
</tr>
<tr>
<td>enrollment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The target applicant pool for this professional degree includes recent graduates and early career researchers wanting to launch a career that leverages environmental data science, as well as mid-career professionals looking to augment their skills and resumes.

Based on experience with the MESM program, we expect much higher application and enrollment rates for out-of-state and international students compared to most graduate departments and programs on campus. From the inception of the program we will invest significant effort in marketing, outreach, and (through philanthropy) financial support to underrepresented communities.

**Recruitment plan**

Following the strategy and activities currently used to recruit MESM students, the Bren School will recruit MEDS students through advertising campaigns, as well as hosting and attending recruiting events throughout the year. Students interested in visiting the campus will be encouraged to schedule a personal visit, which includes attending a core course, meeting with a student ambassador from the MEDS program, as well as an admissions counselor for an overview of the program and tour of Bren Hall. The Bren School will also host two recruiting events for MEDS students during the year: an Open House in the Fall for prospective students and an Admitted Students Day in the Spring. Highlights of these events include presentations about the Bren Schools programs, faculty and student panels, and an overview of career services. For prospective students who are unable to visit the Bren School in person, there will be monthly webinars offered through Zoom during the Fall, including a presentation and question/answer session about the MEDS program, as well as an Admitted Student webinar in April. The Bren School also participates in several recruitment events in the Fall: three Idealist Fairs (two in California and one on the East Coast) as well as the Diversity Forum, which takes place at a different California State University every year.

Supporting recruitment efforts and events, the Bren School will advertise and market to target audiences through a variety of mediums. The Bren website hosts a contact form through which prospective students can submit questions and receive information and updates through the admissions cycle – these are tracked in a Salesforce database. Information will be sent out at important milestones in the admissions process through Constant Contact. Events and information will be advertised through digital media, which includes Social Media campaigns through Facebook and Instagram. There also will be print materials available for recruiting events or visits, which include one-page overviews of programs and an accordion-style brochure. Faculty are also encouraged to promote the program during conferences, lectures, and talks at other institutions.
3.4 Placement of graduates

Recent market surveys have found strong demand and high pay for data scientists. Analysts recently predicted that the already ‘on fire’ job market for data scientists will continue for the foreseeable future\textsuperscript{17}. As of 2015, entry-level data scientists were making $91,000/yr nationally and $110,000/yr in Silicon Valley, and salaries were rising an average of 8\% per year\textsuperscript{18}. The U.S. Bureau of Labor Statistics (US BLS) predicts an 11\% growth in ‘computer and information research scientist’ careers by 2024. Similar statistics are not available for the job category of environmental data scientist as it is too new to be captured by such reporting agencies. However, existing indicators that suggest job growth and compensation is similar for environmental data scientists. Environmental science is predicted to have similarly robust job growth (US BLS: 11\% by 2024). It is thus reasonable to presume that the sub-discipline of environmental data science will see equal or greater job growth potential. The relative scarcity of environmental data scientists compared to other data scientists suggests that graduates with this disciplinary training will be in high demand.

The type of jobs MEDS graduates would be qualified and competitive for include data analyst, geospatial analyst, scientific programmer or similar for environmental NGOs, corporate sustainability programs, government environmental agencies from local to federal level, environmental consulting firms, and academic research initiatives. Sample job ads are provided in Appendix D. These institutions and organizations are increasingly using data science tools and approaches to address programmatic and research questions, such that the job market is expected to further increase in the future.

The MEDS program will implement the same structure for career development and support as the MESM program, building on its success. With staff dedicated to supporting students and alumni in job placement, MESM graduates have, on average, had 98\% placement in a job with the first 6 months after graduating (100\% within 1 year of graduation), with up to 60\% stating they were able to find their ideal position (see Table 5 for placement statistics). The MESM career development team has consistently been described as ‘invaluable’ by enrolled students and graduates. This approach to career support will be replicated for the MEDS program, leveraging and adding to the current staffing. Furthermore, the client-driven group capstone project component of the MEDS program will help build a large and diverse network of businesses, organizations and agencies that are likely to hire graduates of the program; the career development support provided by MEDS and Bren staff will further strengthen those connections and opportunities.

\textsuperscript{17} ‘Predictions for the 2016 Analytics & Data Science Hiring Market,’ Burtch Works Executive Recruiting, Feb. 8, 2016
\textsuperscript{18} ‘Less Noise by More Money in Data Science,’ Steve Lohr, NY Times, Apr. 28, 2015
Table 5. Job placement statistics for recent Bren MESM graduates.

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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Consulting</td>
<td>27%</td>
<td>21%</td>
<td>33%</td>
<td>24%</td>
<td>37%</td>
<td>34%</td>
<td>21%</td>
</tr>
<tr>
<td>Government</td>
<td>18%</td>
<td>18%</td>
<td>14%</td>
<td>23%</td>
<td>11%</td>
<td>16%</td>
<td>15%</td>
</tr>
<tr>
<td>Nonprofit</td>
<td>21%</td>
<td>25%</td>
<td>23%</td>
<td>14%</td>
<td>20%</td>
<td>16%</td>
<td>23%</td>
</tr>
<tr>
<td>Corporate</td>
<td>17%</td>
<td>13%</td>
<td>6%</td>
<td>10%</td>
<td>17%</td>
<td>16%</td>
<td>8%</td>
</tr>
<tr>
<td>Academic/Research</td>
<td>16%</td>
<td>21%</td>
<td>19%</td>
<td>20%</td>
<td>13%</td>
<td>16%</td>
<td>28%</td>
</tr>
<tr>
<td>Other</td>
<td>1%</td>
<td>2%</td>
<td>5%</td>
<td>9%</td>
<td>2%</td>
<td>2%</td>
<td>0%</td>
</tr>
</tbody>
</table>

3.5 Relationship to Research Interests of Faculty

The Bren faculty has been actively involved in research in environmental informatics since its inception. All Bren faculty engage in the analysis of environmental data as a central part of their research. Many faculty also have core strengths in the development of new tools and techniques in environmental Informatics, including James Frew (Informatics), Naomi Tague (Environmental Modeling), and Ben Halpern (Ecosystem Assessments). Many other faculty use data science tools in their research, including Andrew Plantinga (economics of ecosystem services), Chris Costello (tracking fishing effort globally), Kyle Meng (econometrics), Robert Heilmeyer (earth observation and conservation interventions), Kelly Caylor (climate change impacts on global drylands), Samantha Stevenson (climate variability and extreme weather events), Scott Jasechko (global water availability and quality), and Tamma Carleton (socioeconomic impacts of climate change). Bren also has a strong connection with the National Center for Ecological Analysis and Synthesis (NCEAS) through Professor Ben Halpern, the current NCEAS director, and Frank Davis, former NCEAS director and now director of the Long Term Ecological Research (LTER) Network Communications Office, which supports both training and synthesis of environmental data from NSF LTER sites. In discussions about the MEDS proposal, Bren faculty confirmed the program’s alignment with the mission of the Bren School and expressed strong commitment to seeing the program thrive, Integrating new faculty, and seeking synergies between the MESM and MEDS programs wherever possible.

The Computer Science Department at UCSB has built a strong program in data science. It has world-class research groups specializing in databases, data mining, distributed computing, security, software engineering, and visual computing, among others. CS faculty are looking for big data problems to probe the limits of the existing analytical algorithms, while Bren faculty are looking for scalable, user-friendly tools to handle large, complex environmental data. The proposed master’s program will incubate more interactions between the two departments and boost the research activities of their faculty.
The Economics Department at UCSB has a long-standing tradition of excellence in environmental economics (ranked ninth best department in Environmental Economics in the world). The faculty produce cutting-edge research centered around empirical analyses of environmental data. Olivier Deschenes is an expert on the empirical measurement of the economic impacts of climate change and adaptation. Kyle Meng is a specialist on the economic costs of environmental policies. All these areas of research routinely use and produce data relevant to environmental informatics, including GIS layers, climate modelling data, weather data, and remote sensing data. Many faculty in other fields of Economics would also benefit from and contribute to a MEDS program at UCSB. Econometricians like Douglas Steigerwald, Dick Startz and newly hired Clement de Chaisemartin all study and design new quantitative methods for the analysis of economic data from a theoretical perspective. Labor and health economist Heather Royer also uses of environmental data in her research.

The Geography Department at UCSB is internationally recognized as one of the best Departments of Geography in the world, and is routinely ranked first or second in the US. Since its founding in 1974, the Department has been at the vanguard of the “computational revolution” in geography, including leading the establishment of geographic information systems (GIS) as the standard paradigm for spatial analysis, as well as providing training and research in data visualization. Geography faculty whose research interests are highly relevant to the MEDS program include: Leila Carvalho (climate system modeling), Keith Clarke (GIS), Kostas Goulias (transportation modeling), Krzysztof Janowicz (GIS), Werner Kuhn (GIS), Dar Roberts (remote sensing), Dave Siegel (remote sensing), and Stuart Sweeney (spatial analysis).

Through discussions with faculty in various other departments, and demonstrated by many of the letters of support in Appendix A, we anticipate strong collaborative research initiatives to also emerge with individual faculty in the Departments of Mathematics, Political Science, Environmental Studies, Communication, Art, History, English, Mechanical Engineering, and Electrical and Computer Engineering, and with research centers including the Spatial Center, Earth Research Institute, Broom Center for Demography, the Natural Reserve System, and the Interdisciplinary Research Collaboratory at the Library. We also expect many opportunities for collaborative training and outreach efforts with the Library and Graduate Division.

3.6 Program Differentiation

Both within and outside the UC system, broadly speaking there are three types of data science programs at the graduate level: 1) general data science programs, which focus on the theory and application of data science, agnostic to any specific discipline, 2) bioinformatics (or medical data science) programs, which focus on developing the skills and expertise needed to apply data science to the health sector, and 3) engineering data science programs, which often focus on technology and application development for particular uses, especially within the business sector. These programs have proliferated in the last decade, and many dozens now exist (many
are reviewed and ranked by *Master’s in Data Science*\(^{19}\), a complete list of data science programs at R1 universities was also recently compiled\(^{20}\).

The latter two categories of programs demonstrate the utility (and popularity) of focusing data science curriculum and training on particular fields. Each field has unique challenges and opportunities with respect to available data, types of analyses, and pressing questions; data scientists without field-specific training often lack the necessary insight and training to know how to address pressing questions within the field.

Currently there are very few environmental data science programs anywhere, despite the huge need for data science training and application within the field of environmental science (see *Section 3.2 Meeting the Needs of Society*) and the anticipated high demand for this training (see *Section 3.3 Student Demand*). The only potentially similar program to MEDS globally is an Environmental Informatics specialization within the Master of Science degree offered by the School of Environment and Sustainability at University of Michigan\(^{21}\). The specialization at Michigan requires just two courses beyond the MS degree requirements (remote sensing and GIScience) and so bears little resemblance to the scope and mission of the MEDS program. Besides this program, there are also a number of Master of Science degrees in GIScience that are offered around the world with a primary focus on the tools and skills for GIScience (i.e. spatial data analysis). Through the MEDS program, UCSB can leverage its existing strengths and global reputation for environmental science and position itself as a global leader and innovator in this growing and increasingly important field of data science.

Related activities are occurring at UC Berkeley (see also *Section 1.5, Relationship to Programs at Other UC Institutions*), where campus initiatives are coalesced around environmental data science research. These initiatives do not support a degree program in environmental data science, but they create opportunities for interaction with students in the MIDS program. Leaders of those efforts (e.g., Dave Ackerley, Carl Boettinger) already collaborate closely with NCEAS and Bren. We expect that MEDS faculty and students will benefit greatly from existing and increased connections to UCB activities, and vice versa.

Launching the MEDS program would not preclude additional data science initiatives at UCSB, and in fact would benefit from synergies in course offerings, faculty research interests, and increased visibility and reputation for UCSB as a hub for data science. The MEDS program is intended to serve a broad range of students with diverse backgrounds seeking to gain exposure and training in environmental data science; this differs significantly from the aims of existing and potential future data science initiatives on campus and would attract and produce different kinds of students. We are working closely with faculty and department chairs interested in pursuing a campus-wide initiative on data science research to support those efforts and leverage synergies with the MEDS program.

\(^{19}\) http://www.mastersindatascience.org/
\(^{20}\) https://ddd-moore.github.io/datasci-at-R1-institutions/
\(^{21}\) http://www.snre.umich.edu/degrees/masters/environmental_informatics/overview
Section 4. Faculty

A large number of faculty from a wide range of departments on campus have expressed interest in becoming actively involved in MEDS once it officially begins. Below we list potential involvement of existing campus ladder faculty in two categories: 1) teaching role for EDS courses, group project mentoring, and research interest; and 2) primarily research interest within the program, but potentially making existing courses available as electives.

4.1 Faculty with potential teaching and research involvement in EDS

Faculty with potential teaching involvement are listed below in alphabetical order, with letters of support from these faculty provided in Appendix A. CVs for these faculty and the faculty submitting this proposal are provided in Appendix E.

Prof. Olivier Deschenes, Department of Economics: B.S. in Economics from University of Montreal (1995), Ph.D. Economics from Princeton University (2001). Olivier Deschenes is Professor of Economics at the University of California Santa Barbara, where he is also affiliated with the Bren School of Environmental Management. He is a also Research Associate at the National Bureau of Economic Research (NBER), and a Research Fellow at IZA in Bonn, Germany. Deschenes' recent research seeks to determine the potential economic impacts of climate change on human health and agricultural productivity in the U.S. and around the world using historical data. His ongoing research examines the effect of energy prices on labor markets in the context of climate policies, the relationship between extreme temperature and health in India, and the effect of temperature and ambient pollution fluctuations on worker health and productivity.

Prof. James Frew, Bren School: B.A. (1977), M.A. (1980), Ph.D. (1990) in Geography from UCSB. James Frew is an Associate Professor of Environmental Informatics in the Bren School of Environmental Science & Management at UCSB. Frew's recent research focused on automatic capture of computational provenance, the design of digital archives, and crowdsourced geographic information. His ongoing research addresses the automatic generation of data citations, and the applicability of array database technology to environmental data management.

Prof. Christina (Naomi) Tague, Bren School: BEng (1989) in Systems Design Engineering, University of Waterloo (Canada), M.S. (1994) and Ph.D. (1999) in Geography, University of Toronto (Canada). Dr Tague specializes in the design and application of environmental information systems used to understand how climate and land use change alter water resources and ecosystem health and biogeochemical cycling.

Economics for Development, University of Oxford, Ph.D. (2018) in Agricultural & Resource Economics, University of California at Berkeley. Dr. Carleton uses observational data, economic theory, and econometrics to quantify how large-scale environmental change and processes of economic development influence one another, with a focus on climate change and the depletion of freshwater resources.


**Prof. Samantha Stevenson, Bren School:** B.A. (2000) in Mathematics, Western Connecticut State University, M.A. (2003) in Astronomy, Wesleyan University, Ph.D. (2011) in Atmospheric & Oceanic Sciences, University of Colorado at Boulder. Dr. Stevenson specializes in the use of global climate models, in concert with observational and paleoclimate datasets, to understand the dynamical response of the tropical Pacific to climate change and the implications for climate impacts on natural resources.

**Prof. Marko Peljhan:** Diploma terminal Master’s (2001) University of Ljubljana, Slovenia, Master of Architecture (2005) Ohio State University. Dr. Peljhan specializes in the art and visualization of environmental data at the intersection of art, science, technology and digital media. His work has been exhibited internationally at many biennials, festivals and museums.

**Dr. Allison Horst:** (BS Chemical Engineering (2005), MS Mechanical Engineering (2007), and PhD Environmental Science and Management (2012) at UCSB. Allison maintains the current informatics component of the Bren curriculum. She manages the Bren Math Bootcamp to incoming first-year master’s students (2007 - present) and teaches both ESM 206AB (Statistics and Data Analysis in Environmental Science & Management) and ESM 244 (Advanced Data Analysis).

### 4.2 Faculty with potential research involvement

(In alphabetical order, including those listed in section 4.1)

- Prof. Peter Alagona, History, Environmental Studies
- Prof. Deron Burkepile, Ecology, Evolution and Marine Biology
- Prof. David Carr-Lopez, Geography
- Prof. Kelly Caylor, Director of ERI and Bren School
- Prof. Keith Clarke, Geography
- Prof. Vena Chu, Geography
- Prof. Christopher Costello, Bren School
- Prof. Carla D’Antonio, Environmental Studies and EEMB
- Prof. Frank Davis, Bren School

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Prof. Timothy DeVries, Geography
Prof. Amr El Abbadi, Department of Computer Science
Prof. Steve Gaines, Bren School
Prof. Alex Franks, Statistics and Applied Probability
Prof. Kostas Goulas, Geography
Prof. Ben Halpern, Director of NCEAS and Bren School
Prof. Harie Han, Political Science
Prof. Robert Heilmeyer, Environmental Studies and Bren School
Prof. Keith Hiltner, English
Prof. Patricia Holden, Bren School
Prof. Tobias Höllerer, Department of Computer Science
Prof. John Hsu, Statistics and Applied Probability
Prof. Krzysztof Janowicz, Department of Geography
Prof. Charles Jones, Geography
Prof. Bruce Kendall, Bren School
Prof. Chandra Krintz, Computer Science
Prof. Werner Kuhn, Department of Geography
Prof. George Legrady, Art and MAT
Prof. Alan Liu, English
Prof. Doug McCauley, Ecology, Evolution and Marine Biology
Prof. Wendy Meiring, Statistics and Applied Probability
Prof. Kyle Meng, Bren School
Prof. Matto Mildenberger, Political Science
Prof. Holly Moeller, Ecology, Evolution and Marine Biology
Prof. Alan Murray, Department of Geography
Prof. Sang-Yun Oh, Statistics and Applied Probability
Prof. Ronald E. Rice, Communication
Prof. David Pellow, Environmental Studies
Prof. Andrew Plantinga, Bren School
Prof. Simone Pulver, Environmental Studies
Prof. Ron Rice, Communication
Prof. Dar Roberts, Department of Geography
Prof. Dave Siegel, Department of Geography
Prof. Ambuj Singh, Computer Science
Prof. Eric Smith, Political Science
Prof. Adrian Stier, Ecology, Evolution and Marine Biology
Prof. Leah Stokes, Political Science
Prof. Stuart Sweeney, Geography (and Director of ISBER)
Prof. Yon Visell, MAT
Prof. William Wang, Computer Science
Prof. Yuedong Wang, Statistics and Applied Probability
Prof. Rich Wolski, Computer Science
Prof. Xifeng Yan, Department of Computer Science
Prof. Hillary Young, Ecology, Evolution and Marine Biology
In addition, there are a wide range of research scientists within Institutes and Centers on campus, in particular ERI and MSI, that engage in environmental data science and would be likely collaborators on research initiatives.

### 4.3 Adjunct/Visiting Faculty and Lecturers

The Bren MESM program has historically used professionals to teach technical classes, in some cases to help fill teaching loads of faculty on sabbatical leave but often to teach classes that cover basic but critical skills, such as Introductory Statistics or Public Speaking. We anticipate that several classes within the MEDS program will likely initially be covered by lecturers.

The initial quarter of the MEDS program, in the summer, will be formatted as many short (1-3 week), intensive classes. This format works well from an instructional perspective for rapid and efficient learning of basic skills, and will also provide an opportunity (and mechanism) for bringing global leaders in the field of environmental data science to UCSB to help teach part or all of one of these summer classes. As the program ramps up, visiting faculty or lecturers from peer institutions will likely contribute to other courses, in particular through the Distinguished Visitor Series (see Section 1.4.b: MEDS contributions to data science initiative across campus).

### Section 5. Courses

#### 5.1 Course Descriptions

The MEDS core curriculum compares to the curriculum for most other professional master’s degrees in data science but with the important difference that all classes are taught with environmental data and through the lens of environmental problem solving.

##### 5.1a Core Curriculum: required courses

Core classes will be offered primarily to students enrolled in the MEDS program to allow for teaching and content to be tailored to student needs and expectations. These courses will require a new and separate course code: we propose EDS. A few sample course syllabi are provided in Appendix F.

**EDS 211: Team Science, Collaborative Analysis and Project Management**

2 units, offered in Summer

Science in general, and data science in particular, are more and more requiring team science approaches to addressing the most pressing questions. Managing team science projects is therefore becoming an increasingly important skill for any scientist. This course will explore the principles and practical tools available for effective and efficient project management.

*Potential instructors: New hire*
EDS 212: Essential Math for Environmental Data Science  
2 units, offered in Summer  
Review of quantitative methods that are commonly used in environmental science. The course will cover single and multi-variable functions and graphing, basic linear algebra, complex numbers, integral calculus and simple differential equations.  
Potential instructors: Allison Horst

EDS 213: Metadata Standards, Data Modeling and Data Semantics  
2 units, offered in Summer  
Metadata is the information that provides the context for environmental data, rendering it usable by programs and intelligible to humans. The course introduces students to the ontologies that define, and the tools needed to compose, standard environmental metadata. Examples drawn from evaluating fitness-for-use, synthesizing composite datasets, and reusing historical datasets will motivate the need for correct and complete metadata.  
Potential instructors: Samantha Stephenson

EDS 214: Analytical Workflows and Scientific Reproducibility  
2 units, offered in Summer  
The generation and analysis of environmental data is often a complex, multi-step process that may involves the collaboration of many people. Increasingly tools that document help to organize and document workflows are being used to ensure reproducibility and transparency of the results. This course will introduce students to conceptual organization of workflows as a way to conduct reproducible analyses, as well as various software tools that help users to manage multi-step processes that requires tools for storing, managing and sharing workflows, code, documents and data, including GitHub, Pegasus, remake and Kepler.  
Potential instructors: New Hire

EDS 215: Introduction to Data Storage and Management  
2 units, offered in Summer  
This course covers the concepts and techniques for accessing, cleaning, managing, and storing various kinds of data in the environmental sciences, including relational, text, image/video, spatial, and temporal data. The topics include data models, SQL, database integrity, constraints, and indexing methods for fast retrieval of data.  
Potential instructors: James Frew

EDS 216: Meta-analysis and Systematic Reviews  
2 units, offered in Summer  
Synthesis tools in environmental science are rapidly evolving and becoming standard, formalized tools for review and assessment. Synthesis can include data aggregation, narrative reviews, systematic reviews, and meta-analysis. Meta-analyses in particular are often viewed as the gold-standard methodology to quantitatively estimate the state-of-the-art of a research domain. The analytics and assumptions have changed significantly within the last 5 years. Key topics covered in this course include effect sizes, scope of inference, and statistical analyses using weighted measures:  
Potential instructors: Scott Jasechko
EDS 220: Remote Sensing and Environmental Data
4 units, offered in Fall Quarter
This course introduces students to the broad range of data sets that are used to monitor and understand biophysical and socio-economic systems used in environmental science and management. The course will cover both field-based data and remote sensing, including airborne sensor and satellite data and new emerging sensor and sampling technologies (e.g., use of cell phones, the “Internet of Things”). Skill will include designing and evaluating data collection, and working with existing databases of time-series and spatial data including new repositories of environmentally relevant datasets (e.g., NOAA Big Data Project). Remote sensing data is increasingly a critical source of information about the environment. Students will learn the basic workflow involved in selecting, obtaining and utilizing remote-sensing data and will be introduced to emerging products (LiDAR, Unmanned Autonomous Vehicles (UAVs), new satellite data products, new sensors)
Potential instructors: Samantha Stephenson

EDS 221: Scientific Programming Essentials
4 units, offered Fall quarter
This course teaches key scientific programming skills and demonstrates the application of these techniques to environmental data analysis and problem solving. Topics include structured programming and algorithm development, flow control, simple and advanced data input-output and representation, functions and objects, documentation, testing and debugging. The course will be taught using a combination of the R and Python programming languages.
Potential instructors: New Hire

EDS 222: Statistics for Environmental Data Science
4 units, offered Fall quarter. Pre-requisites EDS 212. Concurrent EDS 220, 221.
This course teaches a variety of statistical techniques commonly used to address and analyze environmental data sets and questions and will provide an introduction to foundational concepts of spatial and space-time dependency and associated impacts on inference, with simple models illustrating the impact of space-time dependence when analyzing data from environmental processes. Techniques include: applied regression methods for environmental data, time series methods, spatial distance weighting methods, spatial covariances, spatial prediction using kriging, and multivariate statistics.
Potential instructors: Tamma Carleton

EDS 223: Spatial Analysis for Environmental Data Science
4 units, offered in Fall quarter. Pre-requisites: EDS 213, EDS 214, EDS 215.
This course introduces the spatial modeling and analytic techniques of geographic information science to data science students. The emphasis is on deep understanding of spatial data models and the analytic operations they enable. In addition to this theoretical background, students will acquire facility with libraries, packages, and APIs that support spatial analysis in Python and R.
Potential instructors: James Frew
EDS 230: Modeling Environmental Systems
4 units, offered Winter quarter
Computer-based modeling and simulation are widely used tools in both practical environmental problem solving and in environmental research. Models are core tools for integrating data, analysis from field-based research and theory. A well designed model contributes to understanding how the world works and how decisions that society make alter the environment and the services it provides. There are many different types of models, from simple to complex, and models are often tailored to answer specific questions. The course will cover the design of new model and selection, parameterization and evaluation of existing models. We will emphasize best practices that help to design and implement models that are useful, reliable and get the job done.
Potential instructors: Naomi Tague, New hire

EDS 231: Text and Sentiment Analysis for Environmental Problems
4 units, offered in Winter quarter
This course will cover foundations and applications of natural language processing. Problem sets and class projects will leverage common and emerging text-based data sources relevant to environmental problems, including but not limited to social media feeds (e.g., twitter) and text documents (e.g., agency reports), and will build capacity and experience in common tools, including text processing and classification, semantics, and natural language parsing.
Potential instructors: Lecturer, New hire

EDS 232: Machine Learning in Environmental Science
4 units, offered Winter quarter, Prerequisites: EDS 221, EDS 222
Machine learning can help process big/complex data and extract knowledge. It forms one of the foundations in data science. This course provides a broad introduction to machine learning and statistical pattern recognition. Topics include supervised learning (decision tree, random forest, support vector machines, neural networks) and unsupervised learning (clustering, dimensionality reduction, deep learning). Problems and exercises are framed within environmental science applications. The course will use programming languages like R and Python to support learning how to do advanced scientific programming to solve real environmental problems.
Potential instructors: New hire

EDS 411A: Group Project
4 units, offered Winter quarter
First quarter of a two-quarter group study/analysis of how to apply data science and tools to an environmental problem. In this quarter students are expected to work with their project client to finalize project plans, assign individual roles and responsibilities, develop a project plan and deliverables, and make significant headway on implementing those plans.
Potential instructors: LSOE hire, plus MEDS faculty
EDS 240: Data Visualization and Communication
4 units, offered Spring
Effective display and analysis of scientific information is a critical skill. This course will include a discussion of the theory of good visual design and interactive analysis and also present software tools and techniques supporting visual analysis. Students will learn how to ask an interesting data question through MySQL, learn processing software to visualize it in 2D, do a 3D interactive visualization, then follow with a project of a data of their choice. Additional topics will include dynamic and interactive visualization and web-based visualization frameworks. 
Potential instructors: Marko Peljhan, George LeGrady or New hire

EDS 241: Environmental Policy Evaluation
4 units, offered in Fall quarter
This course will present state of the art program evaluation techniques necessary to evaluate the impact of environmental policies. The program evaluation methods presented will aim at identifying and measuring the causal effect of policies, regulations, and interventions on environmental outcomes of interest. Students will learn the research designs and methods for estimating causal effects with experimental and non-experimental data. This will prepare the students for interpreting and conducting high-quality empirical research, with applications in cross-sectional data and panel data settings.
Potential instructors: Olivier Deschenes

EDS 411B: Group Project
4 units, offered Spring quarter
Second quarter of a two-quarter group study/analysis of how to apply data science and tools to an environmental problem. In this quarter students are expected to complete all project plans and deliverables, write and submit a project report, give an oral defense of the project, present the research to a general audience, and produce a policy brief of the main results.
Potential instructors: LSOE hire, plus MEDS faculty

5.1b Potential Elective Courses
Elective courses can be cross-listed through other relevant departments to encourage enrollment from students and facilitate application to degree requirements in those departments. We list here four courses likely to be offered within the MEDS program. Additional elective classes taught by MEDS faculty will be developed in consultation with faculty hired into the program and in response to student demand as the program matures.

EDS XXX: Bayesian Hierarchical Models for Environmental Processes
4 units, offered spring quarter
Core statistics courses will focus on the frequentist paradigm (hypothesis testing, etc.). Bayesian methods are being used substantially in many environmental fields. This course will cover the basic theory and tools of Bayesian statistics and use a variety of environmental science case studies to explore their application in real-world situations.
Potential instructors: Alan Murray
**EDS XXX: Advanced Scientific Programming**  
2 units, offered spring quarter  
This course covers advanced programming skills within an environmental data analysis and problem solving context and will focus in particular on advanced topics in data entry, data integration, and modeling with data assimilation. Topics include object-oriented design and programming, efficient data structures, programming environmental data acquisition devices (sensors and instruments), program decomposition with map and reduce, and continuous integration. The course will be taught using a range of languages and platforms to provide students full exposure to existing and emerging technologies.  
*Potential instructors: Krzysztof Janowicz*

**EDS XXX: Data Integration and Infrastructures**  
4 units, offered spring quarter  
Data-intensive science and its impact on society are most often discussed from an analysis perspective, i.e., how to transform data into insights. Equally important are questions of how to publish data effectively and break up data silos, how to retrieve relevant data, how to enable the exploration of distributed and unfamiliar datasets from different domains, how to access provenance records, how to determine whether data sets can be meaningfully reused and integrated, how to combine data on-the-fly with processing services and workflows, and finally how to make data readable and understandable by humans and machines alike. This class will introduce students to Web-scale knowledge representation, building blocks of modern cyberinfrastructures, and to international standards used to publish, retrieve, and integrate data.  
*Potential instructors: Krzysztof Janowicz*

### 5.2 Initial Teaching Plan

The teaching requirements for the professional degree program will initially be covered by existing campus faculty, requested new hires and, if new hires are not allocated the first year of the program, part time lecturers. Teaching engagement for existing faculty would be implemented through cross-listing current Bren courses, assigning MEDS courses to new Bren hires, and, if necessary, compensating the home department of faculty for teaching a class (i.e., paying for a replacement lecturer).

Given existing faculty interests, a first teaching year plan is summarized in Table 6. This plan assumes one immediate new faculty hire and an LSOE position within the MEDS program (see Section 6.1 Faculty FTE for full details), or a part-time lecturer if one of the positions is not allocated in the first year, as well as part-time lecturers for 1-2 additional courses.
Table 6. Proposed initial teaching plan.

<table>
<thead>
<tr>
<th>Summer Quarter</th>
<th>Fall Quarter</th>
<th>Winter Quarter</th>
<th>Spring Quarter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructor: New Hire 2 (LSOE lecturer)</td>
<td>Instructor: Samantha Stevenson (Bren)</td>
<td>Instructor: Naomi Tague (Bren)</td>
<td>Instructor: Marko Peljhan (MAT) or Lecturer</td>
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<tr>
<td>EDS 212: Essential Math for Environmental Data Science</td>
<td>EDS 221: Scientific Programming Essentials</td>
<td>EDS 231: Text and Sentiment Analysis for Environmental Problems</td>
<td>EDS 241: Environmental Policy Evaluation</td>
</tr>
<tr>
<td>Instructor: Allison Horst (currently Bren lecturer)</td>
<td>Instructor: New Hire 1 (Bren FTE 2018 request)</td>
<td>Instructor: Lecturer</td>
<td>Instructor: Olivier Deschenes (ECON)</td>
</tr>
<tr>
<td>EDS 213: Metadata Standards, Data Modeling, and Data Semantics</td>
<td>EDS 222: Statistics for Environmental Data Science</td>
<td>EDS 232: Machine Learning in Environmental Science</td>
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<td>Instructor: Samantha Stevenson (Bren)</td>
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<td>Instructors: New Hire 2 (LSOE lecturer), plus MEDS faculty</td>
</tr>
<tr>
<td>Instructor: New Hire 2 (LSOE lecturer)</td>
<td>Instructor: James Frew (Bren)</td>
<td>Instructors: New Hire 2 (LSOE lecturer), plus MEDS faculty</td>
<td>(existing courses in PSTAT, Bren, CS, EEMB, Geography, etc.)</td>
</tr>
<tr>
<td>EDS 215: Introduction to Data Storage and Management</td>
<td>POSSIBLE ELECTIVE (existing courses in PSTAT, Bren, CS, EEMB, Geography, etc.)</td>
<td>POSSIBLE ELECTIVE (existing courses in PSTAT, Bren, CS, EEMB, Geography, etc.)</td>
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<td>Instructor: Scott Jasechko</td>
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Section 6. Resource Requirements

A detailed operational budget forecast over the first 10 years following program approval is provided in Appendix B and includes a proposed $20,000 supplemental fee to support staff resources and other costs. Any potential fiscal impacts will fall primarily on the Bren School and to a lesser degree on NCEAS. The following summarizes the key resource requirements and rationale for the new professional degree program.
6.1 Faculty FTE

The prominence of the Bren School of Environmental Science and Management and the National Center for Ecological Analysis and Synthesis, the global strengths in cross-disciplinary environmental informatics in many affiliated departments on campus, the global reputation of UCSB in environmental science and sustainability, and the campus-wide Data Science Research Initiative that is under development make UCSB an attractive recruiter for excellent faculty in the areas of this proposal. The rapid emergence of data science programs and employment opportunities, and the existing strengths of UCSB in environmental data science, make this a critical time for further development of a graduate program in this area, and a modest number of permanent FTE lines allocated in support of this development. The proposal here requests just two new FTE positions to support the launch and growth of this new graduate professional degree program.

One of the two positions is expected to be an LSOE to teach several of the summer quarter classes as well as the two course-based group project classes (see Section 5.2 Initial Teaching Plan for details) and provide general program administration for the client-driven group projects. The current Eco-Entrepeneur focus at Bren uses a similar teaching and administration load for the person running it (Emily Cotter). A professional degree program benefits from having an instructor solely focused on teaching, but lack of security in employment makes it difficult to retain top lecturers and is disruptive to program continuity and learning. We seek to address this need from the outset by allocating one FTE position to an LSOE.

The ladder-faculty FTE request is to fill the remaining key curriculum gap in machine learning for environmental science (EDS 232) along with one or two additional informatics courses. Machine learning is rapidly becoming an essential research tool for discovery of patterns in high-volume environmental data (such as landcover satellite data) that are in turn key to understand environmental processes and impacts. We recognize that machine learning expertise and courses exist in other departments at UCSB, but the need for curriculum focused on environmental problems and an instructional approach geared towards professional students motivates the need for this position within the MEDS program.

MEDS faculty would be expected to teach three 4-unit courses (at least one core class, and the remaining as electives) and teach one PhD seminar. For MEDS faculty that also teach in the MESM program, one of the 4-unit classes could be mentoring a MESM group project. It is essential for the success of this program that individual faculty have time for an active research program and participation in PhD courses, necessitating avoiding overload teaching. Therefore, we request early availability of new permanent FTE lines.

There has been interest expressed by existing faculty from other departments (see letters of support in Appendix A) to be involved with the MEDS program through potential research collaborations or teaching elective courses. These opportunities will likely expand, as other departments are actively searching for or have placed high priority on hiring data science faculty. We will work closely with these efforts to coordinate MEDS hiring plans with their hires,
and we will actively support and engage in a campus-wide Data Science FTE planning process, similar to that which has been ongoing for marine science across campus.

In summary, we request a total of just two full FTE positions allocated to the MEDS program, both to start in year 2 of the program (first year of instruction), and thus recruited in year 1. Initially we likely will need to bring in a few outside lecturers as instructors for some courses, in particular for the requested ladder faculty position who will have teaching relief in her/his first year (second year of the program).

6.2 Staff FTE

Program staffing will leverage existing resources at Bren and NCEAS to minimize the need for additional resources, and all itemized staff costs will be covered by revenue from the supplemental fee (i.e., no cost to campus) except the single position committed via the Chancellor’s staff initiative (see reference to the memo from EVC David Marshall to Dean Gaines in his letter in Appendix A). Professional schools require significantly higher staff resources than typical academic departments, as staff are needed for marketing and recruitment, career development, and student support, along with more typical departmental needs. Staffing needs described below are in line with other professional programs at other UC campuses and other universities.

To ensure the most efficient use of additional staffing, current Bren staff were consulted extensively for advice on staffing requirements for the MEDS professional degree program (which has many similarities to the current MESM program), and with NCEAS staff on staffing needs to support the program activities that will occur at the Center. The staffing proposal leverages existing people and positions wherever possible, both to reduce the number of additional staff to hire and to simplify management and support of the MESM and MEDS programs. These staff positions are essential for the program to function and ultimately flourish; reduced staffing will force the program to limp along at best and falter at worst.

Bren staff, currently working to support 24 PhD and up to 200 MESM students, will provide substantial experience and resources to be leveraged by the MEDS program, including senior positions deeply familiar with how to run a professional degree program (Assistant Dean, Admissions Director, Business Officer, Director of Career Development and Alumni Affairs, and Director of Information Technology), a development team well versed in environmental science and well connected, with the donor community, an events manager able to support and promote both programs, computer staff familiar with the needs and challenges of supporting a course-based intensive master’s program, and a team of career development staff with experience on placing graduates in competitive jobs. We will use funds from the supplemental fee to hire a cohort of staff, filling similar responsibilities, for the MEDS program (see detailed description below). We will leverage institutional knowledge in the Bren staff to support the design and initial implementation of the MEDS staffing infrastructure.
NCEAS staffing provides a different set of expertise and experience, in particular with respect to the challenges and necessary computing infrastructure and support for data management and analysis in environmental science (Director of Informatics, Director of Computing) and the structure and implementation of short courses in environmental data science (via the Director of Informatics). All of these resources and experience come at no cost to the MEDS program, yet are vitally important.

The Bren School currently supports 3-4 tutors, available to MESM students at no cost, for topics including writing, math and statistics. In the first year of the program, students will access existing MESM tutors given the small size of the initial cohort. Two additional tutors will be added to focus on the MEDS program, beginning in Year 3 when enrollment begins to increase.

For the MEDS program to be successful, we anticipate needing 9 new staff FTE positions and 3 upward reclassifications of existing staff. The schedule for these hires is presented in Table 8. The specific positions to be hired (also defined in the budget in Appendix B) are listed and a brief rationale provided here.

Year 1 hires (year prior to first cohort matriculating):

**Financial Manager (Financial Analyst 2; new hire).** Managing the financial aspects of a program serving dozens of (ultimately up to ~90) new master’s students each year requires personnel dedicated to that program. The Financial Analyst is needed to process administrative paperwork for both the MEDS faculty and students, including payroll for faculty, staff, academic student employees and student assistants, requests for purchasing, advances and reimbursements for travel expenses, and visas.

**Student Affairs Coordinator (Student Services Advisor 2; new hire).** The Coordinator assists the Student Affairs Manager with admissions, recruitment and student advising. Initially this position will report to the MESM Student Affairs Manager (Faloon); once cohort size grows and a MEDS Student Affairs Manager is hired (in Year 4, see below), this position would report to that person. The Student Affairs Coordinator participates in the admissions process, coordinates visits for prospective and admitted students, tracks the academic progress of current students, assists students with planning and reporting academic milestones, and meets individually with students to provide academic advising. The Coordinator builds and maintains databases and records of prospective students and current students, updates operating systems and implements new software to improve communication and work flow, analyzes student progress, compiles reports, and presents information, as requested. The Coordinator also produces digital and print materials for outreach, uses social media platforms to connect with students and promote the Bren School, and plans and hosts events and activities for current and prospective students.

**NCEAS MEDS Coordinator (Academic Coordinator 2; new hire).** This position would be based at NCEAS and provide key program administration and liaison between the wide range of projects and activities ongoing at NCEAS, that could serve as clients for group projects and provide training experience and activities, and MEDS students and faculty. This position would also help build, manage and oversee client connections for MEDS group projects with
corporate, foundation and other partners. Client-driven projects provide invaluable experience and networking for students but require substantial cultivation and management. This position would begin midway through Year 1.

**Academic Programs Coordinator (Student Services Advisor 3; new hire).** Managing day-to-day operations of the program and addressing student needs is critical for a well-functioning professional degree program. This position serves as the main liaison between students and the faculty and staff. The current analogous position for the MESM and PhD programs requires (usually greater than) full time to do effectively; a separate position is needed for the MEDS program. This Academic Programs Manager implements the curriculum plan by making the quarterly class schedules, confirming teaching workload with instructors, scheduling rooms, supporting instructors’ classroom needs for audiovisual equipment, preparing and delivering academic workshops to prepare students for research projects, academic defenses and public presentations. In the first few years, this staff member also would need to take on the advising responsibilities of our Student Affairs Coordinator, including participating in the admissions process, recruiting admitted students, hosting prospective students, tracking academic progress of current students, assisting students with necessary planning and reporting for academic milestones, meeting individually with students to provide academic advising.

**Business Officer (MSO) (Admin Sup 2; upward reclass).** Managing the budgetary and financial aspects (and associated staff) of two separate professional degree programs represents a significant increase in responsibility. The current MSO would be reclassified upward to acknowledge these changes. The MSO hires and trains staff in finance and operations. With the new MEDS program, the MSO would supervise the new Financial Analyst, including additional payroll, purchasing, travel and entertainment advances and reimbursements, contract and grant management for up to 11 new faculty and 90 students.

Year 2 hires

**Academic Personnel Manager (Academic HR Analyst 3; new hire).** For the MESM and PhD programs these responsibilities are addressed part time, with the remaining time serving as the Dean’s assistant. As the Bren School faculty has grown to 24, it is clear that Academic Personnel should be a full-time position and the Dean’s Assistant and other administrative duties should be assigned to a different staff member. As part of the MEDS program, the academic personnel cases and processing would be combined and handled by this new full time position (leaving the Dean’s Assistant as a full time position to support the Dean and other school administrative duties). The Academic Personnel Analyst is responsible for helping the faculty prepare their cases for merit and promotion, scheduling and supporting Personnel Committee meetings, preparing documents for upload to AP Folio or UC Recruit, guiding logistics for faculty hiring and recruitment and retention and supporting, and consulting with faculty regarding Academic Personnel policies and procedures.

**Career Development Coordinator (Career Services Specialist 2; new hire).** A fundamentally important component of a successful professional degree program is to place graduates in desirable and top-choice jobs. These services are currently provided to MESM graduates by two career development staff; they are highly successful but work at and occasionally beyond capacity. The Bren School career program offers career development workshops, including how
to write resumes and cover letters, job search techniques, interviewing skills, and salary negotiation. The staff also gather, screen and distribute job announcements to our students and provide personalized service to students who are preparing to submit applications or interview for a position. Career development support is one overwhelming reason cited by current students about why they chose the Bren School over other schools. Leveraging this outstanding team while adding this additional position to focus exclusively on MEDS graduates provides an efficient way to serve this pivotal function.

**Help Desk Manager (Business Tech Support Analyst 2) (new hire).** This position would oversee all computer hardware and software management for program needs at Bren and NCEAS equipment and student equipment. The MEDS program is focused on teaching robust methods and sophisticated tools to analyze large data sets to solve complex problems. Computing infrastructure and support are essential to the success of this program. One Business Technology Support Analyst 2 position will focus on providing the critical computing support to faculty and students in the new MEDS program.

**Assistant Dean of Career Development & Alumni Relations (Career Services Specialist 4; upward reclass).** Given the larger career development staff serving both the MESM and MEDS programs, the existing Director of Career Development would be reclassified to Assistant Dean and tasked with overseeing both programs and associated staff. The current role played by the Director of Career Development likely already justifies promotion to the Assistant Dean title. With this new parallel master’s program, this advancement is critical.

**Director of Information Technology (Systems Admin Support 2; upward reclass).** The heavy focus of the MEDS program on higher-end computation as well as the greater management needs coordinating people and students across two programs (MESM and MEDS) and two locations (Bren and NCEAS) support the need to reclassify this position.

**Training Coordinator (Academic Coordinator 1; new hire).** As part of MEDS contribution to broader data science initiatives at UCSB, the training coordinator will help conduct and coordinate regular ‘boot camp’ workshops (half day to multiple day) on a range of data science skills and tools. The position will work closely with other existing similar efforts on campus to augment and supplement training needs.

Year 4 hires

**Student Affairs Manager (Student Services Advisor 3; new hire).** Managing the large volume of inquiries, applications, and acceptance processes for a large, annual cohort of potential and incoming master’s students is a demanding and essential job for a professional degree program. This position becomes necessary when enrollment reaches 50 or more; thus it is slated for Year 4, given that enrollment will be smaller in the first few years and start growing past this threshold around Year 4. The Student Affairs Manager participates in the admissions process, hosts prospective students, recruits admitted students, tracks academic progress of current students, assists students with planning and reporting for academic milestones, and meets individually with students to provide academic advising.
Table 8. Total projected new Staff FTE needs, and yearly hires. Year 1 is the year prior to the inaugural class of students.

<table>
<thead>
<tr>
<th></th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total FTEs</td>
<td>4</td>
<td>8</td>
<td>8</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>New hires</td>
<td>4</td>
<td>4</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Upward reclass</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

6.3 Library acquisition

The library currently has all necessary holdings. Discussions with Kristin Andelman at the Library confirm this assessment.

6.4 Computing costs

Students will be expected to bring and use their own laptop/notebook computers, as learning to install and manage your own computing tools is an essential part of data science. Therefore, in general a computer lab (and associated resources) will not be necessary; if a particular lecture or class needs a computer lab, existing facilities at Bren (or Phelps) will be used.

Computing resources will be needed to support computationally-intensive and big data class assignments and group project analyses. In particular, computation servers (1 for Bren, 1 for NCEAS) and large storage servers/arrays (2 for Bren) will support up to 50 students. These servers have a lifespan of roughly 5 years and need to be replaced after that. NCEAS already houses its servers on campus, in North Hall, allowing for efficiency of maintenance. The budget (Appendix B) reflects these projected regular costs, as well as the need for additional servers once student enrollment increases to 80-90 students. Faculty research will likely require additional computational and storage server capacity; faculty grants will be expected to cover the cost of these additional servers.

Additionally, enhanced wireless capabilities will be needed for new space (4 additional wireless hubs on campus, 2 additional ones at NCEAS), and very modest support for virtual desktops for students that enable access to licensed software, etc. from their personal computers.

Initial funds will also be needed for personal computers for new faculty/staff hires and any existing faculty that begin joint appointments with the program. Subsequent such needs will be paid for by resources generated by the program, through ongoing and future development efforts for the program and through faculty recruitment packages.
6.5 Equipment

Equipment needs will be modest and limited primarily to administration (e.g. copy/fax/scanner system) and instruction (potential audio/visual equipment for the new classroom). These are requested as part of the initial seed funding for the program. Recurring costs after the initial years will be met through fundraising for the program.

6.6 Space and Other Capital Facilities

Office and instructional space at UCSB is currently extremely limited, creating unique challenges. Indeed, a recent report by the Office of the Registrar found that total general assignment classrooms on campus were utilized 90% of the time in 2017 (80% is considered ‘bottlenecked’), with small discussion rooms utilized 98% and classrooms for 100+ students utilized 104%. This overall utilization rate is among the highest of over 200 institutions assessed nationwide, and has gone up significantly since then. Below we describe a temporary solution that addresses this challenge in a creative and constructive way.

Space requirements for MEDS are exclusively for offices and lecture halls; faculty in data science generally do not need lab space or equipment (beyond shared servers, described above in Section 6.4 Computing costs). Because faculty will be expected to develop and sustain active research programs that will engage post-docs and PhD students, space requirements address this broader need. New office requirements total 17, including 2 for new faculty, 2 for researchers affiliated with the new ladder faculty (post-docs and PhD students), 4 common offices for master’s students, and 9 for staff (4 immediately, an additional 4 within the year following program launch, and 1 additional office three years following that). Faculty and staff offices will primarily be on campus but a couple of staff will be at NCEAS (see below for details). Nearly all classes will be required and thus taught for all enrolled students, and so a single 100-student lecture hall will cover teaching needs for lecture based classes (20-50 students in the first few years of the program). For classes that rely heavily on hands-on instruction (e.g., live coding), classes will need to be smaller and so will require smaller ‘lab’ sections (supported by a course Teaching Assistant). These labs will use smaller 25-35 person conference rooms in Bren Hall and NCEAS. These smaller instructional rooms will also be used for elective courses offered through the MEDS program. Elective classes, which are already offered in other departments, will occur in their current departmental teaching facilities.

The two new faculty and their graduate students and post-docs will be housed in the Bren building to ensure MEDS faculty and their labs are located in close proximity. Most MEDS staff will be placed in close proximity to existing Bren staff; three staff will be at NCEAS to support instructional and programmatic needs at the Center but will also spend time on campus. In the longer term, pending new building construction, we anticipate moving all MEDS faculty, students, staff and instruction into consolidated space on campus.

Specifically, the MEDS program will require the following additional space:
**Faculty offices:** A total of 2 new faculty offices will be needed, in support of new hires (existing faculty already have an office in their home departments). The new ladder faculty will also need offices for her/his research lab (e.g., PhD students, post-docs, interns).

**Staff offices:** MEDS staff will primarily reside on campus and thus require office space in the space allocated to the MEDS program. These offices will be for the Academic Programs Coordinator, Academic Personnel Analyst, Student Affairs Manager, Career Development Program Manager, and the Financial Analyst. Additional offices at NCEAS will be needed for positions based there.

**Student offices:** Students require some general office space in which they can meet for their group project activities or to conduct individual research. Based on experience with Bren MESM students, we expect a total of 4 offices is sufficient to meet these needs. These offices will be designed as open, flexible space to accommodate different configurations and, if necessary, more than one group meeting at once.

**Lecture space:** For classes taught at NCEAS, we will use the basement lecture hall (capacity 120) and, as needed, the larger conference room (capacity 25). Growth into additional space in the Balboa Building would allow for a second large conference room. Use of these facilities would incur rent recharge costs. For classes taught on campus, we will run classes in conference rooms in Bren Hall, in the Marine Sciences Research Building (MSRB) lecture hall (capacity 120), which is currently under-utilized, in available lecture hall space on campus (if/where available), and eventually in a new building being discussed that will include substantial new instructional space.

**A temporary solution to the shortage of space on campus**

Given the extreme shortage of space on campus, we sought a temporary solution that would allow MEDS to thrive while awaiting approval and construction of new buildings. The proposal to temporarily use NCEAS space for some of the instruction and a couple of staff offices meets these needs.

Although unusual, off-campus instruction has precedent, for example through use of the Isla Vista Theater for instruction. Using NCEAS space would require modest expenses to cover rent for additional offices and instructional space, but allows for dynamic growth (and reduction) of space needs as the program grows and on-campus space becomes available. MEDS staff and faculty and Dean Gaines will work closely with UCSB administration to ensure all off-campus educational policies are fully addressed.

Clearly the ‘dual campus’ structure adds logistical challenges for both students and faculty. Below provides a narrative view of a typical experience in the MEDS program to help illustrate what this dual-campus situation would be like, and to help understand where both challenges and opportunities lie in the arrangement. Notably, because NCEAS is connected to campus by an express bus line (24x route) that provides non-stop service between IV, campus and the main bus terminal two blocks from NCEAS (buses run every half hour – more frequently at rush
hour times – from 6:25am to 11:25pm) and is free to all students through their student fees, and because many graduate students and faculty live downtown, instruction at NCEAS will be relatively easy to coordinate in people’s schedules and for many will be easier than on-campus instruction.

**Typical experience for MEDS students and faculty**

The proposal for the new MEDS program includes some instruction at the downtown facilities based at NCEAS. Because this has not been done before, below we provide a narrative of the likely experience for MEDS students and faculty. For simplicity, it is written the present tense, although some details are necessarily speculative.

**Students**

Most of the courses in the MEDS curriculum are required and are offered only once annually. Therefore, aside from a few electives or their group projects, all MEDS students are taking the same courses at the same time. By virtue of this shared experience, MEDS students have a stronger-than-usual sense of belonging to a cohort. The resulting “we’re all in this together” ethos reinforces the culture of collaboration that is essential to multidisciplinary data science, and is a signature of the MEDS program, as it has become for the MESM degree also administered through the Bren School.

During the initial summer quarter, MEDS courses are being taught primarily at NCEAS; thus, NCEAS constitutes the students’ initial physical experience of the MEDS program. Many UCSB graduate students choose to live downtown (not just for the MEDS program), and these students have a short and easy (often walking) commute, while students living further afield carpool or take public transit. Because there is a direct express bus from IV to campus to downtown (the 24X line), and all bus lines terminate at the main bus terminal just 2 blocks from NCEAS, those taking public transport will be able to easily and quickly commute between home and NCEAS (door to door, campus to NCEAS is roughly 25 minutes). Indeed, the NCEAS location is easier to commute to via public transportation than any location in the greater Santa Barbara region except for IV. For international students unfamiliar with US public transportation systems, and who disproportionately live in university housing, the first week of commuting maybe be challenging; MEDS staff will work to support this transition time for these students.

The initial MEDS cohorts are small enough to fit in the larger meeting rooms at NCEAS, so the Balboa Building auditorium is not currently being used. As MEDS cohorts grow as the program matures, lectures would move to the 120 person lecture hall available to NCEAS within the Balboa Building. All MEDS students are required to own a MEDS-capable laptop computer (i.e., one whose hardware and operating system meet the minimum requirements for supporting a mostly open-source software bundle), so pretty much any room that a class can fit in is an acceptable classroom. Instruction in most MEDS courses is a dynamic mix of set-piece lectures and lab exercises, typically solo or pair programming. Some MEDS courses break their lab components into smaller groups that can make better use of the available space. Almost always, MEDS students are interacting with each other as much as with their instructors.
During the fall, winter, and spring quarters, MEDS instruction shifts to be more based at UCSB. There are several reasons for this: the required curriculum shifts to longer (4- versus 2-unit) courses with more significant lecture components; the students are taking elective courses in other UCSB departments in winter and spring quarters; and in winter and spring the students are working on their group projects, which involve interacting with clients (NGOs, corporations, government agencies, or academic research groups). However, current space constraints at UCSB mandate the teaching of at least some of the MEDS curriculum at NCEAS.

Therefore, a key experience of the MEDS cohort during the regular academic year is a weekly "migration" between UCSB and NCEAS. To simplify scheduling, this migration alternates days: Mondays and Wednesdays are spent at NCEAS, and Tuesdays and Thursdays are spent at UCSB. This is less complicated than it sounds, since the students need only be present at one venue on any given day. It also apportions the commuting burden more equitably between students who live closer to either venue. For those students who also TA, they will need to structure their TA responsibilities to land on Tuesdays, Thursdays and Fridays, or outside of class time on Mondays and Wednesdays. Similarly, all students would need to schedule meetings with faculty or access campus resources outside of instructions time at NCEAS.

The weekly migration pattern can also shift between quarters. As the academic year progresses, MEDS required courses give way to elective courses and group project work. In the current MEDS year, the students are spending the entire spring quarter at UCSB, except for those whose group projects have significant NCEAS involvement.

**Faculty**

Unlike MEDS students, MEDS faculty are based at UCSB. "Based" means that their offices and labs are on campus, but also that they have varying, sometimes substantial, non-MEDS responsibilities (committee meetings, teaching in other programs, special events, etc.) that require their presence at UCSB. Thus, faculty are far more likely than students to be commuting between the MEDS venues in a single day. Faculty often arrange their individual schedules to minimize traveling between locations (for example, by spending research time at NCEAS on days when they have to teach there), but this remains a burden.

Faculty live throughout Santa Barbara (and even Ventura) County; those who live in Santa Barbara or south have a shorter and easier commute to NCEAS, whereas the opposite is true for those living in Goleta or north. For faculty that drive to work, there is ample short-term parking (first 75 mins free) within a block of NCEAS that offers free (when teaching shorter classes) or inexpensive (for longer classes) parking. Faculty that choose to spend most of their day at NCEAS when teaching there have access to inexpensive monthly, month-by-month parking in nearby city lots.

The long-term goal is to consolidate the MEDS program at UCSB. In addition to minimizing faculty commuting, co-location enhances the interactions between MEDS and the rest of campus, both for students and for faculty. In particular, MEDS faculty are more accessible to the
students when they are co-located for all, not just part, of the week. However, in the short run, the MEDS "interleaved" week appears to be a good compromise between scheduling complexity and space constraints.

### 6.7 Other Operating Costs

Additional operating expenses will include standard office costs related to office supplies, telecommunications, printing, course materials, and travel and entertainment, as well as costs associated with marketing/advertising and staff development. These and other indirect costs are detailed in Appendix B. These costs will primarily be covered by IDC return (office supplies, printing) and already committed private funds and future development efforts to raise additional private funding.

Many MEDS classes will use hands-on, practical teaching formats that will require a TA to help support in- and beyond-class time student needs. We anticipate needing 8 TAs per year (for EDS 220, EDS 221, EDS 222, EDS 223, EDS 230, EDS 231, EDS 232, and EDS 240). TAs will be drawn from MESM students with sufficient skills and experience to serve as a TA (in past cohorts, roughly 45% of MESM students receive TAships, and do these TA positions on top of a full 16-18 unit course load) as well as interested graduate students from Geography, PSTAT, CS, Ecology Evolution & Marine Biology (EEMB) or other affiliated departments. MEDS students may also be able to provide a pool of potential TAs for other programs and departments, which are currently facing a shortage of qualified TAs. Although creation of a Masters degree program is not based on the potential provision of TAs, MEDS students may be able to supply up to several dozen TAs once the program is fully mature, based on expected numbers using current TA percentages for MESM students. MESM students currently TA for classes in Bren, Environmental Studies, EEMB, Geography and beyond; MEDS students will likely also be able to do this.

### 6.8 Supplemental Fee

The proposed supplemental fee of $20,000 was chosen to be sufficient (even after one-third is used for financial aid) to cover all program costs once student enrollment reaches about 75 students. Enrollment above this number of students will generate income that can be used to support additional financial aid and/or add new resources (e.g., additional staff) to the program. Given current tuition, fees, and health insurance (for 3 quarters) and summer costs (12 units of tuition and summer fees) at UCSB, total costs (supplemental fee inclusive) for the MEDS program would be $41,198.81 for residents and $56,300.81 for non-residents, with an additional $21,969 for living costs (costs taken from UCSB’s website\(^\text{22}\)). The breakdown of these costs is:

<table>
<thead>
<tr>
<th></th>
<th>Resident tuition+fees</th>
<th>Non-resident tuition+fees</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$13,569.30</td>
<td>$28,671.30</td>
</tr>
</tbody>
</table>

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\(^{22}\) [https://www.finaid.ucsb.edu/cost-of-attendance](https://www.finaid.ucsb.edu/cost-of-attendance)
Health Insurance: $ 3,357
Summer costs: $ 4,305.51
Supplemental fee: $20,000
Cost of living expenses: $21,969

The table below gives information on total tuition costs for analogous professional master’s programs at other UC campuses and select R1 universities around the country. It is not a comprehensive list. The proposed MEDS program at UCSB is included for comparison; note that the total tuition listed here for MEDS includes the supplemental fee and summer tuition, fees, and health insurance but not other living costs to allow more direct comparison to other programs where similar ‘full costs’ that include cost of living could not be obtained. The proposed cost for the MEDS program is similar to or less than most analogous programs.

Table 9. Total costs (inclusive of all fees but exclusive of health insurance costs and cost of living expenses) for data science programs within and outside the UC. The list is not comprehensive.

<table>
<thead>
<tr>
<th>Program</th>
<th>Total Student Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UC programs</strong></td>
<td></td>
</tr>
<tr>
<td>UCI: Master of Computer Science</td>
<td>$45,000 (self-supporting program)</td>
</tr>
<tr>
<td>UCSD: Master of Science in Business Analytics</td>
<td>$48,961 residents $55,946 non-residents (self-supporting program)</td>
</tr>
<tr>
<td>UCB: Master of Information and Data Science</td>
<td>$63,685 (self-supporting program)</td>
</tr>
<tr>
<td>UCSD: MAS – Data Science and Engineering</td>
<td>$39,100 (self-supporting program)</td>
</tr>
<tr>
<td>UCSB: MEDS (proposed)</td>
<td>Resident: $37,874 Non-resident: $52,976 (note: this includes the supplemental fee but excludes health insurance and cost of living expenses to be comparable to costs listed for other UCs)</td>
</tr>
<tr>
<td><strong>Other programs</strong></td>
<td></td>
</tr>
</tbody>
</table>
6.9 Additional one-time costs

The EDS program will host the first of an annual ‘Global Summit on Environmental Data Science’ in Fall 2020 to coincide with the launch of the new program. This event will bring global leaders to UCSB to present cutting edge research and will include several half-day training workshops on specialized topics for event participants and local researchers at UCSB. Most of the cost of this conference will be offset through registration fees, but we will use $20,000 to support 10 travel grants (airfare and hotel) for participants from underrepresented communities and $23,000 to support a staff person for 6 months to plan the initial conference. All subsequent years will be self-funded.

6.10 Summary of Projected Budgetary Needs

Under expected enrollment growth and maturity described above, the program will require 1 ladder faculty, 1 lecture FTE (LSOE), 9 staff FTE, and 3 upward reclassifications of existing staff. The program will also require 17 offices for faculty, staff and research staff (post-docs and PhD students), and MEDS students, with at least some of this space to be based downtown at NCEAS. All operational costs are detailed in Appendix B and briefly summarized below. In the first five years these costs will be covered by a combination of a supplemental fee of $20,000 and a donor-committed gift of $3million. At full enrollment (80-90 students per year), the supplemental fee would generate income above annual costs, making funds available for additional financial aid and/or other program resources. Dean Gaines (Bren School) and Director Halpern (NCEAS) are also committed to raise additional philanthropic funds to provide

<table>
<thead>
<tr>
<th>University/Program</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chapman University: Master of Computer and Data Sciences</td>
<td>$48,515</td>
</tr>
<tr>
<td>Claremont Graduate University: Master of Information Systems &amp; Technology</td>
<td>$70,175</td>
</tr>
<tr>
<td>USC: Master of Science in Computer Science – Data Science</td>
<td>$57,139</td>
</tr>
<tr>
<td>Indiana U Bloomington: Master of Data Science</td>
<td>$43,674</td>
</tr>
<tr>
<td>Johns Hopkins: Master of Information Systems</td>
<td>$69,500</td>
</tr>
<tr>
<td>Columbia University: Master of Data Science</td>
<td>$58,080</td>
</tr>
<tr>
<td>Rensselaer Poly Tech: Master of Information Technology</td>
<td>$55,440</td>
</tr>
<tr>
<td>U Rochester: Master of Data Science</td>
<td>$51,732</td>
</tr>
<tr>
<td>Carnegie Mellon: Master of Information Technology Strategy</td>
<td>$75,000</td>
</tr>
</tbody>
</table>
additional financial aid (with the ultimate aim to make the program free to as many students as possible).

Given the revenue from the supplemental fee and donor-committed funds, the program will not accrue any debt under the very conservative projections presented in this proposal. The budget summary below (next page) provides an overview of costs and revenue (a full, detailed budget is provided in Appendix B).

**Contingency back-up plan**

Under the conservative scenario of growth in enrollment, outlined in Section 3.3 Student Demand, MEDS would remain debt free the entire initial five years of the program and would end with roughly a $150K surplus (see budget details, Appendix B). Assuming no additional success at fundraising for the program – an outcome which is highly unlikely given fundraising success before the program has even begun – the program thereafter would need 73 students to break even. As a back-up plan, if this conservative growth trajectory is not achieved, the MEDS program would delay (or not hire) several of the staff positions that are needed when enrollment is higher - in other words, the MEDS program would scale the increase in staffing to the rate of growth of enrollment to ensure the program remains debt free at all times under actual growth trajectories. Thus, the program can adapt annual growth projections based on realized enrollment levels each year, and adjust staff hiring plans accordingly in response. Furthermore, Dean Gaines, Ben Halpern and UCSB Development will continue to actively fundraise for MEDS and remain very optimistic about future prospects.
## Summary of Operational Budget for MEDS

### PROJECTED REVENUE

<table>
<thead>
<tr>
<th></th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Donor-committed funds</td>
<td>$549,054</td>
<td>$832,839</td>
<td>$670,922</td>
<td>$506,435</td>
<td>$440,751</td>
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<tr>
<td>Supplemental fee</td>
<td>-$</td>
<td>$400,000</td>
<td>$618,000</td>
<td>$848,720</td>
<td>$1,202,000</td>
</tr>
<tr>
<td>Staff line from EVC</td>
<td>$-</td>
<td>$96,600</td>
<td>$99,498</td>
<td>$102,453</td>
<td>$105,557</td>
</tr>
<tr>
<td>IDC from Central</td>
<td>$20,000</td>
<td>$20,000</td>
<td>$20,000</td>
<td>$20,000</td>
<td>$20,000</td>
</tr>
</tbody>
</table>

### PROJECTED COSTS

#### Salaries and Benefits

<table>
<thead>
<tr>
<th>Position</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecturers</td>
<td>-$</td>
<td>$123,140</td>
<td>$124,471</td>
<td>-$</td>
<td>-$</td>
</tr>
<tr>
<td>EDS Training Coordinator</td>
<td>-$</td>
<td>$113,896</td>
<td>$116,856</td>
<td>$119,936</td>
<td>$117,818</td>
</tr>
<tr>
<td>TA</td>
<td>-$</td>
<td>$70,996</td>
<td>$70,996</td>
<td>$70,996</td>
<td>$70,996</td>
</tr>
<tr>
<td>Tutors</td>
<td>-$</td>
<td>$13,368</td>
<td>$13,368</td>
<td>$13,368</td>
<td>$13,368</td>
</tr>
<tr>
<td>MEDS Coordinator, NCEAS</td>
<td>$122,401</td>
<td>$126,740</td>
<td>$131,122</td>
<td>$135,703</td>
<td>$140,432</td>
</tr>
<tr>
<td>Academic Personnel Manager</td>
<td>-$</td>
<td>$60,427</td>
<td>$62,974</td>
<td>$65,671</td>
<td>$68,488</td>
</tr>
<tr>
<td>Student Affairs Manager</td>
<td>-$</td>
<td>$-</td>
<td>$-</td>
<td>$30,785</td>
<td>$37,988</td>
</tr>
<tr>
<td>Academic Program Manager</td>
<td>-$</td>
<td>$90,688</td>
<td>$94,144</td>
<td>$97,800</td>
<td>$101,604</td>
</tr>
<tr>
<td>Asst Dean, Career Dev (upward rec)</td>
<td>-$</td>
<td>$15,039</td>
<td>$15,316</td>
<td>$16,222</td>
<td>$16,853</td>
</tr>
<tr>
<td>Associate Director, Career Dev</td>
<td>-$</td>
<td>$95,682</td>
<td>$99,350</td>
<td>$103,209</td>
<td>$107,223</td>
</tr>
<tr>
<td>IT Director (upward reclass)</td>
<td>-$</td>
<td>$20,022</td>
<td>$20,784</td>
<td>$21,584</td>
<td>$22,417</td>
</tr>
<tr>
<td>CNT III</td>
<td>-$</td>
<td>$104,998</td>
<td>$107,956</td>
<td>$112,024</td>
<td>$116,241</td>
</tr>
<tr>
<td>MSO (upward reclass)</td>
<td>$13,027</td>
<td>$13,532</td>
<td>$14,048</td>
<td>$14,587</td>
<td>$15,149</td>
</tr>
<tr>
<td>Financial Analyst</td>
<td>$82,191</td>
<td>$85,412</td>
<td>$86,686</td>
<td>$92,131</td>
<td>$95,714</td>
</tr>
<tr>
<td>Events staff</td>
<td>$64,819</td>
<td>$-</td>
<td>$-</td>
<td>$-</td>
<td>$-</td>
</tr>
</tbody>
</table>

#### Direct Costs

<table>
<thead>
<tr>
<th>Item</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renovations</td>
<td>$50,000</td>
<td>$50,000</td>
<td>$-</td>
<td>$-</td>
<td>$-</td>
</tr>
<tr>
<td>Equipment</td>
<td>$307,000</td>
<td>$8,000</td>
<td>$-</td>
<td>$-</td>
<td>$-</td>
</tr>
<tr>
<td>Travel</td>
<td>$5,000</td>
<td>$55,319</td>
<td>$35,319</td>
<td>$35,319</td>
<td>$35,319</td>
</tr>
<tr>
<td>Events</td>
<td>$8,000</td>
<td>$8,000</td>
<td>$8,000</td>
<td>$8,000</td>
<td>$8,000</td>
</tr>
<tr>
<td>Supplies &amp; Materials</td>
<td>$15,000</td>
<td>$15,000</td>
<td>$15,000</td>
<td>$15,000</td>
<td>$15,000</td>
</tr>
<tr>
<td>Education &amp; Training</td>
<td>$5,000</td>
<td>$12,500</td>
<td>$20,000</td>
<td>$23,000</td>
<td>$29,000</td>
</tr>
<tr>
<td>Financial Aid (33% of fee revenue)</td>
<td>-$</td>
<td>$132,000</td>
<td>$203,940</td>
<td>$280,078</td>
<td>$366,660</td>
</tr>
<tr>
<td>Advertising &amp; Recruitment</td>
<td>$85,000</td>
<td>$85,000</td>
<td>$15,000</td>
<td>$15,000</td>
<td>$15,000</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>$30,967</td>
<td>$81,740</td>
<td>$97,506</td>
<td>$101,747</td>
<td>$101,747</td>
</tr>
</tbody>
</table>

### SUMMARY, COSTS & REVENUE

<table>
<thead>
<tr>
<th>Item</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>CARRY FORWARD FROM PREVIOUS YEAR</td>
<td>-$</td>
<td>$9,310</td>
<td>$9,118</td>
<td>$957</td>
<td>$957</td>
</tr>
<tr>
<td>ANNUAL PROGRAM COSTS</td>
<td>$569,054</td>
<td>$1,340,129</td>
<td>$1,406,611</td>
<td>$1,485,799</td>
<td>$1,636,128</td>
</tr>
<tr>
<td>REVENUE</td>
<td>$569,054</td>
<td>$1,349,439</td>
<td>$1,406,420</td>
<td>$1,477,638</td>
<td>$1,768,308</td>
</tr>
<tr>
<td>ANNUAL DEFICIT/SURPLUS</td>
<td>$-</td>
<td>$9,310</td>
<td>(191)</td>
<td>$8,161</td>
<td>$132,180</td>
</tr>
<tr>
<td>TOTAL PROJECT REVENUE/EXPENSES</td>
<td>$-</td>
<td>$9,310</td>
<td>$9,118</td>
<td>$957</td>
<td>$133,137</td>
</tr>
</tbody>
</table>

Reviewed and Approved by:

Steve Gaines  
Dean, Bren School  
Signature: [Signature]  
Date: 9/12/18

Chuck Haines  
Acting Asst Chancellor, Office of  
Budget and Planning  
Signature: [Signature]  
Date: 9/10/18
Section 7. Graduate Student Support

Several opportunities and mechanisms for Graduate Student support will be available for MEDS students, in particular through merit- and need-based scholarships and fellowships that would be supported through private donations or endowments, financial aid provided by the supplemental fee structure, and some Teaching Assistant (TAs) positions in MEDS (listed in the operational budget) and affiliated departments.

Fellowships will play a key role in supporting top students and will provide a mechanism for promoting diversity within MEDS. We have already secured a major gift that will, in part, support 10 fellowships per year for the first 4 cohorts (years two through five). We anticipate significant opportunity for additional donor-supported fellowships; in the MESM program at Bren, similar funding has supported the Latin America Fisheries Fellowship and Sustainable Water Markets Fellowship that support up to 8 students per year (funding from Sam Walton).

Per university guidelines, one-third of the supplemental fee must be reinvested in financial aid. Fellowships thus not only support the students directly receiving the award, but also indirectly support other students through this financial aid mechanism. Supplemental fees paid by students not needing financial aid would also support other students through this same mechanism. The program will also generate block grant funding that can be used to support students, and modest support can also be provided for some students serving as tutors for the program.

Finally, some students will be able to offset tuition and fees by serving as TAs in other departments. We acknowledge there is often competition for these opportunities with graduate students in those degree programs and that Masters students are not normally part of the 'TA pool' on campus. As noted in Section 1.4: Relationship to Campus Academic Plan and Existing Programs, students in the current MESM program TA in over 130 classes across 19 departments, and similar opportunities may exist for MEDS students.

Because the professional degree is course-based and intensive, traditional research assistantship support for graduate students that would come from grants from State and Federal research agencies are not expected to play a role in supporting MEDS students. Ladder faculty in MEDS will continue to pursue such grants in support of broader research initiatives that include support for graduate students, primarily within their own research labs.

7.1 Accessibility and Affordability

The MEDS program will have two substantial sources of financial aid that will greatly increase affordability and strongly support accessibility across diverse communities: donor-supported fellowships and direct financial aid provided by the supplemental fee.

A large portion of current donor-committed funds will be used to support 10 fellowships per year over the first 4 years of the program (i.e., through year 5 of the program; year 1 is the
administrative launch of the program). We will actively fundraise for additional fellowship funds for following years).

Five of the 10 fellowships per year will cover full tuition, fees and supplemental fee (i.e., all costs), with an expectation that 3 of those 5 fellowships would go to in-state applicants. The remaining five fellowships per year will cover the entire supplemental fee. Together these fellowships will allow the program to attract exceptional students from diverse backgrounds. The second category of support will be potentially available to any applicant. Per UC guidelines, a third of the revenue from the supplemental fee will be used to support merit, need, and diversity based fellowships. Because some students come with outside support (e.g., international students or other fellowships such as departmental block grants) and the donor-supported fellowships will cover an additional 10 students, this financial aid will be able to substantially reduce realized costs for most students.

To illustrate how this would work, consider two examples: the first matriculating class (25 students) and a class of 80 when the MEDS program is near maturity. For the first matriculating class, five students would pay nothing (full fellowship from donor funds) and five students would not pay any supplemental fee (only regular tuition and fees). The required 1/3 of supplemental fee revenue to be allocated to financial aid would provide about $167,000 in aid. If this were distributed equally to the 20 students paying some to all costs, they would each receive $8333 in financial aid. Of course there would be many other possible ways to distribute financial aid funds.

For the example of a matriculated class of 80 students, and using a conservative estimate of 5 international students (full costs paid by international fellowships), annual support from block grants (equivalent of two students; assumed in-state), and donor-sponsored fellowships (conservative estimate of 5 students; 4 out-of-state and 1 in-state), and financial support from the supplemental fee covering an equal amount of costs for all of the remaining students not receiving other forms of financial aid, realized costs would be $0 for 12 students and a reduction of $7,843 in costs from tuition, fees and supplementary fee for the remaining 68 students (i.e., a realized supplemental fee of $12,157). These are very conservative assumptions. Table 10 below provides details for the scenario of distributing equally to all unfunded students the financial aid from the supplemental fee.

Table 10. Possible scenario of enrollment and associated tuition and fees for the MEDS program at 80 students, with financial aid from the supplemental fee distributed equally to all students not receiving some other form of aid. See text above for scenario details.

<table>
<thead>
<tr>
<th>Student Type</th>
<th># enrolled</th>
<th>Total Cost (tuition, fee and suppl. fee)</th>
<th>Financial aid/ fellowship</th>
<th>Realized Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>International</td>
<td>5</td>
<td>$56,300.81</td>
<td>Paid by host country or fellowship</td>
<td>$0</td>
</tr>
</tbody>
</table>
### Section 8. Governance

The new program will be administered by the Bren School. The School’s current bylaws, which were recently revised internally, are included in Appendix G. Changes needed to incorporate the new MEDS program will be discussed and decided once the MEDS program is approved.

The organizational chart in Appendix C outlines the various staff and their roles in administering different aspects and components of the program. Ultimately the Dean of the Bren School, in coordination with the Director of NCEAS, will have final administrative responsibility for the MEDS program. The Graduate Advisor for the MESM and PhD programs has been Assistant Dean Satie Airame since the faculty is interdisciplinary and it is challenging for any one faculty member to understand all of the program and specialization requirements. For the MEDS program, where the disciplinary focus is narrower, we will have a faculty member serve as the Graduate Advisor, as is done for all other Graduate Advisors, with the position rotated on a 1+ year appointment.

### Section 9. Changes in Senate Regulations

New Santa Barbara Regulation 335 to be appended as follows:

335. Requirements for the Master of Environmental Data Science (M.E.D.S.)

A. The provisions of Divisional Regulations 250 through 300 shall apply.

B. Completion of a minimum of 56 quarter units of course work approved by the faculty of the Environmental Data Science program.

C. Completion of an integrative capstone project acceptable to the student’s master’s advisor.
# Glossary of Terms and Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAAS:</td>
<td>American Association for the Advancement of Science</td>
</tr>
<tr>
<td>ACM:</td>
<td>Association for Computing Machinery</td>
</tr>
<tr>
<td>BIDS:</td>
<td>Berkeley Institute for Data Science</td>
</tr>
<tr>
<td>Bren:</td>
<td>short for Bren School of Environmental Science &amp; Management at UCSB</td>
</tr>
<tr>
<td>CIP:</td>
<td>Classification of Instructional Programs</td>
</tr>
<tr>
<td>CS:</td>
<td>Computer Science</td>
</tr>
<tr>
<td>EEMB:</td>
<td>Ecology, Evolution and Marine Biology at UCSB</td>
</tr>
<tr>
<td>EDS:</td>
<td>Environmental Data Science</td>
</tr>
<tr>
<td>EPA:</td>
<td>Environmental Protection Agency</td>
</tr>
<tr>
<td>ERI:</td>
<td>Earth Research Institute</td>
</tr>
<tr>
<td>EVC:</td>
<td>Executive Vice Chancellor</td>
</tr>
<tr>
<td>GIS:</td>
<td>Geographic Information System</td>
</tr>
<tr>
<td>GPA:</td>
<td>Grade Point Average</td>
</tr>
<tr>
<td>GRE:</td>
<td>Graduate Record Examination</td>
</tr>
<tr>
<td>HPC:</td>
<td>High Performance Computing</td>
</tr>
<tr>
<td>IBT:</td>
<td>Internet-based test</td>
</tr>
<tr>
<td>IEEE:</td>
<td>Institute of Electrical and Electronics Engineers</td>
</tr>
<tr>
<td>IELTS:</td>
<td>International English Language Testing System</td>
</tr>
<tr>
<td>LRDP:</td>
<td>Long-Range-Development Plan</td>
</tr>
<tr>
<td>LSOE:</td>
<td>Lecturer with Security of Employment</td>
</tr>
<tr>
<td>LTER:</td>
<td>Long Term Ecological Research</td>
</tr>
<tr>
<td>MEDS:</td>
<td>Master of Environmental Data Science</td>
</tr>
<tr>
<td>MESM:</td>
<td>Master of Environmental Science and Management at Bren</td>
</tr>
<tr>
<td>MIDS:</td>
<td>Master of Information and Data Science, at UC Berkeley</td>
</tr>
<tr>
<td>MIMS:</td>
<td>Master of Information Management and Systems, at UC Berkeley</td>
</tr>
<tr>
<td>MRSB:</td>
<td>Marine Sciences Research Building</td>
</tr>
<tr>
<td>MSO:</td>
<td>Management Services Officer</td>
</tr>
<tr>
<td>NASA:</td>
<td>National Aeronautics and Space Administration</td>
</tr>
<tr>
<td>NBER:</td>
<td>National Bureau of Economic Research</td>
</tr>
<tr>
<td>NCAR:</td>
<td>National Center for Atmospheric Research</td>
</tr>
<tr>
<td>NCEAS:</td>
<td>National Center for Ecological Analysis &amp; Synthesis at UCSB</td>
</tr>
<tr>
<td>NOAA:</td>
<td>National Oceanic and Atmospheric Administration</td>
</tr>
<tr>
<td>NGO:</td>
<td>Non-Governmental Organization</td>
</tr>
<tr>
<td>NSF:</td>
<td>National Science Foundation</td>
</tr>
<tr>
<td>PLO:</td>
<td>Program Learning Outcomes</td>
</tr>
<tr>
<td>PSTAT:</td>
<td>Statistics and Applied Probability at UCSB</td>
</tr>
<tr>
<td>TA:</td>
<td>Teaching Assistant</td>
</tr>
<tr>
<td>TOEFL:</td>
<td>Test of English as a Foreign Language</td>
</tr>
<tr>
<td>UAV:</td>
<td>Unmanned Autonomous Vehicle</td>
</tr>
<tr>
<td>UCSB:</td>
<td>University of California Santa Barbara</td>
</tr>
<tr>
<td>USBLS:</td>
<td>United States Bureau of Labor Statistics</td>
</tr>
<tr>
<td>USGS:</td>
<td>United States Geologic Survey</td>
</tr>
</tbody>
</table>
Appendix A - Letters of Support

63 letters of support are attached in the following sequence:

**Internal Letters**

**Faculty**
Bren School
- Prof. Tamma Carlton
- Prof. Chris Costello
- Prof. Frank Davis
- Prof. James Frew
- Dr. Allison Horst
- Prof. Scott Jasechko
- Prof. Bruce Kendall
- Prof. Kyle Meng
- Prof. Andrew Plantinga
- Prof. Samantha Stevenson
- Prof. Naomi Tague

Computer Science
- Prof. Chandra Krintz
- Prof. Ambuj Singh
- Prof. William Wang
- Prof. Rich Wolski

Statistics and Applied Probability
- Prof. Alex Franks
- Prof. Mike Ludkovski

Political Science
- Prof. Hahrie Han
- Prof. Matto Mildenberger
- Prof. Eric Smith
- Prof. Leah Stokes

Geography
- Prof. David Carr-Lopez
- Prof. Vena Chu
- Prof. Timothy DeVries
- Prof. Krzysztof Janowicz
- Prof. Alan Murray
- Prof. Dar Roberts
Ecology, Evolution and Marine Biology
- Prof. Deron Burkepile
- Prof. Carla D’Antonio
- Prof. Doug McCauley
- Prof. Holly Moeller
- Prof. Adrian Stier
- Prof. Hillary Young

Economics
- Prof. Olivier Deschenes

Environmental Studies (and shared departments)
- Prof. Peter Alagona, Department of History, Department of Environmental Science
- Prof. Robert Heilmayr, Department of Environmental Science, Bren School

Media Arts and Technology
- Prof. George LeGrady
- Prof. Yon Visell

English
- Prof. Alan Liu

Communication
- Prof. Ron Rice

Administrators
- Kristin Antelman, University Librarian
- Prof. Kelly Bedard, Chair of Economics
- Prof. Kelly Caylor, Director of Earth Research Institute
- Prof. Maria Charles, Director Broom Center for Demography
- Dean Steve Gaines, Dean of the Bren School
- Dean Charlie Hale, Dean of Social Sciences
- Prof. Ben Halpern, Director of NCEAS and Bren School
- Prof. Gretchen Hofmann, Chair of EEMB
- Prof. Werner Kuhn, Director of Spatial Center; Department of Geography
- Dean John Majewski, Dean of Humanities & Fine Arts
- Prof. Jon McCammond, Chair of Mathematics
- Prof. Marko Peljhan, Chair of Media Arts and Technology
- Prof. David Pellow, Chair of ES
- Prof. Katja Seltmann, Director Cheadle Center for Biodiversity and Ecological Restoration
- Prof. Dave Siegel, Chair of Interdepartmental Graduate Program in Marine Science
- Prof. Matthew Turk, Chair of Computer Science
- Prof. Joe Walther, Director of Center for Information Technology and Society
- Dr. Marion Wittman, Executive Director, UCSB Natural Reserve System
- Dean Carol Genetti, Dean of Graduate Division
- Dean Ron Alferness, Dean of College of Engineering
- Dean Pierre Wiltzius, Dean of Math, Life and Physical Sciences
- Prof. Ambuj Singh, Chair of EVC Marshall's Advisory Committee on Data Science
- Nicole Klanger, Managing Senior Director, Development
- EVC David Marshall
September 14, 2018

To:       Professor Ben Halpern  
Director, National Center for Ecological Analysis & Synthesis  
Professor, Bren School

From:    Tamma Carleton  
Assistant Professor, Bren School

Re:      Establishment of the Master of Environmental Data Science (MEDS) Degree

I am pleased to write a letter in enthusiastic support for a new Master’s degree in Environmental Data Science, to be established at the Bren School. The focus on environmental data science is a strong fit with my research interests and expertise as an empirical environmental economist, and it will help create a nexus and growing network of faculty, researchers and graduate students with whom I will be able to collaborate. It will also be equally exciting to be a leader in training the next generation of practitioners of environmental data science, a field that is rapidly expanding across the globe. I am excited and committed to teaching within the MEDS curriculum.

UCSB is already recognized globally as a leader in environmental science and sustainability, and the Bren School for providing world-class professional training in environmental science. The growing initiatives around data science across campus, the clear integration of MEDS within this vision, and the chance to coalesce these strengths and opportunities within MEDS is truly exciting. I very much look forward to being part of this program and helping make it thrive.

Thank you for the opportunity to comment.

Tamma Carleton
Dear Dr. Halpern:

I am writing in support of the Master’s in Environmental Data Science (MEDS) program, to be centered at the Bren School. As a Bren faculty member and director of the new Environmental Market Solutions Lab (emLab), I can attest to the growing importance of data science in solving environmental problems, and I think the proposal clearly spells out how this program can succeed at UCSB.

I also want to reiterate the importance of building this program with UCSB as a whole. While I do think Bren is an ideal location for the program, we all recognize that many faculty and other programs across campus also have a lot to offer, and we should strive to provide incentives to entice them to contribute to MEDS. Of course, this will require resources, and I hope the campus administration will continue to invest considerable campus resources to ensure the program’s success. Finally, I believe that we must take great care in growing this new program in a manner that preserves the extremely high caliber of the student body at the Bren School, and maintains the collegiality and comradery if the Bren School faculty and staff.

While building a new program is never easy, and challenges surely lie ahead, the MEDS program at the Bren School will make a huge contribution to the outstanding innovation, leadership, and scholarship already present at UCSB. Thank you for all of your efforts in helping get MEDS off to a great start.

Sincerely,

Christopher Costello
Professor of Resource Economics
Bren School, University of California, Santa Barbara
August 13, 2018

To: Professor Ben Halpern  
   Director, National Center for Ecological Analysis & Synthesis  
   Professor, Bren School

From: Frank W. Davis  
   Distinguished Professor and Director, La Kretz Research Center at Sedgwick Reserve

Re: Establishment of the Master of Environmental Data Science (MEDS) Degree

I am pleased to write a letter in enthusiastic support for a new Master’s degree in Environmental Data Science.

As former director of NCEAS and current director of the Long Term Ecological Research National Communications Office, I have developed a deep awareness of the need for graduate training in environmental data science and the timeliness of such a program at UCSB. With the campus’ globally recognized strengths in environmental science, geographical information science, informatics and cross-disciplinary synthesis research, we are uniquely positioned to offer such a program.

The proposed partnership between the Bren School, NCEAS, and many other departments on campus is well-conceived and builds on decades of successful collaboration. I would be excited to participate in such a program, as it is perfectly aligned with my teaching and research interests in landscape ecology, land use planning, and environmental analysis and synthesis.

Thank you for the opportunity to comment.

Cc: Steve Gaines, Dean, Bren School of Environmental Science and Management
September 9, 2018

TO: Ben Halpern, Professor  
Bren School of Environmental Science & Management

FROM: James Frew, Associate Professor  
Bren School of Environmental Science & Management

RE: Master of Environmental Data Science (MEDS) proposal

I wholeheartedly support the creation of a Master of Environmental Data Science (MEDS) degree program within the Bren School. Should the program be established, I commit to teaching classes in “Spatial Analysis for Environmental Data Science” and “Introduction to Data Storage” as part of the MEDS curriculum.
Re: MEDS Program

Ben,

I am writing to express my strong support for the proposed MEDS program and my excitement about teaching several of its courses.

The MEDS curriculum is one that will be of great interest to prospective students, and of high appeal and value to their future employers of its graduates. Each year I have students tell me they want to focus on environmental data science, but (based on their feedback) creating their own informal program to advance their EDS skills by taking piecemeal courses in different departments across campus has proven ineffective and inefficient. The MEDS program will provide structured, streamlined and rigorous training to students interested in applied environmental data science beyond what is currently offered at UCSB. Looking back, it’s the Master’s program I wish I’d completed.

I’m also sincerely looking forward to teaching in the MEDS program. While at Bren, I have discovered real passion for leading grad courses in applied math, statistics and data science. Teaching quantitative and data science classes geared specifically towards MEDS students would be exciting, challenging and rewarding work that perfectly builds on courses I’ve been developing over the past 6 years. I am looking forward to creating new course materials, collaborating with the faculty and staff, and working with the leading-edge environmental data scientists who come through the MEDS program.

Sincerely,

Allison Horst
Bren School of Environmental Science and Management
University of California, Santa Barbara 93106-5131
ahorst@bren.ucsb.edu
(805) 441-6340
August 8, 2018

To: Professor Ben Halpern  
   Director, National Center for Ecological Analysis & Synthesis  
   Professor, Bren School

From: Scott Jasechko  
      Assistant Professor, Bren School

Re: Establishment of the Master of Environmental Data Science (MEDS) Degree

I am pleased to write a letter in enthusiastic support for a new Master’s degree in Environmental Data Science.

Environmental data science and associated methodologies including meta-analyses, large data processing, are emerging as core components of the broader environmental sciences. From the perspective of water resources research, my specialty, large data analyses are emerging as a dominant component of the field and numerous high-impact studies are published each year with key implications for better water management.

I enthusiastically support the new Master of Environmental Data Science program.

Thank you for the opportunity to provide commentary on this exciting new program.

Scott Jasechko, Ph.D.  
Assistant Professor  
Bren School of Environmental Science and Management  
University of California, Santa Barbara  
Email: jasechko@ucsb.edu
11 September 2018

To:   Professor Ben Halpern  
       Director, National Center for Ecological Analysis & Synthesis  
       Professor, Bren School

From: Bruce Kendall  
       Professor, Bren School  

Re:   Establishment of the Master of Environmental Data Science (MEDS) Degree

I am pleased to write a letter in enthusiastic support for a new Master’s degree in Environmental Data Science.

In a world where environmental data are becoming increasingly available, it is crucial that professionals in the environmental field be able to efficiently and robustly process these data to produce information that advances effective management. The MEDS degree will provide exactly that toolset. While I do not anticipate engaging in core instructional activities for MEDS, I do look forward to interacting with the students in other ways, such as providing problems to which they can apply their skills.

I am particularly pleased that the MEDS program would have its academic home in the Bren School, while drawing on relevant expertise from across campus. The school’s experience with preparing masters students for professional careers will translate directly to the new program. The students will also benefit from being in an environment that is infused with interdisciplinary environmental scholarship, which will enhance their degree even if they don’t take significant environmental science coursework. The instructors and students will likewise broaden the range of perspectives within the school, and I look forward to new collaborations in both research and teaching. Furthermore, this program, the first of its kind, will again put the Bren School and UCSB on the forefront of environmental education.

Thank you for the opportunity to comment.
September 13, 2018

To: Professor Ben Halpern
   Director, National Center for Ecological Analysis & Synthesis
   Professor, Bren School

From: Kyle Meng
       Assistant Professor

Re: Establishment of the Master of Environmental Data Science (MEDS) Degree

I am pleased to write a letter in enthusiastic support for a new Master’s degree in Environmental Data Science.

Environmental policy and management is rapidly changing with the onset of “big data” settings and advanced computational methods and tools. Many students seeking to be environmental professionals want such training. The Bren School is in a distinct position to provide such training. The Bren MEDS program will help maintain UCSB’s place as a leading educational institution in environmental education.

As an empirical economist who work in rich, complex data settings across the world, I look forward to taking part in this new degree program.

Thank you for the opportunity to comment.

Sincerely,

Kyle C. Meng
September 16, 2018

To: Professor Ben Halpern  
Director, National Center for Ecological Analysis & Synthesis  
Professor, Bren School

From: Andrew Plantinga  
Professor, Bren School

Re: Establishment of the Master of Environmental Data Science (MEDS) Degree

I am pleased to write a letter in support of a new Master’s degree in Environmental Data Science. The Bren School, in collaboration with other departments at UCSB, is uniquely positioned to become a leader in the cutting-edge field of environmental data science. Taking advantage of synergies with the existing MESM program, a successful MEDS degree will provide new opportunities for all Bren students and faculty in learning, research, and career advancement. By developing the first program of its kind in the world, MEDS offers UCSB the exciting possibility of growth through innovation.

I am enthusiastic to participate in the launch of the MEDS degree and look forward to addressing the critical challenges that lie ahead. The revised MEDS proposal has a lower request for new resources, and relies more heavily on existing faculty in the Bren School for teaching and program support. It is essential that the MEDS degree develop in a way that does not compromise the existing MESM program. This will require that we identify complementarities between MESM and MEDS and, as MEDS grows to its full size, seek additional sources of funding. Another key challenge will be to deploy staff resources efficiently to avoid overburdening existing staff and to ensure that new staff are fully dedicated to the MEDS program. The MEDS proposal anticipates and lays out a strategy for addressing these challenges. I look forward to being part of that effort.

Thank you for the opportunity to comment.

Sincerely,

Andrew Plantinga
September 14, 2018

To: Professor Ben Halpern  
Director, National Center for Ecological Analysis & Synthesis  
Professor, Bren School

From: Samantha Stevenson  
Assistant Professor

Re: Establishment of the Master of Environmental Data Science (MEDS) Degree

I am pleased to write a letter in support for a new Master’s degree in Environmental Data Science. The MEDS program has unique potential to provide educational opportunities in a fast-growing sector of environmental science; ‘big data’ and data science skills are becoming more and more in-demand for employers, but a program specifically serving the data science needs of environmental scientists is still lacking at UCSB. I am planning on being involved with teaching MEDS courses, including proposed courses on environmental data and modeling.

I am also quite enthusiastic about the incorporation of MEDS within the Bren School, since this will allow students to interface with the existing strong environmental education and career services programs within Bren while providing new data science-specific opportunities. I believe that this will be beneficial both to students enrolled in MEDS and to students in the existing Masters of Environmental Science and Management program.

Thank you for the opportunity to comment.

Samantha Stevenson

Copy:
I am writing to express my strong support for the proposed Masters in Environmental Data Science (MEDs). The proposed program offers an exciting opportunity for UCSB to leverage its existing strengths in environmental science and informatics and provide a new state-of-the-art professional degree. The design of the program as a professional Masters, similar to the Bren Master’s in Environmental Data Science, will fill a rapidly growing need for training in the application of data science in the environmental field. I anticipate that the program will be in high demand.

The proposed Masters will also be complementary to other emerging initiative in Data Science across campus, including a collaboration between myself and faculty in Computer Science on Visualizing Environmental Models, via a Crossroads grant. I envision that the new faculty hire proposed as part of this initiative will also benefit the campus by building data-science research support in a particular domain (Environmental Science) and building linkages with faculty in core data science areas (Computer Science, Statistics, Mathematics) and other related environmental science areas (EEMB, Geography others).

I am very excited to be part of this program and I am committed to teaching a course in environmental modeling as part of the curriculum.

Sincerely,

Dr. Christina (Naomi) Tague
08/17/2018

To: Professor Ben Halpern  
   Director, National Center for Ecological Analysis & Synthesis 
   Professor, Bren School

From: Chandra Krintz  
   Professor, Computer Science Department

Re: *Establishment of the Master of Environmental Data Science (MEDS) Degree*

I am pleased to write a letter in support of a new Master’s degree in Environmental Data Science at UCSB. My research interests include developing computer systems and data analytics engines in support of environmental data science. In particular, my team and I study how to apply advances in computing and data analysis to agricultural and food production processes. This degree program has the potential for building upon and extending our multidisciplinary educational and research collaborations and impact across campus.

Thank you for the opportunity to comment on the MEDS proposal.

Sincerely,

Chandra Krintz  
ckrintz@cs.ucsb.edu
Professor Ben Halpern  
Director, National Center for Ecological Analysis & Synthesis  
Bren School of Environmental Science & Management  
University of California, Santa Barbara

Re: Support of the proposed Master of Environmental Data Science (MEDS) degree

Dear Ben:

I have read through the description of the proposed Master degree in Environmental Data Science (MEDS) and offer my strong support.

Data Science is an important emerging area and there is a great need for manpower at all levels (undergraduates, Master’s, PhDs). The proposed Master’s program will impart this training through courses and projects in programming and statistics that are rooted in a study of the environment. The program will be unique within UC and nationally in its emphasis on environmental data.

I believe that this proposal is synergistic with the campus’s nascent plans in data science. As you are aware through your service on the faculty committee guiding data science growth at UCSB, we are planning a sequence of undergraduate courses in data science that will likely evolve (through more course offerings in future years) into interdisciplinary emphases and degree programs. It will be great to have collaborations with the proposed MEDS program as the two efforts co-evolve.

Intertwined with the training component, we also need a substantial focus on research. For UCSB’s data science effort to stand out nationally, there need to be prominent and visible areas of strength. Bren, NCEAS, and the broader environmental science research at UCSB undoubtedly provide this. I think the proposed MEDS program will augment this strength at UCSB and possibly provide another avenue of broad interaction with UCSB’s data science community through large centers and research programs.

I look forward to a successful implementation of the MEDS program and its positive impacts on data science at UCSB. I support it wholeheartedly.

Sincerely,

Ambuj K. Singh  
Professor  
Dept. of Computer Science
09/10/2018

To: Professor Ben Halpern  
   Director, National Center for Ecological Analysis & Synthesis  
   Professor, Bren School

From: Professor William Wang  
   Director, UCSB Natural Language Processing Group  
   Assistant Professor, Computer Science

Re: Establishment of the Master of Environmental Data Science (MEDS) Degree

I am pleased to write a letter expressing enthusiastic support for a new Master’s degree in Environmental Data Science at UCSB.

Over the years, there has been growing interests from the campus on topics related to Natural Language Processing, and Data Science. From environmental science, there is also growing demands of applying Natural Language Processing to knowledge extraction problems. It is essential to educate new students on this topic and empower them with better data analytic skills.

I strongly endorse Prof. Halpern for his effort of creating this new masters program.

Thank you for the opportunity to comment on the MEDS proposal.

William Wang

william wang
09/10/2018
September 7, 2018

To: Professor Ben Halpern  
   Director, National Center for Ecological Analysis & Synthesis  
   Professor, Bren School

From: Rich Wolski  
   Duval Family Presidential Chair in Energy Efficiency  
   Professor, Computer Science

Re: Establishment of the Master of Environmental Data Science (MEDS) Degree

I am pleased to write a letter expressing enthusiastic support for a new Master’s degree in Environmental Data Science at UCSB. Clearly Data Science, in general, will be an important part of UCSB’s research and educational mission in the coming years. Having a specific degree program tailored to the needs of Environmental Scientists, who presently have acute academic and career needs for training in this subject certainly presents an opportunity for impact.

My own research interests center on scalable computing, sensing, and actuation for the “Internet of Things” (IoT), particularly with respect to environmental and agricultural applications. My group studies the computer science necessary to design, build, and deploy sensing systems in ecological or agricultural settings as well as the analytical algorithms necessary to make inferences, predictions and decisions from the sensing data. Our work is highly collaborative. In particular, we rely on domain experts and data scientists to help identify promising avenues of research and to validate the results of our work. We are excited to have the opportunity to collaborate with other faculty who will be part of the degree program.

I regularly teach a graduate course in Cloud Computing and am currently preparing a course on IoT and The Cloud. I would welcome MEDS students in either course when it is feasible to include them.

Thank you for the opportunity to comment on the MEDS proposal.

Rich

Copy:
September 10, 2018

To: Professor Ben Halpern  
Director, National Center for Ecological Analysis & Synthesis  
Professor, Bren School

From: Alexander Franks  
Assistant Professor of Statistics

Re: Establishment of the Master of Environmental Data Science (MEDS) Degree

I am pleased to write a letter expressing enthusiastic support for a new Master’s degree in Environmental Data Science at UCSB.

Since arriving on campus, I have been involved in several discussions regarding different data science education initiatives on campus. I believe that creating a strong data science environment on campus requires multiple efforts in parallel across a range of disciplines. In the long term, I believe that introducing a data science program at the Bren School will benefit other data science initiatives and proposals across campus. It will generate attention and bring a plethora of strong applied quantitative researchers to campus.

Personally, the MEDS program would lead to new research collaborations. Part of my own research has focused on developing methods for spatio-temporal analysis. In the past, my focus in this area was primarily with applications to sports. My work focused on analyzing a very large dataset cataloguing player locations in professional basketball games, consisting of the spatial locations of all players (at 25 frames a second) and many annotations specifying in-game events. Although the application area is quite different, much of the spatio-temporal methodology would translate to large dynamic datasets in environmental science. New and exciting methodology is driven by large, novel, and rich datasets. Data science can’t exist without data, and as an applied statistician, collaborations like those that will be fostered by MEDS are essential for my own work.

I also believe that several of our PSTAT courses could be excellent electives for MEDS students. One appropriate course would be, PSTAT231 (Statistical Machine Learning Mining), a masters level course which introduces methods for discovering and exploring patterns in large real world datasets. Students in this course learn about predictive modeling and model selection methods. In the past, we have had several graduate students from other departments, including geography, biology and engineering-- MEDS students would be ideal students as well. Another appropriate elective would be PSTAT 234 (Introduction to Data Science). This course focuses on tools and techniques relevant
to every part of the data science pipeline, including data retrieval, processing, analysis, and visualization.

Thank you for the opportunity to comment on the MEDS proposal.

Sincerely,
Alexander Franks

[Signature]

Alexander Franks
January 1, 2019

TO: Ben Halpern  
Director, National Center for Ecological Analysis & Synthesis  
Professor, Bren School

FR: Mike Ludkovski  
Professor, Department of Statistics and Applied Probability

I am pleased to support the establishment of the Master’s degree in Environmental Data Science. The unique focus of the MEDS program enhances the national prominence of UCSB as an education and research hub in environmental science. Augmenting such areas of strength is critical to building the UCSB brand of Data Science. As a member of the Faculty Advisory Committee on Data Science, we have been discussing the creation of both core DS degrees, as well as domain-centered “Data Science + X” initiatives like this one. A Master’s program is a natural sweet spot for bringing in significant numbers of graduate students to UCSB and building an alumni network of applied data scientists.

Leveraging the existing reputation of the Bren School, MEDS is a timely new interdisciplinary program that complements other campus efforts. In particular, the proposals for a series of data science boot camps and for distinguished visitor series of public lectures and targeted workshops are fantastic initiatives that would be highly valuable for a wide spectrum of graduate students across campus, not least Statistics. The Global Summit on Environmental Data Science would also be a great research catalyst that I would love to participate in. My own research touches upon environmental data science in the context of quantitative analysis of natural commodity markets and environmental finance, such as cap-and-trade regulation and transition to renewable energy, and I look forward to collaborations and discussions with envisioned new MEDS hires and distinguished long-term visitors. Overall, the potential to strengthen cross-disciplinary ties between Bren and multiple other departments is immense and is a major strength of the proposal.

Sincerely,

Michael Ludkovski

Professor and Chair, Department of Statistics & Applied Probability  
Co-Director, Center for Financial Mathematics and Actuarial Research  
ph: (805)893-5634  
e-mail: ludkovski@pstat.ucsb.edu
August 23, 2018

To:  Professor Ben Halpern  
    Director, National Center for Ecological Analysis & Synthesis  
    Professor, Bren School  

From:  Hahrie Han  
        Anton Vonk Professor of Environmental Politics  

Re:  *Establishment of the Master of Environmental Data Science (MEDS) Degree*

I am pleased to write a letter expressing support for a new Master’s degree in Environmental Data Science at UCSB.

I study the politics of environmental policy, with a particular focus on environmental activism, collective action, and advocacy. I draw on multiple methods in my research, including field experiments and large-scale, quantitative data analysis. Most of my projects are collaborative projects. For all these reasons, I can see many opportunities for overlap between the MEDS program and students in my research lab.

Thank you for the opportunity to comment on the MEDS proposal.

Hahrie Han
August 11 2018

To:    Professor Ben Halpern
       Director, National Center for Ecological Analysis & Synthesis
       Professor, Bren School

From:  Matto Mildenberger
        Assistant Professor, Department of Political Science
        Faculty Affiliate, Bren School
        Faculty Affiliate, Environmental Studies Department

Re:    Establishment of the Master of Environmental Data Science (MEDS) Degree

I am writing in enthusiastic support for a new Master’s degree in Environmental Data Science at UCSB.

In my research I approach questions of environmental behavior and politics using a range of big data techniques. Some of this work includes efforts to model public opinion in the United States and abroad at high-resolution spatial scales. This analysis allows social science datasets to be integrated with high-resolution climatic impact data. Other work uses machine learning, comparative text analysis, and innovative survey methodologies to collect new large datasets related to environmental politics. I would be excited to work with and mentor students in the MEDS degree program as part of my Energy and Environmental Transitions (ENVENT) lab here on campus.

My current teaching load includes a graduate-level seminar on quantitative causal (PS207). This course could be provide curricular support for MEDS students, either in its current form or as part of a new custom offering for the program.

Please don’t hesitate to reach out if you have any questions. The MEDS proposal strikes me as timely and exciting. I have no doubt it will deepen our campus’ already formidable strengths in environmental data science.

Matto Mildenberger
Department of Political Science
August 23, 2018

To: Professor Ben Halpern  
   Director, National Center for Ecological Analysis & Synthesis  
   Professor, Bren School

From: Eric Smith  
   Professor, Department of Political Science

Re: Establishment of the Master of Environmental Data Science (MEDS) Degree

I am writing to join those in support of the proposed Master’s degree in Environmental Data Science at UCSB. I believe that it will be an excellent addition to our campus.

My research focuses on environmental politics and policy, with an emphasis on public opinion research. My work, like that of most public opinion scholars, is fairly quantitative. My graduate students and I would certainly benefit from the MEDS program.

I am one of the founding and continuing members of the Quantitative Methods in Social Science Ph.D. Emphasis. In my view, the proposed MEDS degree would complement the QMSS program and enhance UCSB’s reputation.

Finally, I should note that the Political Science Department’s current FTE Plan includes a request to hire a political scientist whose field is “Data Science.” We believe that this is on the cutting edge of our discipline. The proposed MEDS degree would fit wonderfully with our department’s plans by building greater strength in the area.

In sum, I think that establishing the MEDS degree would greatly benefit the campus and our department. I strongly support it.
August 15, 2018

To: Professor Ben Halpern  
   Director, National Center for Ecological Analysis & Synthesis  
   Professor, Bren School

From: Leah Stokes  
   Assistant Professor, Political Science

Re: Establishment of the Master of Environmental Data Science (MEDS) Degree

I am pleased to write a letter expressing enthusiastic support for a new Master’s degree in Environmental Data Science at UCSB.

I believe there is room for our campus to build on our existing strengths in environmental policy with this new program. Given my own research interests, I could see myself collaborating with the new graduate students and the new MEDS faculty. Overall, I think this is a wonderful proposal.

The political science department has spent the last several years investing in our quantitative methods curriculum. Given our emphasis in environmental politics, it is possible that some MEDS graduate students would be interested in participating in our sequence.

Thank you for the opportunity to comment on the MEDS proposal.

Leah Stokes, Ph.D.  
Assistant Professor  
Department of Political Science  
University of California Santa Barbara  
lstokes@ucsb.edu | http://www.enventlab.com
August 31, 2018

To: Professor Ben Halpern
   Director, National Center for Ecological Analysis & Synthesis
   Professor, Bren School

From: David Lopez Carr
   Co-Director, Planetary Health Center of Expertise
   Professor, Geography Department

Re: Establishment of the Master of Environmental Data Science (MEDS) Degree

I am pleased to express my whole-hearted support for the establishment of the Master’s Degree of Environmental Data Science as the Co-Director of the Planetary Health Center of Expertise for the UC Global Health Institute on campus.

My research focuses on the human dimensions of global environmental change with a regional focus in Latin America and Africa, which has highlighted the importance of climate hazards and vulnerability. My work at the Planetary Health Center of Expertise (PHCOE) seeks to advance environmental and population health through interdisciplinary and innovative approaches which strengthen human health, environmental integrity, and local economies. Environmental informatics and climate data has become an increasingly essential component in our community-lead resource management strategies. Our projects utilize key climate data to design and implement long-term solutions for climate and environmental resilience. I highly value the collaboration with faculty members across various UCSB departments in tackling climate and environmental issues; the potential of further collaboration is immense. This proposal brings forth a meaningful opportunity leverage our extensive resources in big data and climate science to respond to environmental demands and global health needs. MEDS will position UCSB as a world class leader in climate data science and be a powerful complement to both the NCEAS and MESM at Bren.

Within the proposed Masters program, I will help train and guide MEDS students in their capstone, client-driven project to design strategies for land restoration, climate and environmental resilience, and, by extension, food security and nutritional wellbeing. These projects provide tools and build capacity for present and future generations to implement interdisciplinary natural resource management with applied data science. I have extensive experience conducting M&E’s worldwide and have assisted communities carry out successful, long-lasting solutions fostering population and environmental health.

I believe it is important to leverage climate data with a focus on implementing solutions for population and environmental health, and I am confident that this master’s degree program will accomplish this. The shared experience and knowledge of the exceptional faculty on campus will
create a synergistic exchange of ideas, skills and practical training to prepare students to approach environmental resilience with expertise. I will also offer my Population Geography (Geog 241A) and Special Topics in Geography (Geog 288) courses as listed electives for MEDS students.

Thank you for the opportunity to comment on the MEDS proposal.

Sincerely,

[Signature]

David Lopez-Carr
Co-Director
Planetary Health Center of Expertise
UC Global Health Institute
Phone: 805-456-2830, E-mail: davidlopezcarr@ucsb.edu

Professor
Geography Department
University of California-Santa Barbara
Santa Barbara, CA 93106-5131
August 27, 2018

To: Professor Ben Halpern  
    Director, National Center for Ecological Analysis & Synthesis  
    Professor, Bren School

From: Vena Chu  
    Assistant Professor, Department of Geography

Re: Establishment of the Master of Environmental Data Science (MEDS) Degree

Dear Prof. Halpern,

I am writing to provide my enthusiastic support for a new Master’s degree in Environmental Data Science at UCSB. As an affiliate in the Bren School, an instructor of Geography's remote sensing series, and a researcher with data science interests, I believe this program will provide a welcomed boost to UCSB's brand in environmental and spatial data science training.

My research interests using remote sensing to understand climate change effects on the cryosphere align very well with the broader goals for the MEDS program and the proposed faculty. In particular, I am currently working on an NSF project to develop polar cyberinfrastructure (ICEBERG: Imagery Cyberinfrastructure and Extensible Building-Blocks to Enhance Research in the Geosciences), and am keenly interested in collaborating with a potential machine learning faculty hire. As the geoscience community moves from small-scale demonstrations of feasibility, to regular (even real-time) pan-Arctic and pan-Antarctic surveys, further progress in imagery-enabled science requires the development of cyberinfrastructure to unite high-performance and distributed computing resources with satellite imagery, and the development and integration of tools required for its analysis. Collaborations between faculty interested in these environmental data science research fields will allow a more comprehensive understanding of global terrestrial and marine processes, while developing cutting-edge image interpretation methods for geoscience workflows that can be applied globally.

I also currently teach the second and third course in our Geography Remote Sensing series, and I look forward to offering these classes in conjunction with the proposed Remote Sensing and Environmental Data course. The Geog 115C: Intermediate Remote Sensing course in particular offers students the chance to work on a group project for the entire quarter and present their findings in the Spatial Center's spatial@ucsb conference each Spring quarter.
This proposal efficiently leverages UCSB's existing faculty strengths in environmental data science (and experience from Bren's successful MESM program) to craft a thoughtful 1-year Master's program that will attracts top students and prepare them for current research and industry demands for data scientists. Please do not hesitate to contact me at venachu@ucsb.edu if I can be of further assistance.

Best regards,

Vena W. Chu
Assistant Professor of Geography
September 13, 2018

Benjamin Halpern  
Director, National Center for Ecological Analysis and Synthesis  
University of California, Santa Barbara

Dear Benjamin,

I am pleased to support the proposed Master of Environmental Data Science (MEDS) program in the Bren School of Environmental Management at UCSB. On the teaching side, I expect that some of the MEDS students will take the Geography 210 sequence which covers analytical, numerical, and statistical methods for geographic data analysis, and I would be happy to have some of the MEDS students in my class (Geography 210A). On the research side, I am excited that the Bren school are proposing an FTE in machine learning and/or informatics as part of the MEDS program. My research group uses machine learning techniques in much of our research and I expect that such a hire would open up exciting new collaborations. In all, I think the MEDS program will be an important component of Data Science on our campus.

Sincerely,

Tim DeVries, Associate Professor  
Department of Geography  
University of California, Santa Barbara  
tdevries@geog.ucsb.edu  
(805) 893-5308
September 1, 2018

To: Professor Ben Halpern
director, National Center for Ecological Analysis & Synthesis
Professor, Bren School

From: Krzysztof Janowicz
Associate Director, Center for Spatial Studies
Associate Professor, Geography

Re: Establishment of the Master of Environmental Data Science (MEDS) Degree

Hereby I would like to express my enthusiastic support for a new Master's degree in Environmental Data Science at UCSB.

I believe that the degree would align very well with the new campus-wide push for Data Science, with Geography's ongoing initiative to establish a 4+1 M.A. in Geographic Information Science (MAGIS), as well as with the Center for Spatial Studies' mission to promote spatial thinking and computing for inter-disciplinary problem-solving.

As far as my research is concerned, interoperability and modern cyber-infrastructures are key components of Data Science as they offer methods to improve the publication, retrieval, integration, and reuse of data. In fact, NSF's EarthCube initiative aims at establishing such a next-generation data and service infrastructure for the broader Earth Sciences. Both Geography and NCEAS have been involved in EarthCube before.

As time permits, I would like to express my interest in offering a class on data integration and infrastructures for MEDS students as a potential instructor. I also believe that classes, e.g., about object-oriented design and software engineering for MAGIS and MEDS could be cross-listed.

Thank you for the opportunity to comment on the MEDS proposal.

Krzysztof Janowicz
August 28, 2018

To: Ben Halpern
   Director, National Center for Ecological Analysis & Synthesis
   Professor, Bren School

From: Alan Murray
   Professor, Geography

Re: Establishment of the Master of Environmental Data Science Degree

I am writing in support of the proposed new Master’s degree in Environmental Data Science.

I think this degree will be of great value to students, and definitely represents an area for which UCSB is well positioned to offer such a degree.

The new degree represents a particularly interesting interdisciplinary venture with many departments/units offering contributions. I see a number of faculty in geography playing a role in this degree given their research strengths and interests. In particular, geography has considerable capabilities in GIS and remote sensing as well as applied mathematics / optimization and spatial statistics. I see all of these as important components of Environmental Data Science, and this is prominently highlighted in the proposal.

While there are undoubtedly issues to be addressed regarding joint appointments and potential impacts (operational and future) on associated departments, I believe this is an important endeavor that is worth pursuing.

Thank you for the opportunity to comment.

CC: Stuart Sweeney
September 7, 2018

To: Professor Ben Halpern  
   Director, National Center for Ecological Analysis & Synthesis  
   Professor, Bren School

From: Dar Roberts  
   Professor, Department of Geography

Re: Establishment of the Master of Environmental Data Science (MEDS) Degree

I am pleased to write a letter expressing enthusiastic support for a new Master’s degree in Environmental Data Science at UCSB.

As you are aware, I have been heavily engaged in many aspects of environmental science, including extensive use of remote sensing to address environmental problems, deployment and interpretation of environmental observations from met towers and in environmental modeling. I have collaborated extensively with several MEDS faculty, including Naomi Tague (wildfire, urban ecohydrology, crop water use) and James Frew (standardized processing of spaceborne remote sensing). I teach advanced graduate level remote sensing classes (active and passive) and typically have several Bren graduate students enrolled in my courses. I would anticipate that the MEDS program may increase the involvement of Bren students in several of these courses. Given the very large volume of remotely sensed data I have, and the breadth of environmental problems I am involved in (all aspects of wildfire, urban heat and energy balance, mapping trace gas emissions, vegetation mapping following disturbance, invasive species mapping etc.) I anticipate numerous opportunities for collaboration will exist with MEDS students in terms of potential capstone projects.

Given the sheer volume of remote sensed data currently available, and the considerably greater volume that will be forthcoming in the next few years, and the immense societal need for a skilled labor force to work with these data, this proposed program is very well timed.

Specific courses that may be of interest that I teach (typically every other year) and may be of interest to MEDS students include:


Geography 202: Environmental Optics. Taught fall in even years (fall, 2020, 2022)

Geography 214b: Advanced remote sensing, active. Taught winter, even years (winter 2020, 2022).

I would welcome MEDS students interest in taking any of these courses as an elective.

Thank you for the opportunity to comment on the MEDS proposal.

Sincerely

Dar Roberts
Dept of Geography, EH 3611
University of California
Santa Barbara, CA 93106
dar@geog.ucsb.edu
805-455-8286

Copy: Stuart Sweeney
September 10, 2018

To: Professor Ben Halpern  
Director, National Center for Ecological Analysis & Synthesis  
Professor, Bren School

From: Deron Burkepile  
Associate Professor, Ecology, Evolution & Marine Biology

Re: Establishment of the Master of Environmental Data Science (MEDS) Degree

I am pleased to write a letter expressing enthusiastic support for a new Master’s degree in Environmental Data Science at UCSB.

Our group’s work is increasingly using large datasets of biotic and abiotic variables to understand patterns in coral reef ecosystems from the effects of fishing on ecosystem health to the impacts of coral bleaching on community dynamics. Thus, I understand how important it is to have data savvy scientists on any team examining large-scale patterns in global change biology. Having a Master’s degree in Environmental Data Science at UCSB would help train the next generation of data scientists and help put UCSB at the front of the data revolution in ecology and environmental sciences.

Thank you for the opportunity to comment on the MEDS proposal.

Sincerely

Deron Burkepile
DATE: Sept. 5, 2018

TO: Ben Halpern, Professor
Director, National Center for Ecological Analysis and Synthesis
Bren School of Environmental Management and Policy

FROM: Carla D’Antonio, Outgoing Chair
Schuyler Professor, Environmental Studies Program

RE: Support for MEDS program

I have reviewed the proposal to create a Masters of Environmental Data Science and believe the proposed program would be a benefit to the campus, the greater society as well as to UCSB’s Environmental Studies students.

Environmental data science is an increasingly complex and important field an understanding of which is critical to the training of environmental professionals of the future. The MEDS program would bring together diverse expertise on the UCSB campus as well as filling a programmatic gap in UCSB’s otherwise strong environmental sciences, statistics and computer sciences programs and offerings.

The Environmental Studies Program offers two Bachelor of Sciences tracts, a straight BS and the BS in Hydrological Sciences and Policy. Students in these tracts could be attracted to this MEDS program and ES would consider offering an upper division course as a pre-requisite for students who might want to apply to the program. Currently our Bachelor of Sciences students complete a year of math (calculus and algebra) and a minimum of one quarter of statistics, thus meeting most of the basic requirements proposed for entry into MEDS. One area that we do not currently require is a course in basic programming. However, the ES faculty have discussed the need for upper division courses that could introduce students to ‘data science’ and in particular data visualization. Such a course could include basic programming skills that could prepare students for entry into the MEDS program. A discussion about this will be an agenda item for the ES Curriculum committee in the coming year. Currently we do not offer any specific courses that would qualify as electives for the MEDS program.

Thank you for offering the opportunity to provide commentary and support for this proposal.
To: Professor Ben Halpern  
Director, National Center for Ecological Analysis & Synthesis; Professor, Bren School

From: Doug McCauley, Associate Professor

Re: Establishment of the Master of Environmental Data Science (MEDS) Degree

I am grateful and pleased to write a letter of enthusiastic support for the new master’s degree program being proposed in Environmental Data Science (MEDS).

I serve as the Director of the Benioff Ocean Initiative, an ambitious initiative to address some of the most pressing environmental problems in the ocean. Through this initiative we are polling the global community for the best ideas, pulling together the best scientific minds to address those ideas, and then funding those solutions. I am extremely confident that the MEDS program will be a great asset to the scientists in our group and to the students with which I interact.

Data science will, in particular, be a necessary component of almost any project that emerges from the Benioff Ocean Initiative. Tackling an idea with the best available science involves synthesizing what is known and unknown about the idea, analyzing available data to find effective and efficient paths forward towards addressing the identified problem, and developing effective ways of communicating the data, results and science emerging from the process so that the solution stage knows what science and information it has to work with.

The MEDS program would offer at least two key assets to the Benioff Ocean Initiative. First, it would provide teams of students that could work on one of the Initiative’s projects as part of their group project – the Initiative could be the client for one or more group projects. Second, the program will produce the kind of graduates poised to take the reins of scientific and analytical dimensions of environmental problem solving of the sort being tackled by the Benioff Ocean Initiative.
Thank you for the opportunity to comment on the value of MEDS to our Initiative and to our campus.

Regards,

Dr. Douglas McCauley
5 September 2018

To: Professor Ben Halpern  
   Director, National Center for Ecological Analysis & Synthesis  
   Professor, Bren School  

From: Dr. Holly V. Moeller  
   Assistant Professor, Department of Ecology, Evolution and Marine Biology  

Re: Establishment of the Master of Environmental Data Science (MEDS) Degree  

I am delighted to write a letter expressing my enthusiastic support for a new Master’s degree in Environmental Data Science at UCSB.  

I am a quantitative ecologist and member of UCSB’s Department of Ecology, Evolution and Marine Biology. As someone with expertise in environmental data science, I can affirm that the need for more graduates with expertise in this area is obvious and pressing; I am certain that this new degree program would be in high demand.  

My personal research interests encompass the mathematical modeling of plant and animal populations and ecological communities, as well as the optimization of natural resource management. I therefore anticipate substantial overlap between my group’s scientific interests, and those of the students and faculty involved in the new MEDS Degree. Specifically, The new degree will provide more opportunities for interaction between my group and NCEAS and Bren faculty who also study fisheries bioeconomics, as well as with students who are interested in ecological modeling more broadly.  

I also teach Ecological Modeling (EEMB 179/279) every Winter Quarter, which covers foundational models used to describe the dynamics of populations and interacting species. This course is taught at the advanced undergraduate level, and cross-listed at the graduate level; it may be of interest as an elective for MEDS students.  

Thank you for the opportunity to comment on the MEDS proposal.  

Sincerely,  

Holly V. Moeller  
UC Santa Barbara
September 11, 2018

To: Professor Ben Halpern  
   Director, National Center for Ecological Analysis and Synthesis  
   Professor, Bren School

From: Professor Adrian Stier  
   Director, National Center for Ecological Analysis and Synthesis  
   Assistant Professor, Dept. Ecology, Evolution, and Marine Biology

Re: Establishment of the Master of Environmental Data Science (MEDS) Degree

I am pleased to enthusiastically support of the creation of a Master’s degree in Environmental Data Science (MEDS). Already a leader in environmental studies, ecology, and conservation, UC Santa Barbara is poised to also lead in a growing field of data science. I am particularly excited about the capacity of this program to accommodate a growing interest in environmental data science at UCSB. Moreover, courses in this program will fill a much needed knowledge gap many graduate students in my lab and department experience. The proposed program has my full support.

If there are any questions or concerns regarding my support for this program please feel free to contact me.

Sincerely,

Adrian C. Stier, Sent electronically
August 16, 2018

To: Professor Ben Halpern  
   Director, National Center for Ecological Analysis & Synthesis  
   Professor, Bren School

From: Hillary Young  
   Associate Professor

Re: Establishment of the Master of Environmental Data Science (MEDS) Degree

I am pleased to write a letter expressing enthusiastic support for a new Master’s degree in Environmental Data Science at UCSB.

I am a community ecologist and disease ecologist and work extensively with large and noisy datasets. My work, and that of my students, would greatly benefit from the creation of the MEDS program. I can speak extensively to the large gaps that exist on campus in terms of environmental data analysis approaches; we have very little faculty expertise in many data analytical tools that are becoming critical to research in my field. I am sure I would collaborate extensively with the two new FTEs requested herein. Although EEMB and other departments have been engaged in several efforts to increase environmental data science in a piecemeal fashion, we are in great need of an integrated effort to launch this program.

Thank you for the opportunity to comment on the MEDS proposal.

Sincerely,

Hillary Young
9/7/18

Ben Halpern, Professor
Bren School of Environmental Science and Management
UCSB

Dear Ben,

It is my pleasure to write a short letter in support of the proposed Masters in Environmental Data Science (MEDS).

It is evident from the proposal that the new Masters degree fills an important niche and will establish UCSB as a leader in the emerging area of data science. I appreciate the efforts to build upon the strength of the Bren School and to bring together experts across multiple departments on campus. Such cross-disciplines endeavors have been a key component of UCSB’s recent successes are also consistent with its strategic plans for the future.

I look forward and am committed to teach a course for the MEDS curriculum and more generally look forward to participate in the development and in the activities associated with this new program at UCSB.

Olivier Deschenes
Professor,
Department of Economics
1 September 2018

To: Professor Ben Halpern  
Director, National Center for Ecological Analysis & Synthesis  
Professor, Bren School

From: Peter S. Alagona  
Associate Professor  
History & Environmental Studies

Re: Establishment of the Master of Environmental Data Science (MEDS) Degree

I am writing to express my enthusiastic support for your proposed master's degree program in Environmental Data Science.

Data collection, analysis, and preservation are central to modern environmental scholarship. The amount of data environmental researchers have available to them is increasing by the day, yet we are struggling to manage this flood of information and make the best use of what we have. How do we turn information into knowledge? Your proposed master's degree will help answer this question by providing diverse students with the skills they will need in their twenty-first century careers, while helping advance our collective understanding of complex environmental changes and problems.

This proposal is particularly appealing to me. We don't generally think of historians as having data management challenges, or even really having “data” at all. Historical data more than a few decades old, however, is invaluable in interdisciplinary environmental scholarship due to its relative scarcity. For the past five years, in part to help address this problem, I have been working to develop an archive of historical materials related to the UC Natural Reserve System. These include primary source documents, images, artifacts, biological specimens, and other materials. Documenting, curating, and making these materials available for research and teaching has proven to be an enormous challenge—one that requires the expertise of a new generation of environmental data scholars of the kind you aim to produce through your program.

UCSB has long been one of the nation's top universities for environmental teaching and research. Your proposed master's program will build on this tradition and take us into crucial new areas. It is for these reasons that I strongly support the effort.

Sincerely,

Peter S. Alagona
8/29/2018

To: Professor Ben Halpern  
    Director, National Center for Ecological Analysis & Synthesis  
    Professor, Bren School

From: Robert Heilmayr  
    Assistant Professor  
    Environmental Studies Program  
    Bren School of Environmental Science & Management  
    University of California, Santa Barbara

Re: Establishment of the Master of Environmental Data Science (MEDS) Degree

I am pleased to write a letter in enthusiastic support for a new Master’s degree in Environmental Data Science. I believe MEDS offers a unique opportunity for UCSB to educate a new generation of professionals who are well-positioned to solve emerging environmental challenges.

My own research is a clear example of the ways in which data science can enable transformative solutions to critical environmental problems. Combining new technologies for the observation of Earth, with methodological advances in causal inference, I am able to quantify the impacts of conservation interventions in ways that were previously not possible. My past roles in government, environmental non-profits, and a technology start-up have impressed upon me the critical need for a new generation of professionals with fluency in data management, analysis and communication.

I believe that, upon its establishment, the MEDS program will be uniquely situated to train this next generation of professionals. Given UCSB’s proven excellence in both environmental and data sciences, the MEDS program provides an important opportunity for innovation in academic programming. I look forward to contributing to the program through research, mentoring and teaching, and to benefitting from the continued growth of the environmental data science community at UCSB.

Thank you for the opportunity to comment.

[Signature]
To Professor Ben Halpern  
Director, National Center for Ecological Analysis & Synthesis  
Bren School

From George Legrady  
Distinguished professor  
Director, Experimental Visualization Lab  
Media Arts & Technology

Re: Establishment of the Master of Environmental Data Science (MEDS) degree

I am writing in support for the proposed new Master’s degree in Environmental Data Science at USCB as there are synergistic opportunities in course and research interactions between the proposed degree and the Experimental Visualization Lab which I direct in the Media Arts & Technology program.

The Experimental Visualization Lab is dedicated to the analysis, methodologies and creation of data processing, visualization and interaction. The lab additionally focuses on creative explorations in the fields of visual language, machine vision, computation & photography, interactive digital installations and related directions addressing the impact of computation on visualization. The fundamental focus is the study of the image, both 2D, 3D and interactivity. The approach is to explore the syntactic nature of how images function to effectively communicate.

I have taught the M259 Data visualization project-based course focused on the aesthetics of algorithmic visualization annually since 2006.

The knowledge acquired in this course include:
1) Learn to explore and retrieve significant data from a dataset with MySQL
2) Develop skills in the fundamentals of visual language expressed through programming
3) Visualize abstract data to reveal patterns and relationships
4) Normalize data to enhance legibility and coherence
5) Implement interactivity within 3D volumetric visualization
6) Correlate various data sources through JSON and APIs.

The class make-up is graduate and highly interdisciplinary as students come from diverse departments that may include Computer Science, Geography, Statistics, Bren, Physics, MAT and other departments. Cross-listing this course with the proposed EDS Data Visualization and Communication is an ideal fit. The class currently can handle 15 students which means that there will be a need for TA support and additional computational/projection resources to expand on lecture and student work analysis presentations.

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Media Arts & Technology is the integration of the application of media and technology to experimental prototyping approaches as in the arts and architecture. Over the years, the term has shifted meaning, and today it may make more sense to say ‘media arts and computation’ or ‘computation, research, engineering,
science and arts”. The underlying core focus is that it is computational-based, there is an experimental applied and research approach, suggestive of the open systems in the arts in comparison to the systematic-procedural approaches specific to the sciences and engineering.

The experiments, projects, research and courses we do and offer contribute to the arts-engineering/scientific community in the following way: 1) Rapid testing of concepts through visual/spatial/interactive means 2) Explore new forms of visualizations through implementation of advanced knowledge of visual language, image syntax and semiotics through computation. 3) Address image-based research that are on the fringe of engineering/science research which may contribute to enhancing engineering/scientific research and discourse.

Students in the program come from a broad range of backgrounds that include computational design, architecture, media arts, engineering, physics, geography, computer science and others. There is an emphasis on interdisciplinary, hybrid approaches to achieve synthesis of high-end skills in conceptualization, visualization, and computation resulting in custom software development, visualization, deployable interactive systems for public installations.
August 13, 2018

To:    Professor Ben Halpern  
       Director, National Center for Ecological Analysis & Synthesis  
       Professor, Bren School

From: Yon Visell  
      Assistant Professor  
      Media Arts and Technology Program  
      Department of Electrical and Computer Engineering

Re:   Establishment of the Master of Environmental Science Degree

I am pleased to contribute this letter expressing my enthusiastic support for a new Master’s degree in Environmental Data Science at UCSB.

I am a faculty member in two departments that are home to large numbers of students with interests in spatial data sciences. The area of environmental data science is one of great interest in our programs, and of tremendous continuing importance to our university, to the broader research community investigating data sciences. It is also an area of great societal significance, not least due to the increasing awareness of the ability of human actions to rapidly change and respond to the environment. These are issues that demand multifaceted inquiry within existing disciplines, and, increasingly, integrated interdisciplinary efforts that account for the complex contexts surrounding environmental issues, and the urgent need for new data science approaches of understanding them. Through my work in science communication, including the radio show Unknown Territories that I co-host, I increasingly engage with the many, multi-faceted questions arising in these areas, whose importance is highly recognized by scientific community, by government and non-government organizations, and society at large.

Environmental data science is already an important strength at UCSB, as embodied through internationally recognized foci including the Bren School, NCEAS, Department of Geography, CCBER, Department of EEMB, Department of CS, and several other units. In addition, the proposed initiative is well-aligned with initiatives in data science that are of tremendous interest across the university. The proposed Master of Environmental Data Science will leverage these established strengths, and realize synergies within this high priority area at the university. As such, I am pleased to lend it my strongest support.

Yours Sincerely,

Yon Visell, PhD  
Assistant Professor  
University of California, Santa Barbara
August 30, 2018

To: Professor Ben Halpern, Director, National Center for Ecological Analysis & Synthesis
   Professor, Bren School

From: Alan Liu, Professor, Department of English

Re: Establishment of the Master of Environmental Data Science (MEDS) Degree

I'm pleased to write in support of the proposed Master of Environmental Data Science degree. Having worked with faculty and graduate students at the Bren school in the past on projects related to data science (for example, events and proposals in which Jim Frew participated under the auspices of the Center for Information Technology and Society or in my own grant projects), I can attest to how well a formal data science training program at the Bren will contribute to the campus at large. Plans for a larger, all-campus data science initiative on our campus make the MEDS proposal especially timely as one important piece of the puzzle. But even absent that larger framework, the way the MEDS degree can link up laterally with other nodes of data-science interest on campus are many.

Thematically, for instance, there is potential for linkage with faculty and graduate students in the English Department, which has a strong center in the digital humanities field as well as another in the field of literature and the environment. Some of the courses and projects in English that feature a data science component could potentially contribute to MEDs in the future in a way that brings a digital humanities and environmental humanities perspective to bear. For instance, the digital humanities do a lot of work with text-analysis and machine-learning—methods that could be brought to bear on documents of all kinds relevant to environmental study, including not just scientific and policy documents but the "cli fi" (climate fiction) that is of great interest to many on campus.

Beyond thematic and methodological issues, moreover, MEDS will contribute to a common need on campus across departments/projects for basic data science literacy. The following point in the MEDS proposal is particularly important in this regard: [MEDS will] "focus on the background, perspectives and tools used by different disciplines to analyze data, with an emphasis on environmental data and problem solving, and an aim to build competency across a range of data science topics." My own Mellon-founded WhatEvery1Says project has in the past contributed one-off workshops on basic data science (starting with issues as simple as data file formats and
going on to common kinds of data mining work). The campus needs a more established and recurrent cluster of such training opportunities for graduate students.

I endorse the MEDS proposal very enthusiastically.

Yours truly,

Alan Liu
Distinguished Professor, Department of English;
Affiliate Faculty, Media Arts & Technology Program
August 11, 2018

To: Professor Ben Halpern  
Director, National Center for Ecological Analysis & Synthesis  
Professor, Bren School  
From: Ronald E. Rice  
Professor, and Arthur N. Rupe Chair in the Social Effects of Mass Communication  

Re: Establishment of the Master of Environmental Data Science (MEDS) Degree

I am pleased to write a letter expressing enthusiastic support for a new Master’s degree in Environmental Data Science at UCSB. I have had the opportunity to comment on and discuss a prior draft, and have been informed about the planning process.

My research and teaching interests in communication campaigns and new media have expanded over the years to include environmental and science communication. I have published several articles in these areas, and have advised several senior honors theses, master’s theses, and Ph.D. dissertations on these topics. I have also recently completed work in the areas of “attention technologies” (collecting user behavior such as in the form of big data from social media but also other sources) and the integration of visual arts and science communication. I am not expert in environmental data science, but have been keeping up with many of the issues and methodologies, and personally would love to learn more about many of the topics in the MEDS program.

Our Department of Communication currently has several courses and faculty with expertise in science communication, and big data, and we do have a position for computational communication science in our FTE plans. However, we do not offer any such courses in our Ph.D. program (we do not have a separate Master’s program).

Thank you for the opportunity to comment on the MEDS proposal.

Ronald E. Rice
Professor Ben Halpern  
Director, NCEAS  

August 13, 2018

Dear Prof. Halpern,

I write to offer the UCSB Library’s support for your Proposal for a Program of Graduate Studies in pursuit of the degree of Master of Environmental Data Science. The Library is currently in the process of investing significantly in Library services in support of data science education and research.

The proposal for a Master of Environmental Data Science (MEDS) cites, among other justifications, that problems are increasingly interdisciplinary and data-driven, that data-driven conclusions must be transparent and repeatable, and that these changes require both new technologies and new skills. As much as this is true for the environmental sciences—the focus of MEDS—it is true for many other disciplines as well, and which explains why the Library has, in recent years, made key investments in supporting new research data-centric services and in developing new data literacy skills:

- The Interdisciplinary Research Collaboratory is UCSB’s home for data-centric research support. The Collaboratory team offers expert guidance on access to the Library’s data collections, and supports software tools to analyze and visualize quantitative, qualitative, and spatial data. It also collaborates with faculty, staff, and students to use these collections and tools for teaching and research.

- The Data Curation Program supports active and ongoing management of data produced by UCSB researchers throughout the research process. The Program aims to ensure that data are well-described and findable; accessible and usable; citable; and sustainably preservable. Program curators work with researchers early in the data lifecycle to establish good management practices.

At their core, both these services employ, and are engaged in developing, new data science skills. These Library services would work synergistically with the proposed MEDS program, for their goals are fundamentally aligned. The Library’s current work with Bren MESM students provides one concrete model of collaboration. Over the last several years the Library has worked with the Bren School to insert a data management requirement in the MESM group project curriculum, has begun giving students education in data management planning, and in the future will be working increasingly closely with the students to assist with their data management needs and approaches. The group projects that MEDS students participate in won’t necessarily generate the same kinds of data curation concerns that MESM projects do, but nevertheless there may be
opportunities for Collaboratory and Data Curation Program staff to contribute to the MEDS program.

Conversely, MEDS students could be a source of expertise for the Library. The Collaboratory is an outgrowth of an earlier Social Sciences Data Lab, which was staffed almost exclusively by graduate students possessing expertise with statistical software packages. The current Collaboratory could provide both a venue and an opportunity for MEDS students to share their expertise with faculty from other disciplines.

The Library is recruiting three new academic professionals to support new services related to research data management and training, including a data curator who has experience with earth and environmental sciences data and a relevant advanced degree. Data Curation Program Director Greg Janee is currently working with faculty on eighteen "Data Collective" pilot projects (seven of which are earth or environmental sciences related) to explore and develop solutions for diverse needs related to data management, workflows, and publication. Those pilots will enable the Library to become a more sophisticated and meaningful partner in supporting data-intensive research and education at UCSB.

The Library instructional program is evolving more broadly in the direction of focusing on data and computational literacies and tools, with the goal of complementing new and existing data science related courses. The Director of the Interdisciplinary Research Collaboratory (IRC) Jon Jablonski, could partner with the MEDS Training Coordinator on development of that training program so that it optimizes existing resources and takes full advantage of training spaces on campus as well as downtown.

The IRC (or other library spaces) could complement NCEAS' downtown facilities in offering on-campus workshops, boot camps, or support for the students' project-based work. The Library could be a convenient on-campus location for seminars, lectures, and events on topics that support MEDS goals of addressing environmental problems currently facing society that are also of broader interest, such as discussions of how data fits into the broader legal, policy, industry and regulatory context.

On behalf of UCSB Library, I would be pleased to provide any additional information.

Sincerely,

Kristin Antelman
University Librarian
August 24, 2018

Benjamin S. Halpern
Director, Nat'l. Center for Ecol. Anal. & Synth. (NCEAS)
Professor, Bren School of Environmental Science and Management

Dear Ben,

I am pleased to support the proposed Masters in Environmental Data Science (MEDS). This Master’s degree will fill an important niche and will establish UC Santa Barbara as a leader in the emerging area of data science. I appreciate the efforts to build upon the strength of the Bren School and to bring together experts across multiple departments on campus. Such cross-disciplinary endeavors have played an important role in UC Santa Barbara’s recent successes are consistent with its strategic plans for the future.

Sincerely,

Kelly Bedard
Professor and Chair
Department of Economics
Dear Ben,

I am writing in my capacity as the Director of the Earth Research Institute (ERI) to provide my enthusiastic support for your proposal for a Program of Graduate Studies in pursuit of the degree of Master of Environmental Data Science (MEDS) within the Bren School of Environmental Science and Management. As the ERI Director, I lead an institute with over 50 graduate students and almost 100 researchers, postdoctoral scholars, and specialists who collaborate with over 60 ERI-affiliated faculty from across the range of natural science departments on campus. In almost all cases, these ERI faculty investigators and the students and scholars they work with are tackling research questions that depend on the collection, curation, analysis, and synthesis of massive - and massively diverse - environmental data. Our community’s capacity to generate data (from both sensors and models) across the domains of coupled social and environmental systems has in many cases exceeded our capacity for interrogation and investigation. In many cases, ERI faculty investigators, their students and affiliated researchers are struggling to adapt to rapidly changing models of data analysis and inquiry. In short, scholarship in environmental science and policy across our campus is suffering from a lack of training and expertise in modern data science. This gap is largely the result of the dearth of data science programs in academia that are focused on disciplinary domains relevant to earth and environmental scientists. As long as we lack programs focused on environmental issues, the skills and expertise of modern data science will continue to diffuse slowly or not at all in our research.

The proposed MEDS program addresses this challenge head-on through its commitment to provide the training and expertise necessary to create a new class of environmental scientists and policy makers that are both proficient in modern data science approaches and the environmental problems to which they must be applied. The new courses and faculty efforts proposed within the MEDS proposal would have immediate
impact on the quality of ERI research and the scope and impact of ERI scholarship. Furthermore, the students graduating from the MEDS program would have exactly the sorts of skills and expertise that ERI faculty so sorely need within their research groups. The test of any new professional degree is the extent to which an un-met demand exists across a broad swatch of both employees and employers. While the greatest impact of MEDS will likely be in corporations, governments, and NGOs focused on environmental science and policy, I can state with certainty that this demand also exists within the academy in general and ERI specifically.

While the practical case for supporting this proposal is clear, I also believe there is a strong institutional motivation - even obligation - for UCSB to take on this initiative. There is a 30-year legacy of UCSB leadership in both methodological and pedagogical revolutions that - individually, and collectively - greatly strengthened the quality and quantity of earth and environmental science scholarship across academia. The first such revolution was UCSB’s foundational role in creating GIScience, which defined both a grammar and toolset for analysis of spatial aspects of coupled social-environmental dynamics. This was followed by decades of consistent innovation and leadership within environmental remote sensing, which continues to this day as UCSB pushes into novel areas of sensor networks and autonomous sensing systems. At the same time, the pedagogical revolution contained within the establishment and growth of the Bren school has created the necessary space for - and demonstrated the importance of - inquiry into the connected and inter-dependent nature of environmental science and policy. Finally, NCEAS’s two decades of success has come to define the critical importance of integration and synthesis for understanding complex system dynamics. Seen in this historical perspective, a proposed Masters in Environmental Data Science becomes an obvious next step for UCSB and one that I am confident will continue to solidify and sustain our campus’s legacy of leadership in advancing the science and policy of the environment.

Sincerely,

Kelly Caylor
Director, Earth Research Institute
Professor of Ecohydrology
Bren School of Environmental Science & Management
Department of Geography
University of California, Santa Barbara
August 3, 2018

To: Ben Halpern  
Director, National Center for Ecological Analysis & Synthesis  
Professor, Bren School

From: Maria Charles, Director  
Broom Center for Demography

Re: Master of Environmental Data Science Degree

As Director of UCSB’s Broom Center for Demography, I am writing to convey my enthusiastic support for the proposed Master’s Program in Environmental Data Science (MEDS). Many of the Broom Center’s graduate student associates, including some participating in our new PhD emphasis in Demography, are doing research related to environmental science and policy. These students would benefit from the data workshops and some of the new 200-level courses being proposed for the MEDS – especially courses related to data programming, statistics, and spatial analysis.

In addition, the hiring and programming described in the MEDS proposal would dovetail nicely with the Broom Center’s ongoing efforts to expand research and graduate training capacity in big data research and methods. Among other things, we are proposing a Consortium on Big Data and Population Research that would bring together all four UC demography centers (Berkeley, UCLA, and UCI, UCSB) around the theme of data science.

In short, I expect that the proposed Master’s Program in Environmental Data Science would generate a host of synergistic activities that would enhance the Broom Center’s intellectual life and advance its research and training mission. I am pleased to answer any questions (mcharles@soc.ucsb.edu).
I am writing to express my enthusiastic support for the new MEDS degree proposal. Data science has exploded in its impact on a wide range of issues, including: human health, strategic marketing for companies and political candidates, defense and national security, among many other areas. Environmental problems were not at the forefront of these developments of the field and its innovative technologies, but the emergence of tools that could employ vast amounts of data from diverse sources to explore exceedingly complex problems has now opened the door for new environmental solutions of global impact that could not be even imagined just a few years ago. UCSB faculty and researchers from across the campus have played a leading role in the development of Environmental Data Science. This proposal capitalizes on these unique campus strengths.

With UCSB’s core interdisciplinary culture and diverse strengths in environmental science, statistics, economics, political science and computer science, we have global leaders in all the relevant components of a more coordinated program in Environmental Data Science. These distributed talents have helped launch a broad campus initiative in Data Science across many areas, and I believe this program in the environmental domain can serve as a model for multiple future efforts (e.g., in the human health domain) that build on this broader campus initiative.

We have an opportunity here to define a new Professional School model for Environmental Data Science. I believe that this new, thoughtful proposal would set a high bar for other institutions around the world who will undoubtedly follow our lead. By linking multiple disciplines, and institutions like NCEAS, the proposal starts from real strength. As a result, building on the campus investments that have already been made in data science, the additional faculty resources needed to develop a comprehensive program are extremely modest relative to the impact this program will have.

In addition, this professional program has many parallels and potential synergies with the existing Bren MESM program. By leveraging our career development, student affairs and professional workshops, the new program can support a comparable number of new graduate students for significantly less cost. There will also be strong synergies between the two programs. I suspect a number of students will be interested in doing both programs. In addition, the proposed client driven MEDS thesis projects could be quite complementary to the current MESM group projects. I can imagine a number of coupled projects each year, where the MESM students tackle problems from the diverse social and natural science disciplines they bring to the table, while a group of MEDS students tackle a complementary problem utilizing large existing data sets.

The potential impact of this proposed program is underscored by the fact that we have successfully raised an initial anonymous gift of $3,000,000 contingent on the approval of the program. This gift is
designed to help launch the program with initial funding for staff and operations before contributions from the professional fees of students fully cover those costs. It will also provide significant fellowship funding to help the program grow and to draw a diverse student body. As a result of this gift, and a commitment from the EVC to fund one of the needed staff positions, even a very modest student interest will allow the program to avoid the need for deficit funding even from the first year. The Bren School can now safely cover risks of funding shortfalls, and I will continue to fundraise aggressively for the program to expand the scope of fellowship funding. Although this initial gift is substantial, I believe it is a small down payment on the level of donor support this program will generate.

With funding now on a sound footing for launching the program, a concern that any new program will raise is the availability of space for faculty, students and teaching. For the long term, in parallel with this program proposal effort, we have been collaborating with Environmental Studies, the Earth Research Institute, and the Natural Reserve System on a proposal for a new Environment building on campus. This design includes space for all the teaching and faculty needs of a fully developed MEDS program. It is a creative, collaborative proposal that has received initial enthusiasm across campus, but this solution is a long term vision dependent on significant new funding from state and philanthropic sources. In the shorter term, I have been working with the EVC on three complementary options: off campus space at the National Center for Ecological Analysis and Synthesis, auditorium space in the Marine Science Research Building adjacent to Bren Hall (conversations ongoing), and/or space in the newly approved and funded campus classroom building that was announced by Chancellor Yang. Even at peak projected size, this new program would only require classes with a capacity of 100. Offering some classes in existing space at NCEAS would be an appealing option even if space on campus is available, because it would allow the Masters students to interact with the international scholars who reside there for working groups on diverse environmental topics. This would be particularly appealing for summer boot camp style classes. I will make sure that appropriate classrooms, conference rooms, and offices for new faculty will be available.

Overall, this is an innovative proposal that provides a pathway to significantly increase the number of graduate students at UCSB while enhancing connections across campus that will help drive new solutions to global environmental challenges. We would be delighted to host this program at the Bren School, and I look forward to helping shape it into another high profile and high impact professional program at UCSB. The Bren School faculty share my enthusiasm for this proposal voting 24 yes, 0 no, 1 abstain, and 1 not voting (traveling) to support the MEDS proposal.

Sincerely,

Steven D. Gaines
Dean
Bren School of Environmental Science and Management
University of California, Santa Barbara
September 10, 2018

Ben Halpern  
Director, National Center for Ecological Analysis and Synthesis  
Professor, Bren School of Environmental Science and Management  
UC Santa Barbara

Dear Professor Halpern,

I am happy to provide this letter of support from the Division of Social Sciences for your proposal for a program of graduate studies in pursuit of the degree of Master of Environmental Data Science (MEDS).

The establishment of such a program with a professional MA will undoubtedly enhance the university’s interdisciplinary breadth; its core objective to establish an “emphasis on environmental data and problem solving, and an aim to build competency across a range of data science topics” will help us provide training to a new generation of environmental data scientists.

This proposal makes a compelling academic justification for why UC Santa Barbara should be a pioneer in developing a new Master’s program in the Bren School. This program will not only be the first in the UC system, but also the nation. The cross-disciplinary collaboration in environmental analysis continues the campus wide initiative on using a data intensive approach to assess environmental impacts and find new solutions in order to solve environmental problems.

The Division of Social Sciences is excited to be a part of this endeavor. We have a cluster of faculty in economics, political science, sociology and the Ethnic Studies, which are fundamental to environmental research and problem solving. The proposal shows an innovative and comprehensive education plan that is very well aligned with and will greatly contribute to initiatives and programs at UC Santa Barbara to support Social Sciences research and education excellence. I fully support this proposal and look forward to the continued dialog with the National Center for Ecological Analysis and Synthesis and the Bren School.

If you need any further information, please do not hesitate to contact me.

Sincerely,

Charles R. Hale  
SAGE Sara Miller McCune Dean of Social Sciences
To: Reviewing committees

From: Ben Halpern  
Director, National Center for Ecological Analysis and Synthesis (NCEAS)  
Professor, Bren School

Re: Establishment of the Master of Environmental Data Science (MEDS) degree

In my roles as Director of NCEAS, Professor at the Bren School, and lead author for the MEDS proposal, I write with enthusiastic support, without reservations, for the idea of a new Master’s degree in Environmental Data Science. My main purpose with this letter is to speak specifically to the resources that would be engaged and committed at NCEAS for the MEDS program.

NCEAS is committed to playing a lead role in helping support and execute the curricular, training, staffing and research dimensions of the MEDS program. NCEAS rents space in the Balboa Building and can expand our office space to accommodate additional staff as well as provide access to our small and medium-sized conference rooms and the larger (120 person) lecture hall for instruction. Our existing administrative, computing and informatics staff are committed to engaging and working with new staff hired as part of MEDS to create seamless instructional and analytical environments at NCEAS and closely coordinate with activities and needs at the Bren School. The many research working groups that occur at NCEAS offer exciting opportunities for capstone group projects, and we will work to align those opportunities as they occur and make sense. Furthermore, our training staff, who run regular environmental data science boot camps (from 1 day to 3 weeks), are excited to work with the MEDS training coordinator to be hired to expand their role in training opportunities across campus, in coordination with other existing and emerging data science trainings.

As Director at NCEAS I am committed to remaining strongly engaged at campus, departmental, and Center levels to ensure the success of the MEDS program. This is a really exciting time and opportunity for UCSB to play a global leadership role in environmental data science, training the next generation of practitioner and scientific leaders. I’m excited to help see that vision to fruition.

Sincerely,

Ben Halpern
TO: Professor Benjamin Halpern  
Bren School of Environmental Science and Management

FROM: Gretchen Hofmann, Chair  
Ecology, Evolution, and Marine Biology (EEMB)

RE: Letter of support for proposal for a Masters degree in data science

This letter expresses the support of EEMB for the proposal to establish a professional Master’s degree in Environmental Data Science (aka the MEDS) at UC Santa Barbara.

This new, proposed professional Master’s program would bolster the training opportunities for graduate students interested in working with EEMB faculty on their research. Many EEMB faculty already have strong connections to data science in an ecological and environmental framework, and this degree option would increase our access to graduate students with an interest in data science in an environmental context. EEMB faculty would, where appropriate, be able to contribute to the mentoring teams for the MEDS students.

The proposed program also leverages many cross-cutting interactions on campus, and from an EEMB perspective, takes advantage of pre-existing data science driven interactions ay UCSB to train a much needed corp of early career data scientists.
To Whom It May Concern:

**Letter in support of the proposal for a Master's degree in Environmental Data Science**

It is with enthusiasm that I write this letter of support for the proposed Master's degree in Environmental Data Science. As director of the Center for Spatial Studies at UCSB, I favor any efforts to promote spatial computing and equip students with a better understanding of and stronger skills in environmental data handling. It is rare that such efforts become possible at the scale that this proposal envisions. The proposed graduate program is the most substantial and most promising interdisciplinary effort on this campus to strengthen spatial thinking and computing in many years. It is timely, highly interdisciplinary, and carried by world leaders in research and practice on the subject. With Geography’s new MAGIS degree being focused on GIS, and the Spatial Center not having an educational mission anymore, MEDS is what UCSB needs as a pillar of its data science efforts. Furthermore, it comes at the very reasonable price of just two new FTE lines.

Interdisciplinary research and education need to go hand in hand, which in turn makes UCSB the ideal university to launch such a degree. Its unique cluster of centers of excellence with environmental foci, including the Bren school, Geography, Computer Science, the Ecology, Evolution, and Marine Biology (EEMB), Economics, Statistics, the Center for Spatial Studies, and the National Center for Ecological Analysis and Synthesis (NCEAS) provides a dynamic body of educators, researchers, and professionals. They will make sure that the graduates coming out of the proposed program are ideally equipped to help solve complex environmental problems.

The natural environment, with its physical, social, and human dimensions, is probably the domain offering the greatest opportunities for turning “big data” and data science into societal benefits. The environmental challenges society faces are enormous, ranging from water supply through wild fires and soil conservation to climate change and biodiversity. Addressing them may be the most important and certainly is the most comprehensive application of data science today and in the foreseeable future. Yet, understanding and solving environmental problems requires novel educational profiles that combine studies of the environment with cutting edge skills in managing and processing big data.

My own teaching and research efforts in this area and those of many colleagues in Geography, Computer Science, Bren, and other parts of UCSB still fall short of addressing the vast and rapidly growing need for graduates with solid skills in environmental data management, particularly at the Masters level. Additional educational efforts need to be tied more strongly to solving real-world problems. Applications (in this case, related to human understanding and acting in the environment) need to drive the acquisition of technological skills by students. For this and other reasons, entities like Bren and NCEAS are uniquely qualified to build and grow such a program. The proposal shows the right vision and calls for very moderate resources to put the vision into practice.

The accelerating pace of student qualification requires balancing a solid educational experience with the possibility to attain a degree in a relatively short time. The full year allocated to
the MEDS degree achieves this balance and make the program competitive on the regional, national, and international level.

To mention just one content aspect, the program emphasis on science communication is immensely important, in my opinion. The days where data analysts were hiding behind their screens in the basements of environmental agencies and planning offices are gone, but technologically oriented educational programs are not yet forming graduates who combine solid data processing skills with an awareness and competence for clear and convincing communication.

In sum, I am thrilled at the perspective of having this new qualification program start soon at UCSB. I will be more than happy to support it in any ways I can, through my Geography faculty and Spatial Center director roles. For example, my introductory GIS course (Geog 176A), which has a non-traditional textbook under development, might provide MEDS students with a clearer understanding of how to ask and answer questions about the environment.

Dr. Werner Kuhn
Director, Center for Spatial Studies
Professor, Department of Geography
Jack and Laura Dangermond Chair in Geographic Information Science
September 10, 2018

Professor Ben Halpern
Bren School
National Center for Ecological Analysis and Synthesis

Dear Ben:

Thank you for giving me the opportunity to review the proposal to establish a Master of Environmental Data Science, which would be administered by the Bren School and the National Center for Ecological Analysis and Synthesis. The well-conceived proposal was clearly written and fully addresses key issues such as funding, staffing, and student demand. I enthusiastically endorse the proposal.

The proposal rightly focuses on the important intellectual connections between the new master’s program and campus initiatives in data sciences. In addition to those synergies, there are also potential connections between the arts and humanities. We have a growing number of faculty members in the Writing Program, Film and Media Studies, Media, Arts, and Technology, and other departments interested in data visualization as both a significant art form and as an important rhetorical device. While students in the Environmental Data Science program will be required to take at least one course in data visualization and communication (EDS 240), arts and humanities faculty members could also develop additional courses to serve as electives for the program.

Please let me know if my office can facilitate possible collaborations. This is an exciting proposal, and I am very pleased to support it.

Sincerely,

John Majewski
Michael Douglas Dean of Humanities and Fine Arts
Date: August 7, 2018

To: Professor Ben Halpern
   Director, National Center for Ecological Analysis & Synthesis
   Professor, Bren School

From: Professor Jon McCammond
      Chair, Department of Mathematics

Re: Establishment of the Master of Environmental Data Science Degree

Dear Professor Halpern,

On behalf of the Department of Mathematics, I am pleased to write a letter in support of the proposed new masters degree in Environmental Data Science.

The Department of Mathematics is an active participant in the campus-wide Data Science Initiative as well as other interdisciplinary data science efforts. We have been offering two graduate courses on the mathematical foundations of data science and similar courses at the undergraduate level are currently in the planning stages. The MEDS program would be an excellent opportunity for an important segment of our graduate student population to be exposed to and to participate in data science applications to environmental science problems. Our department looks forward to collaborative research interactions with the MEDS faculty and graduate students.

As I noted when we met in person, Mathematics is currently stretched to breaking point, so we are unable to offer any concrete resources in support of your efforts. Nonetheless, the Department is very excited about the new opportunities for interdisciplinary research and education that the emerging field of Data Science offers and we look forward to collaborating with you to support this type of initiative.

Sincerely yours,

Professor Jon McCammond
Chair, Department of Mathematics
SEPTEMBER 7, 2018

To: Professor Ben Halpern  
   Director, National Center for Ecological Analysis & Synthesis  
   Professor, Bren School

From: Professor Marko Peljhan  
   Chair, Media Arts and Technology Program  
   Director, Systemics laboratory

Dear Ben,

I am pleased to write a letter of enthusiastic support for a new master's degree in Environmental Data Science, an extremely timely development for strengthening UCSB stature in this field.

The Media Arts and Technology program at UCSB is uniquely positioned to be able to support such a program with our expertise in data visualization, community data gathering and citizen sensing projects experience, sensor networks, large scale data display, parsing, processing and remote sensing.

We think that the MEDS proposal is extremely timely and see great potential for the development of Environmental Data Science as a field at UCSB, with our University's unique, diverse and synergistic set of capacities.

Our program, including our students, would also benefit from the connection with MEDS students and we can definitely envisage joint projects, that combine the skills of our programmers, engineers and artists with their colleagues in MEDS and wider through real-world projects.

As you know, both myself and Prof. Legrady are prepared to teach classes that will fit the MEDS curriculum and the initiative has full support of the Media Arts and Technology community at UCSB.

Sincerely yours,

Marko Peljhan  
Professor  
Interdisciplinary studies  
Media Arts and Technology Program  
University of California Santa Barbara
August 30, 2018

To: Professor Ben Halpern  
   Director, National Center for Ecological Analysis & Synthesis  
   Professor, Bren School  

From: David N. Pellow  
   Chair, Environmental Studies Program and Dehlsen Professor of Environmental Studies  

Re: Establishment of the Master of Environmental Data Science (MEDS) Degree

I am pleased to offer this letter of enthusiastic support for the new master’s degree in Environmental Data Science. The MEDS degree is multi-disciplinary and multi-methodological, drawing on and building on key strengths in the Bren School and UCSB campus, including training in the use of big data to advance solutions to some of the most important challenges facing humankind and the biosphere. The success of this program would be enormously consequential for amplifying UCSB’s global profile as one of the world’s leading academic institutions pursuing solutions to the grand challenges of our time.

While I have not yet had the opportunity to have a formal discussion with my faculty colleagues on this matter, I am personally excited about and supportive of the MEDS goals and aims. The FTE Plan and hiring plan in the Environmental Studies Program includes faculty positions in the following areas, all of which have clear and important linkages with the MEDS program because of their relevance for research and teaching on Environmental Data Science: Agriculture, Food and the Environment; Urban Environments; Global Change Science; and Environmental Ethics.

Thank you for the opportunity to comment on the MEDS proposal.

Sincerely,

David N. Pellow
August 16, 2018

To: Professor Ben Halpern  
   Director, National Center for Ecological Analysis & Synthesis  
   Professor, Bren School

From: Katja C. Seltmann, PhD  
       Katherine Esau Director, Cheadle Center for Biodiversity and Ecological Restoration

Re: Establishment of the Master of Environmental Data Science (MEDS) Degree

I am pleased to write a letter demonstrating my enthusiastic support for a new Master’s degree in Environmental Data Science (MEDS) at UCSB. I see a natural home for this program at NCEAS because of its long career as stewards of data science for ecology through innovative programs such as the development of the Ecological Metadata Language, DataOne, and other programs.

There is an increasing demand for programs such as the proposed MEDS program on campus and within our discipline. For the past three years, I have organized introductory R Software carpentry workshops designed to address a self-described need of the graduate students in Ecology, Evolution and Marine Biology. The graduate students clearly understand that they require foundational skills in data science for ecological and organismal data such as programming, data formatting, visualization, versioning, and analysis. These workshops, held at the UCSB Library Collaboratory, typically fill up to capacity of 25 students within hours of the short course announcement. This is just one example of the many grass roots efforts on campus to train our students in essential data science skills because the need to do is so apparent.

The Cheadle Center offers distinct benefits to the MEDS program and I look forward to establishing future collaborations with the program. We are a campus unit whose mission is to support UCSB through ecological restoration for mitigation, management of natural history collections, and community environmental education. This mission creates an interface between “job training” in ecological services and university education that is unprecedented at other universities. We actively engage in a variety of ecological restoration activities, ecological monitoring, and we are making those data and reports
available. We have an extensive internship program offered through many departments including Environmental Studies, Geography, English and Ecology, Evolution and Marine Biology. In these internships, student gain practical and early research experience in museum data science, environmental education, science communication and ecological restoration.

The UCSB Natural History Collections are actively involved in several Biodiversity Information Science competitive proposals, teaching and we are evolving as a resource for faculty specimen data management. These topics are central to supplying quality datasets about species occurrences, and contribute to our understanding of biodiversity and evolution through the data associated with museum specimens and observations. Again, this is another area where the Cheadle Center could find synergies with the MEDS program and I look forward to exploring some of these options.

Thank you for the opportunity to comment on the MEDS proposal and express my strong support for a Master of Environmental Data Science (MEDS) Degree at UCSB.

Sincerely,

Katja Seltmann, PhD
University of California, Santa Barbara,
Katherine Esau Director, Cheadle Center for Biodiversity & Ecological Restoration
Harder South, Rm 1005
Santa Barbara, CA 93106
Phone: 859-537-9309

Copy: Kelly Caylor, Director Earth Research Institute
Prof. Ben Halpern  
Bren/NCEAS  
halpern@bren.ucsb.edu

Dear Ben,

This letter is written in enthusiastic support of the revised proposed for a Masters in Environmental Data Science (MEDS) program that you are leading for campus. I like that the revised program is a campus-wide initiative and not an isolated development, walled off from the rest of campus. Further, the idea to make it a “professional-like / high touch” program makes a great deal of sense, especially given Campus’ desire to keep increasing the graduate fraction of our total enrollment. As Chair of the Interdepartmental Graduate Program in Marine Science (IGPMS), I appreciate that there will be opportunities for our PhD students to take a class or two as they develop their research objectives. I’m confident the program complements the 5th year BA/MS degree program in Geographic Information Sciences that my home department is currently considering. In all, I see the MEDS program as a big win for campus.

I believe that a UCSB graduate training program in environmental data science is long overdue. UCSB has long been THE national leader in the environmental data sciences. This can be traced back to the 1980’s through large programs like NASA’s Earth Observing System, the UC-Digital Equipment Corporation consortia Sequoia 2000, NSF’s Alexandria Digital Library, the National Center for Geographical Information and Analysis and over the last 20 years the National Center for Ecological Analysis and Synthesis. From the outside world’s perspective, the MEDS program simply codifies UCSB’s global leadership in this important area of graduate training and research.

Congratulations on raising the necessary donor funding to help support the staffing. It is a professional program and rightly belongs run by Bren. From what I have seen so far of the financial side of things I think it all makes sense.

Again, let me know what I can do to help you make the MEDS program a reality. I see it as a piece of the larger puzzle in Data Science and a no brainer for Campus.

Best,

[Signature]

Prof. David A. Siegel  
Chair, Interdepartmental Graduate Program in Marine Science and Distinguished Professor, Department of Geography  
University of California, Santa Barbara  
Santa Barbara, CA 93106-3060, USA  
Email: dave.siegel@ucsb.edu  
Ph: 01-805-893-4547
Professor Ben Halpern  
Director, National Center for Ecological Analysis & Synthesis  
Bren School of Environmental Science & Management  
UC Santa Barbara  

Re: Support of the proposed Master of Environmental Data Science (MEDS) degree  

Dear Ben,  

I am pleased to write in support of the revised proposal for a new Master’s degree in Environmental Data Science (MEDS) at UCSB. As the proposal makes clear, Data Science is an important emerging area of research and study, and I view the MEDS proposal as a significant piece of a larger data science initiative at UCSB. The proposed program makes good sense for Bren and for the university, and it is likely to generate new opportunities for synergy and collaboration between Bren and Computer Science.  

As computer science is a fundamental component of data science, and I expect the new program will help generate new interactions and research collaborations among faculty from Bren, CS, and other departments. The new degree program will add to Bren’s reputation and help UCSB move forward in this timely field of study, which benefits CS as well.  

The proposed program is well constructed and should draw considerable interest from a wide range of students. I strongly support the proposed program and look forward to its successful implementation.  

Sincerely,  

Matthew Turk  
Professor and Chair  
Department of Computer Science
September 10, 2018

Professor Ben Halpern  
Bren School of Environmental Science and Management  
Director, National Center for Ecological Analysis & Synthesis  
University of California, Santa Barbara

Dear Professor Halpern,

As Director of the UCSB Center for Information Technology and Society, I’m pleased to endorse the proposal for a Master of Environmental Data Science (MEDS) degree program. The MEDS objectives and strategies—to develop a synthetic curriculum integrating information technology, big data, decision-making, and science communication, in the context of developing practical understanding of environmental science and management—offers a model, 21st Century curriculum.

Not only does the MEDS curriculum hold merit, it’s also consistent with the vision that our own Center looks to promote: We’re at our best when we tackle the problems that are too big for any one or two disciplines to understand and solve on their own. Our own work attempts to share perspectives and integrate scholarship in research across engineering, social sciences, science, education, and the arts and humanities. Your own proposal mirrors this integrative approach. Moreover, the centrality of data science in the equation resonates not only with our own work but with other current campus initiatives.

What this means for all of us is an increase in the kind of masters students, faculty, and expertise that we desire to foster. New faculty supporting MEDS may be likely to become affiliates of our Center, adding to reciprocal activities in our multidisciplinary efforts and drawing on the expertise of Center affiliates as needed.

The kinds of students MEDS will attract and graduate, should they turn toward doctoral study, will be just the kind we hope to see in our PhD emphasis in Information Technology & Society, in which Bren has been a participant in the past; the emphasis routes PhD students into courses in Humanities and in the Social Sciences that complement their technical foundations. This helps them to apply and temper the scientific knowledge they develop in the major with a formal understanding of social consequences and values and ethics that are so important to them.

For these and many more reasons, speaking for the 54 faculty affiliates of the Center for Information Technology and Society, I’m impressed by the MEDS proposal, encourage its approval, and look forward to its implementation at ICSB.

Sincerely,

Joseph B. Walther  
Mark and Susan Bertelsen Presidential Chair in Technology and Society
University of California Santa Barbara  
Natural Reserve System  
MSRB 520, Room 4003  
Santa Barbara, CA 93106-6150

August 14, 2018

To: Professor Ben Halpern  
   Director, National Center for Ecological Analysis & Synthesis  
   Professor, Bren School

From: Marion Wittmann, Ph.D.  
   Executive Director, UC Santa Barbara Natural Reserve System

Re: Establishment of the Master of Environmental Data Science Degree

On behalf of the UCSB Natural Reserve System (NRS) I am writing to express support for a new Master’s degree in Environmental Data Science (MEDS) at the University of California Santa Barbara.

The UC Natural Reserve System is a network of protected natural areas throughout California which provide undisturbed environments for research, education, and public service in order to contribute to the understanding and wise stewardship of the earth. The seven NRS reserves managed by UCSB represent a wide variety of ecosystems ranging from estuarine wetlands to alpine coniferous forests and have active programs and facilities to support research, university-level education and public outreach in service of the mission of the University of California.

There are many opportunities for synergies between the UCSB NRS and MEDS program. As “living laboratories”, the UCSB Reserves provide not only the opportunity to connect MEDS graduate students and researchers with the environments that they are assessing, but also the research facilities, data networking capabilities and
accommodations to support environmental data science teaching and research goals. The seven UCSB Reserves could provide sites to be utilized by MEDS program to support field-based aspects of the graduate level curriculum as well as potential sites for group thesis projects. Further, the UCSB Reserves have ongoing partnerships with a number of state and federal agencies, NGO's and other organizations, that may offer opportunities for MEDS student engagement and potentially employment after graduation.

The MEDS program will provide benefit to the UCSB NRS directly through increased on-site research and graduate level educational use of the Reserves that directly promote the mission of the UCSB NRS. The MEDS program could enhance UCSB NRS’ ongoing UC and non-UC collaborations a number of data networking programs such as UCSB’s SmartFarm, the UC Natural Reserve Climate Monitoring Network, and the California Phenology project. These and other partnerships stand to benefit from the research and training opportunities proposed in the MEDS program that may improve data collection, management, analysis, interpretation and communication. Lastly, synergies between the MEDS program and the UCSB NRS will increase fundraising and development activities not only for both programs, but also for UCSB and the University of California as a whole.

The proposed Masters of Environmental Data Science is well positioned to fill current and growing market needs for highly trained data scientists who can transform the way corporations, organizations and institutions address and solve environmental problems. This program will undoubtedly place UCSB at the forefront of this emerging and needed field. Thank you for the opportunity to comment.

Marion Wittmann, Ph.D.
Executive Director, UCSB Natural Reserve System

Copy: Patricia Holden, Director, UCSB Natural Reserve System
November 13, 2018

TO: Amr El Abbadi, Chair  
Graduate Council

FROM: Carol Genetti, Chair  
Graduate Division

RE: Proposal for a Master’s Degree in Environmental Data Science

Thank you for the opportunity to comment on the proposal for a new professional Master’s program in Environmental Data Science. It is clear that the program is innovative, timely, and meets a key societal need. The many letters of support amply demonstrate that the program is an excellent fit for UC Santa Barbara, would build on significant strengths, and would complement existing programs across campus. I find the Bren School’s arguments on projected need and student demand to be compelling and the enrollment projections seem feasible.

As the proposal makes clear, the academic program is intensive, but the workload is still reasonable for full-time students. The group project model for the capstone has been highly successful in the Bren MESM program, and I believe it will translate well within the shorter MEDS framework and provide experience that will be highly valued by employers. Due to the admissions requirements, admitted students will come into the program with relevant skillsets. The summer boot-camp classes will provide opportunities to refresh these skills, which will help students transition to the two-week summer classes and the more in-depth courses during the academic year.

As you are well aware, campus space is a significant challenge at UC Santa Barbara. This dearth will eventually be remedied, at least with regard to instructional space: the campus has received an allocation of funding from the State for a new building dedicated to instruction. That project is in the final stage of Regental approval and is entering the design phase. In addition, discussions regarding another new building to support the environmental sciences have been initiated. By the time the MEDS program reaches its full size, the classroom inventory on campus would be greatly increased. There will be challenges in the short term. The proposed two-campus solution is a creative innovation. The plan is to hold classes at the Balboa building in downtown Santa Barbara and at the UCSB campus on alternate days. This arrangement will pose some challenges for faculty and students, but the program’s supporters are well-aware of these and have made a good case that it is a workable arrangement as the program gets established and new facilities are built on campus. Regarding office space, the proposal states that the program will need 17 new offices, mostly at UC Santa Barbara. The letter from Steven Gaines, Dean of the Bren School, indicates that he will take responsibility to ensure that these offices and other campus spaces are available.

The proposal lists eight current faculty members committed to teach in the program. Seven of the eight are listed as instructors in the proposed initial teaching plan (assuming the hire of an LSOE and a ninth faculty member). This suggests that there will be adequate faculty to cover sabbaticals or other leaves. Given the enthusiastic support of MEDS from Bren faculty, I assume that the allocation of five or six courses annually will not negatively impact either the MESM or the doctoral curriculum within the Bren School. The proposed request for two new faculty FTE is sufficiently modest to be accommodated through the regular process of FTE allocation. In addition to new Bren faculty, the data science initiative across campus is likely to lead to additional faculty appointments in relevant areas.

Both the intensity of the one-year program and the two-campus solution will make it challenging for MEDS students to serve as TAs in other departments, although perhaps some will do so. Whether or not MEDS in fact generates a large pool of TAs, the underlying strength of the proposal remains. More important to campus strategic goals is the program’s ability to increase the graduate student population, as well as its commitment to reach out to, admit, and
recruit a diverse student body. The Graduate Division has set an aspirational goal of having the diversity of the graduate students reflect that of our undergraduates. In setting diversity goals, the Bren School may want to consider whether the cohorts that it admits reflect the diversity of UCSB majors in Environmental Science. Even more important from a societal perspective is whether admitted cohorts include members of minority or other underprivileged populations that are directly and disproportionately impacted by the negative effects of environmental degradation.

There are considerable staffing needs laid out in the proposal. I understand that it is important for a one-year professional program to be very well run and to provide significant support for professional development and career attainment. These costs are appropriately covered by the PDST and donor funds.

The budget overall is comprehensive and realistic. The identification of a significant philanthropic gift to launch the program will allow it to avoid deficits as it ramps up to full size, assuming enrollment and cost projections are accurate (which they appear to be). The PDST level brings the overall cost within the range of comparable programs nationally, and there is a strong plan for financial aid to ensure access.

In sum, the Bren School has put forward a compelling proposal for a professional Master’s program that is well designed, appropriately resourced, likely to have significant student demand, and will equip students with skills that can be applied to perhaps the most significant challenge of our century. I enthusiastically endorse this proposal and strongly recommend approval by the Graduate Council.
November 13, 2018

To: Kelly Erland
Senate Analyst, Academic Senate

From: Rod C. Alferness  
Dean, College of Engineering

Re: Comments on the Proposal to establish a Professional Master’s degree in Environmental Data Science

First, I would like to thank the Graduate Council for offering me the opportunity to comment on the proposal from the Bren School and the National Center for Ecological Analysis and Synthesis to establish a Master’s degree in Environment Data Science (MEDS). The authors are to be commended for a comprehensive proposal. As I have previously indicated the concept of a Master's degree in the field of Data Science applied in the field of environmental science is a very reasonable one that would leverage the Bren's strength in environmental science and would be an early entry into this space. It is also clear that data science technologies are being aggressively applied in many areas of industry. We have seen that vividly in the demand for our computer science and engineering graduates.

I would like to commend Ben Halpern and the entire proposal committee for their creative and substantial efforts to make significant changes from their original proposal. I appreciate that they have creatively addressed the concerns that were raised with the previous proposal, I believe that using the professional Master’s degree model is an appropriate one for this program. There is clearly high demand for employees trained in Data Sciences. The Bren School is a top tier, highly prestigious institution for Environment Sciences and Management and this field is rich in data and well suited to reap valuable information and insight from data mining. Therefore, I believe that graduates from this program will be highly sought after in industry making a professional Master’s degree with the additional fee appropriate. I want to commend and congratulate the Bren School for their success in fundraising for this program. It is great that donor funding will be available to help support the program, eliminating upfront debt and providing some fellowships for students for whom the extra fees are a major burden.

This approach with a portion of the extra fee to be used to provide most of the necessary staff mitigates my concern relative to the earlier proposal that required a significant number of campus funded staff while now my understanding is that only one will be required. I appreciate that the new proposal is more reasonable with respect to new faculty FTE needs. I note and appreciate that the new proposal has also added prerequisites that will help to ensure that incoming students are prepared and motivated...
for the rigorous program to be completed in one year. Such prerequisites were viewed as necessary by several of our faculty.

As I indicated in my comments on the previous proposal, I strongly believe that it is important for UCSB to have a campus wide strategy for Data Science and my major concern with the earlier proposal was that the resources requested were so large that the program would preclude future Data Science programs in other areas. For reasons indicated above I am less concerned about that problem with the new proposal. Nevertheless, I do strongly believe that UCSB needs to have a more holistic campus strategy on data science, that includes a strategic vision and high-level resource allocation, in Data Science and its application to other disciplines. That goal is being addressed in the EVC’s Data Science initiative committee chaired by Ambuj Singh. I am pleased to see Bren representation on this committee which has already launched an undergraduate course on Data Science that requires no prerequisites.

So, with the caveat that strong collaborative participation of this program’s leadership continues on the EVC’s Data Science Committee including sharing of best practice and learnings, I am pleased to support this new proposal to establish a professional Master’s degree in Environmental Data Science.
2 January 2019

To: Amr El Abbadi, Chair Graduate Council  
   Kelly Erland, Academic Senate Analyst  
   UCSB Academic Senate

From: Pierre Wiltzius, Dean  
       Division of Mathematical, Life and Physical Sciences

Re: Addendum to Comments on the Proposal to establish a Master of Environmental Data Science

In response to the December 13, 2018 memo from Graduate Council, Prof. Halpern discussed with me my main concerns with the proposal. He also shared with me a draft of the letter in response to reviewing agency comments that responds to the most recent concerns.

Prof. Halpern provides more detail regarding the teaching load of Bren faculty. In particular, he makes it clear that the MEDS program will actually be starting with an effective five new positions; the two requested in the proposal, one FTE that was hired this year into Bren, and two recent hires into Bren that had not yet begun teaching. This makes the feasibility of delivering the curriculum of the MEDS program much more plausible.

The use of MEDS students as Teaching Assistants also had been one of my previous concerns. I am glad to see that in the revised proposal, the discussion of TAships has been reduced and its importance minimized.

Finally, I am happy to hear that Prof. Ambuj Singh has submitted a letter addressing the efforts to integrate the MEDS program with the broader discussion of a cross-campus effort in Data Science.

Overall, I think the MEDS proposal is in much better shape and will be a powerful addition to and UCSB/Bren. This degree would be of great interest to both recent graduates and mid-career professionals. I do strongly support moving forward with this proposal and look forward to its great success.

cc: Dorothy Satomi, Assistant Dean, MLPS
Dear Ben:

I would like to reiterate my support of the proposed Master of Environmental Data Science (MEDS) degree program. The proposed program is an important piece of our campus's response to the growing importance of data science nationally and internationally. Many universities are scrambling to adapt to this fast-changing area by creating new programs at the undergraduate and graduate levels, research centers, and new schools and colleges. The UCSB Data Science Initiative was launched in summer 2018 to address this need. We are already a few years behind a number of other universities (including sister UC campuses at Berkeley and San Diego) and have been playing catch-up for the past year.

The campus working group on the data science initiative has met multiple times in order to coordinate the different ongoing campus efforts and develop an agenda for the future. Our charter includes the development of a sequence of undergraduate and graduate courses that lead to emphases, minors, and degree programs, the development of focused areas that build on UCSB’s strengths, and the recruitment of faculty members that can be situated across multiple departments in order to establish interdisciplinary bridges. Our main undertaking currently has been the offering of undergraduate and graduate courses. We offered a new undergraduate course (INT 5) for freshmen last Fall and will be offering an undergraduate and a graduate course in Spring. We plan to offer more courses in the 2019-20 academic year and follow up with an undergraduate major. While the working group has focused on these courses, it welcomes complementary efforts such as the MEDS program. For UCSB’s data science effort to stand out nationally, there need to be prominent and visible areas of strength. Bren, NCEAS, and the broader environmental science research at UCSB undoubtedly provide this. The MEDS program emphasizes our strengths through a unique graduate level training program. It has the potential of building new cross-disciplinary efforts between Bren and rest of the campus.

I thank you for your leadership in developing the MEDS program and support it wholeheartedly. We need to act on this quickly and in parallel with other activities in data science.

Sincerely,

Ambuj K. Singh
Professor
Dept. of Computer Science
Biomolecular Science and Engineering
Lead, Data Science Initiative
January 2, 2019

To: Ben Halpern, Director, National Center for Ecological Analysis and Synthesis, Professor of the Bren School of Environmental Science and Management; Steve Gaines, Dean, Bren School of Environmental Science and Management

From: Nicole Klanfer, Managing Senior Director, Development

RE: Support for proposed Master of Environmental Data Science (MEDS) Program

I am writing to inform the review process of the proposed Master of Environmental Data Science (MEDS) Program, specifically regarding donor support for the program:

- This is to confirm receipt of a $3 million donation from an anonymous donor to support the proposed Master of Environmental Data Science program. Pledge payment in full was received on December 11, 2018 and is being held in cash at the UC Santa Barbara Foundation. As the donor indicated in memo dated May 17, 2018,

  “I would like . . . $3 Million . . . be directed to support new curriculum and programs in association with the establishment of a new Master’s degree, the Master of Environmental Data Science (MEDS) in the Bren School of Environmental Science and Management . . . I understand that any new degree program requires approval by the UC Santa Barbara administration and Academic Senate, by UC Office of the President, and by the UC Regents.

  Funds may be held in an account at the UC Santa Barbara Foundation and not expended until such time that MEDS is formally approved. . . You may utilize my commitment in the best way to maximize the approval and success of the Master in Environmental Data Science.”

- It is important for donor stewardship that the campus demonstrates the maximum impact of this philanthropic investment and that these funds are used to pursue excellence in the program as quickly as possible. While funds can be used flexibly to launch and implement the master’s degree, it is prudent to direct a meaningful portion of this gift to provide as many fellowships as possible as one of the best ways to attract and support top students.

Furthermore, it is in the experience of UC Santa Barbara Development that our ability to maximize future fundraising for MEDS is better served if the initial gift is spent down in a timely manner to build the stature and visibility of the program and to create a clear need for subsequent donor support. We are optimistic that if the program launches effectively and we can illustrate the impact of the gift, the donor has indicated their inclination to make additional significant future investment in MEDS. Additionally, we have confidence in our ability to develop a strategic plan to leverage this gift and identify and cultivate additional donors who will have an interest in supporting MEDS.

Please let me know if you or the review committee have any additional questions or needs additional documentation. Thank you very much.
January 3, 2019

To: Dean Steve Gaines, Bren School of Environmental Science and Management

From: David Marshall, Executive Vice Chancellor

Re: Bren Masters of Environmental Data Science Proposal

I am pleased to see that the proposal for a new Master’s program in Environmental Data Science submitted by the Bren School of Environmental Science and Management is in the final stages of campus review. Graduate Council has indicated that it is “generally supportive of this initiative” and Dean Genetti has given her endorsement. Graduate Council has requested some clarifications and revisions to ensure that the campus can put “the strongest possible proposal forward.” At this point, after seeing the comments conveyed in Graduate Council’s December 13, 2018 memo to you and Professor Halpern, it seems appropriate for me to make some observations from the perspective of my office that will help reviewing agencies assess the final proposal.

- **Data Science:** I agree that the proposal should be seen in the context of a “holistic campus strategy for data science initiatives.” I have convened several faculty discussions, and an advisory committee chaired by Professor Ambuj Singh, to make recommendations and explore strategies for advancing both research and curricular initiatives in the area of data science. Our academic disciplines are being transformed by the availability of large data sets and data management techniques, as well as new methods, systems, processes, and theoretical insights. At the same time, interdisciplinary and cross-disciplinary collaborations are opening up new opportunities. I have asked the committee to consider comprehensive and connected approaches that could help us think about future directions in data science, both within individual departments and disciplines and across campus. Although I anticipate opportunities for shared curriculum and collaborative projects, I believe that each area should be free to pursue its own initiatives, preferably in dialogue with other programs in order to leverage resources and develop partnerships. In the years ahead, I expect that what we today call data science will be developed in individual disciplines and domains, while also opening up new possibilities for new degrees and interdisciplinary and interdepartmental initiatives. In any case, I do not believe that the proposed Bren program will preclude developments elsewhere on campus, and I expect that the synergies of our interdisciplinary and collaborative culture will strengthen this and other individual programs.

- **FTE:** The deans, the Council on Planning and Budget, and I have identified data science as an important area of focus in reviewing FTE plans and authorizing new searches. Last spring CPB identified some 25 positions requested by departments that could be seen in the general area of data science, and many of these positions were authorized. I have asked the deans to work with faculty and departments over the course of the year to develop strategies to advance data science, building on departmental requests and some special opportunities that might follow the Q-Bio or IGEMS models. I see some parallels with the current planning for a Bioengineering department within the College of Engineering. That being said, numerous relevant recruitments have been approved in individual departments in every discipline, and some new recruitments that were not originally identified as data science positions have ended up recruiting new faculty who have expertise in this area. This has been true in Bren, as you know. In the future, I anticipate positions in various departments that will be resources for Bren, like faculty in Marine Science and Environmental Studies, to take two examples. Again, the modest growth proposed by Bren in relation to enrollment growth will not preclude new faculty appointments elsewhere on campus, and I expect that the synergies of our interdisciplinary and collaborative culture will provide added support. New FTE for Bren will depend on enrollment growth, as with programs elsewhere on campus.
• **Staffing:** Like the Technology Management Program in the College of Engineering, the Bren proposal plans for a level of specialized staffing that is closer to a professional school than to the average UCSB graduate program. This is one of the justifications for assessing a Professional Degree Supplemental Tuition. We have recently completed the second year of a five-year Chancellor’s staff enhancement program. The Chancellor’s Coordinating Committee on Budget Strategy has agreed on the principle that some future positions should be held for the development of new academic programs. In this context, I have indicated that I expect to be able to allocate a new staff FTE to support this new Bren program, assuming appropriate enrollment growth and ongoing need. That being said, the revenue projected from the supplemental tuition, as well as the $3 million gift made on the condition that the new program be established, should ensure that the program will be able to afford the staffing that it anticipates. Regardless of the funding source, any increase in staffing will need to be justified by enrollment growth and programmatic need.

• **Space:** I agree with reviewing agencies that it would be best to accommodate the program on campus as much as possible, although I see the synergies with NCEAS and its downtown research facilities. As you know, an ambitious new classroom building has been approved, which will provide approximately 53,940 assignable-square-feet (ASF) and 95,250 gross-square-feet (GSF) of new space to expand the campus’s general assignment classroom inventory. With 32 general assignment classrooms, the building will increase the campus’s classroom inventory by 35 percent and its seating capacity by 40 percent, or approximately 2,290 seats. It is currently projected that the building will be ready for occupancy in February 2023. This will free up other space on campus, as well as supplement our instructional capacity. We are also hopeful that the new Governor and Legislature will support a resumption of capital projects for the University of California. Another alternative we are actively exploring is the development of existing buildings on our Devereux campus. I expect that by the time the proposed Bren program reaches full capacity, the campus will be able to accommodate the additional students.

The University of California Office of the President has stated: “Professional Degree Supplemental Tuition (PDST) plays a key role in the University of California’s ability to provide students with high-quality graduate professional degree programs in both traditional and emerging disciplines.” Like the Master of Technology Management degree offered by the College of Engineering’s Technology Program, the proposed Bren Master of Environmental Data Science degree, with funding from PDST, has the potential to play an important role in our state, leveraging Bren’s national and international stature and UC Santa Barbara’s unique ability to embed a professional degree within the context of a research university. If the proposal is approved, I assume that more details of the specific curriculum and requirements will be reviewed by the appropriate Bren and Academic Senate faculty committees. At this point, the proposal seems more than viable to me. It is expected that the campus will help launch a new PDST program, with the understanding that the program will be able to pay back any loans and attain self-sufficiency within a specified period of time. Every PDST program ultimately must have a business plan that will achieve solvency and self-sufficiency if it is to continue. If the new Environmental Data Science Master’s program is approved and launched, I believe that the modest campus investments that will be justified in proportion to enrollment growth, along with the projected Professional Degree Supplemental Tuition income and the currently committed and projected donor funding, will be more than adequate to make the program successful.

I hope that these clarifications and comments will be helpful as the campus completes its final review of the revised proposal. Thank you.
Appendix B - Detailed Operational Budget

Budget Narrative

The budget includes 3 broad classes of expenses: faculty and lecturer positions, staff positions, and a variety of direct costs. Salaries and benefits for one ladder faculty and one lecturer with security of employment (LSOE) are expected to be provided by campus and thus are not included in the costs (but are listed as lines in the budget below to indicate the need for them). Salaries and benefits for 9 new staff and 3 upward reclassifications are covered by the proposed supplemental fee except for one position to be supported through Chancellor’s staff initiative (see letter of support from Dean Gaines referring EVC David Marshall’s support, Appendix A). The rationale and timing for these positions is described in detail in Section 6.2.

Direct costs are relatively modest for the proposed program and fall into 9 sub-categories, described here in the order in which they appear in the budget.

Renovations: Years 1 and 2 include modest funds to renovate new office space for faculty and staff, in particular for those located in the downtown Balboa building where NCEAS is located as it is an older building.

Equipment: On a once every five year schedule the MEDS program will need to invest in infrastructure, namely desktop computers for staff, computational and storage servers for students and faculty, wireless connectivity and AV equipment, copy/fax machines, and office furniture.

Travel: The MEDS program will need to cover travel costs for 3 distinguished departmental seminar speakers (one a quarter), student attendance at conferences and professional meetings (on a competitive application basis), recruitment for accepted students, and a one-time allocation of funds to bring distinguished speakers to the first annual Global Summit on Environmental Data Science (subsequent years will be covered by registration fees).

Events: Because MEDS is a professional degree program, it is particularly important to offer an ‘open house’ for potential students, host admitted students, and provide a welcoming orientation for matriculating students. The MEDS program will leverage similar events that occur for the MESM students in Bren, helping keep costs at a minimum. The budget includes $8,000 each year to support MEDS participation in these three events.

Supplies and Materials: Modest annual funds are provided to support instructional needs and administrative needs (for example, printer paper and ink, pens, printing costs, etc.)

Education and Training: This sub-category includes 5 types of expenses. Each group project team is given a small account ($1500) to cover project costs (purchasing data, printing materials, limited travel if needed, etc.). The MESM group projects are provided a similar account and the experience of managing and allocating funds has proven invaluable for project management skill development. MEDS students are also given access to professional development workshops and training, a key aspect of a professional degree program. The annual budget for this is modest at $5000. The final annual cost is modest support for
professional development for staff. Two final expenses are for once every five year program evaluation (mandated by campus) and once every seven year external review (also mandated by campus).

Financial Aid: This is the largest direct cost and scales with the revenue generated from the supplemental fee (one-third of total).

Advertising and Recruitment: These costs are primarily for the first two years when marketing and advertising about the new program is most critical to attract applicants. From Year 3 onward, modest funds are needed for continued program marketing (website maintenance, printed materials, etc.).

Miscellaneous: These costs are standard operating costs to cover telephone and voicemail costs for staff, computer connection and licensing costs for staff and student instructional labs, and printing and copying costs in support of day-to-day operations.

The detailed budget is presented starting on the next page. It is presented as the complete budget for the first five years. A short summary of the budget, signed by VCA Chuck Haines, is also provided in Section 6.10 Summary of Projected Budgetary Needs. As noted in Section 6.10 and detailed below, the program will not accrue any debt, even with very conservative growth projections presented in the proposal.

Detailed Budget
# Proposed Budget - Master of Environmental Data Science (MEDS)

**Period:** July 1, 2019, ongoing

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**SALARIES TOTAL:**

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**TOTAL:** $3,017,167
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<tr>
<td>12.0 mos @ 62% ($4,880) (7/22)</td>
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<tr>
<td>12.0 mos @ 64% ($5,027) (7/23)</td>
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<td>Student Affairs Manager, Student Services Advisor 3, Supervisor - NEW POSITION</td>
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<td>9.0 mos @ 1.9% ($9,000) (7/22)</td>
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<td>Assistant Dean, Career Development &amp; Alumni Relations (Upward reclassification)</td>
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ADVERTISING/ADMISSION/RECRUITMENT:

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MISC:

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<td>(97,506)</td>
<td>(101,747)</td>
<td>(101,747)</td>
<td>(413,707)</td>
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DIRECT COSTS TOTAL:  

<table>
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<tr>
<th></th>
<th>YEAR 1</th>
<th>YEAR 2</th>
<th>YEAR 3</th>
<th>YEAR 4</th>
<th>YEAR 5</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>(148,967)</td>
<td>(439,559)</td>
<td>(394,765)</td>
<td>(478,144)</td>
<td>(600,726)</td>
<td>(2,062,161)</td>
<td></td>
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</tbody>
</table>


<table>
<thead>
<tr>
<th></th>
<th>YEAR 1</th>
<th>YEAR 2</th>
<th>YEAR 3</th>
<th>YEAR 4</th>
<th>YEAR 5</th>
<th>TOTAL</th>
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<tbody>
<tr>
<td>SALARIES TOTAL:</td>
<td>$ (294,278)</td>
<td>$ (611,383)</td>
<td>$ (711,478)</td>
<td>$ (691,182)</td>
<td>$ (708,846)</td>
<td>$ (3,017,167)</td>
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<td>BENEFITS TOTAL:</td>
<td>$ (125,810)</td>
<td>$ (289,187)</td>
<td>$ (302,367)</td>
<td>$ (316,474)</td>
<td>$ (326,555)</td>
<td>$ (1,360,393)</td>
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<tr>
<td>DIRECT COSTS TOTAL:</td>
<td>$ (148,967)</td>
<td>$ (439,559)</td>
<td>$ (394,765)</td>
<td>$ (478,144)</td>
<td>$ (600,726)</td>
<td>$ (2,062,161)</td>
</tr>
<tr>
<td></td>
<td>$ (569,054)</td>
<td>$ (1,340,129)</td>
<td>$ (1,408,611)</td>
<td>$ (1,485,799)</td>
<td>$ (1,636,128)</td>
<td>$ (6,439,721)</td>
</tr>
</tbody>
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REVENUE:

<table>
<thead>
<tr>
<th></th>
<th>YEAR 1</th>
<th>YEAR 2</th>
<th>YEAR 3</th>
<th>YEAR 4</th>
<th>YEAR 5</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDUCATION &amp; TRAINING:</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supplemental Fee (added to base fee):</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>starts @ 20,000</td>
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<tr>
<td>enrollment</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>20</td>
<td>-</td>
<td>400,000</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>400,000</td>
</tr>
<tr>
<td>30</td>
<td>-</td>
<td>-</td>
<td>618,000</td>
<td>-</td>
<td>-</td>
<td>618,000</td>
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<td>40</td>
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<td>-</td>
<td>848,720</td>
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<tr>
<td>50</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1,002,000</td>
<td>1,002,000</td>
</tr>
</tbody>
</table>

Direct Student Support - Supplemental Fees:  

|                              |        |        |        |        |        |       |
|------------------------------|--------|--------|--------|        |        |       |
| 400,000                      |        | 618,000| 848,720| 1,002,000|       | 3,000,000|

STAFF Line:  

|                              |        |        |        |        |        |       |
|------------------------------|--------|        |        |        |        |       |
| Allocated staff position     |        |        |        |        |        |       |
| plus benefits ($70K + 38%    |        |        |        |        |        |       |
| starting Year 1)             |        |        |        |        |        |       |
| 96,000                       |        | 99,498 | 102,483| 105,557| 404,138|
| Total                        |        |        |        |        |        | 3,000,000|

IDC FROM CENTRAL:

|                              |        |        |        |        |        |       |
|------------------------------|--------|        |        |        |        |       |
| Annual IDC Allocation        | 20,000 | 20,000 | 20,000 | 20,000 | 20,000| 100,000|
| IDC TOTAL                    |        |        |        |        |        | 100,000|

Private Gift:

|                              |        |        |        |        |        |       |
|------------------------------|--------|        |        |        |        |       |
| Private Donor                | 549,054| 832,839| 670,922| 906,435| 440,751| 3,000,000|
| Total                        |        |        |        |        |        | 3,000,000|

SUMMARY, PROGRAM COSTS & REVENUE - ALL FUNDING STREAMS:

<table>
<thead>
<tr>
<th></th>
<th>YEAR 1</th>
<th>YEAR 2</th>
<th>YEAR 3</th>
<th>YEAR 4</th>
<th>YEAR 5</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>CARRY FORWARD FROM PREVIOUS YEAR</td>
<td>$ -</td>
<td>$ -</td>
<td>$ 9,310</td>
<td>$ 9,118</td>
<td>$ 957</td>
<td>$ 13,137</td>
</tr>
<tr>
<td>ANNUAL PROGRAM COSTS (includes financial aid)</td>
<td>$ (569,054)</td>
<td>$ (1,340,129)</td>
<td>$ (1,408,611)</td>
<td>$ (1,485,799)</td>
<td>$ (1,636,128)</td>
<td>$ (6,439,721)</td>
</tr>
<tr>
<td>REVENUE</td>
<td>$ 569,054</td>
<td>$ 1,340,439</td>
<td>$ 1,408,420</td>
<td>$ 1,477,638</td>
<td>$ 1,768,308</td>
<td>$ 6,572,819</td>
</tr>
<tr>
<td>ANNUAL DEFICIT/SURPLUS</td>
<td>$ -</td>
<td>$ 9,310</td>
<td>$ (191)</td>
<td>$ (8,161)</td>
<td>$ 132,180</td>
<td>$ 133,137</td>
</tr>
<tr>
<td>TOTAL PROJECT EXPENSES (CF &amp; ANNUAL SURPLUS/DEFICIT)</td>
<td>$ -</td>
<td>$ 9,310</td>
<td>$ 9,118</td>
<td>$ 957</td>
<td>$ 13,137</td>
<td></td>
</tr>
</tbody>
</table>
Appendix C – Organizational Charts

Three different but connected organizational charts are provided below. The first shows the staff directly connected to the MEDS program, as they are allocated to the Bren School and the NCEAS. The second shows the full Bren School staff with new and upward reclass positions connected to the MEDS program highlighted in red and blue, respectively. The third shows the full NCEAS staff with new positions connected to the MEDS program highlighted in red.
Appendix D – Sample Job Ads and Opportunities

Sample Job Opportunities

Waterborne Environmental
Waterborne provides a wide variety of data and geospatial information services supporting exposure and risk assessments, pesticide registration, and water quality issues within the agricultural and environmental domain.

Our geographic information systems (GIS) support:

- **Pesticide registration support**: We provide assessments, map-based analysis, and modeling in support of pesticide registration in the US, Canada, Europe and other regions in the world.
- **Data and statistics**: We acquire, process, and integrate data to develop information and conduct statistical analysis in support of water quality issues.
- **Water quality assessments**: We determine vulnerability at the local, regional or national scale, and to review the potential impacts of nonagricultural compounds in the environment.
- **Land use assessments**: We conduct these to determine land cover and land use composition in the area of interest to provide accurate information for projects. (For example, determining the effect of land use pattern on drift.)
- **Application development services**: We create custom applications for query, analysis, and display of data as maps, charts, and tables.

Using industry standard software including R, VB.NET, Python, ArcGIS, GRASS and SQL Server Waterborne manages data, conducts analysis and creates new geographic information products.

Centre for Ecology & Hydrology
Understanding today’s environmental challenges requires the marshalling of world-wide information and data. Scientific, commercial and societal objectives depend on high quality data and analysis tools. CEH is developing increasingly sophisticated tools and services to manage and secure data for the long term, to deliver improved accessibility, visualisation and reuse of data, and to enable the integration and interoperability of heterogeneous datasets.

Our services

- Data management
- Data management planning, guidance & support
- Environmental data curation
- Multi-platform applications development
● Web-based data portals, catalogues and services
● Semantic integration; vocabulary and ontology development; Linked Open Data approaches
● Data standards definition and implementation (e.g. INSPIRE)
● Design, implementation and review of environmental monitoring networks
● Design and delivery of data management for international environmental monitoring networks
● IT/IS Programme and Project Management (PRINCE2, MSP, Agile)

Environmental applications development
● Development of distributed data management infrastructures
● Bespoke software tools for data discovery, visualisation and analysis
● Information products encompassing national-scale mapping and model outputs
● Development of field-based data capture systems for large-scale environmental survey
● Mobile applications

Training and capability building
● Data management training and knowledge transfer
● Overseas capacity incorporating informatics to underpin environmental research
● Continuing Professional Development (CPD) and professional training
● University student courses/modules

Our Experience
● CEH manages the Environmental Information Data Centre, the UK’s data centre for terrestrial and freshwater sciences, which provides long-term management and curation of research datasets and delivery to the scientific community and other stakeholders.
● CEH developed the UKEOF catalogue containing more than 1200 records of environmental observations by public and third sector organisations. The catalogue provides a unique management tool to underpin the activities and requirements of the environmental observation community.
● CEH co-developed the Indicia toolkit to deliver an online biological recording solution and simplify the construction of websites. Indicia supports wildlife observation recording forms, allowing photo upload, reporting, mapping and verification of the records.
● CEH co-developed a suite of citizen science environmental recording apps including mySoil for crowdsourcing and sharing soils data, iRecord Apps encompassing ladybirds, butterflies, crickets and grasshoppers, and mammal tracker and plant tracker.
● Data from sensor and research network implementation and management, as exemplified by COSMOS, the European Long-term Ecological Research (LTER) network and NERC Research Programmes including Macronutrients, Human-modified Tropical Forests and Biodiversity & Ecosystem Service Sustainability.
● CEH is leading the £1 million development of the NERC Environmental Research Workbench, which will allow scientists access to large computing and storage facilities in the cloud through an easy to use interface to access a range of cloud based tools, models and data.
● CEH developed field-based tablets to collect data for Countryside Survey, accelerating reporting, improving data quality and an estimated saving of £700k.
Oak Ridge National Labs
Environmental Data Science and Systems

Objective: Advance environmental and climate research and policy by developing and providing integrated data products, data delivery systems, and data analysis tools. Our science focus includes:

- Carbon Cycle and Carbon Sequestration
- Climatic Change Research
- Atmospheric Radiation Measurements
- Biogeochemistry of Terrestrial Ecosystems
- Biodiversity

We provide value-added data and tools used to:

- Enable an objective assessment of the potential for, and consequences of, global change
- Improve the treatment of cloud and radiation physics in global climate models in order to improve the climate simulation capabilities of these models
- Understand the complexity of the carbon cycle and the linkages to physical, biogeochemical and ecological processes and human influences
- Harvest, index, and search metadata for the discovery and delivery
- of spatiotemporal data

Sample Job Ads

Global Environmental Data Scientist

Location: St Louis, MO
Salary/Pay Rate: 114000
Employment Type: Full Time

Job Description: Global Environmental Data Scientist

We are pleased to recruit for a company whose is revolutionizing agriculture through big data science and analytics. Breeding's Global Environment & Modeling team is seeking an exceptionally talented individual who is passionate about applications of big data and
analytics in decision agriculture. Our team is a cutting edge group providing intelligent solutions to accelerate genetic gain of key crops and develop best-in-class product characterization and placement, globally. This individual will have ample opportunities to work with interdisciplinary scientists to foster career growth and development. Our client is expanding and seeking a **Global Environmental Data Scientist** in **St. Louis, MO**.

**Responsibilities:**
- Develop environmental analytics solutions/models to quantify subfield-scale yield testing environments of different crops
- Quantify GxE×M interactions from the subfield- to regional -scale testing environments
- Determine environmental correlations among testing locations/regions across the globe
- Optimize phenotyping network across functions and crops
- Apply big data and analytics to turn yield testing data into faster and timely decisions

**Requirements:**
- Proficiency in machine learning algorithms, statistical and mathematical programming packages (e.g., R or Matlab)
- Working Knowledge in IoT, cloud computing, big data analytics including Apache Spark
- Strong ability to translate business problems into research initiatives that deliver business value
- Working experience in analyzing complex data and proven problem solving abilities
- Strong organizational, interpersonal, and written communication skills
- Expertise in applications of environmental data science and analytics to deliver integrated solutions
- Post-doctoral or applicable industrial experience is preferred

**Education:** PhD in Soil Science, Environmental Science, or related disciplines with strong background in statistics, environmental data science & analytics, and geospatial technologies

**Pay Rate:** $93,000 - $114,000

**Work Schedule:** M-F 8AM – 5PM

**Length of Assignment:** Direct Hire

**Location:** St. Louis, MO (63167)
About Us:
S&S is a scientific staffing firm specializing in technical personnel placement within a chemical plant environment. If you are an entry level candidate, a recent graduate, or an experienced individual within your industry, we have an opportunity to fit your needs. We offer temporary, temp to hire, and permanent positions. Please contact us today, call 877.205.9911 or visit www.sslabcareers.com.

Environmental Data Analyst
NCEAS, UC Santa Barbara

A new, multi-year project aims to assess ocean health annually over the past decade for each of several sub-regions within British Colombia, Canada using the Ocean Health Index. The Ocean Health Index has been developed over the past 5 years by a large, collaborative team of international scientists and is now being adapted and applied to specific regions around the world.

The Index will be adapted to the regional context and available data for British Colombia, and will be used to evaluate how different management actions have affected different aspects of ocean health across space and through time. The position will be part of a dynamic research team based at NCEAS and the Bren School of Environment.

The position is funded for two years with the potential for extending a third year.

Responsibilities
*Discover, gather, and manage all spatial and time-series data
*Process data into a common format
*Draft reports on data and methods used
*Support team in writing up results for publication
*Provide project support in meetings and workshops

Minimum Requirements
*Masters in environmental science, geography, ecology or related field
*Experience with GIS analyses and R
*Strong organizational skills
*Strong interpersonal and communication skills

Desired qualifications
*3 years experience working as part of a scientific research team
*Experience with GitHub, Python, GRASS

The position will begin on Jan. 1, 2015 or as soon as possible thereafter.
**Salary and Benefits:** Staff Research Assistant position, with salary step expected at step 2. Full time appointment for two years from start date, with strong possibility for additional year of employment contingent upon performance and funding. Full benefits package included.

### OVERVIEW OF THE FUNCTIONS OF THE POST

<table>
<thead>
<tr>
<th>Post Title</th>
<th>Data Science Officer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domain</td>
<td>Intergovernmental Oceanographic Commission</td>
</tr>
<tr>
<td>Post Number</td>
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</tr>
<tr>
<td>Grade</td>
<td>P1</td>
</tr>
<tr>
<td>Organizational Unit</td>
<td>Intergovernmental Oceanographic Commission</td>
</tr>
<tr>
<td>Primary Location</td>
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</tr>
<tr>
<td>Recruitment open to</td>
<td>Internal and external candidates</td>
</tr>
<tr>
<td>Type of contract</td>
<td>Project Appointment (PA)</td>
</tr>
<tr>
<td>Duration of contract:</td>
<td>1 year with possibility of extension subject to availability of funds and satisfactory performance</td>
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<tr>
<td>----------------------</td>
<td>--------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Annual salary:</td>
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</tr>
<tr>
<td>Deadline (midnight, Paris time):</td>
<td>15 January 2017</td>
</tr>
<tr>
<td>Application to be sent to:</td>
<td><a href="mailto:w.appeltans@unesco.org">w.appeltans@unesco.org</a></td>
</tr>
</tbody>
</table>

Under the overall authority of the Executive Secretary of the Intergovernmental Oceanographic Commission of UNESCO and the direct supervision of the head of the IODE project office, in close consultation with the OBIS project manager and OBIS data manager, and in collaboration with H2020 EcoPotential consortium, the data science officer will:

Support the European Horizon 2020 project ECOPOTENTIAL (improving future ecosystem benefits through Earth Observations), and its PELAGOS Storyline:
- Contributing to the dataset inventory, data and metadata collection, data quality control, data harmonisation
- Database development and providing open access and linking data to GEOSS.
- Contributing to the conceptual framework of Essential Ecosystem Service Variables, and liaise with other international initiatives (GOOS, GEOBON MBON, GEO Blue Planet etc);

Support the OBIS (Ocean Biogeographic Information System) secretariat with the implementation of the OBIS work plan:
- Data capture and synchronization with OBIS nodes;
- Data quality assurance; data integration, standardization and normalization;
- Data reconciliation and occurrence data enrichment with environmental data;
- Customer support and creation of information products in support of national and international initiatives (CBD, IOC, member states, scientists);
- Support geospatial and taxonomic analysis; writing scripts, geographic indexing, calculation of taxonomic and other diversity indices;
- Assisting in the implementation of statistical analysis tools (R, Python).
- Supporting OBIS nodes in data publication, data quality control; including maintenance of guidelines on best practices and manuals
- Teaching OBIS standards and best practices at training courses organized through the IODE Ocean Teacher Global Academy.
Contributing to events, meeting reports and scientific papers;
Regular reporting of activities to the head of the IODE project office, OBIS project manager and OBIS consortium;
Follow-up on new developments in the domain.

REQUIRED QUALIFICATIONS

EDUCATION
Advanced university degree (Masters level or higher) in Earth Sciences (preferably Marine Biology or Geography) or Informatics or Bioinformatics. A first-level university degree in combination with two additional years of qualifying experience may be accepted in lieu of the advanced university degree.

WORK EXPERIENCE
At least 2 years of relevant working experience in biological data management of which at least one year at the international level.

SKILLS/COMPETENCIES
Excellent research, analytical and problem solving ability, including taking part in the resolution of issues and in the application of good judgement.
Good knowledge of a scripting language for statistical analysis, such as R or Python.
Experience in database management (SQL)
Good communication skills. Ability to write and speak clearly and effectively, including the ability to draft reports in a concise style and communicate complex scientific information to a broader audience – via visual, written and verbal modes.
Very good inter-personal skills and ability to maintain effective partnerships and working relations within a multi-cultural environment; ability to work collaboratively as part of a team to achieve organisational goals.
* ability to plan own work and manage conflicting priorities; work under pressure

LANGUAGES
Excellent knowledge of English (spoken and written).

DESIRABLE QUALIFICATIONS

EDUCATION
A combined academic or professional background in the natural science (especially marine and ecological).

WORK EXPERIENCE
Experience in GIS (e.g., QGIS, ArcGIS, PostGIS).
**SKILLS/COMPETENCIES**
Practical familiarity with ocean observing techniques, data management and information generation activities.

**LANGUAGES**
Good knowledge of another UNESCO official language (French, Spanish, Russian, Chinese).

**BENEFITS AND ENTITLEMENTS**
UNESCO’s salaries are calculated in US dollars and exempt from income tax. They consist of a basic salary and a post adjustment, which reflects the cost of living in a particular duty station and exchange rates.
Other benefits include: 30 days annual leave, family allowance, home travel, education grant for dependent children, pension plan and medical insurance. More details on the ICSC Web site.

**HOW TO APPLY**
Please submit a full CV (using the UNESCO template at https://en.unesco.org/careers/media/3705), a motivation letter and three references that may be contacted, to: Mr Ward Appeltans (w.appeltans@unesco.org), by 15 January 2017 (Midnight, Paris time). A test may be used in the evaluation of candidates.
Please note that UNESCO is a non-smoking Organization.

UNESCO does not charge a fee at any stage of the recruitment process.

UNESCO is committed to promote geographical distribution and gender equality within its Secretariat. Therefore, women candidates are strongly encouraged to apply, as well as nationals from non- and under-represented Member States. Persons with disabilities are equally encouraged to apply.

**JOB ANNOUNCEMENT AND DESCRIPTION**
**DATA SCIENCE FELLOW IN CONSERVATION**
Conservation Science Partners (CSP; csp-inc.org) is looking for general and project-specific support on a wide array of high-profile, data-driven projects. The focus of projects is expected to vary, but will likely include: phenology and climate change, wildfire and invasive species, vegetation monitoring, and land use/cover change. This position will provide support as part of a team of ecologists involved in landscape and conservation planning across the US. Strong candidates will need to have well-developed problem-solving, statistical, and analytical thinking capabilities, in addition to significant experience as a programmer. Candidates should also be willing and able to quickly learn new methods and software as needed for specific projects, should have excellent organizational and communication (oral and written)
skills, and should be able to work on several projects simultaneously. Ideal candidates would help to cultivate and propel an internal culture of innovation, creativity, and diversity.

Educational and professional experience
We are seeking someone with a formal science background and not from a particular discipline or field of emphasis. A MSc or PhD is desirable but not required. Post-graduate experience in ecology or the natural resources field also is desirable, but may not be necessary. Applied experience will be looked upon favorably.

Required skills
• Programming in Python, R, and JavaScript (some HTML/CSS would be helpful, but is not necessary) and bash-scripting experience
• Data wrangling / munging skills for large datasets
• Experience working with online repositories for code (e.g., GitHub, GitLab, Bitbucket) — preferably in a group setting, including at least some knowledge of branching or forking workflows
• Model fitting / evaluation (either using machine learning methods or inferential statistics — maximum likelihood or Bayesian parameter estimation methods, for example). A background or training in statistical and sampling design, and experience specifying hierarchical models would be highly desirable.

Desired skills
• Experience working with geospatial and remote sensing data
• Data visualization
• Web application development
• Experience building software images (using, e.g., Dockerfiles), working with containers, etc.
• Continuous integration / deployment
• Experience provisioning and leveraging resources in the cloud (i.e., storage and compute resources) via Azure, AWS, or Google Cloud Platform
• Using / building / linking APIs (data/service interoperability via API calls)
• Experience working with either relational or NoSQL databases (e.g., using MongoDB)
• Some experience with the following APIs / libraries: Earth Engine, TensorFlow, and perhaps some experience using command-line utilities to move data between various clients and cloud-based servers

Expected start date: August/September 2017
Deadline to apply: Open until filled
Location: This position is located in Truckee, CA
Salary: A highly competitive salary commensurate with experience
Benefits: CSP offers a comprehensive group medical, dental, and vision insurance package, as well as retirement benefits

If interested, please send a cover letter, current CV, and contact information for three professional references to: hiring@csp-inc.org. Please place DATA SCIENCE FELLOW in the subject line. Applications will be handled electronically and by email only.
Yale University
Center for Biodiversity and Global Change, Map of Life
Database Architect Position

We are seeking a database architect to work with our growing team of developers and scientists at Yale University in New Haven, Connecticut. A main responsibility of the position will be to oversee the design and management of a large, global spatial biodiversity database of Map of Life (https://mol.org).

Map of Life aims to support effective and global biodiversity education, monitoring, research and decision-making by assembling and integrating a wide range of knowledge about species distributions and their dynamics over time. Built on a scalable web platform geared for large biodiversity and environmental data, Map of Life provides best-possible species distribution information together with a range of information and biodiversity indicator products.

Work environment:
The database architect will be part of a growing and interdisciplinary team of scientists and informaticians in the Yale Center for Biodiversity and Global Change (http://bgc.yale.edu). The center connects biodiversity and global change scientists from across the Yale campus and beyond. Yale has a thriving and growing community of postdocs and graduate students in ecology, evolution and global change science in the EEB Department, the Yale Institute for Biospheric Studies, the Peabody Museum, and the Yale School of Forestry and Environmental Studies. The town and campus are renowned for the classic Ivy League setting, 75 miles north of New York City.

Responsibilities:
The role of the database architect position is to improve on an existing spatial and biodiversity database hosted within a PostgreSQL/PostGIS environment and work with software engineers and a database manager to build, extend and support new databases driving biodiversity web and mobile applications. The ideal candidate will be a quick learner, self-driven, and detail oriented.

Position requirements:
- Demonstrated success working with ‘big data’ on the order of hundreds to billions of records
● Understanding of entity relationship diagrams (ERD) and the inherited cardinality rules of schemas/tables
● Demonstrated experience with documentation and optimization
● Basic proficiency in Unix-based systems
● Demonstrated experience working independently and as part of a team
● Effective oral and written communication skills
● Strong technical writing and briefing skills
● Eligible to work in the United States

Preferred skills:
● Familiarity with Google Cloud Platform (BigQuery, Cloud SQL, Cloud Datastore, and Cloud Storage)
● Experience working with geospatial and biodiversity data
● Experience developing geospatial applications
● Strong technical skills and relevant experience with Python and Shell scripting
● Experience with hosted platforms such as Google App Engine and CARTO

UC Davis
We’re hiring a Research Data Scientist!
www.employment.ucdavis.edu/applicants/Central?quickFind=79482

Description
The UC Davis Data Science Initiative is seeking a full-time Data Scientist to join our team. The Data Scientist will support academic research by designing and implementing practical solutions to data science challenges.

This position involves:
Working on numerous, diverse cutting-edge collaborative research projects
Providing data science advice and services/support for other projects and researchers
Offering workshops to train students, staff, and faculty in data science methods and technologies
Developing general, reusable data science infrastructure, methods, software and tools.
The Data Scientist will apply statistical and machine learning methods and other data science techniques to real-world problems to aid data-enabled, multi-disciplinary research. Our Data Scientists are expected to continually learn, share, and problem solve while working with researchers from across the university.

About the DSI
The UC Davis Data Science Initiative (DSI) was founded to promote and support research and training in data-driven discovery across all colleges, schools and disciplines at UC Davis. We facilitate data-enabled research and training at the frontiers of scientific, engineering, social and humanities disciplines. A highly interdisciplinary, cross-university entity, the DSI is housed in the
main university Library and serves as a hub for a community of researchers and students from many domains interested in data science and pushing the envelope of research in the digital age. The DSI coordinates data-science training activities, provides consulting and collaborative services for research projects, and conducts novel research in data science. We run training workshops on fundamental and intermediate to advanced data science topics. We run problem-solving "un-seminars", reading groups, and generally foster community. Our research and training activities span the entire research data pipeline, from data acquisition, management, cleaning, transformation, visualization, and modeling to dissemination/publication and high-performance computing, and involve aspects of data governance, security, privacy and ethics. The DSI is committed to fostering an inclusive environment to promote all members of the university community, including faculty, students and staff from a variety of domains, backgrounds, cultures and personal experiences. For more information, see https://www.ucdavis.edu and http://dsi.ucdavis.edu.

Data Scientist Qualification Requirements

Minimum Qualifications
Bachelor's degree in a data-analytic discipline (e.g., Data Science, Statistics, Computer Science, Mathematics, Engineering, or a data-driven disciplinary field), or equivalent experience, training and education.
Experience involving hands-on data science problem solving with real-world, complex (messy!) data sets.
Problem-solving and data manipulation skills.
Knowledge and experience applying statistical modeling and machine learning methods to real world problems.
Knowledge and experience conducting one or more of: Web scraping, static and dynamic visualization, text mining, or natural language processing.
Proficiency in a high-level programming language (e.g., R or Python).
Experience using advance organizational skills and knowledge to organize, manage, prioritize and work on multiple, dynamic projects; and fulfill assigned tasks and projects including learning new methods and technologies.
Interpersonal and communication skills for research, technical and lay audiences.

Preferred Qualifications
Advanced degree in a data-analytic discipline, or in a disciplinary field with significant data science background, or equivalent experience/training.
Experience working in teams to solve data-driven, interdisciplinary problems.
Experience with:
- SQL and NoSQL database technologies
- Parallel computing paradigms and technologies for data science.
- Software development, version control, unit testing, portability.
Knowledge of data-driven research, scholarly communication, and the technical and social aspects of the research data lifecycle.
Experience developing and leading training and educational activities on data science topics, methods and/or technologies.
Experience supervising interns.

How to Apply
www.employment.ucdavis.edu/applicants/Central?quickFind=79482/

Questions?
Contact us at datascience@ucdavis.edu with the subject line “DSI Staff Data Scientist Application.” This position is open until filled.

Data Scientist @ SYSENC
Deadline: May 25, 2018

The National Socio-Environmental Synthesis Center seeks a Data Scientist to join the cyberinfrastructure (CI) team in supporting collaborative, computational, and data-driven socio-environmental research. Our supported science teams and postdoctoral fellows come from many different disciplines and synthesize diverse models and data sets to answer large-scale questions at the intersection of humans and the environment. The Data Scientist will work closely with the CI team to assist scientists in performing data and model syntheses.

The Data Scientist’s typical activities include:
- Advise on statistical approaches, design workflows, and prototype/optimize code;
- Help researchers develop and use custom tools;
- Assess and document project needs;
- Teach in hands-on CI education workshops for students and researchers; and,
- Assist researchers in making their data, code, analyses, and applications open, reproducible, and discoverable.

Candidates with experience in machine learning techniques, code optimization, and/or qualitative data analysis will be given priority consideration.

Why SESYNC:
SESYNC is dedicated to solving society’s most challenging and complex environmental problems by bringing together social, natural, and computational scientists to increase knowledge on the complex interactions between human and ecological systems. The computational requirements for conducting this research present many opportunities and challenges. Examples of the work we have supported include:

- map and analyze a billion-point data set;
- model shocks to the global food trade;
- synthesize global biophysical and governance data on Marine Protected Areas;
- develop R Shiny applications for targeted data exploration and cleaning;
- monitor traffic pertaining to illegal wildlife trade through Google Trends data;
- R packages: developed rslurm to facilitate High Performance Computing (HPC) pipelines and contributed major revisions to codyn to facilitate ecological community analysis.

About our CI: SESYNC’s CI is designed to enable mesoscale research, i.e., research that requires access to large data sets and processing resources but not necessarily traditional HPC. We embrace open source software to the fullest extent possible and support a variety of tools. Our CI staff consists of systems specialists, S-E researchers, and data scientists. All CI staff are encouraged to investigate new technologies they think may be useful or interesting in contributing to SESYNC’s mission.

Salary: Commensurate with experience.

Required Qualifications: Master’s degree +2 years’ experience or PhD in social, natural, computer or information science or engineering;

- Legally authorized to work in the United States;
- Experience writing code to process data and/or develop models in R, Python, or Matlab;
- Demonstrated knowledge of basic descriptive and applied statistics;
- Strong interpersonal and communication skills;
- Interest in socio-environmental problems.

Desired Qualifications:

- Knowledge of advanced statistical techniques (e.g., machine learning, SEM, Bayesian techniques, and/or econometric models) and appropriate applications;
- Knowledge of and/or experience in environmental science or issues;
- Experience working with spatial data/GIS;
- Collaborative coding/version control tools;
- Experience developing interactive visualizations or analysis tools (e.g., with Shiny) and/or using Jekyll.
Appendix E – CVs for participating faculty

Short CVs for the faculty submitting this proposal are included in this Appendix in the following order:

- Prof. Olivier Deschenes
- Prof. James Frew
- Prof. Ben Halpern
- Prof. Krzysztof Janowicz
- Prof. Christina (Naomi) Tague
OLIVIER DESCHENES
CURRENT APPOINTMENTS
University of California, Santa Barbara
Professor, Department of Economics July 2016—present

Bren School of Environmental Science and Management, University of California, Santa Barbara
Affiliated Appointment July 2008—present

National Bureau of Economic Research, Cambridge MA
Research Associate October 2009—present
Faculty Research Fellow 2007—Sept 2009
Program Affiliation: Environmental and Energy Economics

Institute of Labor Economics (IZA), Bonn, Germany
Research Fellow May 2011—present
Program Coordinator, Environment and Labor Markets July 2012—present

Broom Center for Demography, University of California, Santa Barbara
Research Associate April 2012—present

PAST APPOINTMENTS
University of California, Santa Barbara
Associate Professor, Department of Economics July 2007—July 2016

University of California, Santa Barbara
Assistant Professor, Department of Economics July 2001—June 2007

Princeton University
Visiting Research Fellow, Industrial Relations Section July 2004—June 2005

University of California, Berkeley
FIELDS OF INTEREST
Environmental and Energy Economics, Health Economics, Labor Economics

CURRENT AREAS OF RESEARCH
Economic and health impacts of global climate change; Adaptation to climate change; Health effects of air pollution; Impact of temperature and air pollution on labor markets; Relationship between energy markets and labor markets

EDUCATION
Ph.D., Economics, Princeton University, 2001
M.A., Economics, University of Montreal, 1996
B.A., Economics, University of Montreal, 1995

PUBLICATIONS
Maybe Next Month? Temperature Shocks, Climate Change, and Dynamic Adjustments in Birth Rates (with A. Barreca, and M. Guldi), *Demography*, Forthcoming


Defensive Investments and the Demand for Air Quality: Evidence from the NOx Budget Program (with M. Greenstone and J. Shapiro), *American Economic Review*, October 2017, Volume 107, Number 10, pp. 2958-89

Agricultural Pesticide Use and Adverse Birth Outcomes in the San Joaquin Valley of California (with S. Gaines and A. Larsen), *Nature Communications*, 2017, 8(302), pp. 1-14

Children and Climate Change: Introducing the Issue (with J. Currie), *Future of Children*, Spring 2016, Volume 26, Number 1, pp. 3-9


Removing Biases in Forecasts of Fishery Status (with C. Costello, S. Gaines, and A. Larsen), *Journal of Bioeconomics*, July 2014, Volume 16, Number 2, pp. 213-219


Using Panel Data Models to Estimate the Economic Impacts of Climate Change on Agriculture (with M. Greenstone), in *Handbook on Climate Change and Agriculture*, Edited by Ariel Dinar and Robert Mendelsohn, Edward Elgar Publishing, 2011
Economic Impacts of Climate Change on California Agriculture (with C. Kolstad), *Climatic Change*, December 2011, 109, 365-386


Sex Preferences, Marital Dissolution and the Economic Status of Women (with K. Bedard), *Journal of Human Resources*, Spring 2005, Volume 40, Number 2, pp. 411-434

Do Unemployment Insurance Claimants Actively Seek Work? Evidence from Randomized Trial in Four U.S. States (with O. Ashenfelter and D. Ashmore), *Journal of Econometrics*, October 2005, Volume 125, Number 1, pp. 53-75

**EDITED VOLUMES**


**James Frew**

Professional Preparation
University of California, Santa Barbara | Geography | B.A. 1977
---|---|---
University of California, Santa Barbara | Geography | M.A. 1980
University of California, Santa Barbara | Geography | Ph.D. 1990
University of California, Berkeley | Computer Science | Postdoctoral researcher 1991-1993

Appointments
2005-2006, 2015-2016: Visiting Professor, School of Informatics, University of Edinburgh
2004-present: Associate Professor, Bren School of Environmental Science and Management, University of California, Santa Barbara (UCSB)
1997-2004: Assistant Professor, Bren School of Environmental Science and Management, University of California, Santa Barbara (UCSB)
1993-1997: Specialist, Institute for Computational Earth System Science and Center for Computational Science and Engineering, UCSB
1991-1993: Research Engineer, Computer Science Division, University of California, Berkeley

Five Closely Related Publications

Five Other Significant Publications


Synergistic Activities
Member (2016–current), Roundtable on Data Science Post-Secondary Education, National Academy of Sciences
Faculty Investigator (2012–2015), Intel Science and Technology Center (ISTC) for Big Data
Co-Chair (2012), 4th International Provenance and Annotation Workshop
President (2009–2010), Federation of Earth Science Information Partners
Chair (2005), 17th International Conference on Scientific and Statistical Database Management
Member (2002–2004), Committee on Environmental Satellite Data Utilization, National Academy of Sciences
Associate Director (1992–1994), Sequoia 2000 Project
Benjamin S. Halpern

PROFESSIONAL PREPARATION
Carleton College  Biology  B.A. 1995
UC Santa Barbara  Marine Ecology  Ph.D. 2003

APPOINTMENTS
2016-present  Director, National Center for Ecological Analysis & Synthesis (NCEAS), UCSB
2013-present  Professor, Bren School of Environmental Science & Management, UCSB
2013-present  Chair in Marine Conservation, Imperial College London
2011-present  Director, Center for Marine Assessment and Planning, UC Santa Barbara
2016             Deputy Director, NCEAS, UC Santa Barbara
2005-2015    Center Associate, NCEAS, UC Santa Barbara
2010-2013    Research Biologist, UC Santa Barbara
2005-2012    Project Coordinator, NCEAS, UC Santa Barbara
2008-2010    Associate Research Biologist, UC Santa Barbara
2007-2008    Assistant Research Biologist, UC Santa Barbara
2003-2005    Post-doctoral researcher, UC Santa Cruz/NCEAS

SELECTED PUBLICATIONS (TOTAL = 189)

Five Relevant Ones


Selected Others


**SYNERGISTIC ACTIVITIES**

Developed database of spatial data for human activities, location of marine ecosystems, and the impacts of activities on ecosystems with free access to all data.

Founded the Center for Marine Assessment and Planning at UCSB that brings together people engaged in the science, policy, management, use, and conservation of marine resources.

Frequent participation in and leading of collaborative working groups with membership across social, ecological, and environmental sciences that were aimed at addressing issues of marine conservation.
Served on steering and advisory committees for a variety of academic and state-agency led projects to evaluate strategies for implementing ecosystem-based management in coastal oceans.

**COLLABORATORS**

*Graduate Advisors*
Robert Warner (UCSB), Steve Gaines (UCSB) and Scott Cooper (UCSB)

*Postdoctoral Advisors*
Mark Carr (UCSC) and Mike Beck (TNC)

*Graduate Student Advisor*
Pagi Guarderas, Carissa Klein (University of Queensland; committee), Rowan Trebilco (Simon Frasier; committee), Cristiane Elfes (UCSB), Shaun Walbridge (UCSB), Gerald Singh (UBC; committee), Emma Hodgson (UW Seattle; committee), Mike Burgass (Imperial), Patricia Faundez (UCSB), Alexa Fredston-Hermann (UCSB), Molly Wilson (UCSB), Sebastian Tapia (UCSB)

*Sponsored Postdoctoral Associates*
Caitlin Crain, Catherine Longo, Jennifer O’Leary, Mary Hunsicker, Crow White, Halley Froehlich
Biographical Sketch

Krzysztof Janowicz, Department of Geography, University of California, Santa Barbara, CA, USA

Professional Preparation

Universität Münster, Germany  Ecology  Diplom  2003
Universität Münster, Germany  Geoinformatics/GIScience  PhD  2008

Appointments

2015 –  Associate Professor for Geographic Information Science, Department of Geography, University of California, Santa Barbara, CA

2011 – 2015  Assistant Professor for Geographic Information Science, Department of Geography, University of California, Santa Barbara, CA

2009 – 2011  Assistant Professor for Geographic Information Science, GeoVISTA Center, Department of Geography, The Pennsylvania State University, University, University, PA.

2008 – 2009  Postdoctoral Researcher, Institute for Geoinformatics, University Münster, Germany

2003 – 2008  Research Associate, Institute for Geoinformatics, University Münster, Germany

5 Products Related to the Proposal


5 Other Significant Products


Synergistic Activities (selection)

Collaborators and Co-Editors: Benjamin Adams (UC Santa Barbara), Payam Barnaghi (University of Surrey), Boris Bäumer (University of Münster), Mohamed Bishr (University of Münster), Matthias Braun (University of Münster), Arne Bröring (University of Münster), Christoph Brox (University of Münster), Raúl García Castro (Universidad Politécnica de Madrid), Michael Compton (CSIRO ICT Centre), Oscar Corcho (Universidad Politécnica de Madrid), Anusurja Devaraj (University of Münster), Thorsten Diekhof (University of Münster), Stephanie Duce (University of Münster), Sören Dupke (University of Münster), Martin Espeter (University of Münster), Thomas Everding (University of Münster), John Graybeal (UC San Diego), Glen Hart (Ordnance Survey), Cory Henson (Wright State University), Arthur Herzog (Fraunhofer Gesellschaft), Pascal Hitzler (Wright State University), Carsten Keßler (University of Münster), Werner Kuhn (University of Münster), Antonio Krüger (DFKI), Manfred Lange (University of Münster), Laurent Lefort (CSIRO ICT Centre), Sergei Levashkin (Centro de Investigación en Computación Mexico City), Wang-Chien Lee (Pennsylvania State University), Michael Lutz (European Commission – Joined Research Centre), Patrick Maué (University of Münster), Jörg Müller (University of Münster), Christoph Mülligann (University of Münster), Holger Neuhaus (CSIRO ICT Centre), Andriy Nikolov (The Open University), Nicole Ostländer (European Commission – Joined Research Centre), Oliver Paczkowski (University of Münster), Kevin Page (University of Southampton), Ilija Panov (University of Münster), Todd Pehle (Orbis Technologies), Florian Probst (SAP), Hardy Pundt (Harz University of Applied Sciences), Martin Raubal (UC Santa Barbara), Ilka Reis (National Institute for Space Research (INPE) Brazil),
Catharina Riedemann (University of Münster), Sven Schade (European Commission – Joined Research Centre), Simon Scheider (University of Münster), Franca Scherer (University of Münster), Johannes Schöning (DFKI), Mirco Schwarz (University of Münster), Angela Schwering (University of Münster), Sumit Sen (University of Münster), Dong Shou (Pennsylvania State University), Christoph Stasch (University of Münster), Kerry Taylor (CSIRO ICT Centre), Marion Wilde (University of Münster), Marc Wilkes (University of Münster), Mao Ye (Pennsylvania State University), Peifeng Yin (Pennsylvania State University)

**Graduate Advisors and Postdoctoral Sponsors:** Werner Kuhn (University of Münster), Edzer Pebesma (University of Münster), Martin Raubal (UC Santa Barbara), Maria Andrea Rodríguez-Tastets (Universidad de Concepción)

**Master or PhD Graduate Thesis Advisees and Postgraduate-Scholar Sponsored:** Thorsten Diekhof, Stephanie Duce, Christoph Mülligann, Franca Scherer, Mirco Schwarz, Marc Wilkes (all University of Münster), Reza Kalbasi Khoramdashti (ITC NL), Crista Livecchi (PSU), Benjamin Adams, Song Geo, Grant McKanzie, Yingjie Hu, Bo Yan, Jiue-An Jay Yang (all UCSB), Simon Scheider (UCSB) (11 graduates, 1 postdoc)
Professional Preparation

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<tr>
<th>Institution</th>
<th>Attended</th>
<th>Degree</th>
<th>Major Field</th>
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<tr>
<td>University of Waterloo, Canada</td>
<td>1985-89</td>
<td>B.Eng.</td>
<td>Systems Design</td>
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<tr>
<td>Engineering</td>
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<tr>
<td>University of Toronto, Canada</td>
<td>1992-94</td>
<td>M.S.</td>
<td>Geography</td>
</tr>
<tr>
<td>University of Toronto, Canada</td>
<td>1995-99</td>
<td>Ph.D.</td>
<td>Geography</td>
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Appointments

<table>
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<th>Institution</th>
<th>Rank</th>
<th>Dates</th>
<th>Major Subject</th>
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<tr>
<td>UC Santa Barbara</td>
<td>Associate Professor</td>
<td>current</td>
<td>Env. Science</td>
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<tr>
<td>UC Santa Barbara</td>
<td>Assistant Professor</td>
<td>2006 to 2010</td>
<td>Env. Science</td>
</tr>
<tr>
<td>San Diego State University</td>
<td>Associate Professor</td>
<td>2005 to 2006</td>
<td>Geography</td>
</tr>
<tr>
<td>San Diego State University</td>
<td>Assistant Professor</td>
<td>2000 to 2005</td>
<td>Geography</td>
</tr>
<tr>
<td>UCAR</td>
<td>Post-Doc</td>
<td>1999 to 2000</td>
<td>Geography</td>
</tr>
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</table>

Recent Publications (since 2014)


https://ecohydrolab.files.wordpress.com/2015/07/citizenscience.pdf


https://ecohydrolab.files.wordpress.com/2015/05/shieldstague2015.pdf


Synergistic Activities
Dr. Tague the chief architect and developer of RHESSys, Regional hydro-ecologic simulation system, a modeling framework that provides science-based information on the spatial patterns and interactions among terrestrial hydrologic, carbon and nitrogen cycling processes. Dr. Tague maintains RHESSys code and supporting materials at the Bren School of Environmental Science and Management (Website: http://fiesta.bren.ucsb.edu/~rhessys/ and http://www.tagueteamlab.com) and provides regular training programs for new RHESSys users. Tague is also a Co-PI on the Sierra Critical Zone Observatory.

*Invited Presentations*  
(last 3 years)

<table>
<thead>
<tr>
<th>Month/Yr</th>
<th>Author/Title</th>
<th>Meeting/Place</th>
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</thead>
</table>

192
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<tr>
<th>Date</th>
<th>Title</th>
<th>Location</th>
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<tbody>
<tr>
<td>Sept. 2014</td>
<td>Tague, C., Consequences of warming temperatures and shifts in precipitation regimes for snow-dominated mountain systems</td>
<td>12th British Hydrological Society National Symposium, University of Birmingham, England</td>
</tr>
<tr>
<td>Dec 2014</td>
<td>Tague, C., Dugger, A., Moritz, M., Seasonal and multi-year ecohydrologic responses to forest thinning</td>
<td>Eos Trans, American Geophysical Union, Fall Meeting Suppl. Abstract H33L-07</td>
</tr>
<tr>
<td>May 2015</td>
<td>Tague, C., Shields, C., Bell, C., Watering urban vegetated patches: computing ecologically useful runoff subsidy</td>
<td>Joint Assembly: American Geophysical Union, Canadian Geophysical Union, Geological Association of Geographers, Mineralocical Association of Canada; Montreal, Canada, B32B-01</td>
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<tr>
<td>Feb 2016</td>
<td>Tague, C., How above-ground forest structure and below-ground water storage interact to determine forest sensitivity to changes in climate and forest management practices</td>
<td>Water Resources Graduate Program, Winter seminar, Oregon State University, Corvallis, Oregon</td>
</tr>
</tbody>
</table>
June 2016  Tague, C., Modeling drought-related disturbance in water limited environments  Computational Methods in Water Resources (CMWR) XXI International Conference, University of Toronto, Canada

Dec 2016  Tague, C., The eco-hydrology of forest density reduction  Weizmann Institute of Science, Rehovot, Israel

Courses Taught

Undergraduate Courses
Watershed Analysis, Hydrology, Introduction to Physical Geography, Introduction to Environmental Science

Graduate Courses
Environmental Modeling, Statistics and Data Analysis, Geographic Research Design, Climate Change impacts on hydrology and ecosystem function, Proposal development and project design for Professional Masters Group Projects; Science and Policy of Climate Change, PhD Seminar in Environmental Modeling, PhD Seminar in Interdisciplinary Problem Solving, PhD Seminar in Ecohydrology, Advanced Topics in Informatics
Appendix F – Sample Course Syllabi

Sample syllabi are provided for the following courses in this order:
- EDS 222, Statistics for Environmental Data Science
- EDS 223, Spatial Analysis for Environmental Problem Solving
- EDS 230, Modeling Environmental Systems
- EDS 241, Environmental Policy Evaluation
EDS 222: Statistics for Environmental Data Science

Instructor: Allison Horst

Description: This course will cover advanced topics in statistics (bootstrapping, transforming data, non-linear models, multivariate statistics, binary, ordinal and multinomial logistic regression, intro to time-series analysis, spatial data analysis and interpolation, principal components analysis, partition-based cluster analysis) and data analysis (organization, manipulation, analysis, interpretation, and communication). Weekly lab attendance is mandatory. Labs and course assignments will be completed in R.

Assignments: Graded assignments will be assigned biweekly. There will be several tutorials posted to GauchoSpace that will not be graded, but should be completed individually. For group assignments, all members of the group are expected to contribute to, and understand, the entire assignment submitted. Assignments may involve oral presentations.

Exams: There will be a final exam (take-home) that you prepare over the course of the quarter. The exam topic(s) and expectations will be covered in detail in Week 5. The final exam will be DUE on the last day of class.

Grading: Assignments (70% total) Final (30%)

Materials: There is no reader or textbook for this course. All necessary materials will be posted on the course GauchoSpace site. Since the lab will be held in a Bren lecture room (1414), you need to bring your charged laptop with R and RStudio to each lab.

Topics (Tentative):

Week 1: Review of intro hypothesis tests (t-tests, ANOVA, chi-squared, multiple regression), tests with covariates and multiple factors (MANOVA, ANCOVA, MANCOVA)

Week 2: MANOVA/ANCOVA continued, dealing with non-parametric data (Mann-Whitney/WSR)

Week 3: Data transformation, bootstrapping

Week 4: Regression with categorical and ordered dependent variables (binary logistic regression, ordered logistic regression, multinomial logistic regression)

Week 5: Nonlinear models

Week 6: Intro to time series analysis

Week 7: Intro to spatial data (exploration, variograms, kriging)

Week 8: Point pattern analysis, dealing with missing data

Week 9: Ordination methods (PCA, RDA)

Week 10: Cluster analysis, course review
EDS 223: Spatial Analysis for Environmental Data Science

Instructor: James Frew

Description: EDS 231 introduces the spatial modeling and analytic techniques of geographic information science to data science students. The emphasis is on deep understanding of spatial data models and the analytic operations they enable. In addition to this theoretical background, students will acquire facility with the libraries, packages, and APIs that support spatial analysis in Python and R, both locally and cloud-based.

Prerequisites: EDS 213, EDS 214, EDS 215, EDS 221, EDS 222

Assignments: 3 to 4 assignments collectively worth 70%, plus a final small-group project worth 30%. The assignments and projects will be submitted as executable notebooks (Jupyter or RMarkdown)

Materials: Readings will be online, either open source or available through the UCSB Library's electronic subscriptions. Data will either be provided, or obtained by the students as part of the class activity.

Topics:

- geodetic and projected coordinate systems
- spatial features
- spatial fields
- spatial analysis pipelines
- terrain/bathymetry models
- temporal analysis
- spatial interpolation
- spatial uncertainty
EDS 230 Modeling Environmental Systems
Instructor: Naomi Tague

Computer-based modeling and simulation are widely used tools in both practical environmental problem solving and in environmental research. Models give us a way to look at the world through a mixture of data and theory. A good model can help us to understand how the world works and how decisions that we make might change the world in ways that are important to us. There are many different types of models, from simple to complex, and models are often tailored to answer a specific questions. This course will give you skills that help you to choose which model, or modeling technique, is right for you - given the task at hand. The course will cover both designing a new model and evaluating existing models. We will emphasize best practices that help to design models that are useful, reliable and get the job done. This is a skills based course and we will use R (a data analysis and programming environment) as our basic platform. Topics to be covered are listed below (this is a tentative list - we may change it as the course progresses to adapt to class interest/abilities).

There are 7 assignments (each worth 10% of the grade) and a project to make up the other 30%. The project and most assignments will be done in groups of 2-3.

<table>
<thead>
<tr>
<th>Lecture Date</th>
<th>Lecture Topic</th>
<th>Assignment Given</th>
<th>Assignment Due</th>
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<tbody>
<tr>
<td>April 3</td>
<td>Intro</td>
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<td>April 5 P</td>
<td>Conceptual Models</td>
<td>Conceptual Model</td>
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<td>April 10 P</td>
<td>Building Models</td>
<td>Building Models: Crop Example</td>
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<td>April 12 P</td>
<td>Building Models</td>
<td>Conceptual Model</td>
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<td>April 17</td>
<td>Data Structures and Models</td>
<td>Building Models: Crop Example</td>
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<tr>
<td>April 19</td>
<td>Control structures</td>
<td>Building blocks</td>
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<td>April 24</td>
<td>Building Blocks</td>
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<td>April 26</td>
<td>Building blocks 2</td>
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<tr>
<td>May 1</td>
<td>Model Testing</td>
<td>Model Testing</td>
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<tr>
<td>May 3</td>
<td>Dynamic Models (discrete)</td>
<td>Project</td>
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<tr>
<td>May 7</td>
<td>Dynamic Models (ODE)</td>
<td>Building blocks-</td>
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<tr>
<td>May 10</td>
<td>Optimization</td>
<td>Population/Prey</td>
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<tr>
<td>May 15</td>
<td>Guest Lecture - Models in Use - Lesson From Experience</td>
<td>Model Testing</td>
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<td>May 17</td>
<td>Visualizing Model Output</td>
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<td>May 22</td>
<td>Selecting Models</td>
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<td>May 24</td>
<td>Evaluating/Calibrating Models</td>
<td>Calibrating Models - 2parts</td>
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<td>May 29</td>
<td>Memorial Day</td>
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<td>May 31</td>
<td>Uncertainty and Parameter Sensitivity</td>
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<td>June 5</td>
<td>Guest Lecture - Models in Use - Lesson From Experience</td>
<td>Project Presentation</td>
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<td>June 7</td>
<td>Project Presentations</td>
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<tr>
<td>June 12</td>
<td>Project Presentations/Review Wrap up</td>
<td>Project Report</td>
<td></td>
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</table>
Course Overview and Objectives:

This course will present state of the art program evaluation techniques necessary to evaluate the impact of environmental policies. The program evaluation methods presented will aim at identifying and measuring the causal effect of policies, regulations, and interventions on environmental outcomes of interest. Students will learn the research designs and methods for estimating causal effects with experimental and non-experimental data. Methods and concepts covered will include: regression adjustment and matching, regression discontinuity methods, panel data methods, and “big data” methods for causal inference. Each concept will be introduced in class through relevant real-world applications. This course will prepare the students for interpreting and conducting high-quality empirical research in policy evaluation, with applications in cross-sectional data and panel data settings.

Many empirical analyses in biological and environmental applications are based on non-experimental data. The objective of this course is for students to learn the research designs and econometric methods for estimating causal effects with non-experimental data. This will prepare the students for conducting high-quality empirical research, with applications in cross-sectional data and panel data settings. The class will mostly emphasize research designs and identification (relative to statistical techniques) and applications (relative to theoretical proofs). Methods and concepts covered will include: regression adjustment and matching, instrumental variables techniques, regression discontinuity methods, and panel data methods. Each concept will be introduced in class through relevant real-world applications.

The course grade will be assigned as follows:

Class Participation: 10%

Assignments: 30% (3 individual assignments worth 10% each). Students can work individually or in teams of 2.

Final Take-Home Examination: 60% (held during the examination period)

Statistical Software:

Students may use the software of their choice but the class applications and the solutions for the problem sets will be done with R and Stata (available in Bren GIS Lab and in Library’s Interdisciplinary Research Collaboratory Lab).
Tentative Course Outline
Additional readings may be assigned as the quarter progresses.

<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
<th>Readings</th>
</tr>
</thead>
</table>
| TBA  | Linear Regression with One Regressor, Multiple Regression, Heteroskedasticity, and Hypothesis Testing | A&P Chapter 3  
S&W Chapters 4-7                           |
| TBA  | Regression Specification: Dummy Variables, Interactions, and Nonlinear Terms | A&P Chapter 3  
S&W Chapter 8                                 |
| TBA  | Definition of Causal Effects and Fundamental Problem of Causal Inference | A&P Chapters 1-2  
I&W Lecture 1                                  |
| TBA  | Regression and Matching                                                | A&P Chapter 3  
I&W Lecture 1                                  |
| TBA  | Propensity Score Matching                                               | A&P Chapter 3  
I&W Lecture 1                                  |
| TBA  | Instrumental Variables Methods                                          | A&P Chapter 4  
I&W Lecture 5                                  |
| TBA  | Regression Discontinuity Methods                                        | A&P Chapter 6  
I&W Lecture 3                                  |
| TBA  | Panel Data Methods and the Clustering Problem                           | A&P Chapters 5 and 8  
I&W Lectures 8 and 10                           |
| TBA  | Big Data Methods for Causal Inference                                   | TBA                                           |
BYLAWS: FACULTY OF THE BREN SCHOOL OF ENVIRONMENTAL SCIENCE & MANAGEMENT

SECTION 1. GENERAL PROVISIONS

1. Functions

The Faculty of the Bren School of Environmental Science & Management is a committee of the Santa Barbara Division of the Academic Senate. Subject to the authority of the Graduate Council in graduate matters, the Faculty shall be responsible to the Santa Barbara Division for the supervision of the Bren School in all such matters of admissions, curricula, and instruction as fall within the jurisdiction of the division. [See Divisional Bylaw 40(A).]

The Bren School and its facilities exist to further and support instruction and research in environmental science and management. This involves the furtherance of knowledge, the education of students, and the transfer of findings to students and the public. The mission of the Bren School is to solve environmental problems. The Bren School develops interdisciplinary solutions to environmental problems, trains environmental leaders, and works for a sustainable future.

2. Membership

The membership of the Faculty of the Bren School is that specified in Divisional Bylaw 40(B).

3. Officers

The Chair of the Faculty Executive Committee serves as the chair of Faculty meetings and represents the Faculty to the Dean and staff (Section 2 describes the election process.)

4. Meetings

A. Frequency

The Faculty meets at least once each quarter as scheduled by the Chair of the Faculty Executive Committee. Other meetings may be held at the call of the Dean or Chair of the Faculty Executive Committee, or upon written request of a quorum of eligible voting members of the Faculty (Divisional Bylaw 215, per Bylaw 180). Membership rules for meetings, voting, and other participation in Academic Unit governance shall be governed by Senate Bylaw 55 (Departmental Voting Rights), except as noted below.
B. Quorum
A quorum of at least one half the eligible ladder faculty must be present at any meeting where a vote is taken. Faculty members not in attendance will be polled by e-mail or telephone if at least one faculty member requests a poll. A poll may be taken either in the absence of a meeting or from a meeting where fewer than a quorum attend. Polled faculty must respond within 72 hours of the request for a vote, or other longer interval as determined by the Chair of the Faculty Executive Committee.

C. Rules of Order
Questions of order not covered by legislation are governed by Robert’s Rules of Order.

D. Ballots
All ballots on appointments, promotions and merit increases will be by secret ballot. A secret ballot on any other issue is required if at least one faculty member requests a secret ballot.

E. Faculty with Additional Campus Administrative Positions or Joint Appointments
Bren School Faculty with additional campus administrative positions or joint appointments in other departments participate in Bren School matters as regular Senate Faculty. Votes by these faculty members each count as one, even if their percentage of appointment in the Bren School is less than 100%. Continuing Lecturers may participate in Faculty meetings but they do not vote on Bren School matters although they may be consulted. Visiting Faculty, Adjunct Faculty, Affiliated Faculty (those with a 0% appointment in the Bren School), researchers and Unit 18 Lecturers do not participate in Bren School Faculty meetings or vote on Bren School matters, although they may be consulted unofficially.

F. Voting
Voting on appointments is open to all Ladder Faculty. The designation of all other voting rights follows Academic Senate Bylaw 55 Sec. B, paragraphs 2-6, without exception.

G. Emeriti
Emeriti Faculty are sometimes consulted in critical Bren School issues, but they do not vote. Upon request, they may attend Faculty meetings.

H. Graduate Student Representatives
Graduate student representatives will serve on a MESM Dean’s Advisory Council (MESM DAC) consisting of 3 first-year MESM students and 3 second-year MESM students elected by MESM students and PhD Dean’s Advisory Council (PhD DAC) consisting of up to 5 PhD students elected by PhD students and representing each year.

One second-year MESM student, elected by MESM students, will serve on the MESM Program Committee along with 2 faculty members appointed by the Dean, and staff.
At least one PhD DAC member, elected by PhD students, will serve on the PhD Program Committee along with 2 faculty members appointed by the Dean, and staff.

One PhD student representative selected by the chair of the search committee will be invited to serve as a non-voting member on a search committee for a new faculty recruitment.

I. Minutes
Minutes of Bren School Faculty meetings are taken by the Assistant to the Dean and posted to the Faculty Wiki. Bren School Faculty, Continuing Lecturers and administrative staff who support Faculty meetings will be granted access to the Faculty Wiki.

SECTION 2. COMMITTEES

1. Faculty Executive Committee (see Divisional Legislative Ruling 1.93.A, Appendix II)

A. Membership
The Faculty Executive Committee consists of four Academic Senate Faculty members, at least one of them tenured, elected at large from among those holding Faculty appointments in the Bren School at greater than 0% and the Bren School Dean (ex officio). In special circumstances, and with concurrence of two-thirds of the voting faculty, membership may be extended for limited periods of time to other members of the Academic Senate at UCSB or other UC campuses.

B. Officers
The Faculty Executive Committee selects its Chair from one of its tenured members by a vote of Faculty Executive Committee members.

C. Tenure
Members serve for two consecutive years, with half of the membership changing every year. Members may be re-elected for additional terms.

D. Replacements
Vacancies in the elected membership occurring during the term of office are filled for the remainder of the vacating member’s term by request of the Faculty Executive Committee. A vacancy is defined as an absence of more than one consecutive academic quarter.

E. Authority
The Faculty Executive Committee, by majority vote, represents the Faculty in all aspects of the academic administration of the Bren School.

F. Duties
1. To assist the Dean in administration of the Bren School.
2. To exercise such portions of the authority of the Faculty as are specifically delegated to the Faculty Executive Committee by the Faculty.
3. To submit curricular and general policy recommendations to the Faculty.
4. To make recommendations to the Faculty regarding petitions of students and any other matters referred to the Faculty Executive Committee for presentation to the Faculty.
5. To supplement its membership by seeking ad hoc consultants, who shall be non-voting members, as may be necessary in the discharge of its duties. Prior to each such action, full details shall be reported to the Faculty.
6. At its direction, to authorize the Dean of the Bren School to administer those regulations of the Academic Senate and the Division that apply to students enrolled in the Bren School; to approve such suspensions of the regulations as deemed necessary or equitable in the individual cases; to supervise students who are subject to probation or dismissal, and to take appropriate action in the case of each student. The Dean shall report annually to the Faculty concerning his or her exercise of such authority.

2. Personnel Committee
The Personnel Committee consists of all members of the Bren School Academic Senate Faculty. The Dean will appoint, with advice from the Faculty Executive Committee, a full professor from the Bren School Academic Senate Faculty to serve a two-year term as Chair of the Personnel Committee. The Dean also will appoint, with advice from the Faculty Executive Committee, a Vice Chair to serve with the Chair. The Personnel Committee Chair shall have served previously as a Chair or Vice Chair of the Personnel Committee or shall have equivalent experience. Vacancies of more than one academic quarter in the Chair or Vice Chair positions occurring during the term of office will be filled by appointment by the Bren School Dean. The duties of the Personnel Committee are to oversee all aspects of the academic personnel process for the Bren School, culminating with the composition of the department letters on appointment, merit and promotion cases. Voting on personnel cases follows Academic Senate Bylaw 55, Section B paragraph 2-6, without exception.

3. Standing Committees
At the beginning of the academic year, the Dean, in consultation with the Faculty and senior staff, designates the membership of and appoints a chairperson to each of the standing committees of the Bren School.

SECTION 3. MODIFICATION OF BYLAWS

Except for Bylaws 1 and 2 in Sec. 1, any of these Bylaws may be modified at any meeting of the Faculty in accordance with the procedure prescribed in Divisional Bylaw 190, per Bylaw 180.
## Appendix H – Comparison table of data science Masters programs

A list and attributes of comparable Masters programs in data science. The list is not comprehensive but is instead a selection of programs at major universities within North America. Courses listed are sometimes a sample from a larger list of courses. When applicable, information about full-time programs is reported. This table is also included in the MEDS proposal as Appendix H.

<table>
<thead>
<tr>
<th>Program</th>
<th>University</th>
<th>Duration</th>
<th>Units</th>
<th>Foundation/Course Courses</th>
<th>Advanced Courses</th>
<th>Electives / Concentration Areas</th>
<th>Capstone Project / Courses</th>
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<tr>
<td>UC Programs</td>
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<tr>
<td>Master of Environmental Data Science (MEDS)</td>
<td>UC Santa Barbara</td>
<td>11 months (full time)</td>
<td>56 units</td>
<td>12 units</td>
<td>36 units</td>
<td>Yes (4-12 units)</td>
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<tr>
<td>-Proposed-</td>
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<td>- Team science, collaborative analysis &amp; project management</td>
<td>- Remote sensing and environmental data</td>
<td>- Bayesian hierarchical models for environmental processes</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>- Essential math for environmental data science</td>
<td>- Scientific programming essentials</td>
<td>- Advanced scientific programming</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>- Metadata standards, data modelling, and data semantics</td>
<td>- Statistics for environmental data science</td>
<td>- Distributed computing, remote and parallel computing</td>
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<td>- Analytical workflows and scientific reproducibility</td>
<td>- Text and sentiment analysis for environmental problems</td>
<td>- Data integration and infrastructures</td>
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<td></td>
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<td></td>
<td>- Introduction to data storage and management</td>
<td>- Modelling environmental systems</td>
<td>- Introduction to bioinformatics</td>
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<td>- Spatial analysis for environmental problem solving</td>
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<tr>
<td>Program</td>
<td>University</td>
<td>Duration</td>
<td>Total Units</td>
<td>Required Units</td>
<td>Courses</td>
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<tr>
<td>Master in Data Science &amp; Engineering (DSE)</td>
<td>UC San Diego</td>
<td>24 months (part time;</td>
<td>40 units</td>
<td>16 units</td>
<td>- Python for data analysis&lt;br&gt;- Data management systems&lt;br&gt;- Probability and statistics using python&lt;br&gt;- Machine learning in environmental science&lt;br&gt;- Data visualization and communication&lt;br&gt;- Environmental policy evaluation</td>
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<tr>
<td>Master of Science in Business Analytics (MSBA)</td>
<td>UC San Diego</td>
<td>12 months (full time)</td>
<td>50 units</td>
<td>16 units</td>
<td>- Business analytics in marketing, finance, and operations&lt;br&gt;- Collecting and analyzing large data&lt;br&gt;- Business analytics&lt;br&gt;- Customer analytics&lt;br&gt;- Business intelligence systems&lt;br&gt;- Experiments in firms&lt;br&gt;- Business forecasting&lt;br&gt;- Technology and innovation strategy</td>
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<tr>
<td>Master of Information and Data Science (MIDS)</td>
<td>UC Berkeley</td>
<td>20 months or less (part time; online)</td>
<td>27 units</td>
<td>12 units</td>
<td>- Python for data science&lt;br&gt;- Research design and application for data and analysis&lt;br&gt;- Statistics for data analysis&lt;br&gt;- Fundamentals of data engineering&lt;br&gt;- Applied machine learning&lt;br&gt;- Experiments and causal inference&lt;br&gt;- Behind the data: humans and values&lt;br&gt;- Deep learning in the cloud&lt;br&gt;- Statistical methods for discrete response, time series, and panel data&lt;br&gt;- Machine learning at scale&lt;br&gt;- Natural language processing with deep learning</td>
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207
<table>
<thead>
<tr>
<th>Program</th>
<th>Institution</th>
<th>Duration (full time)</th>
<th>Units</th>
<th>Courses</th>
<th>Include in Core Courses</th>
<th>Additional Courses</th>
<th>Core Courses</th>
<th>Include Core Courses</th>
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<tbody>
<tr>
<td>Master of Computer Science (MCS)</td>
<td>UC Irvine</td>
<td>16 months</td>
<td>48</td>
<td>12 units (3 courses)</td>
<td>No</td>
<td>- Principles of data management</td>
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<td>- Data structures with applications</td>
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<td>- Machine learning and data mining</td>
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<td>Other Programs</td>
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<td>Yes</td>
<td>24 units (6 courses)</td>
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<td></td>
<td>- Introduction to artificial intelligence</td>
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<td>- Data compression</td>
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<td></td>
<td>- Visual computing</td>
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<td>- Advanced programming and problem solving</td>
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<td></td>
<td></td>
<td>- Machine learning and data mining</td>
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<tr>
<td>Master of Information Technology Strategy (MITS)</td>
<td>Carnegie Mellon University</td>
<td>18 months</td>
<td>120</td>
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<td>- Data structures for programming</td>
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<td>- Machine learning large data sets</td>
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<td></td>
<td></td>
<td></td>
<td>- Big data analytics</td>
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<td></td>
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<td>- Cloud computing</td>
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<tr>
<td>Master of Data Science (DSC)</td>
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<td>- Tools for data science</td>
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<td>- Machine learning</td>
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<td>- Time series analysis &amp; forecasting in data science</td>
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<td>- Causal inference</td>
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<td>- Geospatial data analysis</td>
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<td>Master in Information</td>
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<td></td>
<td></td>
<td>- Machine learning from data</td>
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<thead>
<tr>
<th>Program</th>
<th>University</th>
<th>Duration</th>
<th>Credits</th>
<th>Course Options</th>
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<tbody>
<tr>
<td>Master of Science in Data Science</td>
<td>Columbia University</td>
<td>9-13 months (2-3 semester full time)</td>
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<td>- Probability and statistics for data science</td>
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<td>- Algorithms for data science</td>
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<td>- Statistical inference and modeling</td>
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<td>- Machine learning for data science</td>
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<td>- Computational linguistics</td>
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<td>- Interactive data visualization</td>
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<td>- Advanced econometrics</td>
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<td>- Big data policies</td>
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<tr>
<td>Master of Science in Information Systems</td>
<td>Johns Hopkins University</td>
<td>12 months (full time)</td>
<td>24</td>
<td>- Statistical analysis</td>
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<td>- Data analytics</td>
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<td>- Operations management</td>
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<td>- Information systems</td>
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<td>- Business communication</td>
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<tr>
<td>Master of Science in Computer Science (Data Science)</td>
<td>University of Southern California</td>
<td>Not specified</td>
<td>32</td>
<td>- Analysis of algorithms</td>
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<td>- Database systems</td>
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<td>- Foundations of artificial intelligence</td>
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<td>- Advanced big data analytics</td>
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<td></td>
<td>- Probabilistic reasoning</td>
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<td>- Applied probability</td>
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- Technology
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<tr>
<th>Program</th>
<th>Institution</th>
<th>Duration</th>
<th>Credits</th>
<th>Required Courses</th>
<th>Electives</th>
<th>Online</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master in Data Science</td>
<td>Indiana University</td>
<td>12-15 months (full time) 36 months (part time)</td>
<td>30 credits</td>
<td>12 credits - Introduction to statistics - Data mining - Applied machine learning - Data visualization</td>
<td>No</td>
<td>Yes (3 credits)</td>
</tr>
<tr>
<td>Master of Data Science</td>
<td>Illinois Institute of Technology</td>
<td>12 months (full time); 24 months (part time)</td>
<td>33 credits</td>
<td>18 credits - Big data technologies - Applied statistics - Machine learning - Statistical learning - Data preparation and analysis</td>
<td>No</td>
<td>Yes (6 credits)</td>
</tr>
<tr>
<td>Master of Information Systems (MIS)</td>
<td>University of Arkansas</td>
<td>12 months (full time)</td>
<td>30 credit hours</td>
<td>9-credit hours - Data management systems - Seminar in systems development - Management of information technology seminar</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Master of Information Systems and Technology (MSIST)</td>
<td>Claremont Graduate University</td>
<td>12-18 months (full-time) (also offered part-time &amp; online)</td>
<td>36 units</td>
<td>Not specified - Data analytics &amp; information visualization - Data mining practicum - Databases &amp; big data - CS insights via</td>
<td>Not specified</td>
<td>No</td>
</tr>
<tr>
<td>Program</td>
<td>University</td>
<td>Duration</td>
<td>Credits</td>
<td>Required Courses</td>
<td>Elective Courses</td>
<td>Additional Notes</td>
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<td>Masters of Science in Computational &amp; Data Sciences</td>
<td>Chapman University</td>
<td>24 months (full time). Part time enrollment also possible</td>
<td>At least 31 credits</td>
<td>16-22 credits - Statistical methods - Applied methods in mathematics - Computing for scientists - Data mining - Multivariate data analysis</td>
<td>No 18 credits - Satellite image processing - Earth system science - Bayesian data analysis - Machine learning - Digital image processing</td>
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<td>Master of Science in Data Science</td>
<td>George Washington University</td>
<td>Not specified</td>
<td>30 credits</td>
<td>12 credits - Machine learning I: Algorithm analysis - Machine learning II: data analysis - Visualization of complex data - High performance computing and parallel computing</td>
<td>6 credits - Data science applied research - Geographical information systems I - Applied linear models - Modern regression analysis</td>
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<tr>
<td>Master of Science in Analytics</td>
<td>Georgia State University</td>
<td>12-18 months</td>
<td>30 credits</td>
<td>21 credits - Data programming for analytics - Machine learning for analytics - Statistical foundations for analytics - Econometric modelling for analytics</td>
<td>No 9 credits - Text analytics - Image analytics - Image and text analytics with deep neural networks</td>
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<td>Master of Science in Analytics</td>
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<td>12 months (full time) 24 months</td>
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<td>- Data structures for scientists and engineers</td>
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<td>- Probability and distribution</td>
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<td>- Intro to quantitative research methods</td>
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<td>- Database management systems</td>
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<td>- Data science analytics using python</td>
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<td>- Applied regression analysis</td>
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<td>- Data mining and statistical learning</td>
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<td>- Machine learning: Methods and applications</td>
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<td>- Probability and distribution theory</td>
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<td>- Longitudinal analysis</td>
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<td>- Generalized linear models</td>
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<tr>
<th>Master of Science in Data Science</th>
<th>University of Washington</th>
<th>18 months (full time) 30 months (part time)</th>
<th>45 credits</th>
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<td>- Information Visualization</td>
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<td>- Data Science Visualization Lab</td>
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<td>- Applied Statistics &amp; Experimental Design</td>
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<td>- Software Design</td>
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<td>- Scalable Data Systems &amp; Algorithms</td>
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<td>- Human-Centered Data Science</td>
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<tr>
<th>Master of Science in Data Data</th>
<th>New York University</th>
<th>18 months</th>
<th>36 credits</th>
<th>12</th>
<th>3 credits</th>
<th>18 credits</th>
<th>Yes (3 credits)</th>
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<td>- Inference and Representation</td>
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<td>- Deep Learning</td>
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<td>- Big Data track</td>
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<td>- Mathematics and</td>
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<tr>
<td>Course</td>
<td>Institution</td>
<td>Duration</td>
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<td>Required Courses</td>
<td>Electives</td>
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<tr>
<td>Master in Applied Statistics: Data Science</td>
<td>Cornell University</td>
<td>9 months (2 semesters)</td>
<td>30 credits</td>
<td>13 credits &lt;br&gt; - Linear models with matrices &lt;br&gt; - Probability models and inference &lt;br&gt; - Applied statistics data project &lt;br&gt; - Professional development</td>
<td>No &lt;br&gt; - Python programming and its application in statistics &lt;br&gt; - Data mining and machine learning &lt;br&gt; - Big data management and analysis &lt;br&gt; - Econometrics &lt;br&gt; - Monte carlo simulation</td>
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| Master of Science in Data Science               | Stanford University| 18 months         | 45 units | 12 units <br> - Numerical linear algebra <br> - Discrete mathematics and algorithms <br> - Optimization <br> - Theory of probability | 6 units <br> - Distributed algorithms and optimization <br> - Parallel computing <br> - Parallel methods in numerical analysis | 21 units <br> - Introduction to statistical inference <br> - Introduction to regression models and analysis of variance <br> - Modern applied statistics: Learning <br> - Modern applied statistics: Data mining <br> - Computing for data science | Yes (6 units)
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<tr>
<th>Program</th>
<th>University</th>
<th>Duration</th>
<th>Units</th>
<th>Courses</th>
<th>Required?</th>
<th>Additional Courses</th>
<th>Notes</th>
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<td>Master of Science in Data Science</td>
<td>University of San Francisco</td>
<td>12 months (full time)</td>
<td>35 units</td>
<td>Unspecified - Relational databases - Computation for analytics - Review of probability and statistics - Linear regression analysis</td>
<td>No</td>
<td>Unspecified - Introduction to machine learning - Distributed computing - Advanced machine learning - Problem solving with Python</td>
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<tr>
<td>Master of Science in Data Science</td>
<td>University of Virginia</td>
<td>11 months</td>
<td>31 credits</td>
<td>23 credits - Programming and systems for data science - Statistical computing for data science - Linear models for data science - Data mining - Machine learning</td>
<td>No</td>
<td>6 credits - Theory of computation - Data visualization - Econometrics II - Longitudinal analysis - Advanced use of Geographical Information Systems</td>
<td>Yes (2 credits)</td>
</tr>
<tr>
<td>Master of Science in Statistics – Data Science</td>
<td>University of Wisconsin</td>
<td>12 months</td>
<td>30 credits</td>
<td>15 credits - Statistical methods I and II - Introduction to statistical inference - Statistical learning - Professional skills in data science</td>
<td>No</td>
<td>15 credits - Introduction to time series - An introduction to sample survey theory and methods - Introduction to computational statistics - Statistical methods for spatial data</td>
<td>No</td>
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April 8, 2019

To: Henning Bohn, Divisional Chair
    Academic Senate

From: Ronald E. Rice, Chair
      Committee on Rules, Jurisdiction & Elections

Re: Response to the Proposed Revision of SB Regulation 125H3

The Committee on Rules, Jurisdiction & Elections (RJE) reviewed the proposal to revise SB Regulation 125H3, as well as SB Regulation 115E, regarding calculation of major GPA. RJE approves the revised language as proposed.

However, RJE notes there is still ambiguity:

There are two different GPAs mentioned in the first sentence of 125H3:
“To be eligible for graduation, the student must earn a University grade-point average of at least 2.00 in all courses required in the major program (comprising the lower-division courses in preparation for the major and the upper-division courses constituting the major), and a University grade-point average of at least 2.00 in all upper-division courses required in the major program.”

However, the proposed revision of the second sentence and the new third sentence is:
“Courses appropriate for the satisfaction of requirements in the major program but in excess of minimum requirements in the major program will not be utilized in the computation of the grade-point average. When more electives are taken than the major requires, those courses with the lowest grades will be designated to be the ones in excess and, thus, not be calculated in the grade-point average.”

The revised language refers to “the grade-point average” and refers to the “major program”, which includes the preparation for the major. It is not obvious, but probably intended, that the GPA for the upper division courses constituting the major (which also must be at least 2.0) would be calculated in the same way.

RJE recommends further discussions to clarify this.

CC: Debra Blake, Executive Director, Academic Senate
November 14, 2018

TO: Trevor Hayton  
Chair, Undergraduate Council

FROM: Ralph Armbruster-Sandoval  
Chair, College of Letters and Science Faculty Executive Committee

RE: SR 125H3, Calculation of Major GPA

The College of Letters and Science Faculty Executive Committee (FEC) has reviewed a proposal put forth by the three undergraduate deans at UCSB to alter the manner in which our campus calculates the major GPA.

Specifically, the proposal is to adjust Senate Regulation 125H3 as follows:

Courses appropriate for the satisfaction of requirements in the major program but in excess of minimum requirements in the major program must _not_ be utilized in the computation of the grade-point average. _When more electives are taken than the major requires, those courses with the lowest grades will be designated to be the ones in excess and, thus, not be calculated in the grade-point average._

The deans outline the various impacts of the current and proposed approaches.

The L&S FEC is persuaded by the arguments and unanimously endorses the deans’ proposal to adjust local regulation SR 125H3. The FEC urges the Undergraduate Council to consider and advance the proposed change.

Enclosure: October 18, 2018, memo from UG Deans

cc: Pierre Wiltzius, Executive Dean of the College and Dean Science  
Jeffrey Stopple, Associate Vice Chancellor and Dean, Undergraduate Education  
John Majewski, Dean of Humanities and Fine Arts  
Charlie Hale, Dean of Social Sciences  
Bruce Tiffney, Interim Dean, College of Creative Studies  
Glenn Beltz, Associate Dean for Undergraduate Studies, College of Engineering
October 18, 2018

To:   John Latto, Chair CCS FEC
       Irene Beyerlein, Chair CoE FEC
       Ralph Armbruster, Chair L&S FEC

From:  Bruce Tiffney, Interim Dean CCS
       Glenn Beltz, Associate Dean for Undergraduate Studies, CoE
       Jeffrey Stopple, Dean of Undergraduate Education, L&S

Re:   Calculation of Major GPA via SR 125H3

One would think that calculation of GPA in the major is straightforward. In fact, a long-standing Senate regulation has unintended consequences which inappropriately benefit a few students, and inappropriately harm more students. This memo attempts to explain, and proposes a change. (This is an updated version of a proposal from the co-Interim L&S Dean from 2016. Since some students move between colleges and SR 125H3 is a Senate regulation, all FECs are asked to weigh in and endorse this onwards to Undergraduate Council.)

Senate Regulation 125H3 details how the major GPA is calculated: “Courses appropriate for the satisfaction of requirements in the major program, but in excess of minimum requirements in the major program, must be utilized in the computation of the grade-point average.” We propose the following modification: “Courses appropriate for the satisfaction of requirements in the major program but in excess of minimum requirements in the major program must will not be utilized in the computation of the grade-point average. When more electives are taken than the major requires, those courses with the lowest grades will be designated to be the ones in excess and, thus, not be calculated in the grade-point average.”

We offer below the case for the change, but want to emphasize at the outset this is not a lowering of standards, and has no effect on overall GPA. Indeed, major GPA, as defined by SR 125H3, is not transcripted by the Registrar, nor stored anywhere in their records, but rather calculated on the fly by the degree audit system. It exists only in one of two states: ‘clear to graduate’ or ‘not clear to graduate’

Inappropriate benefit: Currently some students who struggle in a major are able to pad their major GPA by taking additional soft courses which will not count towards the major. For example consider the Chemistry B.S. The major requires 45 upper division units. A recent student has taken both Chem 123 Environmental Chemistry and Chem 149 How Science Works as electives. According to the major sheet, at most one of these can be used to satisfy the major. But since both were taken, and either one could have fulfilled the requirement, both must be

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1 In this memo ‘elective’ means elective for the major, for example Math 113 Non-Euclidean Geometry is not a required course for the BA in Mathematics, but an allowable elective for the major.
included in the major GPA, clearing the student to graduate by .11 grade points. Under the proposed change, the student would not clear to graduate by -.02 grade points.

The Mathematics B.S. includes 12 units of elective, which can be taken in either Mathematics or PSTAT. But if a student double majors in Mathematics and PSTAT, every PSTAT course taken goes into the calculation of the Mathematics major GPA, because any one of the PSTAT courses could have been used as part of the 12 units of elective.

Inappropriate harm: Some students struggle in a major, but later turn it around and earn good grades. For example consider the History B.A. The major requires 40 upper division units, of which 36 are elective. A recent student has passed 40 upper division units, and has a major GPA based on those, which would clear to graduate by .05. However, this individual has five earlier courses with a grade of F. These courses, as F’s, of course don’t count towards graduation, but under the current regulation they must be included in the major GPA, which fails to clear by -.64. The major requires only 40 units, but this student will have to pass many more than that in order to graduate. The data below show this is a significant issue in reducing our graduation rate.

UCSB’s standard of computing major GPA (SR 125H3) is atypical within the UC System. For example, at UCLA, UC San Diego, and Berkeley, major unit requirements are both a minimum and maximum: if the major requires 40 UD units, then only 40 UD units can apply toward satisfaction of the major requirements and be calculated into the major GPA. At these campuses, if a major requires 12 units of elective, only 12 units of elective work can be included in the major requirements and GPA. UC Merced follows this in practice, but it is not written in Senate Regulations. UC Davis allows individual departments to decide; most follow the proposal but at least one department follows current UCSB practice. UC Irvine and UC Santa Cruz do not calculate major GPA, which effectively means they follow the proposal. Only UC Riverside consistently follows current UCSB practice.

The Office of Undergraduate Education did an analysis of the impact of the proposal, for a sample of students. We determined the following

- For 30 students selected at random who did clear to graduate between Spring 2017 and Winter 2018, none were negatively affected by the proposal.²
- For the 33 students who did not clear for graduation between Spring 2017 and Winter 2018 due to major GPA failure, there is significant impact. 73% of theses students go from not meeting, to meeting the major GPA requirements after the proposed change.

We strongly support this proposal as a matter of equity. Should all UC Santa Barbara students in a given major be held to the same standard number of units to graduate, or should students who have struggled and overcome, or who wish to take additional courses in their area, be penalized by being required to pass additional courses beyond what the major requires? Berkeley and UCLA, which already follow this proposal, have four-year graduation rates of 76% and 78% respectively. UCSB has a four-year rate of 68%.

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² The Chemistry example above was found as a result of a deliberate search. This random sample data indicates that students benefit inappropriately only infrequently.
From another viewpoint, the current regulation imposes a ‘one size fits all’ standard on what the major consists of, overruling the judgment of departments, both for and against the student in various examples. This proposal returns control of the major back to departments. Departments are of course, free to include any specific class in the requirements for the major, in which case it will always be included in the major GPA calculation.

The University Registrar has been consulted about the practical implications of the proposed change. Implementation can be done with an appropriate start date. Major sheets will need to be modified where they quote SR125H3.
January 23, 2019

TO: Trevor W. Hayton, Chair
Undergraduate Council

FROM: Irene Beyerlein, Chair
College of Engineering, Faculty Executive Committee

RE: Proposed Revision of SB Reg 125H3 and Proposed Changes to Senate Regulation 115E

We were asked to comment on the proposed amendment to Senate Regulation 125H3 as described in the October 18, 2018 memo to the FEC Chairs. While that regulation technically only pertains to Letters and Sciences students, it has campuswide ramifications as calculating major GPAs differently for students in different colleges would seem to be impracticable.

In order to maintain parity across colleges, we would like to make an amendment to SR 115E. The committee has read the attached SR115E proposal by Associate Dean Glenn Beltz and approved the change based on the rationale laid out on the October 18, 2018 memo (6 yes, 0 no, 0 abstained – out of 10 eligible voting members).

Unfortunately, we did not receive the memo addressed to the FEC chairs dated October 18, 2018 and were surprised that the Undergraduate Council approved it on December 11 prior to receiving feedback from all FECs on campus. Even so, we appreciate the opportunity now to weigh in on what is clearly a campuswide issue.
January 23, 2019

To: Irene Beyerlein, Chair  
   Engineering Faculty Executive Committee

From: Glenn Beltz, Associate Dean for Undergraduate Studies  
       College of Engineering

Subject: Proposed Changes to Senate Regulation 115E—Major Grade-Point Average

Recently, the College of Letters and Science proposed a change to how major GPA is calculated. Senate Regulation 125H3, which only applies to L&S students, details how the major GPA is calculated: “Courses appropriate for the satisfaction of requirements in the major program, but in excess of minimum requirements in the major program, must be utilized in the computation of the grade-point average.” L&S adopted the following modification, which was recently approved by the Undergraduate Council: “Courses appropriate for the satisfaction of requirements in the major program but in excess of minimum requirements in the major program will not be utilized in the computation of the grade-point average. When more electives (“elective” means elective for the major, for example ME 169, Nonlinear Phenomena, is not a required course for the BS in Mechanical Engineering, but an allowable elective for the major) are taken than the major requires, those courses with the lowest grades will be designated to be the ones in excess and, thus, not be calculated in the grade-point average.” The rationale for the change is laid out in a memo from the Associate Vice Chancellor for Undergraduate Education dated October 18, 2018.

Students change their college from time to time, and we have students double majoring in CoE and L&S. It would be impracticable for major GPAs to be calculated in more than one way. The Registrar communicated with me that they definitely prefer that all major GPAs be calculated in the same way for all students at UCSB. It is easier to code and maintain, it is easier to explain to students, it cuts down on potential errors, and it minimizes complaints. The College of Creative Studies voted recently to adopt the new GPA calculation.
Accordingly, I propose the following be added to the extant SR 115 that applies to students in the College of Engineering (subsection E, which is our counterpart to SR 125H, currently only has 2 sections):

Senate Regulation 115E3
Courses appropriate for the satisfaction of requirements in the major program but in excess of minimum requirements in the major program will not be utilized in the computation of the grade-point average. When more electives are taken than the major requires, those courses with the lowest grades will be designated to be the ones in excess and, thus, not be calculated in the grade-point average.

Cc: Haley Orton, College of Engineering
March 1, 2019

To:    Henning Bohn, Chair  
       Academic Senate

From:  Trevor Hayton, Chair  
       Undergraduate Council

Re:    Proposed Revision of Divisional Regulations 125H3 and 115E

The Undergraduate Council (UgC) has completed its review of the proposed changes to Divisional Regulation 125H3 and 115E regarding the calculation of grade-point-average for the major.  UgC considered the comments of the faculty executive committees of the College of Letters and Science, the College of Engineering, and the College of Creative Studies.  All three groups endorsed the proposal. UgC found the proposed changes to be cogent and agreed with the need for equity and uniformity. The Council unanimously approved the proposed changes.

CC:    Debra Blake, Executive Director, Academic Senate
April 2, 2019

To: Henning Bohn, Chair, Academic Senate

From: Jeffrey Stopple, Dean of Undergraduate Education, L&S

Re: Calculation of Major GPA via SR 125H3

The proposal from the undergraduate deans (myself, Bruce Tiffney, Glenn Beltz) to change the Senate regulation on the calculation of Major GPA (SR 125H3), has, after three years, been approved by all the relevant FECs, and by Undergraduate Council. In coordination with the Registrar, degree audit software has already been coded and tested on numerous actual UCSB student records. If and when the Faculty Legislature approves the proposal, it can be implemented immediately, even for spring 2019 degree candidates.

But the topic is technical, and much more subtle than it first appears. Face to face conversations have been helpful in clearing up misunderstandings along the way. The Committee on Rules, Jurisdiction, and Election has weighed in on the proposal. Their final recommendation seems to be the opposite of what was proposed and agreed to by the FECs and UgC.

This memo attempts to clarify. Please forgive me for stating what may seem obvious. Senate Regulation 20 (in particular 20C) describes the calculation of GPA (sometimes called overall GPA). All courses taken for letter grade are included, subject to the rules regarding excess repeats in overall GPA. This GPA is transcripted by the Registrar, and used to determine, among other things, Honors at Graduation. The present proposal has nothing to do with and in no way changes overall GPA.

A separate section of the regulations, 125H3 describes the calculation of a second GPA, called major GPA. This is not transcripted by the Registrar, and not even visible to students at the top level of the degree audit system DARS. It exists in one of two states ‘cleared to graduate’ or ‘not clear to graduate.’ To describe what courses go into major GPA (under the current system or the proposed revision) we need to introduce some terminology.

- A **major required** course is a course that must be taken and passed to satisfy the major. ECON 101 is a major required course for the Economics BA. Major required courses need not be in the department of the major: Anthropology 100 is required for the Classics major.
- A **major elective** course is one that may be used to satisfy the unit requirements of the major but is not required. It may or may not be in the major department: the Mathematical Sciences BS requires 12 units of upper division courses from either Mathematics or PSTAT.
- A **major distribution** course is one used to satisfy a distribution requirement within a major. For example, the Music Studies BA requires two courses from Music 113 through Music 119. Four units from Writing 105AA-ZZ, Writing 107AA-ZZ, Writing 109AA-ZZ are required to complete the Economics major.
• A major limited course belongs to a subset of course with limitation on how many may be used for the major. For example, no more than one course from Chem 110, 123, 149 may be used to satisfy the requirements of the Chemistry BS.

This list does not exhaust all the possibilities; the more than 100 majors we offer have complex and detailed requirements. Departments in the future may create other permutations.

Because of this complexity, the current wording of 125H3 “Courses appropriate for the satisfaction of requirements in the major program, but in excess of minimum requirements in the major program, must be utilized in the computation of the grade-point average” has unintended consequences. If a Chem major takes Chem 110 and 123 and 149, they are all used in the calculation of major GPA, because the Senate regulation overrides the intent of the department. If an Econ major does a Writing minor, every course used to complete the minor goes into the Econ major GPA, because any one of them could have been the one to satisfy the requirement for a single Writing course. Similarly, if a student double majors in Math and PSTAT, every PSTAT course goes in the Math major GPA. These are just some of the unintended consequences; my original memo describes the measurable impact on our graduation rate.

The intent is, as discussed with UgC and the FECs:

• If a major required course is taken more than once, only the best grade is used in the major GPA. For example, an Econ major takes Econ 101 with grades of D+, F, C. Only the C would be used.
• If more major electives are taken than the major requires, only the best grades would be used in calculating major GPA.
• If more major distribution courses are taken than the major requires, the best courses up to the number required are used in the major GPA.
• If more major limited courses are taken than the major requires, the best grades only up to the number which count towards the major are used. For example, a Chem major takes Chem 110 and 123 and 149, earning an A in each. Only a single A goes into the major GPA.

The wording proposed by Rules, Jurisdiction, and Elections does not seem to capture the above complexity. If the wording needs to be changed, an alternative that captures the intent of the memo and the FEC and UgC discussions is

“If a student takes more courses appropriate for the satisfaction of requirements in that student’s major program than the minimum requirements of that program, then among all the subsets of the student’s courses that are sufficient to meet the minimum major requirements exactly once, the subset used to compute the student’s major grade-point average will be one in which the student earned the highest grade-point average.”