Department of Biology, University of Washington

10-year Review Self-study 2018-2019

(previous review in 2008)

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Degrees offered:
Bachelor of Arts in Biology
Bachelor of Science in Biology
Master of Science in Biology
Doctor of Philosophy in Biology

Natural Sciences Division
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University of Washington, Seattle

1 December 2018

Table of Contents

Part A – Unit responses to questions

Section I – Overview

Mission. The mission of the Department of Biology at the University of Washington is to discover and disseminate knowledge of the living world through research, teaching, service, and public outreach. Our goal is to become the world's preeminent, truly integrative, biology department.

Undergraduate degrees and options offered. 1) Bachelor of Science in Biology with 5 tracks (in descending order of number of degrees awarded): a) General Biology; b) Cell/Molecular/Developmental Biology; c) Physiology; d) Ecology/Evolution/Conservation Biology; e) Plant Biology; and, 2) Bachelor of Arts in General Biology

Biology is the largest undergraduate major at the UW, awarding ~600 Bachelor's degrees each year (~6% of all UW Bachelor's degrees in 2017), and is the largest STEM degree program in Washington state. Nearly 40% of UW students take at least one BIOL course.

Based on surveys of alumni, half of our graduating seniors go on to careers in the health sciences (many of them *via* professional schools in medicine, dentistry, or pharmacology), one-third become teachers, ~5% go on to graduate school, and the remainder enter a wide range of careers including biotechnology, natural resources, NGOs, and science policy.

Graduate degrees offered. Master of Science in Biology; Doctor of Philosophy in Biology

The Department of Biology views graduate education as one of our central missions, and certainly one of our most rewarding activities. Graduate students enrich and enliven the intellectual environment, create bridges among faculty research programs in different sub-disciplines, foster a culture of inclusiveness and openness, and help convey the excitement of scientific discovery to the undergraduate students in our laboratories and classrooms.

Graduate student recruitment and admissions. We compete not only with the other top-tier Research 1 public universities (e.g., UC Berkeley, UC Davis, UCSF, U Michigan, U Arizona, U North Carolina, U Oregon, U Wisconsin), but also with private universities having strong basic biology grad programs (e.g., Duke, U Chicago, Stanford, Yale, Harvard). What makes our grad program competitive with these (and other) premier institutions?

- Our department is truly integrative across all biological scales from the molecule to the ecosystem. Visiting grad recruits immediately grasp the interconnected, collaborative environment that characterizes our department (and the whole UW).
- Graduate students are admitted to, and supported by, the whole department. Students are not committed to any one faculty lab or disciplinary area at the outset, as is the case in many programs elsewhere. Students feel free to pursue their

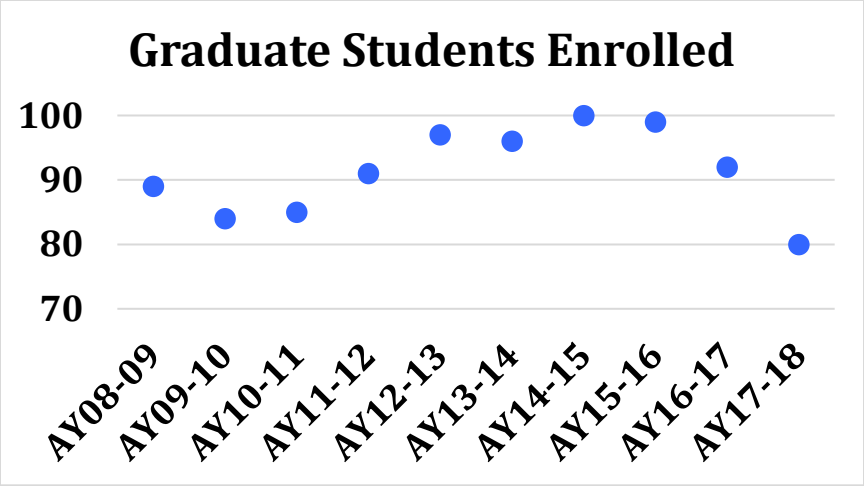
research across disciplinary boundaries, seeking advice and expertise from anyone and everyone as the dissertation project is defined and developed. The program of study is individually tailored to each student's needs and interests. Graduate students are treated as junior colleagues, rather than as pupils.
- Our graduate student body is extraordinarily welcoming for new students from all backgrounds and nationalities. More than half of our current grads are women, ~12% are from other groups of Americans historically underrepresented in the sciences, and ~15% are international students.
- Seattle is a wonderful city in which to live, especially for the many graduate students with interests in outdoor recreation and the cultural amenities in urban centers.

The department's Graduate and Postdoc Program Committee prepares a list of admissible applicants (which is put to a vote of the whole faculty), decides which applicants to bring in for interviews, and makes recommendations for admission. Of the ~200 applications we receive each year, 40-50 applicants are interviewed and 20-25 offers of admission are made, leading to an average class size of ~10 students. Each offer comes with five years of support (stipend and tuition waiver) guaranteed by the department.

Retention rates in our program are high. More than 85% of our graduates receive a Ph.D. A few students elect to leave with a M.S. degree. Most graduates go on to postdoctoral positions at research universities, others take teaching positions, and a smaller number go on to work in industry, government, or non-governmental organizations.

Funding. In any one quarter, roughly 30% of the students are supported with their own fellowships, another 30% are supported as RAs on faculty research grants, and the remaining 40% are supported as TAs for our large undergraduate program (~1200 majors). One challenge we face is that the way that each student is supported is largely correlated with their PI's funding status and subdiscipline. Many students support themselves through TAships nearly every quarter, while other students TA only for the minimum requirement of 2 quarters. This can lead to obvious tensions within the community. The department has worked diligently over the past 10 years to increase the number and flexibility of departmentally-awarded graduate fellowship quarters. The WRF-Hall Award, in particular, has enabled a large number of our graduate students to spend a funded quarter outside of their home lab (and indeed outside of the department altogether). We have also started including available RA quarters in our considerations of priority in new graduate student recruitment (except for faculty in their first three years).

A mandated budget cut (3 TA positions this year) and rapidly increasing RA/TA salaries (up 36% since AY14-15) have produced a sharp decline in graduate student admissions and enrollments. Our current graduate student enrollment is the lowest since the Department of Biology formed 15 years ago. **Graduate program funding, including fellowship/RA support for the student's first year, is a high priority.** We are concerned that our graduate program will fall below critical mass, especially considering our department's disciplinary breadth and the national need for broadly-trained biologists.



Graduate student service appointments. All UW grad students serving as RAs and TAs are represented by the United Auto Workers. The union contract was written and accepted by all parties, and has not changed the fundamentally collaborative nature of the relationship between faculty and grad students. Determination of academic progress is entirely up to the student's supervisory committee and Graduate Program Committee, while evaluations of professional performance in the RA or TA positions are provided by the supervisor.

Support services (refer to Appendix A). *Academic.* Undergraduate academic support is comprised of four full-time staff positions: Director of Academic Services, two Senior Academic Counselors, and a Program Coordinator. This team supports ~1200 undergraduate Biology majors in addition to students in other life sciences majors across our introductory courses, and the campus at large. Admissions to the Biology major are made quarterly to allow for qualified students to move into the major in a timely manner. A primary function of academic support staff is to assist students with all aspects of curriculum planning and registration. Support is also provided to faculty and TAs with administrative details related to instruction. Academic Services contributes to overall campus pre-health advising, College of Arts & Sciences advising, First-Year Programs (UW Orientation), Office of Minority Affairs and Diversity programs, and recruitment efforts for students interested in STEM majors. A variety of activities are designed to help students explore the life sciences, curriculum, careers, leadership opportunities, and personal development. Full workloads for staff and lack of funding for student activities limit the scope of offerings to our large, diverse student population.

Undergraduate course staffing includes a Manager of Instruction, classroom scheduler, 4 course coordinators for the Introductory Biology series, and lab/facilities support staff.

Graduate student advising is staffed by the Graduate Program Manager, who also sends the quarterly appointment letters to graduate students and handles the monthly payroll.

Research. The Department of Biology provides direct support for research in two major ways, through pre- and post-award grant assistance and by providing access to

department-owned core equipment used for research purposes. Four Biology Department staff members aid personnel in preparing grants, including budget details (e.g., benefit rates, position types), compliance, and communication with the University of Washington Office of Sponsored Programs (which ultimately submits the grant). Additionally, staff monitor budgets of existing grants and aid in budgetary reports required by federal agencies. The department also provides access to departmentally-owned research equipment and facilities through three recharge centers: the Biology Imaging Facility (operational since 2002), the Greenhouse (operational in 2019) and the Life Sciences Building (LSB) Shared Equipment and Facilities Center (operational in 2019). The Imaging Facility provides access to high-end imaging equipment for both light and electron microscopy, as well as sample prep labs. The Greenhouse provides access to a large plant collection (which can be used for research and teaching purposes), bench space for experiments, and routine plant care. Finally, the LSB Shared Equipment and Facilities Center provides access to departmentally-owned equipment in the Life Sciences Building (e.g., centrifuges and ultracentrifuges, shaker-incubators, growth chambers, backup ultracold freezers). Recharge centers allow the department to sustainably manage these resources by charging users, while users benefit from an economy of scale. The department anticipates subsidizing all recharge centers (~20-40%), in keeping with the key role many of these facilities play in research, and to help stabilize prices (which otherwise fluctuate unpredictably with unanticipated repairs due to University of Washington rules).

Infrastructure. The Department of Biology is housed in 4 buildings (ranked by the number of personnel in each): the Life Sciences Building (open as of Autumn 2018), Hitchcock Hall, Kincaid Hall (and adjacent Physics Astronomy Annex), and Johnson Hall.

- **Life Sciences Building (LSB)**: We anticipate that the majority of research activities will take place in our new Life Sciences Building, which can house up to 40 Biology PIs and 220 graduate students, staff, and postdocs. LSB also includes the Greenhouse, a controlled-environment growth chamber facility, a vertebrate animal care facility (terrestrial and aquatic), and 6 conference rooms. The first floor of LSB has 4 teaching labs (serving >350 students with authentic research experiences annually), a 60-seat active learning classroom, and 2 student conference rooms.
- **Hitchcock Hall**: Both research and teaching activities take place in Hitchcock Hall. Undergraduate teaching is supported by the advising offices, 17 teaching labs, and a computer lab serving our ~1200 undergraduate majors. Hitchcock provides office space for instructional faculty and instructional support staff. Hitchcock also contains research space, primarily housing the Biology Education Research Group (BERG), labs with specialized research needs (Torii lab), or emeritus faculty with research programs. Minor renovation of Hitchcock space is planned to increase collaborative opportunities among lecturers and provide more space for the BERG.
- **Kincaid Hall**: The department is vacating Kincaid Hall, the total renovation of which is to be completed by June 2020. After renovation, ~10% of Kincaid will be returned to the Department of Biology to provide space for our administrative staff (e.g., Administrator, grants management, HR, purchasing). Kincaid also provides access to the department's space in the attached Physics Astronomy Annex,

including research space (e.g., Center for Ecosystem Sentinels, Boersma lab and offices, Imaging Facility, Wind Tunnel), and offices for emeritus faculty.
- **Johnson Hall**: Biology space in Johnson Hall includes 2 classrooms, office space, and research space allocated to the Center for Conservation Biology, Wasser lab, emeritus faculty, and research activities incompatible with shared space in LSB.

Governance. A few actions require voting by the faculty as a whole: new permanent faculty appointments, promotions, and ratification of the admissible list of graduate students. The whole faculty periodically affirm some departmental policies: faculty merit review, retention of faculty, and delegation of routine annual faculty appointments and reappointments to a committee. Proposed changes to the Graduate Program Guidelines traditionally have been put to a vote of the graduate faculty.

The department has seven standing committees: 1) Research; 2) Graduate/Postdoc Program; 3) Undergraduate Program; 4) Diversity/Equity; 5) Faculty Appointments (routine appointments and reappointments); 6) Health/Safety; and, 7) Executive (composed of the Department Chair, Administrator, and the Chairs of the Research, Grad/Postdoc Program, and Undergrad Program committees). The Executive Committee deals largely with strategic planning, policymaking, budgeting, and sensitive personnel issues. There are staff members on all committees. Postdocs and grad students are invited to appoint members to all committees except Faculty Appointments and Executive.

Faculty Search Committees are appointed *ad hoc* by the Department Chair, and usually include at least one member from outside the department. Working groups and task forces are appointed to address specific topics in a time-limited manner; e.g., the Strategic Faculty Hiring Working Group whose recommendations are shown in Appendix D.

Our Life Sciences Advisory Board (original membership in Appendix E) was constituted in 2013 to help the department plan and fundraise for the new Life Sciences Building.

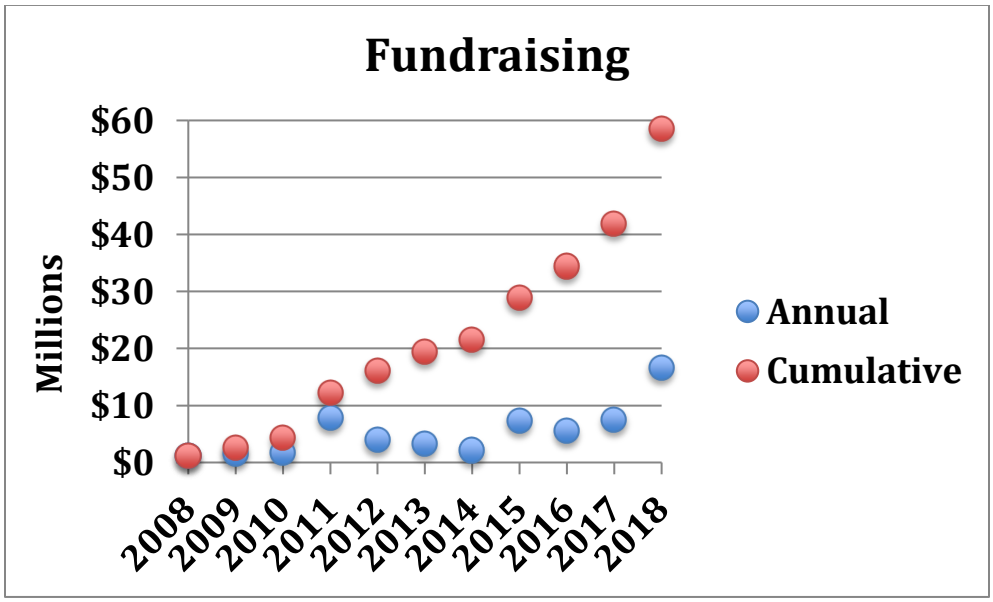
Budget & resources. The Department of Biology's ~$20M annual budget (details in Appendix B) comes from six sources:

- An ~$7.5M permanent allocation from the College of Arts & Sciences, >98% of which is used to cover faculty, staff, and TA salaries; nearly all of this allocation is derived from tuition, which is apportioned to each college (not each department) by the Provost based on a fixed "activity-based budgeting" algorithm using student credit hours and degrees granted as inputs
- A variable temporary allocation from the college, used to cover the cost of fringe benefits and for additional undergraduate instruction
- ~$8M in research grant and contract direct costs
- ~$400K in grant/contract indirect costs returned to Biology from the college
- Variable salary recapture from faculty on leave or whose salary is paid by another entity (e.g., HHMI, grant agencies)
- ~$5M in gifts and ~$650K in endowment proceeds

Four of the budget components have some discretionary funds. The Undergraduate Program Committee makes recommendations to the Executive Committee on how to allocate *temporary instructional funds* among TA positions, temporary faculty hired to teach a specific course, and course support staff, with the final decision made by the Administrator and Department Chair. The Research Committee makes recommendations to the Executive Committee on how to allocate *indirect cost returns* among a wide variety of competing demands (e.g., equipment maintenance/repair, research support staff salary/benefits, graduate student recruiting, covering shortfalls in training grants and fellowships, graduate student travel not covered by grants), with the final decision made by the Administrator and Department Chair. *Salary recapture* is allocated by the Administrator and Department Chair, most often to cover temporary instructional needs. *Gifts and endowment proceeds* are allocated by the relevant committees or individuals. For example, the Grad/Postdoc Program Committee makes awards from the many endowments designated for graduate student support, and the Undergrad Program Committee does the same for undergraduate endowed scholarships and awards.

In order to increase grant and contract revenue **we have considered hiring a dedicated staff person to work under the direction of the Research Committee, specifically tasked with supporting multi-investigator (including multi-institution) proposals** for major equipment/instrumentation, training grants, NRTs, etc. **We would welcome the review committee's feedback on this proposed strategy.**

Biology has made fundraising a priority, in response to flat or declining legislative appropriations, tuition, and federal research funding. This effort has been extraordinarily successful, particularly in conjunction with our initiative to recruit new faculty to coincide with the opening of our new Life Sciences Building. Last year's faculty search for 4 new Assistant Professors was funded by $10M in private giving.



Biology has two staff devoted to advancement: a Major Gifts Officer and an Advancement and Communications Officer, responsible for donor stewardship, event planning, outreach to alumni and friends (e.g., quarterly newsletter, departmental news page on website, social media), and stewardship/disbursement of endowment proceeds.

Biology's 10-year fundraising goal is to grow our endowment to $50M from its current ~$17M, with an emphasis on endowed chairs ($2M minimum) and professorships ($1M minimum) to give Biology the freedom to recruit and retain outstanding faculty even in times of budget austerity at the university and college levels. **Biology faculty salaries are competitive with peer institutions for instructional faculty and at the Assistant and Associate Professor ranks, but at least *15% below the median of our global challenge peers for full Professors***.

Diversity. The Department of Biology's Diversity Statement:

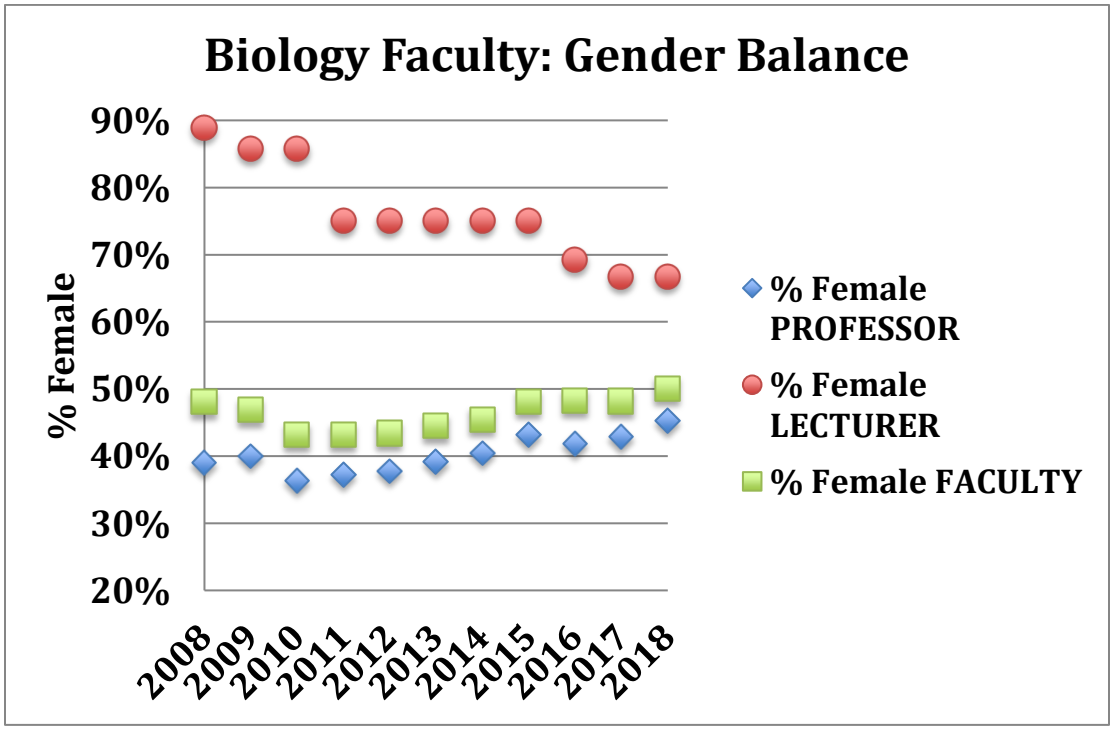
"In the Department of Biology, we continue to strive for an inclusive and welcoming departmental culture that recognizes and encourages individual differences, that fosters the constructive expression of ideas, and that promotes shared values such as intellectual curiosity, creativity, collegiality, and sense of mission. Traditions of inclusivity can only flourish and reach full potential with continued active nourishment and effort, and with a collective sense of responsibility and mission on the part of the entire community. We as a department are committed to the continued development of our diverse and collegial community of people, ideas, and approaches through our missions of research, education, and public outreach."

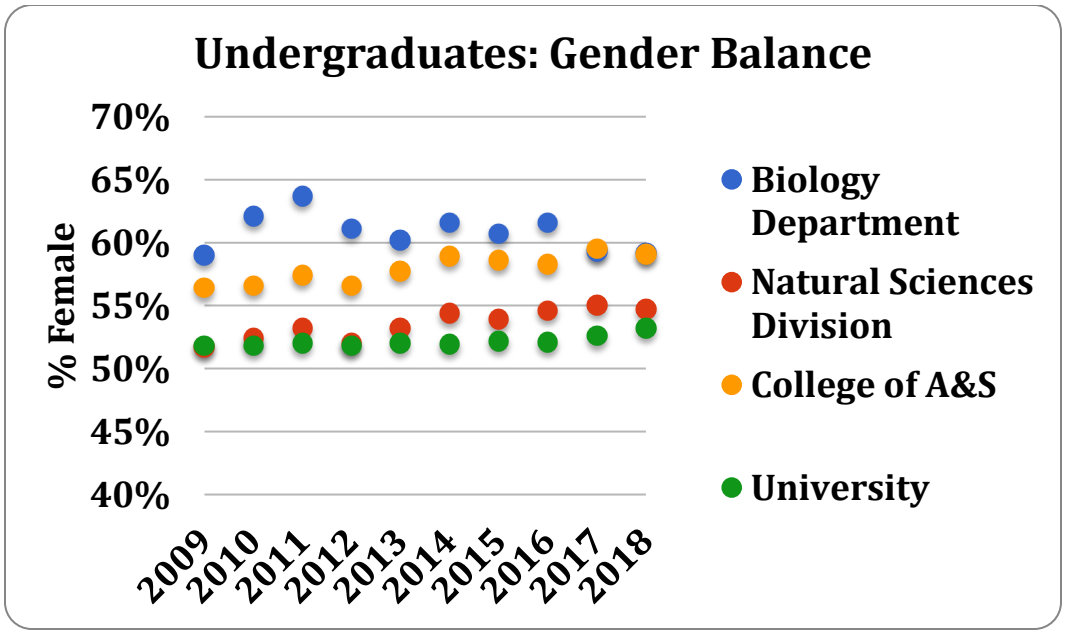
As reflected in our diversity statement, the Department of Biology strives to integrate diversity, equity, and inclusion into all of the missions of the department. Accordingly, throughout this self-study, we highlight attempts to align our practices with our values. For example, at the undergraduate level we invest in the success of diverse learners in numerous ways: participation in cross-campus partnerships to coordinate advising and promote opportunities (e.g., Office of Minority Affairs & Diversity, Educational Opportunity Program, GenOM Alliances for Learning and Vision for Underrepresented Americans, Health Sciences Center Minority Students Program, Louis Stokes Alliance for Minority Participation), supports our Biology Fellows course (BIOL 106) to increase the success of diverse bioscience pre-majors, and conducts internationally-renowned research (*via* the Biology Education Research Group) on pedagogical approaches to reducing opportunity gaps. At the graduate level, the department sends representatives to the Annual Biomedical Research Conference for Minority Students and the annual meeting of the Society for Advancement of Chicanos/Hispanics and Native Americans in Science, offers endowed recruitment fellowships to students from diverse backgrounds, and continues to add programmatic elements to enhance mentoring and professional development.

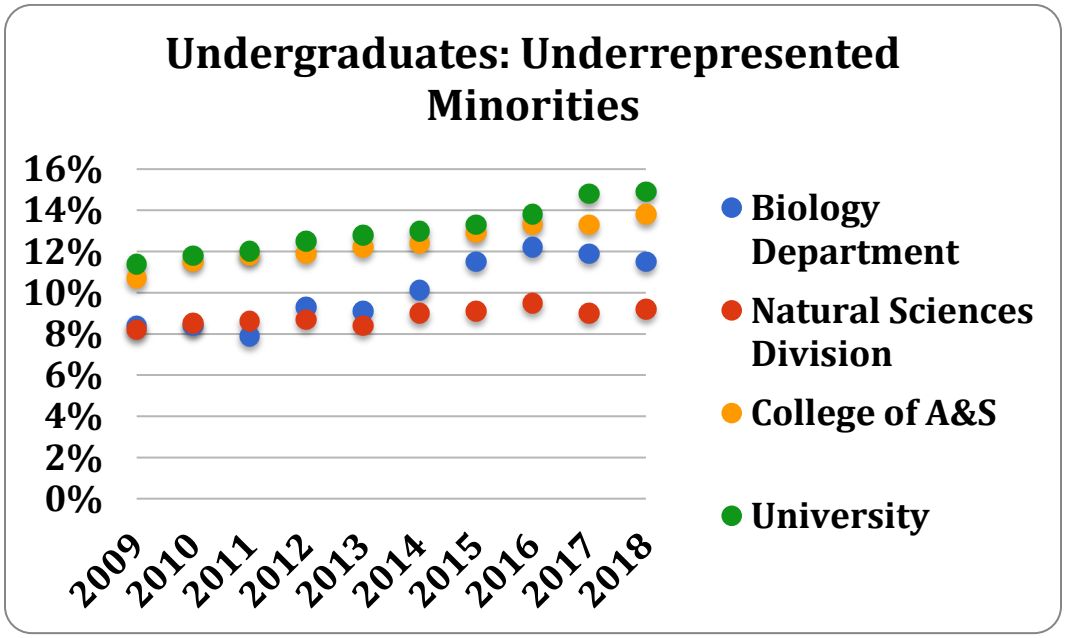
Since 2011, the department's efforts have been supported by a Diversity/Equity Committee (DEC). The DEC has representatives from faculty, graduate students, postdocs, staff, and undergraduate students. It currently employs a hybrid organization as both a free-standing committee and a source of representatives to contribute to the work of other

committees. As one example, the department recently introduced diversity statements to the faculty search process. Contributing to this important work, DEC subcommittees review diversity statements, interview faculty candidates, and share relevant resources, assisting in the recruitment of faculty members who will contribute to diversity, equity, and inclusion as colleagues, mentors, and teachers. In addition, learning from past implementations, this year we appointed a faculty member to both the DEC and the Faculty Search Committee to enhance communication and coordination between the committees. The Graduate and Postdoc Program Committee and DEC are working jointly this year on two subcommittees tackling departmental efforts to improve mentoring and recruitment.

As a department and a university, we also have improvements to make. Last year, our graduate students presented an open letter that asked our community to take additional steps to create a more inclusive and equitable climate. In response, the department formed a joint task force, with representatives from faculty, graduate students, and staff, to facilitate the work, either by completing it directly or assigning it to standing committees. In addition, the department commissioned Eagle Hill Consulting to conduct a climate survey, and we are currently developing an inter-committee strategic plan for diversity, equity, and inclusion. Although we have made significant strides in some areas since our last 10-year review (see figures below), we recognize that long-term continuity and adoption of best practices would benefit from a staff position dedicated to this work. **Given the overlapping efforts of individual departments, as well as limitations of funding, a single staff member could serve on the diversity committees of multiple departments within the Division of Natural Sciences and support our shared goal of broadening participation in STEM.**







Section II – Teaching and Learning

Graduate student training and mentoring. The first-year experience for graduate students was recently restructured, implementing a requirement for new students to explore at least 3 faculty labs before identifying a primary advisor. Students may choose to spend either 5 weeks to complete a "tutorial" or 10 weeks to complete a "rotation" with up to 4 faculty members in their fields of interest. They must complete at least 3 such

experiences. Faculty outside of the department are eligible to host rotations and even co-advise Biology students, broadening the potential for mentorship in other areas of discipline. At the end of the first academic year, students schedule their "first-year conversation" with the faculty who hosted their rotations and tutorials, as well as their temporary advisor. This discussion provides the opportunity to reflect on knowledge and skills gathered in the first year, reinforces the student's sense of a mentoring team, and prepares the student for their general exam.

During the first Autumn quarter, all incoming graduate students enroll in BIOL 500 (Graduate Professional Life), under the instruction of the Graduate/Postdoc Program Chair and Program Manager. The class meets once a week for an hour and a half, covering topics such as graduate student competencies, completing program milestones, Individual Development Plans, mentoring undergraduate students through Teaching Assistantships, and ethics in research, including equity. The Grad Professional Life course also strengthens connections within the cohort. BIOL 502 (Grant Writing) is offered to our first-year students during the last 5 weeks of Spring quarter and the first 5 weeks of Autumn quarter. This course is aimed specifically at competing for the prestigious NSF pre-doctoral fellowships. Last year, 4 of the 7 students received the award.

Graduate students receive most of their mentorship within their research lab and from their supervisory committee, consisting of their primary advisor (committee chair), at least two additional Biology faculty, and a Graduate School Representative (a UW faculty member outside the Biology Department). Students update their Individual Development Plan (IDP) and meet with their supervisory committee annually.

Graduate student inclusion in departmental governance. All departmental committees, except the Executive and Faculty Appointments committees, have graduate student representatives. Students also participate in the interview and selection process for faculty members and key staff.

A graduate-led committee, called GLADE (Graduate-Led Actions for Diversity and Equity), formed independently in 2017 to promote the development of a more equitable and inclusive departmental culture. The charge inspired the Graduate/Postdoc Program Committee to create a more transparent and structured set of guidelines for student success and removed barriers to the application process, such as the GRE requirement.

Postdoctoral scholars training and mentoring. While postdoctoral scholars are traditionally mentored almost exclusively by their PI, we have been influenced by the NAS report *The Postdoctoral Experience Revisited* (2014), among many other studies that urge implementation of a more department-centered perspective. Postdocs in our department serve on the same departmental committees as graduate students. A faculty member on the Graduate/Postdoc Program Committee serves as a postdoctoral liaison, planning quarterly Professional Development seminars on topics such as "How to Write an Effective Teaching Statement" or "How to Apply for a Fellowship," as well as having monthly social activities for postdocs and their mentors. A significant fraction of our postdocs participate in mentored teaching experiences as guest lecturers or Instructors of Record.

Undergraduate student learning goals and outcomes. In 2008, the Department of Biology adopted a set of broad learning goals aligned with the UW College of Arts & Sciences Vision Statement, focused on 5 areas: 1) scientific reasoning; 2) information literacy/technological fluency; 3) communication; 4) independent learning; and, 5) social responsibility. Since that time, there have been several national calls (e.g., AAAS/NSF Vision and Change) to reform biology education by: 1) focusing on core concepts and competencies throughout the curriculum; and, 2) promoting student-centered learning. In the Department of Biology we have addressed this effort in the following ways.

Core concepts. To better define and elaborate the core concepts that students should internalize by the time they graduate, the UW Biology Education Research Group (BERG) led a grassroots effort to develop a nationally-validated set of knowledge statements aligned with the Vision and Change core concepts. This effort culminated in the publication of the BioCore Guide (Brownell *et al*. 2014 *CBE Life Sci Educ*. 13(2):200-211), which we have adopted to guide decisions on curricular content in the Introductory Biology series.

Core competencies. Over the last 4 years, 2 teams of Biology faculty/advisors have participated in regional Partnership for Undergraduate Life Sciences Education (PULSE) Workshops. In addition, one member of the department has been on the NW PULSE steering committee and facilitated all of the meetings. This involvement has led to 2 major outcomes: 1) development of a set of departmental learning goals specifically focused on core competencies (skills); and, 2) development of a plan to identify when and where UW Biology students acquire these core skills during their coursework, as well as during extracurricular activities (e.g., research, seminars, honors). Departmental learning outcome goals were developed iteratively through faculty group discussions and feedback gathered from departmental workshops. The resulting set of department-specific goals formed the basis of a successful NSF grant to further develop and nationally validate the core competency learning outcomes. Once completed, this validated "Bioskills Guide" will replace the department's existing set of competency learning goals. NSF funding will also be used to develop a programmatic survey to assess coverage of competencies across the curriculum. As a first step in this process, a pilot programmatic survey has been completed to assess coverage of competencies across Biology courses.

Student-centered learning. Over the past 10 years we have made a concerted effort to transform our courses from traditional lecture format to student-centered active learning classrooms. In addition to reforming lecture-based courses, we have also focused efforts on providing all Biology students an opportunity to engage in hands-on research either through apprentice-style research experiences with faculty/off-campus partners or through course-based undergraduate research experiences (CUREs). To this end, we have developed 6 new 400-level CURE lab courses where students engage in collaborative scientific research on topics such as the cellular biology of neural stem cells , plant physiology, and the functional morphology of mammals. An average of 135 students/year (~20% of Biology B.S. degree earners) have taken these classes during the past three years. However, we also recognize that providing earlier access to a research experience will likely have an even greater impact on recruiting and retaining students in the biology

major, particularly students from underrepresented groups. In 2016, the Biology Department successfully competed for HHMI funding to develop and implement a CURE to be integrated into the first two quarters of the Introductory Biology series. Students engage in experiments exploring antibiotic drug resistance in *E. coli*. Pilot versions of the CURE have been implemented in BIOL 180 and BIOL 200, and a scaled-up version of the CURE will be introduced in the 2018-2019 academic year. Finally, a CURE on sleep regulation has been added to the third quarter of Introductory Biology (BIOL 220).

Assessment of student learning. In an effort to provide a more rigorous non-instructor-based evaluation of student learning, we have engaged in a multi-institution collaboration to develop and validate a suite of program-level assessments aligned with Vision and Change. This has resulted in creation of 4 biology assessments called BioMAPS. At the UW, we focused our efforts on Gen-BioMAPS, an instrument designed to measure a general biology majors' understanding of the Vision and Change core concepts. **Data obtained from Gen-BioMAPS on introductory and advanced-level UW Biology students revealed a steady increase in student performance across our curriculum in all five core concept areas.**

We are conducting a longitudinal study to assess progress of individual students through our undergraduate curriculum to assess whether there are any opportunity gaps in the performance of different demographic groups. In addition, individual instructors use validated concept inventories to assess student learning in their courses (*e.g.*, Central Dogma Concept Inventory, Concept Inventory of Natural Selection). We have also assessed the impact of BIOL 106, a STEM training class targeting underrepresented minorities in the sciences, including first-generation college students, who constitute more than 25% of the UW's freshman class. BIOL 106 effectively improves academic performance of these student groups throughout the Introductory Series classes (Buchwitz *et al*. 2012 *CBE Life Sci Educ*. 11(3):273-282). **Analysis of student course grades in our introductory biology series over the past two years found no evidence of performance gaps based on gender, URM status, or first-generation status.**

Assessment of student satisfaction, including from underrepresented groups. Graduating Biology majors complete an exit survey, co-designed with input from the UW Office of Educational Assessment, based on Biology Department learning goals and asking Likert-scale questions for perceptions and experiences on a wide range of topics including departmental climate and overall experience in the major. This information informs the advising staff, who use it to advise faculty about changes to their courses, and in discussions with the Undergraduate Program Committee.

As a proxy to measure overall satisfaction of our majors we focused on student responses to 2 questions: 1) The departmental climate for students in the major is…welcoming to unwelcoming; and, 2) Overall, my experience in biology has been…poor to excellent. Logistic regression analysis of the last 7 years of exit survey data to these 2 questions indicates that URM students report similar overall satisfaction with their experience in biology to non-URM students and, likewise, female students report the same level of satisfaction as their male counterparts. However, first-generation college students and

Asian students are 40% and 47%, respectively, more likely to report lower overall satisfaction with their experience. Importantly, ~80% of students in both of these groups still rated UW Biology a good or excellent experience. Similarly, in terms of departmental climate, neither URM nor female students perceive a more unwelcome climate; however, Asian students and first-generation female students are more likely to answer this question more negatively (51% and 84%, respectively). Even with these slightly lower rankings in perception of overall climate, >80% of respondents felt the department was generally welcoming to all. Based on these findings, we plan to organize followup focus groups to gain a better understanding of why students from particular demographic groups might express a lower level of satisfaction with our program.

Students who express dissatisfaction with their program or with individual courses to staff or faculty are encouraged to make appointments and discuss with the Manager of Instruction. Complaints (~10/year from 1200 majors) are then forwarded to individual faculty, the Chair of Undergraduate Program Committee, or the Department Chair. Courses for which student evaluation of teaching (SET) scores are below 3.0 (out of 5.0) are referred to the Department Chair.

Actions resulting from assessments of learning and student satisfaction. We have used the results of our BioMAPS survey to determine whether student progression in acquisition of core concepts meets our expectations. Following a teaching assignment strategy that came out of a departmental retreat, most of the Introductory Series classes are taught by lecturers who are either researchers in biology education or have been trained in active-learning techniques. These classes have been designed and tested to engage students in large classroom settings (300-700 students). Professorial faculty primarily teach upper-division classes, including course-based undergraduate research experiences (CUREs).

Our pilot programmatic survey to assess the coverage of core competencies revealed an underrepresentation of classes with content on "Science and Society." In response to this, we: 1) increased the enrollment limit in BIOL 380 (Biomedical Advances in Society); and, 2) developed and taught the new lab course BIOL 313 (Civilizational Biology) and the classroom course BIOL 494 (Controversies in Biology and Society).

We have also updated our Biology Honors requirement materials to emphasize competency training and developed several new courses teaching quantitative reasoning skills: BIOL 419/519 (Data Science for Biologists), BIOL 420 (Game Theory in Biology), and BIOL 504A (Analysis of Spatial/Temporal Biological Data Sets). Next year we plan to introduce quantitative skills course for undergraduates, to be developed with NSF funding.

Our department has worked to maintain a curriculum that responds to newly-emerging ideas in biology and societal needs, and that is welcoming to the diverse population of students at the UW, including a large population of community college transfer students (~30% of our majors). Key changes in the UW Biology curriculum include:

- Resource allocation – where to assign TAs, lecturers, and professorial faculty. We strive to maintain quality of instruction despite the loss in TAships that our department has suffered in the last 10 years.
- Development of course-based research experience (CUREs) courses for both our introductory and advanced laboratory classes.
- Continued development and improvement of the Biology Fellows course (BIOL 106) designed to enhance learning skills of students intending to take our Introductory Biology series.
- Creation of an application-based admission to the Biology major to regulate the student:instructor ratio and maintain quality of instruction.
- Development of BIOL 240, an intensive (15 credits) summer Introductory Biology class with a human biology theme that serves pre-health/engineering majors.
- Increased incorporation of evidence-based teaching practices in our undergraduate and graduate courses.
- Postdoc teaching/mentoring program to prepare postdocs for academic careers with a strong teaching component.

Non-majors undergraduate courses: learning goals and assessment of student learning. Because Biology is the largest major on the UW campus, the vast majority of undergraduate teaching in Biology is, by necessity (due to limited faculty number, TA budget, classroom/lab space), focused on pre-majors and majors. However, we teach a large-enrollment (>1000/year) non-majors Survey of Physiology lecture course (BIOL 118) and a non-majors Physiology Laboratory course (BIOL 119) every quarter. These students primarily intend to become allied health professionals – nurses, physical therapists, etc. BIOL 118 and BIOL 119 teach students introductory-level physiology topics in the context of cultural and societal issues and provide students with practice applying scientific reasoning skills. A major learning goal of these courses is to teach students to be scientifically literate citizens who can "think like a scientist" and critically evaluate information that they read. We also teach a non-majors Introduction to Neuroscience course (BIOL 130, ~100 students/year). In Spring 2018, the Deans selected two of our proposals for new high-enrollment non-majors courses to be taught beginning this year: "Sex, Death, & Evolution" and "Drug Dilemmas: The Biology of Cannabinoids and Opioids."

Instructional effectiveness. Collegial reviews of teaching are performed annually. The reviewer may use the departmental guidelines that are based on the NSF Vision and Change report, or may write a letter. Faculty are subject to the university's online student evaluation of teaching (SET) as mandated by the Faculty Code. Faculty select the form that reflects their teaching situation (e.g., large class, small discussion, lab). During the second week of the quarter following their teaching quarter, faculty receive a compilation of SET scores as well as a pdf copy of all written comments from students.

The department is concerned about the documented biases against women and non-Caucasian instructors inherent to SET. Based upon practices implemented at other institutions, we are currently exploring alternative evidence-based methods to evaluate instruction using validated classroom observation tools (e.g., PORTAAL, COPUS). These

tools could be used in combination with instructor self-reflection using the Teaching Practices Inventory to provide feedback to instructors on their use of evidence-based teaching strategies. Student feedback would continue to be collected using SETs (or an alternative form) as long as this is required by the Faculty Code.

Training in instructional methods. The University of Washington has a vibrant Center for Teaching and Learning (CTL) that offers workshops on various aspects of teaching, learning, and inclusivity. The CTL also organizes various faculty learning communities to provide ongoing support for faculty. Graduate students are encouraged to take part in the TA training workshops offered during the week before the start of Autumn quarter.

Many faculty in the department incorporate undergraduate peer facilitators in their courses. As part of this effort, faculty meet with their peer facilitators on a weekly basis to train and support them.

In November 2017, two of our Biology Education Research Group faculty received an NSF grant (CAUSE) to invest in faculty development efforts to implement more evidence-based teaching methods. Each year, 3 faculty from 7 different STEM departments on campus (including Biology) begin a 2-year effort to explore the evidence-based teaching literature and to redesign their courses. Each faculty member has a class session scored using PORTAAL, their exams evaluated for cognitive challenge, and exam scores analyzed to identify any opportunity gaps in student performance.

Teaching innovations driven by evidence-based pedagogy research. In the past 10 years the Biology Education Research Group (BERG) has become a world leader in biology education research. This has been evident through the ~$7.8M of extramural grants awarded to the group, which have contributed to the mission of continuously improving the effectiveness of biology teaching. They have published >40 papers on the effectiveness of active learning to enhance student learning and diminish academic gaps. As a result, faculty teaching in the Introductory Biology series are employing various levels of active learning from the use of clicker questions to fully flipped classes. In the past 5 years many of the faculty teaching upper-division courses have incorporated more active learning into their courses.

Undergraduate teaching and mentoring outside the classroom. Over the past 6 years, an average of 89 students/year have registered for peer facilitation or fieldwork classes (BIOL 396/496). An average of 5 students/year have performed library research (BIOL 498). Over the same time period, an average of 62 students/year have enrolled in Biology Internships (BIOL 399), and been placed in patient care labs at local hospitals. Other internships have included conservation research in Panama, an animal clinic in the Cook Islands, the Ryther Center for Children and Youth, halibut fisheries and education in Alaska, a research lab at Peking University, and athlete care at the UW Sports Medicine Clinic.

Undergraduate students are also mentored in undergraduate research (BIOL 499, which does not include students doing work-study or paid jobs in labs). An average of 152 students have registered for formal credit for undergraduate research each year. This represents an underestimate of the number of students who participate in independent

research projects; at least 60% of our undergraduates, judged by their response in the Biology Graduation Ceremony, participate in independent research. Faculty in the Department of Biology spend ~$250K in grant funds each year to pay undergraduate researchers working in their laboratories. Another measure of student participation in independent research is the large number (~25/year) of Biology majors who obtain a Mary Gates Fellowship. Furthermore, our department has the highest number of undergraduate student researchers presenting at the UW Undergraduate Research Symposium, with 1340 Biology majors authoring posters or giving oral presentations in the past 10 years. Finally, over the past decade 262 undergraduates have been authors on peer-reviewed publications originating in Biology Department research labs, with an average undergraduate authorship of 6.2 students per PI.

Assessing academic progress. Undergraduate students are required to meet with academic advisors once or twice within their academic progressions; however, students are encouraged to meet with advisors quarterly. Using the Degree Audit Report System (a university-wide self-auditing system), undergraduates are able to assess how they are fulfilling requirements based on their area of interest for their majors and minors. This is also the means by which the university verifies degree progress and attainment. In addition, we are formulating Biology Audit Report System so that Biology students can assess their completed and future classes based on the NSF-outlined core competencies.

The Biology Department sponsors Tri-Beta, a national undergraduate honors society, which conducts tutoring and writing sessions for specific classes or assignments. Tri-Beta has a Biology faculty sponsor and space available in the Biology Advising office.

Preparation of undergraduates for future academic and professional life. Faculty mentor undergraduates either when students are excelling or struggling with courses, to inform them of research opportunities, or to discuss the means of achieving their career goals. Faculty participate in Brown Bag seminars, in which they give a short synopsis of their research focus, and discuss with students the pathway by which they arrived at this point in their careers. Students are encouraged to participate in the weekly Departmental Seminar to observe the range and depth of research in the various fields within biology. Faculty write letters of recommendation for students – these involve a personal meeting with the student to vet their resumes and statements, and to assess the student's motivation and fit for that particular career. Faculty encourage their lab personnel to informally advise undergraduate researchers.

In Autumn 2017, a graduate student-led initiative was formed to bring alumni of the Biology Ph.D. program back to campus quarterly to talk about their careers, especially non-academic paths such as science writing and consulting. These small, informal conversations are attended by postdocs, graduate students, and undergraduates.

Section III – Scholarly Impact

Awards and honors. The University of Washington is ranked #7 in Biological Sciences in the Shanghai Academic Ranking of World Universities, and #11 in the US News & World Report rankings.

Faculty Awards & Honors (2008-2018)	Count
National Academy of Sciences Members	4
MacArthur Fellows	4
American Academy of Arts & Sciences Members	7
American Association for the Advancement of Science Fellows	14
HHMI Investigators	2
HHMI Faculty Scholar	1
PECASE Award	2
Allen Distinguished Investigators	2
International Cosmos Prizes	2
Heinz Award	1
Sloan Fellow	1
Guggenheim Fellows	15
NSF CAREER Award	6
UW Distinguished Teaching Awards	7
UW Distinguished Graduate Mentor Awards	3
UW Distinguished Undergraduate Research Mentor Award	7
UW Professor of the Year	1
Endowed Chairs/Professors	6

Postdoc Awards & Honors (2008-2018)	Count
National Science Foundation Postdoctoral Fellowships	13
NIH NRSA Postdoctoral Fellowships	3
NIH K99 Pathway to Independence Award	1
Marie Curie Global Fellowship	2
International Human Frontiers Fellowship	1
Cancer Research Institute Fellowship	1
Life Sciences Research Foundation Fellowship	1

Graduate Awards & Honors (2015)	Count
National Science Foundation Graduate Research Fellows	19
NSF DDIG Fellowships	7
NIH Training Grants Trainees	5
Bonderman Fellows	2
IGERT Fellowships	3
NOAA NRRS Fellowship	1
A&S Dean's Medalist	1

Undergraduate Awards (2010-2018)	Count
Mary Gates Research Scholars (2015-2016 only)	25
Bonderman Fellows	5
Arts & Sciences Dean's Medalists	3
President's Medalists	2

Response to current and anticipated changes in the research landscape. With state funding declining, federal research funding flat or declining (in purchasing power), costs for personnel and equipment increasing, and startup costs for new faculty increasing (~$1.25M each), we have implemented strategies for supporting our research mission:

- Fundraising (>$58M since 2008) to support people, programs, and ideas
- Increased cost-effectiveness by sharing research spaces, equipment, and staffing in the Life Sciences Building
- Partnering with the college and university to provide bridge funding for PIs who are between grants
- Startup funding as a bridge to the first major grant rather than as a "signing bonus"

The pace of technological change in high-cost equipment (e.g., imaging, DNA sequencing) makes it challenging to stay current. We have created shared-equipment "recharge centers" to recoup some of the costs of purchasing, maintaining, and staffing major equipment, but in no case are the costs recovered fully. The disciplinary breadth of our department also means that there are no items of equipment/instrumentation that are shared among more than a modest fraction of our research groups.

Collaborative and interdisciplinary work. One-third of Biology's tenure-track faculty have joint appointments in other academic units (see Appendix C), including Pathology (Medicine), Otolaryngology (Medicine), Atmospheric Sciences (Environment), Earth & Space Sciences (Environment), School of Aquatic and Fisheries Sciences (Environment), Friday Harbor Labs (Environment), Psychology (Arts & Sciences), the Burke Museum (Arts & Sciences), and the UW eScience Institute. Many more hold adjunct appointments in the College of Arts & Sciences, School of Medicine, College of the Environment, or the College of Engineering. Biology faculty are members of graduate programs that span academic units (e.g., Neuroscience, Molecular and Cellular Biology). Biology's adjunct and affiliate faculty represent a wide range of colleges, schools, departments, agencies, and research institutes.

As an integrative biology department, we value collaborative "post-disciplinary" research and teaching. Indeed, the vast majority of faculty have coauthored papers or served as coPI on grants with other faculty members.

Promotion and tenure. Assistant Professors and Lecturers meet annually with the Department Chair to review progress towards promotion. A letter summarizing that meeting, with expectations outlined, is sent to each candidate for written approval.

Associate Professors and Senior Lecturers meet with the Chair every second year, and Professors and Principal Lecturers meet with the Chair every third year.

All promotable faculty are evaluated for merit and potential promotion by a 2-person review team. The merit/promotion report is discussed with the candidate.

At the UW, assigning mentors for junior faculty is officially discouraged because of an adverse ruling following a denial of tenure case (not in Biology, which has never had a failed promotion case).

Section IV – Future Directions

Where is UW Biology headed? *Faculty size and hiring (see also Question 1, below)*. Our faculty size has been relatively constant over the past decade, and is likely to remain so. With 50-55 faculty we expect 1-2 retirements per year. While the UW faculty as a whole may shrink because of persistent budget shortfalls, Biology's faculty size is likely to be protected as long as undergraduate enrollments continue at current levels.

Our faculty hiring plan for the next 5 years is to search for 2-3 tenure-track faculty every other year, and 1 instructional faculty every third year. In general, we prefer to run multi-position searches because they allow the department to think creatively and broadly about the research area(s) in which to search, without "circling the wagons" around each current faculty member's subdiscipline. The ad for last year's tenure-track faculty search (which drew 1027 applications for 4 Assistant Professor positions) is shown in Appendix F. Focal area(s) for hiring will come from expansion of our strategic hiring plan (Appendix D).

Beyond the target subdiscipline(s), our tenure-track faculty search image is for scientists focused on a mechanistic understanding of major unsolved problems of broad interest, using quantitative methods and a combination of theory, modeling/computation, and experimental approaches. Demonstrated enthusiasm for collaboration, commitment to undergraduate teaching, and promoting diversity within the department are essential.

Historically, we have searched for two types of instructional faculty: 1) traditional lecturers whose primary duty is teaching; and, 2) discipline-based educational researchers expected to have extramurally-funded research programs, as well as teaching undergraduate classes, typically in the large-enrollment Introductory Biology course series. **It has become clear that we will no longer be competitive nationally in recruiting discipline-based education researchers unless those positions are tenure-track. Maintaining our Biology Education Research Group will require 2-3 tenure-track faculty lines.**

As we fundraise to create more endowed chairs, we anticipate that many of them will be at the $3M-$5M level, sufficient to fund the entire salary and benefits of a new faculty member, making it possible for Biology to hire even when the college is unable to fund a new position. Just last year we recruited Julie Theriot as the Benjamin Hall Endowed Chair in Basic Life Sciences, and this will be a model for future searches of this nature.

Evidence-based teaching. There are several strategies to increase the use of evidence-based teaching methods (many of them developed and validated by our own Biology Education Research Group) in BIOL courses across the curriculum:

- Assign new faculty to co-teach with an experienced faculty member well-versed in the literature and practice of evidence-based pedagogy
- Provide training opportunities (e.g., CAUSE) for faculty developing a new course or converting an existing course from traditional lecture to evidence-based practices
- Provide teaching release for faculty converting a course from traditional lecture to evidence-based practices
- Use instructor-independent evaluations of teaching (e.g., Teaching Practices Inventory, PORTAAL) in addition to, or in lieu of, traditional collegial and student evaluations

Undergraduate curriculum. The undergraduate curriculum has grown more by accretion than by design over the past decade. The Undergraduate Program Committee will undertake a year-long comprehensive review of the curriculum in light of our department's learning goals, core competency criteria, and evaluative metrics (e.g., BioMAPS, concept inventories). The committee's recommendations will be presented to the whole faculty for comment and voting (where necessary – e.g., changes in B.S. degree requirements).

The Executive Committee will make recommendations to the Department Chair regarding any changes to faculty teaching assignments in response to the new curriculum. The Executive Committee will also be responsible for reconciling departmental curricular priorities with College of Arts & Sciences priorities (e.g., number of student credit hours vs. number of degrees awarded, majors vs. non-majors course offerings).

Goals. Our goals for the next 10 years are to:

- Establish UW Biology as a top integrative biology department nationally and internationally – the most desirable place for an integrative biologist to work
- Raise $30M to fund 10 new endowed chairs, to provide flexibility and autonomy in recruiting and retaining faculty with competitive salaries
- Increase graduate program support with endowments for fellowships for at least the first year for every student, tuition waivers for RAs, and funds to make up shortfalls in fellowships and training grants
- Update our undergraduate curriculum consistent with departmental learning objectives, available resources, a departmental/college/university priorities
- Align new staff hiring with critical needs in research and teaching
- Continue to increase diversity among faculty, students, and staff by using best practices in hiring, mentoring, and retention

Opportunities. The most exciting opportunity for UW Biology is to define and create a globally-unique departmental identity, powerfully attractive to the people who will thrive in a collaborative, post-disciplinary culture of research, teaching, mentoring, and outreach.

This requires a combination of shared vision, ample and predictable financial resources, and sustained, capable leadership at all levels within the university.

Our success at fundraising over the past decade suggests that we are in the right place at the right time with the right friends and supporters to realize our vision for the future, despite the vagaries of federal/state/university/college funding.

The 1027 applications that we received for 4 Assistant Professor positions last year, the $10M in philanthropy that supported the faculty search, and the fabulous new faculty that we hired as a result, tells us that we are on the right track.

Part B – Unit-defined questions and background

1. How do we become the best integrative biology department in the country, while distinguishing ourselves from other life sciences units within the University of Washington (e.g., School of Medicine, College of the Environment)? Should we grow around existing strengths, establish new strengths (e.g., through cluster hires), or should we diversify with each new hire?

Background. The UW Department of Biology has made a conscious decision not to split along taxonomic lines (e.g., Botany and Zoology) nor across scales of biological organization (e.g., cell/molecular, physiology, ecology/evolution). We believe that many of the outstanding problems in biology are most likely to be solved with an integrative, comparative, collaborative, "post-disciplinary" approach.

However, Biology is just one of many life sciences-related academic units on the UW-Seattle campus. The School of Medicine has basic sciences departments of Biochemistry, Microbiology, Genome Sciences, Biological Structure, Physiology and Biophysics, and Biostatistics, among others. Within the College of the Environment (CoEnv), the Schools of Environmental and Forest Sciences, Fisheries and Aquatic Sciences, and Oceanography are home to many faculty with biology-themed research programs. The Friday Harbor Labs marine station is administered by the CoEnv, as well, though all 6 FHL faculty come from Biology. Within our own College of Arts & Sciences, the Department of Psychology has Animal Behavior and Behavioral Neuroscience groups, and the Burke Museum has 7 curators whose academic appointments are in Biology.

Among the features that distinguish the Department of Biology from other life sciences units on campus are: 1) our integrative nature ("molecules to ecosystems"); 2) the phylogenetic breadth of our study systems (not just humans, laboratory model organisms, or commercially-important natural resource species); and, 3) our dominant role in undergraduate life sciences education at the UW.

2. What is the ideal curriculum for graduate students in a broad and interdisciplinary biology department? In particular, what is the right balance between subdiscipline-specific "content" courses and core "skills" courses (e.g., grant/manuscript writing, communication, quantitative methods, professional

development)? Given that our graduate program likely will become smaller due to funding constraints, should we recruit graduate students whose interests fall squarely within a single lab or with interests that fundamentally cross labs?

Background. High demand for the undergraduate Biology major has absorbed the vast majority of our teaching capacity for the past decade, limiting graded-credit graduate course offerings in Biology. The diversity of research interests among graduate students in their first two years (20-30 students), when graded-credit coursework is generally taken, means that enrollments would be unacceptably low in most subdiscipline-specific graduate courses, unless those courses would also appeal to students in other graduate programs.

Biology faculty do offer a suite of skills-based graded-credit graduate coursework, including Scientific Communication (BIOL 500B), Grant Writing (BIOL 502), Evidence-based Teaching in Biology (BIOL 505), Manuscript Writing (BIOL 506), Topics in Mathematical Biology (BIOL 511), and Data Science for Biologists (BIOL 519).

Graduate seminar courses are offered every quarter in all of the major subdisciplines within the department, providing graduate students with an opportunity to delve deeply into the literature of their field(s). However, these are not graded-credit courses.

Absent a major budget increase (with philanthropy as the only likely source) or a change in our guarantee of support for each grad student's first 5 years, our graduate enrollment will continue to decline as RA/TA salaries increase. This year, the charge to a grant for a graduate student RA (0.5 FTE + tuition) is approaching $60K/yr – very nearly the same as the cost of a 1.0 FTE postdoc. This near-parity has, predictably, led some faculty to recruit postdocs rather than grad students. [The situation will change soon, because UW postdocs have unionized and, like the graduate RAs and TAs, will be represented by the UAW.]

These issues are likely to be common to many public research universities, and we are interested in amelioration strategies used successfully elsewhere.

3. Given financial challenges (e.g., declining state support, tuition reductions/caps) how should our department allocate resources (e.g., faculty, infrastructure) to meet undergraduate student demand for our major while maintaining instructional quality and our world-class research program? Given that our faculty is comprised of professors and lecturers, what is the optimal ratio to meet undergrad major needs and to maintain strength in disciplinary and education research? What are ways to ensure mutual exchange of education research and disciplinary research between these groups (e.g., co-teaching, minisymposia, class shadowing)?

Background. Biology is the largest undergraduate major at the UW, awarding ~600 Bachelor's degrees each year (~6% of all UW Bachelor's degrees in 2017). Nearly 40% of students will take a Biology course. Biology does this with ~1% of the UW's faculty FTEs.

The Biology faculty consists of 45 (31.7 FTE) professorial faculty and 12 (12.0 FTE) full-time permanent instructional faculty. Of the 45 professorial faculty, 9 (6.0 FTE) have no

undergraduate teaching responsibility (Department Chair, Friday Harbor Labs Director, 2 HHMI Investigators, 3 Professors with 0% joint appointments, 2 Research Professors).

Typical undergraduate teaching assignments are 2 graded-credit courses per academic year per professorial faculty FTE, and 5 courses per instructional faculty FTE. Teaching release is commonly given for labor-intensive administrative duties. Instructional faculty also receive teaching release for extramurally-funded research on biology education.

By mutual agreement reached at a departmental retreat, instructional faculty teaching is concentrated in high-enrollment lower-division courses where state-of-the-art pedagogy is critical for retaining undergraduates in our rigorous, challenging major. Professorial faculty focus their undergraduate teaching on upper-division laboratory and field courses in their area of research expertise, to give junior and senior undergraduates an opportunity to learn how scientists approach questions at the boundaries of current knowledge.

The UW receives just ~$5K/student/year from state appropriations, very near the bottom among our 25 designated peer institutions (public R1 universities with medical schools), while also being in the bottom third in resident tuition (just under $12K/yr in 2018). Following the most recent legislatively-mandated cut in resident tuition (11% in 2015), the legislature capped further tuition increases to the rate of growth of the median household income in Washington, which historically is well below the ~4% annual rate of academic inflation. Considering that the share of resident tuition paid by state appropriations has declined from 67% in 2003 to 33% today, there is no reason to believe that higher education funding is a priority for the Washington legislature.

UW undergraduate enrollments have increased dramatically, especially for non-resident students, in an attempt to bring in more tuition revenue. Just since 2010 the entering freshman class has grown from 5877 to 7786 (32%), while the proportion of Washington resident students has dropped from 71% to 60%.

There are four basic strategies for dealing with increasing undergraduate student demand for the Biology major when instructional funding is not increasing:

- Reduce the quality (and cost) of courses by eliminating labs, field work, discussion sections, etc.
- Reduce the number of majors using the application-based admissions process.
- Increase the number of courses taught by professorial faculty.
- Increase the proportion of faculty who are lecturers without research programs.

We have categorically rejected the first option. The second option is potentially problematic because a competitive GPA-based admission to the Biology major is likely to reduce the diversity of our undergraduate population. The third option would likely reduce our competitiveness for recruiting new faculty. The fourth option is a tradeoff between teaching capacity and research capability.

We expect the Biology faculty to continue to be a mixture of professorial and instructional faculty. The benefits of this faculty structure would be maximized by greater sharing of expertise between the groups, with instructional faculty sharing their evidence-based pedagogy knowledge with professorial faculty, and professorial faculty keeping the instructional faculty abreast of research advances in their subdisciplines.

4. In a large department whose strength depends upon recruiting and retaining top talent in diverse roles, how do we assure that new department members feel welcome/included, and foster their personal and professional development?

Background. The NAS report *Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads* (2011) calls for the implementation of strategies to recruit, support, and retain undergrads, grad students, postdocs, and faculty in STEM disciplines. At the post-secondary level, recommended actions include assuring affordability of higher education, providing academic and social support, and recurring evaluation of implementation efforts.

We welcome suggestions for adding to our current repertoire (below) of "best practices." **In particular, resources for postdocs need attention, and a more comprehensive "onboarding" process for all department members should be developed.**

Undergraduates

- 10,000 UW undergraduates pay zero tuition, even though this "Husky Promise" program is not funded by the legislature
- 60% of UW undergraduates finish their bachelor's degree with no student debt
- Our department has raised $1.5M in endowed fellowships and scholarships
- Economically-disadvantaged (EOP) students are invited to enroll in the Biology Fellows course (BIOL 106), which prepares them for the rigors of STEM curricula by (among many other things) helping them find undergraduate research opportunities mentored by faculty, postdocs, and grad students
- The Introductory Biology series (BIOL 180-200-220) has been transformed with active learning to eliminate the "opportunity gap" for underrepresented groups
- Biology's Academic Services office sponsors or co-sponsors a variety of social events: Networking Nights, Book Club, faculty panel for undergrads interested in grad school, autumn and spring barbecue, graduation ceremony

Graduate students

- Guaranteed stipend support and tuition waiver for 5 years
- 3 departmental endowed fellowships specifically for increasing diversity
- $10M in departmental endowments to support grad students
- UW-level fellowships for URMs (e.g., GO-MAP)
- Applications reviewed by Diversity/Equity Committee, with URMs enriched in the interview pool and offer list
- Elimination of the GRE for application

- Revision of application materials to allow for holistic review of all applications by a faculty subcommittee
- Application fee waiver available from the Graduate School
- Emergency aid for financial hardships
- Grad Professional Life course (BIOL 500) builds community within each cohort
- Mentoring and Recruitment subcommittee formed with GPPC and DEC members
- Individual Development Plans
- 5 grad-invited endowed seminars
- Graduate Student Symposium sponsored and funded by the department
- Grad welcome barbecue (Autumn quarter) and awards barbecue (Spring quarter)

Faculty

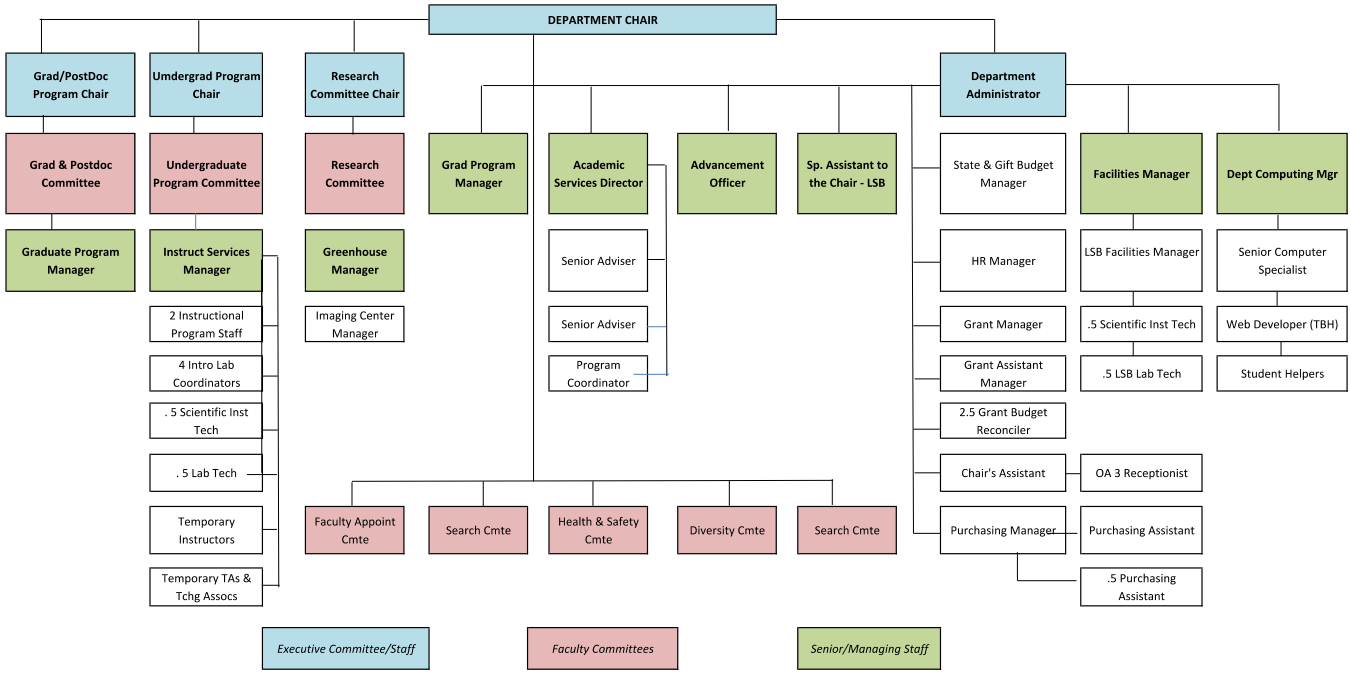
- Diversity statement required in the application for faculty positions
- Applications reviewed by Diversity/Equity Committee, with URMs enriched in the interview pool
- UW ADVANCE programs for leadership training, faculty recruiting, and bridge funding for life transitions (e.g., new parents, care of elderly relatives)
- Wide participation in departmental leadership roles

Staff

- Diversity questions in the interviews for staff positions
- Professional development opportunities for staff
- Flexible work hours and location

Part C – Appendices

Appendix A. Organizational Chart



Biology Organization Chart

Rev. 11/27/18

Appendix B. Budget Summary

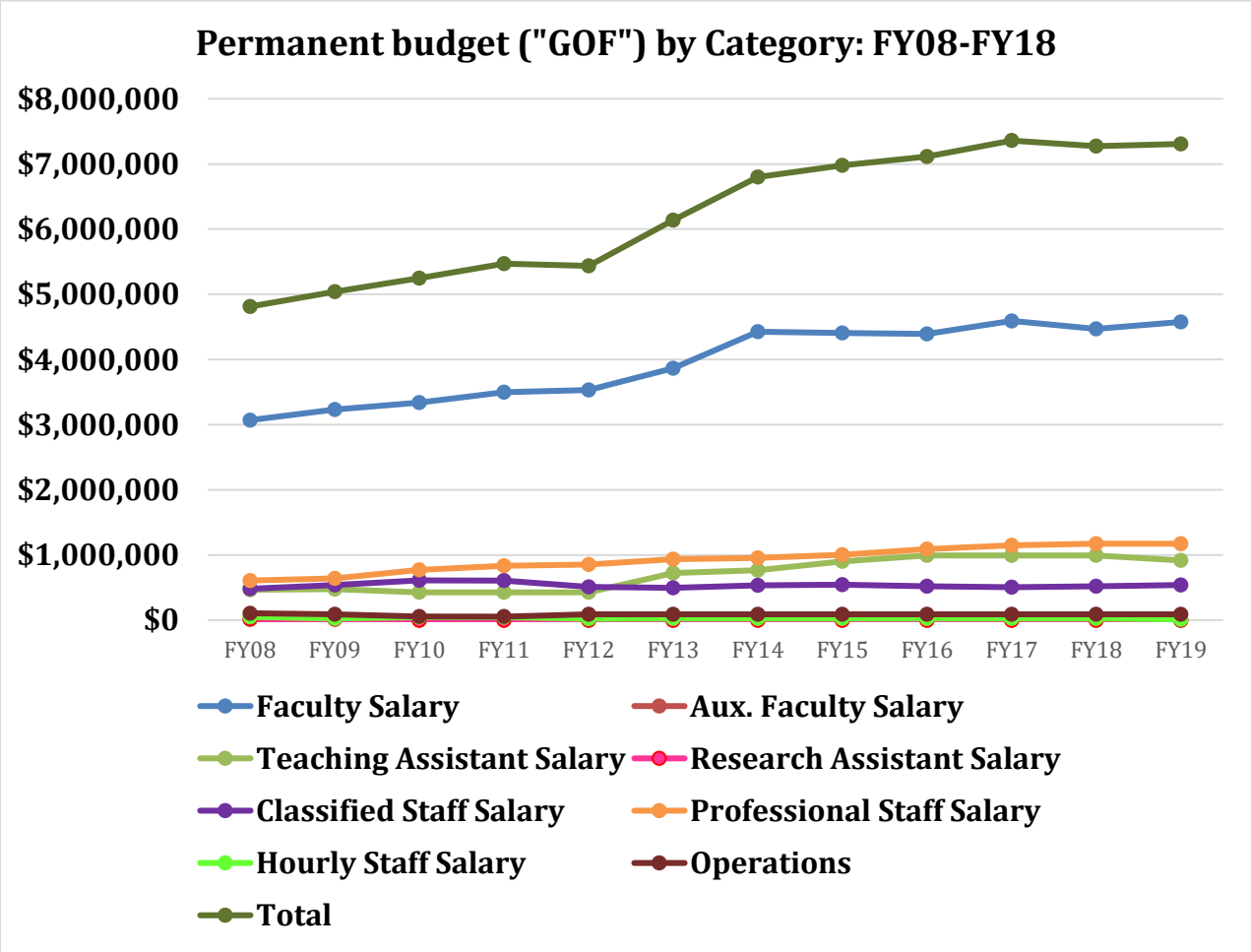
The Department of Biology has a permanent annual operations/instructional budget of ~$7.5M. More than 98% of our budget is devoted to salaries for current, permanently-budgeted faculty, staff, and TAs, with a small fraction (~1.6%) for all of our general operations and hourly personnel. This small operations budget and our reliance on temporary funds (inculding faculty salary recapture) to support our instructional mission creates challenges in managing our curriculum and our workloads. Our operations budget has been stagnant for years, with the only increases to our budget in the form of funding for salary increases for faculty and staff. The TA salary increases (36% over the past 5 years) are not funded, which effectively is an annual budget reduction. In FY19 our operations budget was reduced by $139K as part of a college-wide budget cut. Because most of our budget is not discretionary, we had to take our budget reduction in the form of TA salary ($75K, or 9 TA quarters) as well as in a few staff positions. Since it was impossible to reduce the actual staffing levels, we shifted some of the staff salaries to course fees for the courses that those staff support. This, of course, also shifts more costs to students. As part of that reduction we also reduced our allocation for hourly staff by 50%, which impacts our students in the form of reduced reader/grader support.

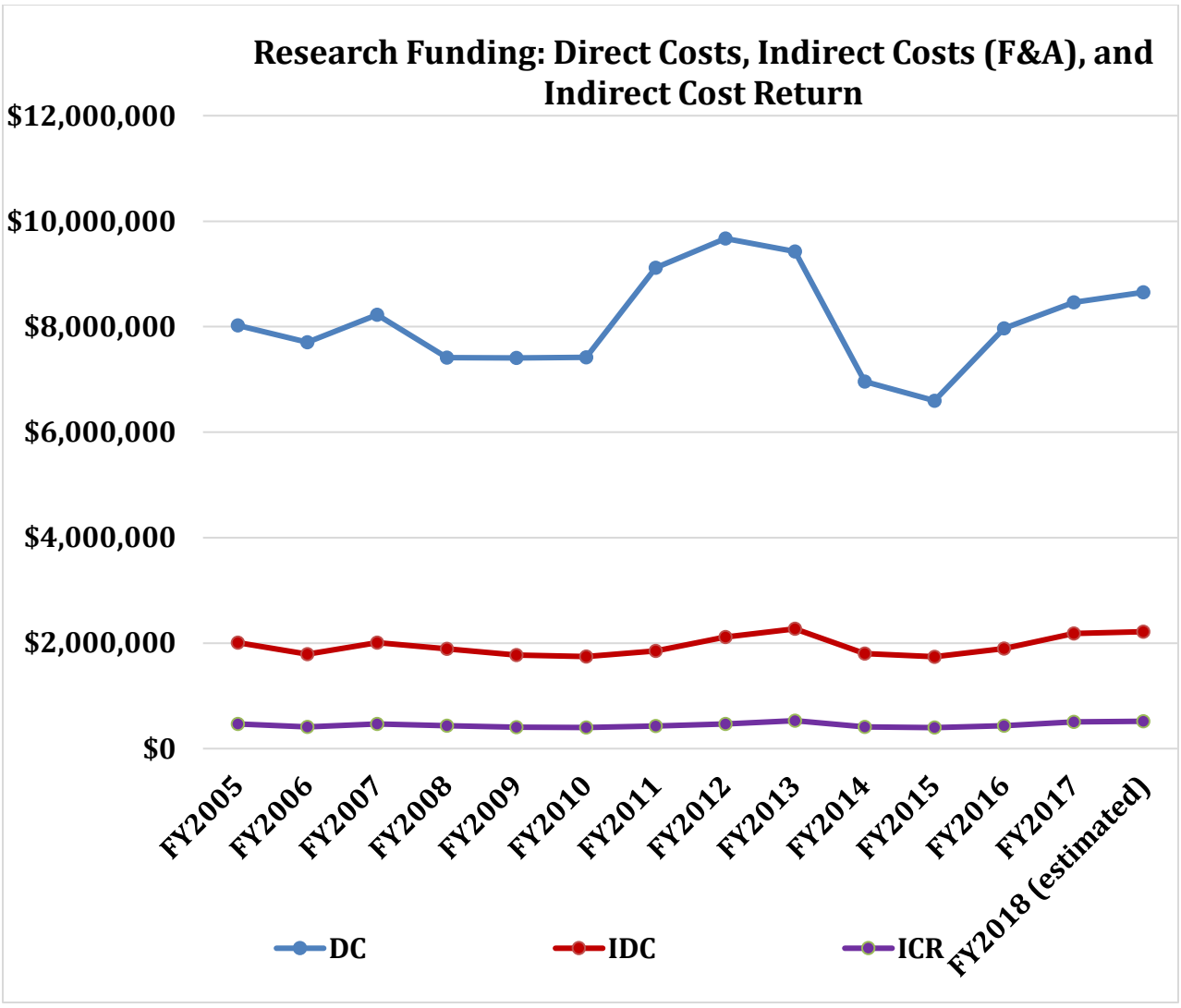
In the midst of these budget reductions our need for staff support increases. We have a strong need for additional IT staff support (we are currently recruiting a Web Developer), and we anticipate future staffing needs in purchasing and grants management with increased activity in those areas and with the opening of LSB. In an ideal world we would like to increase our Instructional Services Manager position to 100% for 12 months (currently 100% for 10 months). These needs are impossible to meet with the current budget situation. To help combat this we are instituting recharge centers to cover some of the real costs of staffing, supplies, equipment, and service agreements that are crucial to the research and teaching missions of the department—items and services that can be charged as direct costs to grants or to course fees paid by students for their enhanced educational experiences. This is painful for all of us, but is the only realistic way that we can do all of the things that we need to do, to provide an outstanding educational experience for students, and to provide the research infrastructure that our faculty, staff, and students need.

In addition to the operations/instructional budget, we receive an indirect cost return (ICR) of ~$400K annually. Of the ICR the department receives (~20% of the total ICR generated) we return 10% to the PI. The balance is used for supporting the equipment, facilities, and infrastructure of the Department, including (currently) 100% of the service and maintenance agreements for departmentally-owned equipment, facilities staff, grants staff, greenhouse staff, a subsidy for the Imaging Facility, travel grants for graduate students and postdocs, and for startup packages for new hires.

We realize that funds are tight across the university; however, our ability to carry out our research and teaching missions while making a large service contribution to the College of

Arts & Sciences and the university through our service instruction—are threatened by continued decline in financial support from the university.




Research Funding: Direct Costs, Indirect Costs (F&A), and Indirect Cost Return
$12,000,000
$10,000,000
$8,000,000
$6,000,000
$4,000,000
$2,000,000
$0
FY2005
FY2006
FY2007
FY2008
FY2009
FY2010
FY2011
FY2012
FY2013
FY2014
FY2015
FY2016
FY2017
FY2018 (estimated)
DC
IDC
ICR

Appendix C. Information about Faculty

Last Name	First Name	Title	Affiliation	Adjunct or Joint Department
AMMIRATI	Joseph	Professor	Curator	Burke Museum
BERGSTROM	Carl	Professor		
BOERSMA	P. Dee	Professor		
BOSMA	Martha	Professor		
BRADSHAW	Harvey	Professor		
BRENOWITZ	Eliot	Professor	Joint	Psychology
BRUNTON	Bingni	Assistant Professor	Adjunct	Applied Math, Computer Science & Engineering
BUCHWITZ	Brian	Senior Lecturer		
BUCKLEY	Lauren	Associate Professor		
CABERNARD	Clemens	Assistant Professor		
CARRINGTON	Emily	Professor		
CROWE	Alison	Principal Lecturer		
DANIEL	Thomas	Professor	Adjunct	Computer Science & Engineering, Mechanical Engineering, Bioengineering
DE LA IGLESIA	Horacio	Professor		
DETHIER	Megan	Research Professor		
DI STILIO	Verónica	Associate Professor		
DOHERTY	Jennifer	Senior Lecturer		
FREEMAN	Scott	Principal Lecturer		
HERRON	Jon	Senior Lecturer		
HILLE RIS LAMBERS	Janneke	Professor		
IMAIZUMI	Takato	Professor		
KENNEDY	Michael	Principal Lecturer		
KERR	Benjamin	Professor		
KLICKA	John	Professor without Tenure	Curator	Burke Museum
LEACHÉ	Adam	Associate Professor	Curator	Burke Museum
LIEPKALNS	Justine	Lecturer		
MARTIN-MORRIS	Linda	Principal Lecturer		
MOODY	William	Professor		

NEMHAUSER	Jennifer	Professor		
OLMSTEAD	Richard	Professor	Curator	Burke Museum
PAREDEZ	Alexander	Associate Professor		
PARRISH	Julia	Professor	Joint	Aquatic & Fishery Sciences
PARRISH	Jay	Associate Professor		
PERKEL	David	Professor	Joint	Otolaryngology
PETERSEN	Karen	Senior Lecturer		
PROMISLOW	Daniel	Professor	Joint	Pathology
RIFFELL	Jeffrey	Associate Professor		
RUESINK	Jennifer	Professor	Adjunct	Aquatic & Fishery Sciences
SANTANA	Sharlene	Associate Professor	Curator	Burke Museum
SCHIVELL	Amanda	Senior Lecturer		
SCHINDLER	Daniel	Professor	Joint	Aquatic & Fishery Sciences
SEBENS	Kenneth	Professor		
SELF	Casey	Lecturer		
SIDOR	Christian	Professor	Curator	Burke Museum
STRÖMBERG	Caroline	Professor	Curator	Burke Museum
SUMMERS	Adam	Professor	Adjunct	Aquatic & Fishery Sciences
SWALLA	Billie	Professor		
SWANN	Abigail	Associate Professor	Joint	Atmospheric Sciences
TORII	Keiko	Professor		
VAN VOLKENBURGH	Elizabeth	Professor	Adjunct	Environmental and Forest Sciences
WAKIMOTO	Barbara	Professor	Adjunct	Genome Sciences
WARD	Peter	Professor	Joint	Earth & Space Sciences
WASSER	Samuel	Research Professor		
WENDEROTH	Mary Pat	Principal Lecturer		
WILSON	Gregory	Associate Professor	Curator, Adjunct	Burke Museum, Earth & Space Sciences

Biology faculty CVs (2018): https://uwnetid-my.sharepoint.com/:f:/r/personal/opatti_uw_edu/Documents/10%20Year%20Review/Faculty%20CVs%202018?csf=1&e=Q326sb

Appendix D. Hiring Strategy for Tenure-track Faculty

Working Group on Strategic Faculty Hiring
Spring Quarter 2016

Working Group participants (*author of report):

Jennifer Nemhauser, Chair*
Clemens Cabernard
Scott Freeman
Janneke Hille Ris Lambers
Ben Kerr
Alex Paredez
Jeff Riffell
Jen Ruesink
Liz Van Volkenburgh
Barbara Wakimoto

Action Items

I) Information for applicants must be clear, easy to navigate and on-message.
We recommend establishing a dedicated, evergreen website for job applicants, including: A. Job Ad (see details about this is section II and Appendix A)
B. Brief descriptions of areas of interest with names/links of associated UW faculty
Our working group's list is included as Appendix B. C. Departmental diversity statement
D. Information on LSB & how it relates to mission of our department
E. Snapshot infographics about our dept—like those used for lobbying in Olympia
F. Highlight on BERG/teaching mission. It is critical that applicants share our view that a strong teaching mission is a feature and not a bug of this department.

II) Among the attributes that make our department an attractive place to work, the effortlessly post-disciplinary nature of so much of what we do is perhaps the most compelling. To attract the applicants most likely to embrace this ethos and thrive here, the Job Ad should avoid mention of specific disciplines or approaches (although these will likely be mentioned in the descriptions of areas of interest on the website). In addition, it should also avoid using language like "outstanding", "highly productive" or "leader in the field". These superlatives are implied as desirable for any candidate at a department of our caliber, and generally work against us, especially in encouraging applications by members of traditionally under-represented groups. We include here a sample ad for consideration (Appendix A).

III) The datasheets developed for the working group on strategic hiring should be revisited annually. There should be an opportunity for any faculty to put forward a suggestion for a new area (with the approval of at least three other faculty members) and a mechanism for that suggestion to be evaluated by the hiring committee (ideally in consultation with that faculty member or members). Our data sheets had the following categories, agreed on by the group, that we would recommend retaining in future iterations: Brief description (similar to what appears in Appendix B); 3-10 top researchers in the field with contact information and websites; 5-7 key papers highlighting impact, innovation, significance of the research area; one paragraph rationale for why this area is high impact, innovative, significant and also a good fit for our department; names of current UW Biology faculty that connect to the area; names of others in Seattle area that connect (optional); endorsement by at least three UW Biology voting faculty. All working members agreed that the process of completing the data sheet aided in focus and strengthened their argument. It is also a reasonable bar to expect anyone to fulfill that wants to make a case that an area furthers our department's strategic plan.

IV) The hiring committee should be populated by individuals with a strong interest in hiring outcomes, as well as an eagerness to work intensively as individuals and as a team. We strongly recommend at least a portion of the membership of the committee be opt-in by faculty (that is, interested faculty willing to agree to the terms set by the chair should be allowed to volunteer for this post). One note: opt-in members cannot use this as a mechanism to reduce
teaching load or other departmental service commitments. Given the large workload of the hiring committee, a larger number of members—potentially divided into different tasks—is likely to be beneficial. Different tasks could include some members who focus on recruitment of applicants and establishing the short list, while others could focus on on-line interviews of the short list and guiding the visits and subsequent vote on offers.

V) We must actively strategize how to maximize quality, diversity & potential fit of applicants.
A. Leaders have been identified in each datasheet describing an area of interest. A
departmental point person should be assigned to each leader.
1. A sample letter should be developed that can be personalized by each point person.
The goal is to inform others about our department, including our new building, and encourage them to send us their best people as applicants.
2. The point person should also look at lab websites of the identified leaders and
reach out to particular postdocs of interest with the same goal as for their PIs. B. Maximize opportunities for coordination among units—chairs should be in contact.
C. Our departmental diversity statement must appear on both dept & hiring websites.
D. We should add on-line interviews for all candidates on the short list. Several departments (including Biochemistry and SEFS) have used this approach to great effect. These interviews have to be done by a small number of hiring committee members using the same questions for each candidate. Among other advantages, this additional filtering mechanism increases the likely ‘fit’ of the candidates brought out to interview and reduces faculty burnout during interview season.

Appendix A. Sample Job Ad

The Biology Department at the University of Washington invites applications for multiple tenure-track faculty positions in areas complementary to our department's diverse research portfolio. Successful candidates will share our commitment to integrating scientific research with teaching and community engagement.

The UW Department of Biology embraces a post-disciplinary approach to discovering the origin and function of dynamic living systems by connecting processes at the molecular scale to those operating at the level of whole organisms and ecosystems. Of particular interest are processes that address: (1) the mechanistic basis of information processing and adaptation and/or (2) systemic responses to novel conditions. While no one candidate's research program is expected to span the entire molecular to ecosystem spectrum, we are seeking individuals with a strong interest in collaboration across fields. In addition, we are especially interested in investigators who thrive in an environment that prioritizes quantitative approaches to modeling, engineering, and visualizing biological systems.

Successful applicants are expected to develop original independent research programs and excel in research and teaching undergraduate and graduate students. These positions are part of a longer-term strategic hiring plan that coincides with occupancy of a new Life Science Building on the University of Washington Seattle campus (URL).

Applicants are encouraged to visit UW Biology Recruitment (URL) for descriptions of areas of particular interest for this search and information on the research and training opportunities provided by the highly interactive community of biologists at the UW and affiliated institutions.

Bio-Networks
We are interested in applicants who combine theoretical, experimental, observational, and data-analysis research to understand and engineer biological networks operating at diverse spatial and temporal scales (e.g., from gene regulatory systems to intercellular communication networks to food webs). We are particularly interested in individuals with a focus on the dynamics within, and the evolution of, these networks.

Disease Ecology And Evolution
We encourage applications from scientists working on understanding the relationship between infectious diseases and their hosts. Specifically, we are interested in novel approaches integrating molecular, genomic and/or imaging techniques to gain insight into the dynamics of these ubiquitous relationships and their implications for community and ecosystem dynamics.

Evolution of Information Processing
We are interested in applicants studying how environmental-sensing systems have evolved. We are particularly excited by individuals incorporating a variety of experimental and computational methods to understand biological computations at the level of the molecule, single cell and cell circuit level, and identifying the selective pressures that operate on them and connecting evolutionary changes to adaptation.

Integrative Cell Science
Applicants working in what we are calling ‘”integrative cell science” aim to fill the intellectual gap between cellular parts list and the dynamic behaviors of single cells and groups of cells to understand problems such as how cells assemble and disassemble subcellular structures in time and space, achieve cell type specific phenotypes, regulate transitions between states, and integrate behaviors with other cells. We are particularly interested in individuals who study diverse organisms, develop and apply novel approaches, and seek collaboration with experts in big data science, mathematical modeling, and evolutionary biology.

Integrative Physiology
We are interested in interactions between ecological and environmental forces, and in the mechanisms that impact an organism’s ability to adapt to those pressures. The explosion of existing and potential “omic” data offers an unprecedented opportunity to link organismal function with specific environments. We encourage applications from physiologist who working on vertical integration of physiological processes across organizational levels within organisms, horizontal integration of physiological processes across organisms within ecosystems, and temporal integration of physiological processes during evolutionary change.

Molecular Basis for Metabolic Adaptation
We are interested in applicants whose research has the potential to shed light on the underlying principles driving emergence of distinct behaviors in metabolic pathways. Research into the regulation of metabolism offers a link between parts (e.g., organelles, cells, tissues, organisms, group of organisms) and their emerging behaviors.

Novel Ecosystems
We are interested in applicants whose research examines changing species and functional group composition from paleontological to modern eras, including shifts due to extinctions,

biological invasions, urbanization, climate change, speciation, and restoration. We are particularly interested in approaches that elucidate the mechanisms and consequences of change, as well as those that generate predictions of future patterns of biological diversity.

Subcellular, Cellular and Tissue Dynamics in Development
We encourage applications from individuals applying interdisciplinary approaches (e.g., genetics, cell biology, biophysics, engineering, mathematics) to understand the dynamic nature of molecules, organelles, cells and tissues during development. The ideal candidate(s) would build bridges to chemistry, engineering and physics to be at the forefront of equipment and tool development, particularly in areas of microscopy, genomic editing and molecular visualization.

Synthetic Biology/Chemical Biology/Protein Engineering
We are interested in applicants whose research is inspired by the potential for engineering with biological molecules to understand fundamental properties of the natural world and build novel interventions/devices. Research areas of highest interest would be those that bridge one or more of the following areas: protein or small molecule engineering, biochemistry and quantitative analysis of dynamic signaling circuits.

DATA SHEET FOR BIO-NETWORKS
SHORT NAME OF AREA: Dynamics in, and evolution of, biological networks

ONE SENTENCE DESCRIPTION:
Combination of theoretical, experimental, observational, and data-analysis research to understand and engineer biological networks varying widely across spatial and temporal scales (e.g., from gene regulatory systems to intercellular communication networks to food webs) with a focus on the dynamics within, and the evolution of, these networks.

3-10 TOP RESEARCHERS IN THE FIELD (INC. EMAIL AND WEBSITE)

Réka Albert (ralbert@phys.psu.edu) http://users.phys.psu.edu/~ralbert/

Uri Alon (uri.alon@weizmann.ac.il) https://www.weizmann.ac.il/mcb/UriAlon/homepage

Jordi Bascompte (jordi.bascompte@ieu.uzh.ch) http://www.bascompte.net/

Jennifer Dunne (jdunne@santafe.edu)
http://www.santafe.edu/about/people/profile/Jennifer%20A.%20Dunne

Michael Elowitz (melowitz@caltech.edu) http://www.elowitz.caltech.edu/index.html

Jeff Gore (gore@mit.edu) http://gorelab.homestead.com/index.html

Joe Thornton (joet1@uchicago.edu) http://www.thorntonlab.org/

5-7 KEY PAPERS HIGHLIGHTING IMPACT/INNOVATION/SIGNIFICANCE:

1. Anderson DW, McKeown AN, Thornton JW (2015). Intermolecular epistasis shaped the function and evolution of an ancient transcription factor and its DNA binding sites. eLife 4:e07864
2. Axelrod K, Sanchez A, Gore J (2015) Phenotypic states become increasingly sensitive to perturbations near a bifurcation in a synthetic gene network. eLife 2015;4:e07935 DOI: http://dx.doi.org/10.7554/eLife.07935
3. Dunne JA, Lafferty KD, Dobson AP, Hechinger RF, Kuris AM, Martinez ND, et al. (2013) Parasites Affect Food Web Structure Primarily through Increased Diversity and Complexity. PLoS Biol 11(6): e1001579. doi:10.1371/journal.pbio.1001579
4. Friedlander T, Mayo AE, Tlusty T, Alon U (2015) Evolution of Bow-Tie Architectures in Biology. PLoS Computational Biology, 11:UNSP e1004
5. Levine JH, Lin Y, Elowitz (2013) Functional Roles of Pulsing in Genetic Circuits. Science 342 (6163) 1193-
1200, DOI: 10.1126/science.1239999
6. Rushmore, J., D. Caillaud, R. Hall, R. Stumpf, L.A. Meyers, S. Altizer (2014). Network-based vaccination improves prospects for disease control in wild chimpanzees. *Journal of the Royal Society Interface* **11**:
20140349.
7. Sun Z, Jin X, Albert R, Assmann SM (2014) Multi-level Modeling of Light-Induced Stomatal Opening Offers New Insights into Its Regulation by Drought. PLoS Comput Biol 10(11): e1003930. doi:10.1371/journal.pcbi.1003930

PARAGRAPH RATIONALE FOR WHY THIS AREA IS HIGH IMPACT/INNOVATION/SIGNIFICANCE AND ALSO GOOD FIT FOR OUR DEPARTMENT

From molecules to ecosystems, the behavior of any biological system depends on intricate interactions among the parts of the system. For instance, the binding interaction between hormones and steroid receptors affects the expression of target genes; the synaptic interactions among neurons affects how an animal processes information; and the interactions between predators and their prey affects the ecology and evolution of both players. A tangled web of interactions occurs within and among organisms as well as between organisms and their environment. One central mission of biological science is to understand the origin, nature, dynamics and effects of such interactions. In addition to top-down approaches (including statistical analysis of large quantities of observational data, from 'omics to ecosystems), bottom-up approaches are also necessary to shed light on the behavior of networks. These bottom-up approaches include the construction of mathematical/computational models, synthetic gene circuits, and experimental communities (among other things). The marriage of top-down and bottom-up approaches yields insight into how the form of a biological network influences its function, and furthermore how the structure of a network evolves. Comparisons of the behavior of networks across different spatio-temporal scales reveal general principles governing living systems. Such understanding influences our ability to manage and engineer networks at different levels in the biological hierarchy. UW Biology is uniquely poised to embrace the theoretical, experimental and statistical exploration of biological networks. Why? First and foremost, we have researchers working across a wide spectrum of spatial and temporal scales studying networks, from the cellular/molecular level through the organismal level to the level of populations, communities, and ecosystems. Many of our faculty specifically focus on how components of their systems interact. Second, our faculty are employing, or are collaborating with others who use, cutting-edge quantitative techniques to understand, engineer and forecast network behavior (including development of network metrics, tools to visualize networks, statistical models of networks, various computational approaches to predict network behavior, etc.). Third, this research theme builds interdisciplinary bridges between our department and other units, programs, and institutions in the Seattle area (e.g., synthetic biology, genome sciences, eScience, engineering, computer science, applied mathematics, ISB, the Hutch, etc.). These units, programs and institutions will attract top researchers in this field. Because UW Biology is already a home to researchers that model, observe, experiment, and build biological networks, our department serves as a natural hub for bio-network science.

NAMES OF CURRENT UW BIO FACULTY THAT CONNECT AND 1 SENTENCE ON HOW/WHY:
(sentences from researchers or their websites)

1. **Carl Bergstrom**: Studies how information flows through living systems, develops network metrics, and ways to search, visualize and understand various biological and human-created networks.
2. **Toby Bradshaw**: Studies evolution of gene regulatory networks controlling adaptive morphological differences between closely related species, addressing the longstanding question of whether divergence speciation primarily involves mutations in structural or regulatory genes.
3. **Bingni Brunton**: Studies how networks of neurons compute to produce behavior, especially building models that bridge different scales of description in space and time.
4. **Janneke HilleRisLambers**: Studies the forces that influence plant community structure, including the many competitive and trophic level interactions between networks of species within those communities.

5. **Jen Nemhauser**: Studies how the architecture and dynamics of signaling networks allow for the effective processing of information, and how plants tune these networks to optimize their morphology for a given environment.
6. **Dave Parichy**: Studies the genes and cell behaviors underlying adult pigment pattern formation and how these mechanisms have evolved between closely related species to generate strikingly different pigment patterns; this development is underlain by molecular/genetic/cellular networks.
7. **Jeff Riffell**: Studies sensory neurophysiology and ecology, primarily focusing on olfactory-mediated behaviors because chemical signals control many fundamental interactions structuring populations and communities.
8. **Jennifer Ruesink**: Studies ecological consequences of additions of nodes in interaction webs via species invasions
9. **Sam Wasser**: Studies physiological and genetic mechanisms impacting health in wildlife, community level interactions in the ecosystem, and networks from source populations of poached elephants to transit locations to end-use markets.

DATA SHEET FOR DISEASE ECOLOGY AND EVOLUTION

SHORT NAME OF AREA: Disease Ecology and Evolution

ONE SENTENCE DESCRIPTION:
Research on the relationship between infectious diseases and their hosts, using molecular, genomic and / or imaging tools and techniques to gain insight into the dynamics of these ubiquitous relationships and their implications for community and ecosystem dynamics.

3-10 TOP RESEARCHERS IN THE FIELD (INC. EMAIL AND WEBSITE):
- Sonia Altizer: saltizer@uga.edu (http://www.ecology.uga.edu/facultyMember.php?Altizer/)
- Janis Antonovics: ja8n@virginia.edu (http://people.virginia.edu/~ja8n/Home.html)
- Elizabeth Archie: earchie@nd.edu; http://blogs.nd.edu/archielab/
- Drew Harvell: cdh5@cornell.edu
(http://ecologyandevolution.cornell.edu/people/faculty/drew- harvell.cfm)
- Felicia Keesing: keesing@bard.edu (http://www.feliciakeesing.com/)

5-7 KEY PAPERS HIGHLIGHTING IMPACT/INNOVATION/SIGNIFICANCE:
Why infectious disease research needs community ecology
By: Johnson, Pieter T. J.; De Roode, Jacobus C.; Fenton, Andy
SCIENCE Volume: 349 Issue: 6252 Article Number: 1259504 Published: SEP 4 2015
Biodiversity and disease: a synthesis of ecological perspectives on Lyme disease transmission
By: Wood, Chelsea L.; Lafferty, Kevin D.
TRENDS IN ECOLOGY & EVOLUTION Volume: 28 Issue: 4 Pages: 239-247 Published: APR 2013
Climate Change and Infectious Diseases: From Evidence to a Predictive Framework
By: Altizer, Sonia; Ostfeld, Richard S.; Johnson, Pieter T. J.; et al.
SCIENCE Volume: 341 Issue: 6145 Pages: 514-519 Published: AUG 2 2013
Emerging fungal threats to animal, plant and ecosystem health
By: Fisher, Matthew C.; Henk, Daniel. A.; Briggs, Cheryl J.; et al.
NATURE Volume: 484 Issue: 7393 Pages: 186-194 Published: APR 12 2012
Infecting epidemiology with genetics: a new frontier in disease ecology
By: Archie, Elizabeth A.; Luikart, Gordon; Ezenwa, Vanessa O.
TRENDS IN ECOLOGY & EVOLUTION Volume: 24 Issue: 1 Pages: 21-30 Published: JAN 2009
Causal inference in disease ecology: investigating ecological drivers of disease emergence
By: Plowright, Raina K.; Sokolow, Susanne H.; Gorman, Michael E.; et al.
FRONTIERS IN ECOLOGY AND THE ENVIRONMENT Volume: 6 Issue: 8 Pages: 420-429 Published: OCT 2008
Co-infection alters population dynamics of infectious disease
By: Susi, Hanna; Barres, Benoit; Vale, Pedro F.; et al.
Nature Communications Volume: 6 Article Number: 5975 Published: JAN 2015
Phylogenetic structure and host abundance drive disease pressure in communities
By: Parker, Ingrid M.; Saunders, Megan; Bontrager, Megan; et al.
NATURE Volume: 520 Issue: 7548 Pages: 542-+ Published: APR 23 2015
Museum samples reveal rapid evolution by wild honey bees exposed to a novel parasite
By: Mikheyev, Alexander S.; Tin, Mandy M. Y.; Arora, Jatin; et al.
NATURE COMMUNICATIONS Volume: 6 Article Number: 7991 Published: AUG 2015

ONE PARAGRAPH RATIONALE FOR WHY THIS AREA IS HIGH IMPACT/INNOVATION/SIGNIFICANCE AND ALSO GOOD FIT FOR OUR DEPARTMENT

Infectious diseases are ubiquitous, and have large impacts on the evolutionary trajectories and population dynamics of both disease causing agents and their hosts, which can further structure the communities and ecosystems in which these organisms are embedded. Moreover, humans are increasingly changing the ecological and evolutionary landscape for infectious diseases and their hosts (through landuse change, climate change, pollution, invasions and extinctions). Understanding the ecological and evolutionary dynamics of diseases and their hosts in a changing world is facilitated by the use of concepts and tools available from cell biology, genetics and / or physiology (amongst others), which means this researcher can interact with faculty in EEC as well as in CMD and PBB. Additionally, tractable and often studied hosts and their diseases span broad taxonomic areas (plants, animals, fungi, protists, viruses) and
habitats (terrestrial, marine, intertidal) our faculty work in. There could also be natural links for this researcher to faculty in departments in the Medical School and funding possibilities from NIH. To differentiate this position from one in the medical school, we should be looking for researchers whose research programs are focused understanding the mechanisms behind disease dynamics, as opposed to developing treatments.

NAMES OF CURRENT UW BIO FACULTY THAT CONNECT AND 1 SENTENCE ON HOW/WHY:

Carl Bergstrom uses mathematical models to understand the dynamics of emerging infectious diseases.

Ben Kerr conducts research on the ecology and evolution of microbes, and many of his research questions involve bacteriophages.

Alex Paredez studies the cytoskeleton and G-protein in Giardia, an important parasite.

Jeff Riffell studies the mosquito, an important vector for malaria.

DATA SHEET FOR INTEGRATIVE CELL SCIENCE
SHORT NAME OF AREA: Integrative Cell Science (ICS)
Concept: Parichy Contributors: Bosma, Cabernard, Nemhauser, Torii, Wakimoto

DESCRIPTION: Integrative cell science is defined here as intentionally broad and opportunistic. It aims to fill the intellectual gap between cellular parts list and the dynamic behaviors of single cells and groups of cells. As importantly, it serves as an organizing theme to establish Biology as a hub for innovations and collaborative research and training in areas that include "quantitative cell biology" and "developmental cell biology".

3-10 TOP RESEARCHERS IN THE FIELD (INC. EMAIL AND WEBSITE)
Yohanns Bellaiche (http://ugbdd.curie.fr/en/article/00219-polarity-division-and-morphogenesis) (genetics, imaging, and modeling to study embryo shape and morphogenesis)

Meng Chen, http://www.plasticgenome.org/ meng.chen@ucr.edu (nuclear organization, chloroplast- nuclear signaling)

Gaudenz Danuser http://profiles.utsouthwestern.edu/profile/139751/gaudenz-danuser.html (molecular manipulations, superb imaging technologies, and mathematical modeling to study mechanical and chemical signal integration affecting cell behaviors)

Tetsuya Higashiyama http://www.itbm.nagoya-u.ac.jp/en/members/t-higashiyama/ (genetics, cell biology and superb imaging methods to study plant fertilization)

Tony Hyman http://hymanlab.mpi-cbg.de/hyman_lab/ (biophysics, genetic, chemical methods to study cell organization)

Tom Jessel http://sklad.cumc.columbia.edu/jessell/about_us/about_us.php (molecular, genetic, cellular approaches to study neuronal identity and connectivity)

Galit Lahav, http://lahav.med.harvard.edu/index.html Systems Biology, Harvard galit@hms.harvard.edu, (dynamics of mammalian signaling)

Carolyn Rasmussen, http://rasmussenlab.weebly.com/ carolyn.rasmussen@ucr.edu http://rasmussenlab.weebly.com/(dynamics of cell division; tissue patterning)

Julie Theriot http://cmgm.stanford.edu/theriot/ (biophysics, biochemistry, and imaging to study cytoplasmic mechanics)

Orion Weiner http://cvri.ucsf.edu/~weiner/research.html (morphological perturbations, cell-severing experiments, and computational simulations to study cell polarity and mechanotransduction)

Bob Goldstein http://goldsteinlab.weebly.com (combining genetic manipulations and imaging to study fundamental dev cell questions, plus using –omics to develop a new model system to id evolutionary novelties that permit adaptation to extreme stress

5-7 KEY PAPERS HIGHLIGHTING IMPACT/INNOVATION/SIGNIFICANCE:
Competition for actin between two distinct F-actin networks defines a bistable switch for cell polarization. Lomakin AJ, Lee KC, Han SJ, Bui DA, Davidson M, Mogilner A, Danuser G. Nat Cell Biol.

2015 17(11):1435-45.

Mechanical control of morphogenesis by Fat/Dachsous/Four-jointed planar cell polarity pathway. Bosveld F, Bonnet I, Guirao B, Tlili S, Wang Z, Petitalot A, Marchand R, Bardet PL, Marcq P, Graner F, Bellaïche Y. Science. 2012 May 11;336(6082):724-7.

Reversible Optogenetic Control of Subcellular Protein Localization in a Live Vertebrate Embryo. Buckley CE, Moore RE, Reade A, Goldberg AR, Weiner OD, Clarke JD.Dev Cell. 2016 Jan
11;36(1):117-26

Visualizing the molecular sociology at the HeLa cell nuclear periphery. Mahamid J, Pfeffer S, Schaffer
M, Villa E, Danev R, Cuellar LK, Förster F, Hyman AA, Plitzko JM, Baumeister W. Science. 2016 Feb
26;351(6276):969-72. 1

Light-regulated gene repositioning in Arabidopsis. Feng, C.-M., Qiu, Y., Van Buskirk, E.K., Yang, E.J., Chen, M. (2014) Nat Commun 5:3027 doi: 10.1038/ncomms4027

Cell-to-Cell Variation in p53 Dynamics Leads to Fractional Killing. Andrew L. Paek, Julia C. Liu, Alexander Loewer, William C. Forrester and Galit Lahav.. Cell, 2016 165(3): 631-42

Live imaging of calcium spikes during double fertilization in *Arabidopsis* Hamamura, Y. et al. (2014) Nature Comm. 5:4722 doi:10.1038/ncomms5722

Tip-localized receptors control pollen tube growth and LURE sensing in Arabidopsis. Takeuchi H and
Higashiyama, T. (2016) Nature 531:245-8

RATIONALE FOR WHY THIS AREA IS HIGH IMPACT/INNOVATION/SIGNIFICANCE AND ALSO GOOD FIT FOR OUR DEPARTMENT
The fields of genomics, proteomics, and metabolomics are maturing. UW scientists have outstanding reputations for inventing and applying these technologies to multicellular organisms and single cells; so, it is now relatively easy to obtain a “parts list” for cells of interest. But we still don’t know how cells use information to assemble and disassemble subcellular structures in time and space, achieve cell type specific phenotypes, regulate transitions between states, and integrate behaviors with other cells.

Our faculty group has opportunities to work in an integrated fashion on these questions using diverse organisms and approaches, and with colleagues who are experts in big data science, mathematical modeling, and evolutionary biology. LSB design should facilitate interactions among research groups and provide supportive infrastructure for the new technologies that are essential for advances in ICS. We see an identity that is unique from, but synergistic with UW Biochem, BioE, Chem, Phys & Biophys, Genomic Sciences Departments, FHL and other scientific institutions in our area.

NAMES OF CURRENT UW BIO FACULTY THAT CONNECT
Marti Bosma: signaling patterns and cell fate determination in development
Veronica di Stilio: evolution and development
Clemens Cabernard: cell division, polarity, and fate
Takato Imaizumi: cell and organismal response to environmental signals
Jennifer Nemhauser: signaling pathway integration and synthetic biology
Dave Parichy (primary author); cell fate, morphogenesis, pattern formation and its evolution

Alex Paredez: evolutionary cell biology; regulation of the cytoskeleton Jay Parrish: cell type specific patterning; molecular homoeostasis Billie Swalla; regeneration in development and evolution
Keiko Torii: cell signaling, differentiation and patterning
Barbara Wakimoto: cell type specific phenotypes and morphogenesis
Linda Wordeman: cell division
Bingni Brunton: information processing and dynamic models
Jeff Riffell: chemical communication; chemotaxis
Liz Van Volkenburgh: cell and organismal growth response to environmental signals
Horacio de la Iglesia: cyclic behavior of cells and organisms
Bill Moody: signaling and electrical activity
Carl Bergstrom: modeling and information flow
Ben Kerr: phenotypic plasticity, information processing, and evolution
Daniel Promislow: metabolomics, phenotypic outcomes and evolution

SAMPLE DATA SHEET FOR INTEGRATIVE PHYSIOLOGY
SHORT NAME OF AREA:
Organismal Physiology, Environment and "Omics"

BRIEF DESCRIPTION:

There is increased interest in the interaction between ecological and environmental forces and an organism's ability to adapt to those pressures. In tandem, there is a veritable explosion of "omic" methods and data that provide unprecedented linkage between organismal physiology and behavior with environment. Our "template" of an organismal (either plant or animal) physiologist is one who an has the ability to link vertical integration of physiological processes across organizational levels within organisms, horizontal integration of physiological processes across organisms within ecosystems, and temporal integration of physiological processes during evolutionary change.

3-10 TOP RESEARCHERS IN THE FIELD (INC. EMAIL AND WEBSITE)

Steve Palumbi (spalumbi@stanford.edu) - http://palumbi.stanford.edu/index.html

Jonathon Stillman (stillmaj@sfsu.edu) - https://ib.berkeley.edu/labs/stillman/index.html

David Denlinger (denlinger.1@osu.edu) - http://www.oardc.ohio-state.edu/denlingerlab/t01_pageview2/About_Us.htm

Joel Kingsolver (jgking@bio.unc.edu) - http://jgking.web.unc.edu/

Annie Schmitt (jschmitt@ucdavis.edu)- http://plantgxe.ucdavis.edu/

Cameron Ghalambor (Cameron.Ghalambor@ColoState.edu)- http://sites.biology.colostate.edu/ghalamborlab

Gretchen Hoffman (hofmann@lifesci.ucsb.edu)- http://www.hofmannlab.com/

Others that are doing cool stuff and link these research areas (maybe better than those listed above (and are relatively young)):
Rowan Barrett (https://barrettlab.ca/)

Josh Benoit (http://www.artsci.uc.edu/faculty-staff/listing/by_dept/biology.html?eid=benoitja)

Zac Cheviron (https://chevironlab.wordpress.com/)

Kristi Montooth (http://montoothlab.unl.edu/)

Melissa Pespeni (https://blog.uvm.edu/mpespeni/)

Andrew Whitehead (https://whiteheadresearch.wordpress.com/)

Caroline Williams (http://www.cmwilliamslab.com/)

5-7 KEY PAPERS HIGHLIGHTING IMPACT/INNOVATION/SIGNIFICANCE:

Stillman, Jonathon H., and Eric Armstrong. "Genomics are transforming our understanding of responses to climate change." BioScience 65.3 (2015): 237-246.

Whitehead, Andrew. "Comparative genomics in ecological physiology: toward a more nuanced understanding of acclimation and adaptation." Journal of Experimental Biology 215.6 (2012): 884-891.

Barrett, R.D.H. and Hoekstra, H.E. (2011) Molecular spandrels: tests of adaptation at the genetic level. Nature Reviews Genetics 12: 760-780.

Zavala, Jorge A., et al. "Anthropogenic increase in carbon dioxide compromises plant defense against invasive insects." Proceedings of the National Academy of Sciences 105.13 (2008): 5129-5133.

Donald L. Mykles, Cameron K. Ghalambor, Jonathon H. Stillman, and Lars Tomanek Grand Challenges in Comparative Physiology: Integration Across Disciplines and Across Levels of Biological Organization. Integr. Comp. Biol. (2010) 50 (1): 6-16

RATIONALE

Omic approaches, particularly when paired with physiological experiments, are providing novel mechanistic understanding of how organisms adapt to their environment. The position would build on existing strengths in organism-environment interactions and bridge groups studying physiological ecology, systematic biology, molecular mechanisms, and biomechanics. The position would also extend the department's strength in forecasting responses to environmental change.

NAMES OF CURRENT UW BIO FACULTY THAT CONNECT AND 1 SENTENCE ON HOW/WHY:

Riffell-The ability to link physiological responses in an ecological framework would complement neurophysiological and sensory ecological approaches.
Buckley- Physiological ecology and evolution experiments and modeling would benefit from further employing organismal physiology and omics approaches.
Carrington- Research applying biomechanics to understand sensitivity to environmental change would complement position.
Imaizumi- Research on molecular mechanisms underlying responses to the environment would integrate well with omics approaches.

RESOURCES Funding:

NSF IOS Enabling Discovery through Genomic Tools (EDGE):

http://nsf.gov/pubs/2016/nsf16505/nsf16505.htm

NSF Dimensions of Biodiversity:

https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503446

Symposia:

Kansas State Ecological Genomics Symposia: http://ecogen.k-state.edu/symposia/pastsymposia.html

American Society of Naturalists 2016 Symposium on “Using population genomics to predict evolutionary responses to environmental change”: http://amnat2016.org/symposia.html

Evolution 2016 Symposium on “How and why? Toward an evolutionary physiological synthesis”: http://www.chrisdmuir.com/evo-phys-symposium/

DATA SHEET Molecular basis for metabolic adaptation

SHORT NAME: Metabolic regulation

ONE SENTENCE DESCRIPTION:
Discovery of principles driving emergence of distinct behaviors in metabolic pathways.

3-10 TOP RESEARCHERS IN THE FIELD(S):

[Diane Beckles dmbeckles@ucdavidmbeckles@ucdavi
http://www.plantsciences.ucdavis.edu/plantsciences_faculty/beckles/]

Natalia Dudareva doudarev@purdue.edu
https://ag.purdue.edu/hla/Pages/Profile.aspx?strAlias=doudarev&intDirDeptID=16

Gerald Edwards edwardsg@wsu.edu
https://mps.wsu.edu/dr-gerald-edwards/

Wolf Frommer wfrommer@carnegiescience.edu
https://dpb.carnegiescience.edu/labs/frommer-lab

Rainer Hedrich hedrich@botanik.uni-wuerzburg.de
http://www.bot1.biozentrum.uni-wuerzburg.de/forschung/hedrich/

Jorg Schwender schwend@bnl.gov
https://www.bnl.gov/biosciences/staff/Schwender.php

Y. Shacher-Hill yairhill@msu.edu
http://shachar-hill.plantbiology.msu.edu/

Daniel Segre dsegre@bu.edu
http://www.bu.edu/segrelab/

Mark Stitt mstitt@mpimp-golm.mpg.de
http://www.mpimp-golm.mpg.de/9333/Mark_Stitt

Susanne von Caemmerer Susanne.Caemmerer@anu.edu.au
http://biology.anu.edu.au/research/labs/von-caemmerer-lab-co2-fixation-and- water-loss-leaves

5-7 KEY PAPERS HIGHLIGHTING IMPACT, INNOVATION, SIGNIFICANCE:

Allen DK, Libourel IGL, Shachar-Hill Y (2009) Metabolic flux analysis in plants: coping with complexity. *Plant Cell and Environment*. 32: 1241-1257

Chew, Y. H.; Wenden, B.; Flis, A.; Mengin, V.; Taylor, J.; Davey, C. L.; Tindal, C.; Thomas, H.; Ougham, H. J.; de Reffye, P. et al.: Multiscale digital Arabidopsis predicts individual organ and whole-organism growth (vol 111, pg E4127, 2014). Proceedings of the National Academy of Sciences of the United States of America
112 (19) (2015)

Ed Reznik, Pankaj Mehta and Daniel Segre': Flux imbalance analysis and the sensitivity of cellular growth to changes in metabolite pools, **PLOS Computational Biology** (2013), 9(8): e1003195. [PLOS Comp Bio]

Dudareva N, Klempien, A Joëlle K. Muhlemann JK, Kaplan I. 2013. Biosynthesis, function and metabolic engineering of plant volatile organic compounds. Tansley review. New Phytologist, 198: 16-32.

Furbank RT, S von Caemmerer, J Sheehy, G Edwards. 2009. C4 rice: A challenge for plant phenomics. Functional Plant Biology 36: 845-856.

Scossa, F.; Brotman, Y.; de Abreu e Lima, F.; Willmitzer, L.; Nikoloski, Z.; Tohge, T.; Fernie, A. R.: Genomics-based strategies for the use of natural variation in the improvement of crop metabolism. Plant Science 242, pp. 47-64 (2016)

Plant Metabolic Networks
Schwender, Jörg (Ed.)
2009, X, 390 p. 13 illus., 11 in color., Springer, NY, Hardcover ISBN: 978-0-387-78744-2

von Caemmerer, S, Quick WP, Furbank RT (2012) The Development of C4 Rice: Current Progress and Future Challenges. Science 336, 1671-1672

JUSTIFICATION
With increasing amounts of 'omic data, and strong interest in adaptive phenotypes, research into the regulation of metabolism offers a link between the parts (of an organelle, cell, tissue, organism, group of organisms) and their emerging behaviors. Plants are an excellent system for many reasons, including: plant cells
are compartmentalized than animal cells offering more complexity in cellular regulation of metabolism, and, plant behavior relies on elaboration of biochemical pathways and growth regulation, instead of neural and muscular physiology. Photosynthesis is the obvious target for study if plant regulation of metabolism, and since the UW has no photosynthesis research (at the biochemical level) it would be fantastic to hire in this area. However, to do that would require multiple hires, and I suggest that if we go for one plant biologist in this field, we focus on signaling- induced changes in behavior, for example: sugar-signaling induced changes in reproductive strategy, or insect (agonist)-induced signaling leading to plant defense.

Opportunities for multiple hires in this field would easily fill the 5th floor of LCB. This field could have been called organismal physiology, and has historically linked the ecologists and evolutionary biologists to the cell and molecular biologists in our department. A "focus on the organism" (to quote Tom Daniel upon the merging of Botany and Zoology) has been the link that has held our department whole rather than splitting into two fields as many other university biologists did.

NAMES OF CURRENT UW BIO FACUTLY THAT CONNECT:
Bingni Brunton, Takato Imaizumi, Jennifer Nemhauser, Jeff Riffell, Keiko Torii, Liz Van Volkenburgh, Toby Bradshaw, Daniel Promislow, Lauren Buckley

Questions addressed by this field:

What is the metabolic basis for the difference between "slow-growing" and "fast-growing" plants? Crops and invasive species often are fast-growing, having lost an internal basis for conservative strategies in growth and nutrient acquisition. Wild species are often slow-growing, with slower metabolism and growth rate. How is this regulated?

How are nutrients allocated during plant development and acclimation? Plant behavior is based on developmental strategies, and acclimation accomplished by shifts in allocation. For example, developing plants use morphological strategies to compete above- and below-ground. Acclimation to stressors often involves a change in allocation from shoot to root. Defense strategies may divert nutrients from reproduction. How are these decisions made, metabolically, within the plant?

How are processes integrated in whole-plant bodies? What are the mechanisms for whole-plant signaling? Some known signaling processes involve emission of volatile compounds (leaf-leaf communication), root exudates (root-root communication), electrical and hydraulic signals travelling through the vascular tissues, and chemical signaling via hormones, peptides, miRNAs. How are these signals generated, propagated, perceived, and integrated?

NOVEL ECOSYSTEMS

SHORT NAME: Novel ecosystems: past, present, future

BRIEF DESCRIPTION: Research to examine changing species and functional group composition from paleontological to modern eras, including shifts due to extinctions, biological invasions, urbanization, climate change, speciation, and restoration; mechanistic approaches and consequences of change, as well as predictions of future patterns of biological diversity.

TOP RESEARCHERS IN THE FIELD (INC. EMAIL AND WEBSITE)

Jacquelyn Gill (Jacquelyn.gill@maine.edu) https://jacquelyngill.wordpress.com/
Dan Simberloff (dsimberloff@utk.edu) http://eeb.bio.utk.edu/people/daniel-simberloff/
Richard Hobbs (Richard.hobbs@uwa.edu.au)
http://www.web.uwa.edu.au/people/Richard.Hobbs

Margie Mayfield (m.mayfield@uq.edu.au)
http://www.mayfieldplantecologylab.org/site/Margie_Mayfield.html Jennifer Funk (jfunk@chapman.edu) http://www1.chapman.edu/~jlfunk/ Katharine Suding (suding@colorado.edu) http://www.colorado.edu/sudinglab/
Jeremy Jackson (jbjackson@ucsd.edu)
http://www.stri.si.edu/english/scientific_staff/staff_scientist/scientist.php?id=17

Justin Yeakel: (jdyeakel@gmail.com) http://jdyeakel.github.io

Caroline Lehmann: (clehmann@staffmail.ed.ac.uk)
http://www.ed.ac.uk/geosciences/people?indv=3626

KEY PAPERS HIGHLIGHTING IMPACT/INNOVATION/SIGNIFICANCE:

Hobbs, RJ; Arico, S; Aronson, J; et al. 2006. Novel ecosystems: theoretical and management aspects of the new ecological world order GLOBAL ECOLOGY AND BIOGEOGRAPHY 15: 1-7

Seastedt, Timothy R.; Hobbs, Richard J.; Suding, Katharine N. 2008. Management of novel ecosystems: are novel approaches required? FRONTIERS IN ECOLOGY AND THE ENVIRONMENT 6: 547-553

Funk, Jennifer L.; Cleland, Elsa E.; Suding, Katherine N.; et al. 2008. Restoration through reassembly: plant traits and invasion resistance TRENDS IN ECOLOGY & EVOLUTION 23:695-
703

Klein, Alexandra-Maria; Vaissiere, Bernard E.; Cane, James H.; et al. 2007. Importance of pollinators in changing landscapes for world crops.PROCEEDINGS OF THE ROYAL SOCIETY B-BIOLOGICAL SCIENCES 274:303-313

Ellis, Erle C.; Goldewijk, Kees Klein; Siebert, Stefan; et al. 2010. Anthropogenic transformation of the biomes, 1700 to 2000 GLOBAL ECOLOGY AND BIOGEOGRAPHY 19:589-606

Jackson, Jeremy B. C. 2008. Ecological extinction and evolution in the brave new ocean PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA 105:11458-11465

RATIONALE FOR WHY THIS AREA IS HIGH IMPACT/INNOVATION/SIGNIFICANCE AND ALSO GOOD FIT FOR OUR DEPARTMENT

Ecological and evolutionary forces that shaped living systems in the past have transitioned in pace and source, and our planet has entered the Anthropocene. Species present in communities have changed from extinctions, biological invasions, urbanization, climate change, speciation, and restoration. Does this matter for the ecological functions underlying life-support systems? To what extent does this change in ecological stage have evolutionary consequences? This area of research capitalizes on the impressively long history in UW Biology of field experimental research, whose mechanistic approaches are essential to understanding the consequences of different species representation in communities. It also capitalizes on the paleobiological strengths of the department in being able to place the pace and type of modern ecological change in a context of deep history. Modern tools in remote-sensing and genomics could be applied to span response variables at both larger and smaller scales than community ecology. A key value of “novel ecosystems” as an area of focus is in distinguishing the research from conservation and environmental problem-solving that would sit naturally in the College of the Environment, whereas UW Biology’s niche is in basic research into the causes and consequences of changes in interaction networks.

NAMES OF CURRENT UW BIO FACULTY THAT CONNECT AND 1 SENTENCE ON HOW/WHY:

Jennifer Ruesink: Jennifer’s lab researches consequences of non-native ecosystem engineers
whose presence transforms the structural and functional attributes of tideflat ecosystems.

Greg Wilson: Greg and other paleontologists in the department are actively involved in exhaustive searches for representation by different taxa by stratum, which provides a view of the structure of communities through earth’s history.

Caroline Strömberg: Caroline’s lab works on understanding the patterns and processes of the deep time assembly of grassland ecosystems around the world, including vegetation responses to changing climates and CO2 levels, and herbivore responses to climate and vegetation change.

Janneke HilleRisLambers: In Janneke’s lab, research focuses on the suite of environmental biotic and abiotic factors that result in shifts in communities across altitudes under warming conditions.

DATA SHEET FOR SYNTHETIC BIOLOGY

SHORT NAME: Synthetic Biology/Chemical Biology/Protein Engineering
BRIEF DESCRIPTION: Research inspired by the potential for engineering with biological molecules to understand fundamental properties of the natural world and build novel interventions/devices. The research area of highest interest would be in a region of overlap between protein engineering, biochemistry and quantitative analysis of dynamic signaling. The targeted research organism(s) is quite open-ended, although research with an emphasis on plants and/or microbes could be a 'sweet spot' for UW Biology hiring.

TOP RESEARCHERS IN THE FIELD: Sean Cutler (sean.cutler@ucr.edu)
http://www.cutlerlabs.org/
Michael Elowitz (melowitz@caltech.edu)
http://www.elowitz.caltech.edu/
Hana El Samad (Hana.El-Samad@ucsf.edu)
http://elsamadlab.ucsf.edu/
Alexander Jones (alexander.jones@slcu.cam.ac.uk)
http://www.slcu.cam.ac.uk/research/jones-group
Yuichiro Tsuchiya (yuichiro@itbm.nagoya-u.ac.jp)
http://www.itbm.nagoya-u.ac.jp/en/members/y-tsuchiya/ Christina Smolke (csmolke@stanford.edu)
http://smolkelab.weebly.com/research.html

KEY PAPERS HIGHLIGHTING IMPACT/INNOVATION/SIGNIFICANCE:
1. Park SY, Peterson FC, Mosquna A, Yao J, Volkman BF, Cutler SR. Agrochemical control of plant water use using engineered abscisic acid receptors. Nature. 2015 Apr 23;520(7548):545-8.
2. Lin Y, Sohn CH, Dalal CK, Cai L, Elowitz MB Combinatorial gene regulation by modulation of relative pulse timing. Nature 2015 October
3. Jones AM, Danielson JA, ManojKumar S, Lanquar V, Grossman G, Frommer WB. Abscisic acid dynamics in roots detected with genetically encoded FRET biosensors. eLife 2014.
4. Tsuchiya Y, Yoshimura M, Sato Y3, Kuwata K, Toh S, Holbrook-Smith D, Zhang H, McCourt
P, Itami K, Kinoshita T, Hagihara S. PARASITIC PLANTS. Probing strigolactone receptors in Striga hermonthica with fluorescence. Science. 2015 Aug 21;349(6250):864-8.
5. Venturelli OS, Zuleta I, Murray RM, El-Samad H. Population diversification in a yeast metabolic program promotes anticipation of environmental shifts. PLoS Biol. 2015 Jan 27;13(1):e1002042.

JUSTIFICATION: Synthetic biology is rapidly becoming as essential to molecular biology as crystallography, i*n vitro* biochemistry, genetics and the many 'omics'. Detailed knowledge of a genome, specifically the genotype-to-phenotype map, is essential for targeting and rapidly prototyping the optimal candidates for engineering. Synthetic biology, as a multiscale and cross-

disciplinary approach, offers a deeper understanding of development and signaling. This new perspective will make it possible to tackle a diverse set of challenging fundamental and applied problems. There are very few (no?) groups in our department that have their core research program built around protein/small molecule chemistry. This is a challenge/opportunity since many of us have research projects that 'dip a toe' into these areas, often mediated by collaborations. While other UW units have substantial investment here, there is not a strong connection to evolution in most of these efforts. This seems like a place where UW Biology could really make a large impact.

NAMES OF CURRENT UW BIO FACULTY THAT CONNECT:
Jennifer Nemhauser: Jennifer's work in plant synthetic biology starts from an organismal/developmental perspective. It would be greatly complemented by research that aims at the same problems, starting from a biochemical/structure or theory/modeling perspective.

Ben Kerr: Ben's work on microbial evolution and ecology would be enhanced by interactions with researchers with expertise in biochemistry/structure. In addition, there is synergy between the modeling and simulation approaches used by Ben's lab and in this area more generally.

Keiko Torii: Keiko is already deeply involved in using synthetic biology approaches to understand plant development, and this work would be complemented by additional faculty with deep knowledge in biochemistry.

Takato Imaizumi: Takato's work is strongly devoted to plant transcriptional mechanisms as they relate to seasonal developmental responses, as well as on-going efforts to improve models of circadian regulation of these responses. Expertise in modeling and/or biochemistry would be a resource for his trainees, and likely lead to new collaborative projects.

Alex Paredez: Alex's work is heavily invested in protein structure/function in an evolutionary cell biology context. As with others on the list, expertise in modeling and/or biochemistry would be a resource for his trainees, and likely lead to new collaborative projects.

Dave Parichy: Dave's work on the evolution of cell-cell and molecular networks in pigment patterning are increasingly leading to models where expertise/tools from biochemistry and small molecule engineering would be beneficial.

Also, clear connections to CSE, EE, GS, as well as to Institute of Protein Design and UW Institute for Neuroengineering. Possible connections to Hutch, ISB & Allen Cell Science.

Appendix E. Life Sciences Advisory Board Membership (2014)

Life Sciences Advisory Board Members	*UW Faculty/Staff Members*
Susan Adkins Past President, ARCS Foundation Seattle Chapter	**Toby Bradshaw** Professor and Chair, UW Biology
Vicki Chandler Chief Program Officer, Science Gordon and Betty Moore Foundation	**Damien Chapman** Associate Director of Advancement, Natural Sciences College of Arts & Sciences
Chandan Chauhan Co-Founder, Intelius Founder, Clock Tree Systems	**Tom Daniel** Professor and Komen Endowed Chair, UW Biology
Sue Coliton Senior Fellow, Paul G. Allen Family Foundation	**Candice Douglass** Director of Marketing and Communications, College of Arts and Sciences
Mark Emmert President, NCAA Former President, UW	**Felicia Gonzalez** Associate Director of Corporate and Foundation Relations, College of Arts and Sciences
Dan Evans Chairman, Daniel J Evans Associates Former Washington State Governor and Senator	**Natalie Hisdahl** Advancement and Communications Coordinator, Department of Biology
Ben Hall Professor Emeritus, UW Biology	**Liz Larsen** Director of Advancement, Natural Sciences College of Arts and Sciences
Ron Howell President and CEO, Washington Research Foundation	**Steve Majeski** Associate Dean for Research Administration and Infrastructure, College of Arts and Sciences
Gordon Orians Professor Emeritus, UW Biology	**Tracy Ostrem** Associate Dean of Advancement, College of Arts and Sciences
Chris Rivera President and CEO, Washington Biotechnology and Biomedical Association	**Bob Stacey** Dean, College of Arts and Sciences
Kathleen Wright Chair, UW College of Arts & Sciences Board	**Werner Stuetzle** Divisional Dean, Natural Sciences; College of Arts and Sciences
Maggie Walker Past President, ARCS Foundation	**Aggie Sweeney** Divisional Dean, Natural Sciences; College of Arts and Sciences

Appendix F. Faculty Search Ad 2017-18

Multiple Faculty Positions
Exploring biological systems from molecules to ecosystems
Department of Biology
University of Washington

The University of Washington (UW) Department of Biology is seeking individuals with a strong record of innovative and integrative research and outstanding future potential, as part of a long-term strategic hiring plan associated with a new Life Sciences Building on the UW Seattle campus. This search is intended to be broadly inclusive rather than targeting specific research topics, approaches, or systems. Applicants are encouraged to visit the UW Biology website (https://www.biology.washington.edu/about-us/join-uw-biology/2017-18-faculty-search) to find some specific examples of research areas we are interested in. We invite applications for multiple, full-time (100% FTE, 9-month), tenure-track faculty positions at the Assistant Professor level (job code 0116).

The UW Department of Biology provides a supportive research environment. Our faculty use innovative and quantitative approaches to investigate the evolution and function of biological systems from molecules to ecosystems. A candidate's research program is not expected to integrate across all levels of organization; instead, we are seeking outstanding individuals with an interest in collaborating across fields to make these connections. All UW faculty engage in teaching, research, and service. Successful applicants are expected to develop original, independent research programs, excel in teaching and training undergraduate and graduate students, and promote community engagement. Applications will be submitted through the UW Biology website (https://admin.biology.washington.edu/faculty/search/). Priority will be given to applications received by 1 October 2017. Applicants must have earned a doctorate, or foreign equivalent, by the date of appointment.

The University of Washington is an affirmative action and equal opportunity employer. All qualified applicants will receive consideration for employment without regard to race, color, religion, sex, sexual orientation, gender identity, gender expression, national origin, age, protected veteran or disabled status, or genetic information.