University of California, Santa Cruz
Undergraduate Research Annual Report
July 1, 2013-2014

Rebecca Anderson, Ph.D.
Undergraduate Research Coordinator

Contents Page

Executive Summary

The University of California at Santa Cruz (UCSC) is a public research university, where professors and researchers are actively expanding the boundaries of their fields. Many undergraduates participate in this research, which includes discovery, design, performance arts, critical analysis of primary sources, scientific investigations in social, physical, and biological sciences, and other endeavors that make original intellectual or creative contributions to a discipline. This undergraduate research (UR) is a critical component of an effective undergraduate education, since it offers students the opportunity to apply what they learn in their coursework as they engage in the practice of their discipline.

A substantial part of my work as UR Coordinator is to support and to expand UCSC undergraduates' opportunities for success. I reach students though advising, workshops, class presentations, and an extensive website, Undergraduate Research Opportunities. During the last year, utilization of my services has expanded dramatically, with a 300% increase in the number of hours I advised students and a greater than 325% increase in the number of unique visitors to the website. There is clearly an audience for information about UR.

As my contact with students increases, it has become clear to me that many students lack basic knowledge of what UR is and how to get involved. Additionally, even if a student has a project and a mentor, funds to support the project are often not available. To address these hurdles, I propose establishing an Undergraduate Research Center (URC) focused on educating all students about UR and providing them with the practical and social support they need. The URC will oversee a new Undergraduate Research Award (URA), a central funding source open to all undergraduates to support undergraduate research expenses. The center and award will help firmly establish undergraduate research as an essential part of the UCSC undergraduate experience. In turn, the URC will offer a central location to celebrate students' achievements with the UCSC community and to attract potential donors.

The URC will also be important to the campus community as a source of rigorous data on the state of UR at UCSC, including reliable counts of the number of students involved in UR before graduation and their success in research after graduation. With the assistance of other UCSC faculty and staff, I have already begun working on these topics. We have added a new question about UR to the UC Undergraduate Experience Survey, and have begun investigating at what rate UCSC bachelor's graduates go onto receive PhDs; a preliminary analysis of the data indicates that UCSC's PhD production rate exceeds the average of other UC campuses.

I am committed to the vision that all UCSC undergraduates will know that UR is an option that can help them master their disciplines and develop skills that will be invaluable regardless of their future career paths. Communicating this information to students is challenging, and I am eager to work with the UCSC community to achieve it.

Introduction

The University of California at Santa Cruz (UCSC) is a public research university, where professors and researchers are actively expanding the boundaries of their fields. In addition to the research done on campus, UCSC's location on the Monterey Bay and near Silicon Valley facilitates collaborations between the University, industry, government agencies, and other research organizations. By working with these professionals, both in academics and in business, the more than 15,000 undergraduates at UCSC have excellent opportunities to practice their discipline and contribute to the academic community by participating in undergraduate research (UR).

UR includes discovery, design, performance arts, critical analysis of primary sources, scientific investigations in social, physical, and biological sciences, and other endeavors that make original intellectual or creative contributions to a discipline. It is a critical component of undergraduate education, since it offers students the opportunity to apply what they learn in their coursework as they engage in the practice of their field. Participating in UR transforms them from passive observers to active participants in their discipline, and develops the tenacity and focus that are required for success in any future career path.

While excellent programs and opportunities for students to become involved in UR are found throughout UCSC, prior to summer 2012 there was no central online location or designated individual to provide information about UR to students. To address this, the Division of Physical and Biological Sciences, the Baskin School of Engineering, and the Dean of Undergraduate Education funded the new position of Undergraduate Research Coordinator, which I began in July, 2013.

During my first year in this position, I focused on investigating how many UCSC students were involved in UR, exploring what opportunities were available to students in each division, creating a website to educate students and the surrounding community about UR at UCSC, facilitating communication between academic and academic support units, and reaching out to educate students through activities such as workshops and student advising.

Through my outreach activities and discussions with students and staff during the year, it became clear to me that undergraduates face a series of hurdles to participation in UR. Frequently, students lack an understanding of university and academic culture. While this can be true of any student, the lack of cultural capital is especially relevant for the more than 40% of frosh admitted to UCSC for the fall of 2014 who are the "first in the[ir] family to go to college" (UCSC Newscenter, http://news.ucsc.edu/2014/04/admits-fall14.html). Often these students are unaware that participating in research is an option for an undergraduate, and do not know how to prepare to be a strong candidate, when to start looking for a position, or how to succeed if they find one. They are often intimidated by their professors and are hesitant to make appointments or speak to potential research mentors outside of class. Consequently, they rarely attend office hours or build relationships with professors that will help them get involved in research and culminate in the letters of reference required for many future career opportunities.

A second major obstacle that students encounter is funding a project. While small awards are available from colleges, divisions, and private donations, there is no central fund to which students can apply to support their work. Dr. Richard Hughey, the Vice Provost and Dean of Undergraduate Education (VPDUE), and the faculty have determined that research funds—small financial awards for students of $500 to $1,000—are one of the most effective ways to enable more young people to do research. Students may use the funds for a capstone or thesis project, for summer or term-time research, for travel for their research, to cover other research expenses, or to present the results of their work at a professional conference. These awards would be available to students from all divisions.

During the past year I pursued two initiatives to help increase broad awareness of UR. First, I attended multiple gateway Physical and Biological Science (PBSci) classes, including introductory chemistry, math and biology, and made short announcements about preparing for UR, the website, and my availability as an adviser. This approach was very successful, and led so many students to come to drop-in advising or to contact me by email that I struggled to meet my other responsibilities. Due to the overwhelming volume of the response, I have not made classroom announcements again, but they remain a valuable tool that could be deployed very effectively if more personnel or resources were made available to handle the resulting inquiries. Second, I gave a presentation at a meeting of the PBSci department chairs and department manages meeting, and suggested that I help them organize an information session for students in their major. These would be modeled after the Astronomy Department Social, which has proven very effective at connecting students to potential research mentors. However, no department contacted me in order to arrange such a function.

While these two initiatives have been discontinued for now (though in the case of classroom announcements that is because they were *too* successful for the available advising resources), in the last section of this report I outline new initiatives to address these critical student needs. UCSC undergraduates have the right to know that UR is an option, and it is our responsibility as educators to make them aware of how they can get involved in UR, and how it can help them master their discipline and develop skills that will be invaluable regardless of their future career paths. While meeting this goal will be not be easy, I challenge the UCSC community to embrace it.

In this annual report, I first review the current data on UR participation at UCSC and describe ongoing research that will improve the data. In the second section, I present new data that provides an example of one method to evaluate whether our graduating students are succeeding in academic careers. In the third section I give an overview of my activities during the 2013-14 year. Finally, in the fourth section, I propose a substantial expansion in the university's support for UR through the creation of a Center on Undergraduate Research (URC) and an Undergraduate Research Award (URA) that is available to all UCSC undergraduates.

Section 1. UR participation at UCSC and improving the data

The UCSC Undergraduate Research Annual Report for 2012-13 shows that approximately 60% of seniors graduating in 2012 participated in UR while students at UCSC (Table 1). These data are based on the University of California Undergraduate Experience Survey (UCUES), which is an online census survey administered every other spring quarter. The survey asks undergraduates about their academic and extracurricular activities. Dr. Anna Sher, Assistant Director for Assessment, provided these analyses.

Table 1. Graduating seniors by division who assisted faculty in research and/or worked on creative projects under the direction of faculty, from the UCUES 2012

	Division				
	Arts	Humanities	Social Sciences	PBSci	SOE
Assisted faculty in research and/or creative projects	74%	51%	67%	60%	63%
Assisted faculty in research	1%	12%	16%	30%	27%
Assisted faculty in research AND Worked on creative projects	15%	13%	20%	18%	22%
Worked on creative projects	58%	29%	22%	12%	19%
Neither assisted faculty in research nor worked on creative projects	26%	46%	33%	40%	33%
Total Count	104	195	503	264	79

The rate of research participation varies widely by division. A higher proportion of students in the Arts (74%) and the SOE (67%) engaged in UR than did those in the Social Sciences (58%) and PBSci (60%). The lowest rate of UR was in the Humanities (54%).

One potential complication with the analysis above is that students in different divisions might not share a common definition of what constitutes participation in UR. To reduce this potential bias, I collaborated with Dr. Sher and Dr. Hughey to formulate a new question for UCSC students in the 2014 UCUES (Figure 1). We expect that these data will yield a more accurate estimate for the number of UCSC students involved in UR, and will serve as baseline information as we work to improve the UR participation rate.

Figure 1. New question for UR participation in 2014 UCUES survey

As a UCSC student, have you completed or are you now conducting a research or creative project? These are original projects that include design, performance arts, critical analysis of primary or secondary sources, and scientific investigations in social, physical, and biological sciences.

	Yes, doing now or have done	No
a. under the guidance or supervision of a faculty member		
b. without the guidance or supervision of a faculty member		

Section 2. New Data to evaluate one measure of UCSC graduates' success

One way to measure the effectiveness of the UR experience at a campus is to determine how many of the undergraduates who receive bachelor degrees from that campus go on to receive PhDs. The National Science Foundation (NSF) records the undergraduate degree-awarding institution for all PhDs granted in the United States, and the University of California records the number of undergraduate degrees awarded by each UC Campus. From the NSF database I determined the number of PhDs from 2002-2011 awarded to individuals whose undergraduate institution is listed as UC Santa Cruz, and I divided this figure by the number of undergraduate degrees awarded by UCSC from 2000-2009. This calculation yields an approximate estimate of the fraction of UC Santa Cruz undergraduate degree awardees who then went on to receive a PhD. Table 2 shows the data I obtained and the resulting estimate of the rate of PhD production per undergraduate degree awarded. Details on the data sources used are given in the footnotes to the table.[1]

[1] Malika Bell, Director of STEM Diversity Programs at UCSC, performed a similar analysis as part of funding proposals to the National Institutes of Health. I thank her for suggesting both the method of analysis and the data sources used to perform it.

Table 2. PhDs produced per 100 students with bachelor's degrees from UCs

	Undergraduate Fall Enrollment 2002-2011 [1]	Number Bachelors awarded, 2000-2009 [2]	Number of P.h.D. Degrees Awarded Individuals from Baccalaureate Institution 2002-2011 [3]	Rate of PhD Production (Ph.D.s Per 100 bachelors awarded) [4]	Standard Deviation
Santa Cruz	144,221	31001	1308	4.2	
Other UC campuses (except Merced)	1,512,021	365,696	13,898	3.8	1

1	http://data.universityofcalifornia.edu/student/stu-admissions-enrollment.html Undergraduate Fall Headcount Enrollment by Campus and Ethnicity (2000-2011) (xlsx)
2	http://data.universityofcalifornia.edu/student/stu-success.html Bachelors Degrees Conferred by Campus and Major Discipline - 1999-00 through 2009-10 (xlsx)
3	https://webcaspar.nsf.gov/ Data Source- NSF Survey of Earned Doctorates/Doctorate Records File Analysis Variable- Number of Doctorate Recipients by Baccalaureate Institution Classification Variables- Academic Institution (standardized)
4	= 100 * (Number of PhD Degrees Awarded Individuals from Baccalaureate Institution 2002-2011) / (Number Bachelors awarded, 2000-2009)

Santa Cruz has a PhD production rate higher than the average of the other campuses. While the rate is within one standard deviation of the average, Santa Cruz's high PhD production rate suggests that graduating UCSC students are successfully pursing PhDs at a rate that compares favorably with the other UC campuses. If we can raise the number of UCSC undergraduates who successfully engage in UR, we may be able to increase this production rate even further.

Section 3. Undergraduate Research Coordinator Activities

In the introduction, I discussed two major hurdles students face to becoming involved in UR: understanding the culture of UR (how to prepare, get a position, and succeed) and funding their projects. In this section, I describe ongoing efforts to lower these barriers, and to disseminate information about the excellent UR done at UCSC throughout both the University and the larger Santa Cruz community. These initiatives are motivated and framed by the goals of the Undergraduate Research Coordinator:

1. To assist all UCSC undergraduates in engaging in the world-class research at UCSC and/or through other programs or institutions
2. To provide a central clearing house to help faculty, staff, prospective students, and the community become aware of the wide array of research resources in the region available to undergraduates
3. To increase awareness of the important contributions of UCSC undergraduates to research.

To address these goals I:

A. Expanded the UCSC Undergraduate Research Opportunities website
B. Expanded the Undergraduate Research Opportunities Database
C. Conducted outreach activities: emails, tabling, presentations, workshops
D. Advised students
E. Took a leadership role in organizing a mentoring activity for Women in Physics (WiP)
F. Worked with academics and staff to develop and expand UR opportunities

A. Expanded the UCSC Undergraduate Research Opportunities Website

The primary audience for the website is UCSC undergraduates who are exploring what UR is and how to get involved. The homepage is designed to provide a menu of information for students. The top of the page features a series of photos of students engaged in many types of UR, from laboratory to artistic work, to demonstrate to students that there are UR opportunities, and students involved in UR, in every discipline.

In addition to providing information for current UCSC undergraduates, the website is a resource for faculty and staff to learn about UR at UCSC. Academic and College Advisers, in particular, have told me that the website is very helpful; when I add new material to the site, I send an email to the adviser list-serve and it often is then sent to department email lists.

The website is also a communication tool to help demonstrate the importance of UR to the Santa Cruz community. On the front page, a News block highlights recent donations for UR and accomplishments of UCSC undergraduate researchers. In addition, the website gives donors the opportunity to give specifically to UR by division.

Additions and improvements from the past year are as follows:

- The STEM Career Life Resource Center, founded by Dr. Amy Ralston and now directed by Dr. Carrie Partch, "aims to increase participation in STEM careers by raising awareness of the successful coexistence of STEM career and family, and by providing the tools to plan for both. Since undergraduates are often in the pre-planning stages of both career and family, our efforts begin with undergraduates, and include graduate students, postdocs, and junior faculty." Information provided on the webpage includes a series of interviews with UCSC faculty and staff and resources on and off campus. This addition to the website is important, since it can help undergraduates understand that academics and family life can be compatible.
- Expansion of the Examples of Emails to Professors webpage, which was the most visited webpage on the website this year. During the last year, it had 38,896 hits, which was over 33% of the total page hits. A Google search on "email professor" lists this page second.
- The Undergraduate Research Awards page was substantially expanded with information on UCSC awards for completed scholarly activities. This is important for students who have completed UR, in order to get their work recognized. This page also advertises the range of research done in each division.
- Substantial additions to each division's webpage listing potential sources of UR funding.
- Extensive additions to and reorganization of the Other Research Opportunities webpage to include links to databases and opportunities in each division, federal programs, and national-level research programs.
- Additions and updates to the Undergraduate Research Opportunities Database. This provides students with additional programs to consider. Details are given below, in section B.
- At the end of spring quarter, starting with the campus-wide Student Achievement Week through mid-July, I replaced the "Application Date" block with an "Excellence in UR" block on the homepage.
- The website provides a central location to highlight the excellent work of UCSC undergraduate researchers. Short introductions on the website homepage link to full profiles focused on how the student became involved in UR, his or her research, and the impact on the student's academic experience. An additional webpage provides links to profiles of UCSC undergraduate researchers across a wide range of disciplines. I highlight these profiles at the top of the relevant division page under the "For Students" tab to provide examples of current UR in the division. In addition to the two profiles from last year of Ariel Anders from Engineering and Lois Rosson from History, this year I profiled the three students listed below.

David Murakami, BA in Film & Digital Media, 2014

David Murakami divides his time evenly between directing film, directing theater, and combining the two with digital media design for the stage. While his interest in film began when he made several award winning films in high school, his creative work gained momentum during his freshman and sophomore years at UCSC, with the creation of 60 short films, two feature films, and one stage play. He discovered his talent to fuse theater and media when he took Theater Arts (TA) classes as a sophomore. After directing a full-length film/theater hybrid work at UCSC, he began pursuing numerous projects in academic and professional settings. A comprehensive list of his work can be found here. David will begin his Masters in Theater Arts at UCSC in the fall of 2014.

See the full profile at: http://ugr.ue.ucsc.edu/Profile_Murakami

Kaitlin Hellier, BS in Physics, 2014

Katie Hellier's route to physics was non-traditional. After graduating early from high school, she earned her associates degree at the Fashion Institute of Design and Merchandising while working at a restaurant. Then, when Katie began classes at Los Medanos Community College, she dove right into calculus, which she hadn't taken in 5 years. She had to re-learn everything, but an amazing teacher worked with her to help her catch up. Then, when Katie took her first physics class, she was "…interested and excited about what I was learning..." After transferring to UCSC, she began working in Dr. Sue Carter's lab, which develops new materials to improve solar power systems, and is currently working as a staff researcher while she applies to graduate school. Her goal is "to change the way we understand energy, how we use it, and what its impacts on the earth are... To do that, I needed to make people understand. So ultimately I decided that, first, I needed to go to grad school… Then, I needed to get in to science communication and policy, maybe even politics."

See the full profile at: http://ugr.ue.ucsc.edu/Hellier

Eric Curiel-Lares, BS in Ecology & Evolutionary Biology, 2014

Eric Curiel-Lares transferred to UCSC in 2011. Since then, he has conducted UR on how climate change affects lizards and amphibians (with Dr. Barry Sinervo) and on the evolution of genes associated with the immune system of sea urchins (with Dr. Grant Pogson). He advises students interested in undergraduate research to "keep an open mind about research topics. You don't have to do research in the particular department in which you are studying. Being versatile could benefit you. You should also use resources available on campus, such as the STEM Diversity Programs, ...(and) talk to other students doing research." Eric found that "research has helped me academically by providing me (with) the perspective of the researcher. Now I have a better understanding of why certain studies were conducted. I have also been able to integrate what I have learned from my classes into my research."

See the full profile at: http://ugr.ue.ucsc.edu/Eric_URCiel_profile.

Website Utilization

I launched the Undergraduate Research Opportunities website on October 26, 2012 with Google Analytics embedded to track utilization. Table 3A shows utilization information for Year 1, 10/26/12-6/30/13 and Year 2, 7/1/13- 6/30/14. Table 3B show the data for IP addresses located in California.

Table 3A. Overall website utilization

	Year 1	Year 2	% change
# Visits	13,708	58,716	+328%
# New Users	9,712	46,882	+383%
# Page Views	51,711	116,148	+125%
Pages/Visit	3.77	1.98	-47%
Average Visit Duration	3 minutes	1.5 minutes	-50%
% New Sessions	70%	80%	+14%

Table 3B. Website utilization for IP addresses located in California

	Year 1	% of total	Year 2	% of total
# Visits	10,015	84%	20,615	55%
# New Users	6,411	79%	13,386	48%
# Pages/Visit	4.5		3.4	
Average Visit Duration	3.5 minutes		3 minutes	
% New Sessions	64%		65%	

Overall utilization of the website has risen by more than 300%, from almost 10,000 new users in year 1 to almost 47,000 in year 2. In contrast, during the same time period overall pages per visit and time per visit site decreased by half. While users in California accounted for 84% of the visits on the first year, in the second year they represented only 55% of the total. In contrast to the trends shown in Table 3A for all visits, the data shown in Table 3B for California visits show a more modest increase in the total number of visitors (200% versus 300%), but only a marginal decrease in the number of pages per visit and the average visit duration. One possible interpretation is that, as the website has become better known, users from locations outside California have visited more frequently, but that these visits do not last very long because much of the information is most useful to students in California. In contrast, the utility of the information for California visitors remains roughly steady, leading to about the same duration and number of pages per visit for sessions originating in California.

Tables 4A and 4B show the 5 most visited webpages within the site in both years. As shown in the tables, the same 5 pages were the most popular each year. While in the first year the home page was the most visited page, in year 2 the *Examples of Emails to Professors* became the most visited site. Since the information on about email examples is applicable to students in most universities, I am not surprised that the page is becoming more utilized over time.

Table 4A. Most visited webpages Year 1. Numbers are rounded to the nearest whole number.

Webpage Title	# of Pageviews	% of Pageviews
Overview (homepage)	9,380	18%
Undergraduate Research Opportunities Database	8,911	18%
Examples of Emails to Professors	2,661	5%
Join a Lab or Research Group	2,605	5%
Physical and Biological Sciences Division	1,842	4%

Table 4B. Most visited webpages Year 2. Numbers are rounded to the nearest whole number.

Webpage Title	# of Pageviews	% of Pageviews
Examples of Emails to Professors	41,974	25%
Overview (homepage)	24,349	15%
Undergraduate Research Opportunities Database	20,686	12%
Join a Lab or Research Group	8,733	5%
Physical and Biological Sciences Division	5,612	3%

The popularity of these 5 pages also shows what type of information students are seeking: advice on communicating with professors, opportunities to get involved in UR, and guidance on how to join a research group. In the coming year, I plan to develop a workshop on communicating with professors at a research university. I address the topic briefly in most of my workshops, but its prominence as a topic of web research suggests that more focus in workshops is warranted.

B. Undergraduate Research Opportunities Database

The website includes a database to help students at UCSC and other institutions find opportunities in established research programs. As of July 1, 2014, the database includes 84 entries, which represents a roughly 40% increase over the 62 entries a year ago. A complete list of programs is found in the Appendix.

The database includes three broad categories of entries.

1. Organized UCSC programs focused on UR: 38 entries. These programs range from College Research Fellowships to the STEM Diversity Programs, which offer students the opportunity to work directly with faculty and graduate students to develop skills and gain UR experience. Numbers of participants range from 1 student every few years to 400 or more per year.
2. UCSC Programs with possible UR opportunities: 14 programs. For example, the Environmental Studies Internship Program places hundreds of students per year in internships. Chris Krohn, the Environmental Studies Internship Coordinator, estimates that up to 10% of the positions include research. Other opportunities in the program focus on public policy, education, etc. Since it is difficult to determine which students are doing research, numbers of students are not generally included in these entries.
3. Non-UCSC organizations and programs that offer UR opportunities. Many of the 32 organizations in this category are near UCSC and collaborate with the University or with affiliated institutions, such as the Monterey Bay Marine Sanctuary. Additional entries provide detailed descriptions for many of the large

federal UR programs. One of the main purposes of these entries is to clarify the application process. For example, NASA has one main site for UR applications, but multiple programs are not part of the site. A new database entry, National Aeronautics and Space Administration (NASA) Student Internship Programs, contains both links to these other programs and links to specific opportunities for UCSC students at the closest NASA facility.

C. Outreach Activities

Outreach activities enable me to meet with students individually and in groups, formally and informally, to provide information tailored to that group or individual in person or through targeted emails, and to answer specific questions.

Emails

I have an email list-serve, with over 800 subscribers, that current and prospective students, staff, faculty, student groups and other members of the UCSC community can join by signing-up online, at a workshop, or at a presentation. For individual students, I collect the student's name, major, and graduation year so that I can target emails to specific groups of students. I also routinely send emails to student groups to forward to their members.

Tabling at Events

Tabling involves standing at a specific location near a table that has appropriate informational material and talking to event participants and giving informal advice. I tabled at multiple events that provided students with the chance to learn more about UR, including:

- Summer Orientations for frosh and transfer students
- Orientations for student groups and academic units
- Spring Spotlight for admitted students
- The annual spring Undergraduate Research Symposium for PBSci and Engineering students

Presentations

Short presentations of 15-20 minutes are a critical component of the outreach I provide to students. I gave short topical presentations to a wide range of audiences, including student groups, students attending the Astronomy Research Socials in fall and spring, international students, transfer students, Engineering undergraduates in a new UR program, and students in the Arts Internship Program. While providing a quick dose of information, these presentations also give students a chance to learn about the website and the services that I provide.

Longer presentations of at least half an hour are usually in lecture style. They are helpful for reaching a large number of students, but lack the opportunity to provide individualized responses to student questions. I gave longer presentations at "Navigating the Research University," a class for frosh who are first in their families to go to college, in both winter and spring quarters.

Workshops
Workshops offer an opportunity to work with students for an extended time and engage them in activities related to the topic. In addition to refining the two workshops I created last year, Getting Involved in Undergraduate Research at UCSC and Secrets of STEM Research Groups - Structure, Function, & Dynamics, this year I developed two new workshops, Preparing for Undergraduate Research and STEM Summer Programs. The slides used in all these workshops are posted on the UR website in PDF format.

In order to engage the students, typically each workshop begins with a student peer explaining how s/he got involved in UR, his or her experience, and how it has influenced his or her academic career. The workshops end with a paper evaluation with open-ended questions that asks about each participant's goals for the workshop, what information was helpful, and how the workshop could be improved. At the end of the workshop, I give students a handout that lists important links mentioned in the workshop, as well as my contact information.

I presented modified versions of the workshops to a wide range of audiences.

- The Professional Development Workshop Series sponsored by the STEM Diversity Programs and the Research Mentoring Institute that is open to all undergraduates
- WEST, a program to support STEM transfer students to UCSC
- The Educational Opportunity Program (EOP) in fall and spring quarters, with separate workshops for STEM and the Social Sciences & Humanities
- Undergraduate Research Science Association (URSA) student group
- Regional meeting for Society for Asian Scientists and Engineers

The workshops had a total of 217 attendees; some students attended more than one workshop. Since these workshops provide an opportunity for me to get feedback directly from UCSC students, I use their comments to improve the information and activities I provide. I am committed to consistently evaluating my advising services. Key points from the workshop evaluations for *Getting Involved in Undergraduate Research* and *Secrets of STEM Research Groups- Structure, Function, & Dynamics* are described in the following paragraphs. I did not tally the evaluations for the two new workshops, since they have not yet been given enough times for the evaluations collected to support general conclusions.

Getting Involved in UR had 112 student evaluations, on which students were asked to list their goals for the workshop, which aspects of the workshop they found most helpful, and how the workshop could be improved. These questions were open-ended, but for the purposes of tabulation I categorized each of the responses. For each of the three topics, the top three responses were:

- Students' goals: (1) learn steps to getting involved in UR (listed in 48% of responses), (2) learning about specific research opportunities (26%), (3) obtaining general information (18%)
- Most useful aspects of the workshop: (1) handouts with list of useful web links (22%), (2) tips on approaching professors (12%), (3) timeline of what students hoping to engage in UR should do each year of their undergraduate careers (9%)

- Areas for improvement: (1) more specific opportunities in a student's major (14%), (2) more student speakers (12%), (3) more graduate student and professor speakers (7%)

Overall these responses indicate that the students' goals were consistent with the topics covered in the workshop. The title is clear and students seem to know what to expect. I was particularly pleased that the timeline for getting involved in UR was considered helpful, since I added that topic specifically in response to a suggestion in a previous student evaluation. Another request was for specific opportunities for a student's major. This is only feasible if the audience is from a specific department, as is the case for example at the Astronomy Research Social. Typically, my audience comes from a wide range of majors. I could address this concern by reminding students to look at the UCSC Database and search by major, and to look at the professors' webpages. As described above, I am also interested in working with individual departments to host UR related events. Since research varies across departments, a department-level event with graduate students and professors talking about their research would provide students with the in the department most relevant information.

Secrets of STEM Research Groups - Structure, Function, & Dynamics had 89 student evaluations, which I analyzed in the same manner as for the previous workshop. The top responses by topic were:

- Students' goals: (1) learn more about research group dynamics (37%), (2) obtain general information (21%), (3) get advice about finding a research group (18)%
- Most useful aspects of the workshop: (1) accounts of personal experiences (21%), (2) discussion of variations in PI mentoring style (20%), (3) explanation of culture and hierarchy within research groups (20%)
- Areas for improvement: (1) workshop should be longer (14%), (2) workshop should provide more information about opportunities in industry (11%), (3) more examples of personal experiences (11%)

The improvements suggested in the evaluations indicate that the students are learning about the intricacies of research group structure and dynamics but would like more information. One possible solution would be to expand the current workshop into two sessions, with one session focused on research group structure and the variations in academics and industry and another session focused on the wide range of personal experiences in different groups. The second session could also include suggestions on finding a research group that met your personal mentoring needs and academic goals.

In addition to the outreach described above focusing on current UCSC students, I also communicate with prospective students to help them understand the opportunities at UCSC and the importance of getting involved early, getting to know their professors, and getting good grades. I have a webpage and a workshop on "Preparing for Undergraduate Research." I hand out a flier with the same information at the Spring Spotlight, an event for accepted students to learn more about UCSC. I also respond to emails and have individual meetings with prospective students.

D. Student Advising

In addition to the informal advising I do at workshops, I do more formal advising through drop-in hours, appointments, email, and by phone if the student is not available to meet in person. I keep accurate records of these student contacts using a FileMaker Pro database in which I record all available information about the interaction, which can include the student's email, major, department, and expected year of graduation, the type of communication (email, in person, etc.), the topic(s) of discussion, and the duration.

Table 5 summarizes my advising work during the past year, broken down by type of contact. The numbers listed in the first column are numbers of unique students. For example, even if a student had two appointments, s/he would only be counted as a single appointment. The number of events is larger than the unduplicated count of students, since one student can receive advice through multiple methods. Times are rounded to the nearest hour.

Table 5. Student Advising July, 2013-14

	# Unique Students	# Events	Total Time
Appointments	35	43	21 hours
Drop-In	99	115	42 hours
Email	136	181	35 hours
Phone	2	2	1 hour
	Total	341	99 hours

From July 1, 2013 to June 30, 2014, I advised 224 students. Multiple topics can be addressed in one session. The topics addressed most frequently during these contacts were:

- How to get involved in UR and find a lab (76%)
- Communicating with professors (44%)
- General introduction to UR and the website (40%)
- Summer programs (26%)
- Getting a reference letter (17%)
- Options for students with low GPAs (15%)

Evaluations:

In June, 2013 I developed a short online evaluation to send to students after my first interaction with them through email, drop-in advising or an appointment. The survey includes questions about the student's goals for the advising session and whether those goals were met, and provides opportunities for the student to suggest improvements. Starting on August 1, 2013 I sent out the on-line evaluation to all students advised in person or by email for the first time during the previous month. During the last year, 32% of students (73 of 224) responded to the survey.

All 73 students entered their year in school. Students from every year used the advising services. Juniors were the heaviest users (40%), followed by frosh (22%), sophomores (19%) and seniors (18%). 61 students answered questions related to the helpfulness of the advising and whether they would recommend the advising to a friend. Of those, 90% of

the students found the advising very helpful or helpful, and 95% would be very likely or likely to recommend advising to a friend.

E. Took a leadership role in organizing a mentoring activity for Women in Physics (WiP).

This academic year I collaborated with Professor Tesla Jeltema, assisted by senior physics major Katie Hellier, to create a mentoring activity for physics students in Women in Physics (WiP). In 2014, WiP was awarded a Chancellor's Diversity Award for its activities, and Prof. Jeltema included both Ms. Hellier and me as significant contributors.

In the mentorship activity, frosh and sophomores were paired with seniors, and seniors were also paired with graduate students. Prof. Jeltema and Ms. Hellier matched the mentors with advisees; since they knew the people involved, they could make matches considering academic stage, personality, and research interests. Thirteen graduate student mentors and fifteen undergraduates participated. We had an initial meeting early in the fall quarter to provide information on mentoring and to gather information to match mentors and mentees. In later meetings I conducted activities to address mentoring strategies.

I solicited feedback for the activity at the end of the spring quarter and 38% of the participants replied to the online evaluation. Every participant reported that mentors and mentees had both emailed and met in person, while 45% attended an event together. The most commonly addressed topics were:

- Balancing the demands of research with other responsibilities (90%)
- Academic skills, such as reading journal articles, publishing, presenting at conferences, etc. (82%)
- Advice on strategies for graduate school, including which classes to take, senior thesis plans, best schools in the field, etc. (82%)
- Defining and developing your role in a research group (64%)
- Discussing career paths and goals (73%)
- The details of graduate school, post-docs, and being hired as faculty (55%)

73% of the respondents thought they met frequently enough with their mentor/mentee, and all respondents indicated a desire to continue the program in the fall of 2014.

F. Worked with academics and staff to develop and expand UR opportunities
This year I have contributed to expanding UR at UCSC by working with development offices, sitting on award committees, helping researchers find undergraduate assistants, and developing a new summer UR program. I could not have accomplished this without the help of Ms. Malika Bell, my supervisor, whose academic and professional skills and experience as the STEM Diversity Director enable her to provide me with both advice and opportunities to contribute to the UR community.

I have worked with both the university and the PBSci development offices. I worked with the UCSC Undergraduate Experience Development team to help them understand what UR is, to develop a statement to give to donors, and to find ways to include more students

in UR. In addition, I have developed and implemented procedures for PBSci students to apply for several prizes and research funds supported by external donations, and for these funds to be disbursed to students.

UCSC community members also solicit my help for a wide range of tasks related to UR. I have been a member of several UR award committees. I also consistently help researchers, including graduate students and program managers from UCSC affiliates, find UR assistants by sending targeted emails to undergraduates with the appropriate qualifications.

Finally, I collaborated extensively with Dr. Enrico Ramirez-Ruiz and Ms. Bell to establish a new National Science Foundation Research Experience for Undergraduates site program, the Lamat Program in Computational Astrophysics, that began with nine students this summer. I took a leading role in organizing the application process and reviewing applications. Ms. Bell and I collaborated in planning a series of activities for the Lamat students in conjunction with the STEM Diversity summer programs. These activities help the students learn the academic skills they need to pursue a research career and to develop a strong community. They include workshops, lunches, community-building activities, and seminars. Many of the events include students from several of the summer programs, which helps students network and build a community of like-minded scholars.

Section 4. Moving Forward: The UCSC Undergraduate Research Center and the Undergraduate Research Award

My efforts, in combination with the stellar work by other UR advocates, help students gain access to and succeed in research. However, given the large number of students at UCSC who lack basic knowledge of what UR is and how to get involved in it, there is a critical need for a more comprehensive and visible program to promote and publicize UR. This need is illustrated by the overwhelming response I received when I made short announcements in introductory science and math classes this year; the volume of inquiries greatly exceeded my capacity, as a part-time employee with competing demands on my time, to provide detailed responses. The campus and its students would therefore benefit significantly from a more comprehensive approach. In addition, there is a critical need for a central funding source to support undergraduate research expenses. In the sections below I outline initiatives to address these issues, and provide an implementation plan for them.

The Undergraduate Research Center (URC)

I propose that UCSC develop a Undergraduate Research Center (URC) to serve as the central physical and online presence for undergraduate research (UR) by:

A. Providing access to information and services related to UR to UCSC students, faculty, and staff, and to the surrounding community
B. Developing new Undergraduate Research Awards (URA) for all UCSC students
C. Educating undergraduates about UR through a wide range of outreach activities, including: workshops and advising at the URC, workshops with coordinated academic support units and student organizations, tabling at orientations, events, and lectures

The URC will be located in a central location on campus, with visibility to both students and visitors, and will be an important addition to campus tours and orientations. Information on the URA is in the next section.

Physical location: The URC office will include a main room with a front desk staffed by student assistants, a computer lab, a gathering space with comfortable couches and chairs, and a poster printer. Examples of UR from each division will be displayed in the adjoining hall, around the main room, and on large screens. These examples will include items such as posters from conferences, objects from the arts, and visual and audio recordings of musical performances and theater. Additional rooms will provide office space for staff and peer advisers and a large room for workshops, presentations, and meetings.

Website: The current Undergraduate Research Opportunities webpage will become the core of the new Undergraduate Research Center webpage. This website will continue to serve its current functions:

1. Assisting all UCSC undergraduates in engaging with the world-class research accomplished at UCSC and/or other programs or institutions
2. Providing a central clearing house to help faculty, staff, prospective students, and the community to become aware of the wide array of research resources in the region available to undergraduates
3. Increasing awareness of the important contributions of UCSC undergraduates to research

Developing additional material and keeping the information current will be a central function of the URC staff.

Staff: The **Director of the URC** will:

- Develop and implement the URC's mission and goals
- Establish and oversee the campus-wide Undergraduate Research Awards (URA)
- Represent the URC at conferences and meetings, such as the proposed annual UC meeting of campus UR Directors
- Build and develop collaborations with campus administration, divisions, academic support units and student organizations

- Work with the UCSC Development Office and campus administration to increase financial resources for UR
- Oversee reporting, including maintaining a database of utilization, soliciting and responding to student evaluations, and producing an annual report
- Supervise the undergraduate peer advisers
- Oversee and engage in outreach activities and advising
- Supervise the hiring and training of staff

The **URC Coordinator** will:

- Oversee daily activities at the URC office
- Supervise and train student staff, including the front desk staff and the media assistant
- Implement the URA, including advertising, the application process, the faculty review process, financial transfers, and monitoring implementation of the awards to ensure compliance with the guidelines
- Organize URC outreach activities, including workshops and events
- Be responsible for financial management, including purchasing supplies, reimbursements, and student staff pay records

Student staff will be as follows:

- Front desk staff will answer the phone and basic email questions, update the website and database, provide administrative support, and be responsible for the physical infrastructure for events
- Peer advisers with undergraduate research experience from each division will provide information to students through email, drop-in hours, and appointments. Each peer adviser will also be responsible for collecting current information related to the division for the website, including events, opportunities, and resources. Each peer adviser will also coordinate with division administration, departments, individual faculty, and student groups to make announcements and presentations.
- A media assistant will be responsible for maintaining and updating the website, a monthly newsletter, displays in the main office, running social media venues, and display materials for outreach.

Oversight: Oversight will be from two sources. First, the Director will report to the Vice Provost and Dean of Undergraduate Education in regular meetings to evaluate the URC. Second, an advisory committee comprised of division representatives, faculty, and staff will review the annual report and provide guidance to the Director and VPDUE.

Implementation Plan

While the full URC is being developed, a critical interim step will be to recruit and to train Peer Undergraduate Research Mentors (PURM). They will be able to provide immediate service to students with a minimal amount of investment beyond access to a computer lab and a room designated for peer advising. The peer student mentors will be either work-

study or volunteers with UR experience in their field. Finding mentors will be facilitated by the substantial pool of strong candidates that already exists in academic enrichment and support programs, such as ACE and the STEM Diversity Programs, and student organizations, such as the Society for the Advancement of Chicanos and Native Americans in Science (SACNAS).

The first major action for the PURM will be to expand outreach activities, such as classroom announcements and website additions, that reach a large number of students but are beyond the resources of one part-time staff member. The intended audiences will be primarily lower-division students taking gateway classes and new transfer students. The goals will include educating students on what UR is, the information available on the URC website, the availability of peer mentors, and the importance of UR summer programs. Each PURM will have a separate email for UR related advising, and students would first email the appropriate PURM. Questions needing more expertise could then be forwarded to me.

The increased visibility for UR generated by the PURMs will be an important tool for raising funds for the URC and the URA.

The UCSC Undergraduate Research Award (URA)

The award will support undergraduate research and encourage and celebrate the research conducted. The URA will be administered by the Undergraduate Research Center and will be open to students from all divisions. It will have two funding options: to directly support research or to support a student so that the student can have the time to do research.

Application
Students will apply quarterly online. The application will require a personal statement outlining the research and the need for funding, a letter of support from a faculty member, and a statement addressing the student's long-term career goals.

Evaluation of Applications
The URC will work with each division to organize a faculty committee to serve for a year. The committee for each division will meet quarterly to evaluate and rank applications.

Disbursement
The URC will be responsible for disbursing funds quarterly.

Student Presentations
The URC will coordinate with appropriate campus units to consolidate poster and research presentations. All award winners will be required to present at an annual event.

URA Reception
The URC will coordinate with the development office to have a URA Reception each year during Student Achievement week. The reception will be for members the UCSC

community, students award recipients, and donors. It will include short speeches, presentations by selected students from each division, and the opportunity for donors and potential donors to interact with students. A webpage and booklet will promote the award and students' achievements.

Evaluation
Participating students and faculty will be asked to fill out a brief online survey evaluating the award process and soliciting feedback. The URC will also request feedback from the faculty committees and will meet annually with the VPDUE to evaluate the award process.

Reporting
The Director will include data, evaluations, and suggested improvements for the URA in the URC annual report.

Conclusion

I am eager to continue my work in the coming year to educate UCSC undergraduates about UR: what it is, how they can become involved, and how they can succeed. It is an encouraging start that 60% of undergraduates engage in UR, and that, compared to other UC campuses, UCSC has a high ratio of undergraduate degree recipients continuing though PhD programs. This high rate may be substantially influenced by the support provided to selected students: excellent academic skills courses such as the Academic Excellence Program (ACE), and research programs such as the STEM Diversity Program.

While these steps will help undergraduates at UCSC become more involved in UR, they are not enough to help all UCSC students. I propose to establish an Undergraduate Research Center (URC) focused on educating students in all divisions about UR and providing them with the practical and social support they need to become involved in UR at UCSC or other institutions. The URC will oversee funding for a new Undergraduate Research Award (URA) that is open to all UCSC students. These developments will help firmly establish undergraduate research as an essential part of the UCSC undergraduate experience, and will help our students take what they have learned out of the classroom and become active participants in their disciplines. In turn, celebrating their achievements with the UCSC community and donors will provide increased opportunities for more students.

Appendix- Programs in the UR Opportunities Database

Organized UCSC programs focused on UR

ACCESS
California Alliance for Minority Participation (CAMP)
Center for Games and Playable Media
Coastal Conservation Action Lab
Crown Undergraduate Research Program & Fellowships
Digital Art and New Media (DANM) Undergraduate Research Opportunities
FERNS Research Programme
Field Research at the UCSC Reserves
Humanities Undergraduate Research Awards (HUGRA)
Learning and Experimental Economics Projects (LEEPS)
Merrill College Undergraduate Mentorship Program
Minority Access to Research Careers (MARC)
Natural History Research at the UCSC Museum of Natural History
Network Management and Operations (NMO) Lab
Pathways to Research Program, Educational Opportunity Program (EOP)
Pinniped Cognition and Sensory Systems Laboratory
Porter Research Fellowships
Psychology Department Advanced Research
Research Mentoring Institute (RMI) and Diversity Fellowships
Science Learning and Exploration with the Help of Sea Lions (SLEWTHS)
Sea Otter Research Cooperative, Tinker Estes Lab
Sustainability Office- Student Research Internship
The Advanced Studies Laboratories (ASL) Summer Internship Program
The Center for Agroecology and Sustainable Food Systems (CASFS)
The Center for Integrated Spatial Research (CISR)
The Expressive Intelligence Studio
The Initiative for Maximizing Student Diversity (IMSD)/Minority Biomedical Research Support (MBRS)
The Santa Cruz Predatory Bird Research Group
UCSC Campus Natural Reserve (CNR)
UCSC Forest Ecology Research Plot (FERP)
UCSC Natural Reserves - Younger Lagoon Reserve
UCSC Natural Reserves- Fort Ord
UCSC NSF REU- Lamat Summer Research Program
UCSC NSF REU-Summer Undergraduate Research Fellowship in Information Technology (SURF-IT)
UCSC NSF REU-Undergraduate Research in the Biological Effects of Climate Change
Undergraduate Research Apprenticeship Program (URAP) / LALS 199F
University Affiliated Research Center (UARC) Systems Teaching Institute (STI)

University of California Leadership Excellence through Advanced Degrees (UC LEADS)
Water Teaching and Research Laboratory: WaterLab

UCSC Programs with possible UR opportunities
Chancellor's Undergraduate Internship Program (CUIP)
Environmental Studies Internship Program
Impact Designs: Engineering and Sustainability through Student Service (IDEASS)
Institute of Marine Sciences (IMS)
Seymour Center at Long Marine Lab
Storage Systems Research Center (SSRC)
Sustainability Office- Provost's Sustainability Internship Program
The Cultural Arts and Diversity (CAD) Resource Center
UCSC Arboretum
UCSC SlugQuest and Employee Request System
UCSC-Minority Health and Health Disparities International Training Program (MHIRT)
University of California Center Sacramento (UCCS)
University of California, Washington Center (UCDC)

Non-UCSC organizations and programs that offer UR opportunities
Agricultural Research Service (ARS), United States Department of Agriculture (USDA)
American Physiological Society (APS) Undergraduate Summer Research Fellowships
Amgen Scholars
Arthritis Foundation Summer Science Internship Program
Cabrillo Festival of Contemporary Music
CIC- Summer Research Opportunities Program (SROP)
Department of Energy (DOE) Internship Programs
Department of Energy (DOE) Mickey Leland Energy Fellowship (MLEF)
Department of Energy (DOE) Science Undergraduate Laboratory Internship (SULI)
Department of Homeland Security STEM Summer Internship Program
DREU: Distributed Research Experience for Undergraduates in Computer Sciences
Earth Team, Natural Resources Conservation Service (NRCS)
EPA Greater Research Opportunities (GRO) Fellowships For Undergraduate Environmental Study
Equine Research Foundation
Field Research at Elkhorn Slough Reserve
Fisheries Ecology Division, NOAA Southwest Fisheries Science Division
Island Conservation Science Research
Leadership Alliance Mellon Initiative (LAMI)
Leadership Alliance Summer Research - Early Identification Program (SR-EIP)
Monterey Bay Aquarium
Monterey Bay National Marine Sanctuary (MBNMS)

Monterey Bay Research Institute (MBARI) Summer Internship Program
National Aeronautics and Space Administration (NASA) Undergraduate Internship Programs
National Institute of Health (NIH) Summer Research Programs
National Science Foundation Research Experience for Undergraduates (NSF REU)
Naval Research Enterprise Intern Program
Pathways for Students and Recent Graduates to Federal Careers
Santa Cruz Biotechnology, Inc.
Significant Opportunities in Atmospheric Research and Science (SOARS)
State of California Coastal Conservancy
The Community Agroecology Network (CAN)
The National Oceanic and Atmospheric Administration (NOAA) Student Opportunities