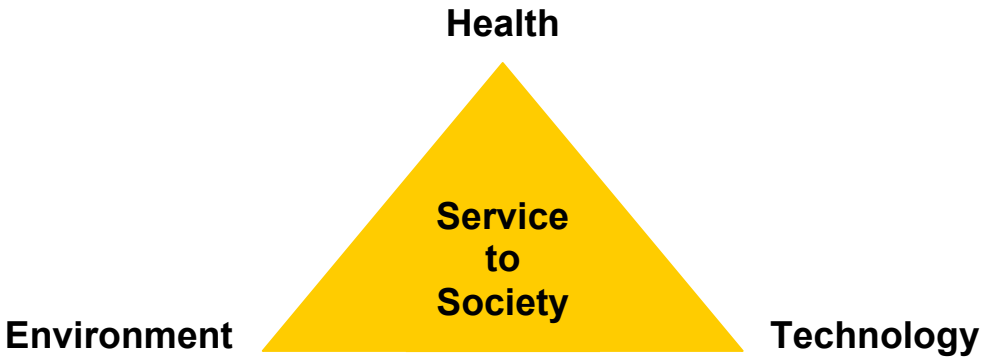
ACADEMIC PLAN
2001-02 TO 2010-11:
AN INTEGRATED APPROACH TO PLANNING

Division of Natural Sciences
University of California, Santa Cruz



Submitted by:

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Executive Summary

The long-range plans, priorities, and strategies established by the Division of Natural Sciences will allow us to take advantage of strengths and opportunities, mitigate limits and constraints, and serve the division, the campus, and society. We will enhance an already robust science enterprise to meet the educational needs of the next generation and provide a strong economic base through increased contract, grant, and gift revenue that is essential to the long-term health of UCSC. The division's blueprint for the next 10 years includes research and instructional objectives, FTE priorities, an analysis of resource needs and strategies, and an outline of needs for staffing, space, core facilities, and measures to help insure our success.

The planning assumptions and goals outlined for academic divisions in the campus planning instructions were the principal underpinnings for our plan, coinciding rather neatly with the departmental goals identified within the division. Given the appropriate resources, Natural Sciences will contribute to all eight campus goals, with especially significant gains in the areas of strengthening research and scholarly accomplishment and distinction, increasing graduate enrollments, developing interdisciplinary programs, markedly increasing external support, creativity in combining current and future resources, and proposing accountability measures.

The key **research objectives** are: 1) to build a set of focused programs in biomedical research and education, 2) to link global and regional environmental processes, and 3) to develop and apply new technologies to fuel scientific advancement.

The key **instructional objectives** are: 1) to sustain current and develop new instructional programs to train leaders and innovators in our technological society, 2) to continue supporting co-curricular activities, and 3) to increase our enrollments through a variety of approaches.

Faculty continue to investigate interdisciplinary junctures with campus and UC colleagues and continue to enhance collaborations with industry and external research facilities, capitalizing on research and funding opportunities. We will provide students with rigorous training in the core science disciplines and give them the opportunity to advance their understanding of the interdisciplinary approaches that must be employed to solve the complex problems we face in the areas of human health, the environment, and technology.

Research and instructional programs have been purposefully designed to leverage faculty expertise and departmental goals with the most exciting areas of the disciplines. The very highest priorities for new faculty recruitments correspond to high-priority positions needed to advance the organized research efforts. These areas present the most immediate opportunities to insure judicious and prudent investment of available resources in order to maximize return on investment. The division's short-term faculty FTE priorities are in the areas of:

1. Molecular, Cellular, and Developmental Biology
2. Chemistry and Biochemistry/Environmental Toxicology
3. Environmental Sciences
4. Complex Materials
5. Astrophysics and Cosmology
6. Mathematics/Applied Mathematics

1.0 Introduction

UCSC recently entered an aggressive and fast-paced growth period that is expected to bring significant new resources to the campus, as well as serious challenges presented by accelerated growth. Although the current budget situation may slow the availability of new resources and the timing in which our plans will be realized, once enrollment targets are reached we will enter a stage of steady-state enrollment and resource management. In planning for this growth the Division of Natural Sciences has looked into the state of each scientific field represented by our departments and tried to determine what the most exciting areas of those fields are likely to be in the foreseeable future. We seriously considered our current strengths relevant to each area and explored directions for growth in order to position our departments to become leaders in their fields. We then went beyond departmental planning to see how our departments can work together and across divisions to create new, exciting interdisciplinary programs.

While our planning process has been ongoing for several years, this document presents a refinement of our plan and implementation strategy in terms of the level of detail (resource requirements, space, infrastructure needs). In this plan we also address how our activities will contribute to the campus goals as articulated in the recent refinement of the campus planning process. As we will argue throughout this document, most of the campus goals, particularly doubling extramural funding, greatly expanding private gift support, and achieving membership in the AAU, will not be possible without the majority contribution from the Division of Natural Sciences. One would be hard pressed to find a highly ranked research university that does not place a major emphasis in the sciences. UCSC is not likely to be the exception to this rule. We must insure a healthy Natural Sciences Division if we are to achieve our campus goals.

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The programs and ideas presented here have emerged from a strategic planning process that evolved over the last five years within each department, between departments within the division, and through collaborative planning with other divisions. Nevertheless, it should not be viewed as an unchangeable blueprint for the future but rather a framework for growth. While much of this thinking is likely to be borne out, we must maintain flexibility to alter our plans to take advantage of the unanticipated opportunities that will undoubtedly emerge as new discoveries alter the directions of research and education.

While details of this plan will change with time, it is likely that the overall framework will remain valid for some time to come. That framework is based on the premise that the exciting areas of science will be areas that are well funded at the national level. Those areas will be the ones perceived to be most beneficial to society in the areas of protecting our **health**, protecting our **environment**, and in developing **technologies** that will provide physical and economic protection.

CP/EVC Simpson has identified eight priorities for shaping the UCSC of 2010. The departments within the Division of Natural Sciences have established programs and plans for the future that fully support these priorities:

- **Strengthen research and scholarly accomplishment and distinction**

  Natural Science faculty members have an enviable array of accomplishments in research. Our Astronomy and Astrophysics and Earth Sciences programs are well known as outstanding programs, but our strengths extend beyond those departments. We have one of the top few centers for RNA research in the world, an extremely small but very influential program in ocean and marine sciences, and an outstanding high-energy physics program. We also have the foundations of excellence in other areas, such as biophysics, toxicology, and environmental sciences. Building on our success by supporting aggressive growth in the sciences is likely to reap large dividends in advancing the campus's goals of increased scholarly distinction.

- **Markedly increase graduate programs and enrollments**

  Expansion of our existing programs and development of the new programs outlined in this plan is essential if the campus is to achieve its goal of doubling graduate student enrollment. Programs in the Division of Natural Sciences have established a strong record in graduate education since the founding of the campus. We can contribute to substantial growth in graduate education, as we are in a good position to fund additional graduate students through extramural funding (approximately 30 percent of our graduate support is funded through extramural awards). Our departments provide excellent graduate training in the basic biological and physical science disciplines as well as in the interdisciplinary areas of marine science, astrophysics, environmental sciences, and the biomedical sciences. Our Science Communication program enjoys a national reputation for excellence in the field. The Division of Natural Sciences trains the largest number of Ph.D. students on campus and maintains an average time-to-doctorate record that is equal to or better than systemwide averages.

- **Develop interdisciplinary programs at all academic levels**

  The most difficult questions we now face in health, environmental and technology research are those that require an interdisciplinary approach to solve. New, interdisciplinary graduate and undergraduate programs in the biomedical sciences, environmental sciences, and technology have been established or are currently in development. These programs are explained in more detail in Section 4.0 of this document.

- **Enhance faculty, staff and student diversity**

  Historically UCSC and the Natural Sciences Division have hired a more diverse faculty than is found in other science programs or at other campuses throughout the system. This division has taken this responsibility seriously, not only in the hiring of faculty and

staff, but also in contributing to the education of a diverse student population. Science faculty and staff support a number of academic programs that strive to increase the diversity of students graduating with degrees in science and engineering. Descriptions of these programs can be found in Section 4.5 of this document. The students supported by these programs will be the faculty and staff of the future, and through our support of these programs we contribute effectively to enhancing diversity at all levels of the institution.

- **Markedly increase external support from grant/contract as well as private fundraising**

  In 2000-01 the Division of Natural Sciences received extramural awards totaling $35,599,372. This was a 38 percent increase from 1997-98. The division is more productive in this area than other divisions on campus, particularly in acquiring external funding that brings overhead to the campus. It will not be possible for the campus to achieve its goal to markedly increase external support without a major contribution from the sciences. Our plan seeks to identify areas where strategic faculty hires will establish the critical mass necessary to compete for large program project grants and graduate training grants that will significantly increase our levels of external support.

- **Creatively combine present resources with new resources**

  Sufficient funding for faculty start-up packages and science instrumentation continues to be a challenge for the division. As will be discussed, funding a growing science enterprise is not a trivial investment. We have been extremely successful in leveraging resources to support growth across the division. Details of our funding strategies are discussed in Section 7.1.

- **Develop innovative programming in non-traditional areas including the Silicon Valley Center and state-supported summer instruction.**

  Programs within the division certainly have the potential to contribute substantially to campus efforts in Silicon Valley and expansion of summer instruction. Admittedly, our planning to date has been somewhat cursory because the planning frameworks for both Silicon Valley and the state-supported summer quarter have not been fully developed. Excellent ideas have been proposed by the departments and are discussed more fully in Sections 4.4 and 5.0. It is expected that divisional programs will contribute significantly to the development of the Silicon Valley Center, particularly through potential opportunities provided by collaborative efforts with NASA Ames and industrial partners.

- **Propose accountability measures**

  The departments have given serious thought to appropriate accountability measures and have considered them carefully within the context provided by the Millennium Committee Report and the campus goals established through this planning process. A full discussion of our thoughts on accountability measures is found in Section 7.6.

I believe that insuring the success of the research and education programs of the Natural Sciences Division is crucial if the campus is to realize these goals. Building a strong and vibrant science enterprise that will meet the educational needs of the next generation and provide a strong economic base through increased contract/grant/gift revenue is essential to the long-term health of UCSC. However, we must recognize that this will be an expensive investment. In deliberating the overall campus budget strategy, difficult decisions must be made regarding the allocation of new resources. It is expected that each divisional plan will be evaluated in the context of overall campus goals. The plan presented here illustrates how I believe this division will contribute to the achievement of those goals. The plan is aggressive, seeks the maximum range of resources, and will not be cheap to implement. However, making this investment is absolutely necessary to achieve the success we envision. If we are to become less dependent on state funding and create an institution that remains healthy, vibrant, and relevant, we must invest wisely and consider where the greatest return on investment is possible. One way to build an institution that is less vulnerable to fluctuations of the state economy is to develop a strong base of federal contract and grant support that provides a stable source of indirect cost income for the campus. One might think, for example, that it is expensive to hire first-rate science faculty due to high start-up costs. ***However, one-time start-up funding will lead to increased opportunity funds for the campus for the entire career of that faculty member***. When viewed in terms of long-term return on initial investment, increasing the size of our science enterprise becomes an attractive and wise strategy.

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As an aside, opportunity funds produced by the Natural Sciences Division have historically been disbursed across the campus to benefit all divisions, not just the Natural Sciences. Science faculty have been hampered in our ability to generate opportunity funds because our small size does not allow us to compete as effectively as other campuses for large program project funding. The campus administration must decide to increase the proportion of science faculty at UCSC if we are to be more effective in generating opportunity funds that benefit all. Alternatively, if the campus chooses to maintain a smaller proportion of science faculty than other campuses, then there must be an increased return of the opportunity funds we generate. This will allow us to make strategic investments in science programs that will enable us to be more competitive in seeking extramural support.

Among the top ranked programs on campus are Astronomy, Earth Sciences, high-energy Physics, and Marine Sciences. This is no accident. It is due to the substantial investment the campus has made in support of organized research through UCO Lick Observatory, the Santa Cruz Institute for Particle Physics (SCIPP), the Institute of Tectonics (now the Institute of Geophysics and Planetary Physics), and the Institute of Marine Sciences. If the campus wants more departments in the top 25 rankings, we need a similar commitment of support to other departments. We have shown that we can make these ventures pay off. It is now time to invest more broadly.

This document seeks to make the case for a major campus investment in the Division of Natural Sciences. It describes our plans for utilizing our current resources, growth funds, and extramural

support to meet departmental, divisional, and campus goals. It lays out an exciting future that will enable the campus to make important contributions to society that will bring UCSC to a new level of stature.

I think we have produced exciting ideas for the future of sciences at UCSC. This dream will only be realized, however, if the campus goes through a similar strategic approach to planning and makes similar hard choices to determine how best to invest in our future.

2.0 A New Approach to Planning

The process of developing this plan has been fascinating. It began with departments creating plans that were quite traditional. It evolved when I asked departments to assess both what we have accomplished to date and to identify the programs that will define their disciplines in the future. Department chairs and faculty worked diligently within their own departments and collaboratively across disciplines to develop academically sound and well integrated strategic plans that have produced the foundation for a strong divisional plan. Departments will continue to refine their plans as they envision their unit in 2010 and consider how growth will be phased, how teaching programs will respond, and how ongoing research and interdisciplinary efforts will be leveraged. We have focused our efforts on creating plans that will allow departments to shape their programs in order to take advantage of new developments within the disciplines, to consider what academic opportunities must be available to students as the campus develops, and to have the financial flexibility to achieve their goals. This was done while the division went through a parallel process of evaluating the areas of science likely to hold most promise in the foreseeable future.

I must emphasize that the divisional plan presented here rests on the foundation of strong departmental plans. The success of the division to date has relied on the individual strengths of the faculty that have built strong research programs and effective teaching programs. The science faculty has enjoyed great success, and our departments and programs have achieved distinction through this success. We have carefully considered how to sustain and support departmental plans and at the same time have looked for opportunities to leverage our available resources and participate in new activities that address some of the most important and challenging areas of science today.

The initiative process certainly catalyzed our planning efforts. As implemented by the campus, it required a divisional process that insured a realistic integration of initiative planning with long-term divisional academic planning. Throughout this process we have worked to build on our foundation of academic excellence and to develop new ideas and collaborations that will lead to innovation and discovery.

2.1 General Planning Principles

The goals reflected in the discussion that follows have been prioritized, and effective implementation strategies have been developed, through the continuation of the planning process. Divisional prioritization criteria that will continue to guide our implementation plans include:

- The extent to which programs build upon or extend expertise already in the departments or in other UCSC departments.
- Prospects for student growth or increased funding.
- The quality and comparative advantage of the program or activity.

- The demand for the program or activity on the part of students, other programs, and society.

The dominant areas of science are affected by new technologies and funding patterns. It is often difficult to predict what new technologies will be developed in the coming years, but we can guess about funding patterns with more certainty. Scientific research is primarily funded by federal agencies. The investment of federal resources will generally follow the security concerns of the country. While national focus in past decades has primarily been directed to military concerns, of primary importance in the next few decades will additionally be new security issues: the security of our **health**, our **environment**, and of our **economy**. Basic research directly related to improvements to the economy, public health, and the environment will be the major emphases of the division as we grow.

Accordingly, the divisional plan has identified three broad areas of overlap within the department plans that will define our programs in the future. Strategic investments in these areas will position the division to take advantage of anticipated future opportunities and will wisely leverage the campus's limited resources:

- **HEALTH**: Biological Sciences, Chemistry and Biochemistry, Environmental Toxicology, Physics

- **THE ENVIRONMENT**: Biological Sciences, Chemistry and Biochemistry, Earth Sciences, Environmental Toxicology, Ocean Sciences

- **TECHNOLOGY**: Astronomy, Chemistry and Biochemistry, Earth Sciences, Mathematics, Physics

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2.2 Current State of Planning

We began our planning by forecasting the distribution of divisional faculty at target growth (Appendix 1). We can now understand the range of new initiatives and programs that can be fully supported as new resources are realized and also improve other areas of planning (space, staff, technical support, graduate support, etc.).

It is important to note that the divisional plan and priorities are solidly anchored to the unique departmental goals and objectives. Summaries of divisional research objectives, instructional objectives, and initial thoughts regarding summer quarter and Silicon Valley Center are presented below.

3.0 Divisional Research Objectives

As discussed previously, our planning has been focused on examining our current strengths and how new resources could be directed to address areas of importance to the state and nation—those areas that are likely to be well supported by federal agencies. Subsequently the wisdom of this strategy was underscored by the cohesiveness of the department plans that resulted from this approach. The relevance of the approach we have taken was recently articulated by Office of Science and Technology Policy Director Nominee John Marburger's statement to the Senate (*The American Institute of Physics Bulletin of Science Policy News*, Number 127: October 12, 2001):

> *"Two immense forces have emerged in recent decades to transform the way all science is performed, just as they have altered the conditions of our daily lives: access to powerful computing, and the technology of instrumentation which provides inexpensive means of sensing and analyzing our environment. These have opened entirely new horizons in every field of science from particle physics to medicine. Nanotechnology, for example, - the ability to manipulate matter at the atomic and molecular level - and molecular medicine - the ability to tailor life essential substances atom by atom - both owe their capabilities to advances in computing and instrumentation.*
>
> *These forces are influencing our approach to each of the grand challenges we face in the national missions of security, environmental protection, healthcare, and education:*
>
> *National Security: Many factors have changed the face of war over the past decade. And our expectations about terrorist attacks on U.S. soil have been dramatically altered since September 11. Science and technology can help the country through innovations in detection technology, newly developed vaccines, and advances in weaponry for our warfighters. Defense technologies today depend increasingly on the commercial sector, not only to make cutting edge technologies available, but also to reduce the cost of defense procurements. For the last half century, possession of superior technology has been the cornerstone of our military preparedness. Such a strategy requires a sustained investment in science and technology to enable us to succeed in high priority missions, to minimize casualties, and to mobilize all of our military services in coordinated action. New technologies are necessary to strengthen our efforts in counterproliferation, counterterrorism, peacekeeping, and the stewardship of a safe and reliable nuclear weapons stockpile.*
>
> *Environment: Creating new scientific knowledge and technology to help us avoid environmental damage and its consequences is one of the great challenges facing our research enterprise. Recent advances in environmental science and technology hold enormous promise for the creation of a sustainable future in which our environmental health, our economic prosperity, and our quality of life are mutually reinforcing. At the same time, our growing knowledge has revealed vast gaps in our understanding of many environmental issues, particularly the human influence on the global climate. In the next 30 years, our population will grow by 60 million people, almost 40,000 individuals per week. During that same time, our economy is expected to double. Given such trends, we must develop a new generation of technologies that can supply*

the goods and services our society needs with less energy, fewer materials, and far less environmental damage.

Health Care: Medical advances have lengthened our average life expectancy more than 60 percent beyond what it was nearly a century ago. Scientific and technological breakthroughs are providing new approaches to solving many of the long-standing mysteries of life and its damaging diseases. Genetic medicine offers us the greatest hope, but the ethical, legal, and social implications of human genome research must also be addressed in parallel with the scientific exploration and in a manner that encourages maximum public involvement. The public sector has a dual role - to facilitate the advances and to protect the interests of the public, and in both ways serve as an advocate of the public good. Our newest technologies must always incorporate our oldest and most cherished human values. We will need to reassess our public investments and adjust our science and technology portfolio to reflect the new realities."

The Division of Natural Sciences aspires to be recognized for the distinction of its scientific programs. Many of the exciting scientific questions relevant to our understanding of the physical world today extend beyond the ideas, tools, and capabilities of any single discipline and must be approached in a multi-disciplinary fashion. We have identified multi-disciplinary research agendas in the broad areas of health, the environment and technology.

Our research objectives provide a focal point for increased funding, leverage faculty FTE investment, and will serve as an aid in recruiting and retaining the best faculty and students. Further, new partnerships will facilitate major project development that will have the potential to increase institutional research capacity (e.g., new space, support for students, postdoctoral researchers and staff, and major equipment). Because the department plans are designed to be flexible, with sustainability possible within a range of resources, we envision that the full complement of proposed research activities can be successfully implemented by the time the campus realizes target growth.

3.1 Excellence in Research: Biomedical Sciences/Health Sciences

OBJECTIVE: Build a set of focused programs in biomedical research and education.

It is imperative that we advance our current efforts and invest in future plans to build a set of focused research programs in biomedical research. UCSC has the potential to establish a world-class environment for biomedical research and education at UCSC. A strong research program will provide the sort of exciting environment that will engage the best graduate students, undergraduates, and postdoctoral fellows in the world. By working with and being taught by faculty participating at the highest levels in their fields, these students will receive rigorous preparation for future endeavors in biomedicine. UCSC will be a center for creative and groundbreaking biomedical research, and insure that the work of our faculty remains at the forefront of this field in the years to come.

Biomedical sciences are an increasingly important and productive area of academic research. Recent technological advances, such as the decoding of the human genome, are driving biomedical research to advance at an unprecedented pace. In addition, with an aging population, the identification of new environmental and inherited health risks, and the emergence of new infectious diseases, it is no surprise that the federal government has placed biomedical and health science as its foremost research priority. Consistent with this national priority on biomedical research, we find that an increasing number of UCSC undergraduate science majors are interested in pursuing one of our many majors focused on health issues. For these reasons, a concerted effort in the continued development of biomedical science research at UCSC is essential for our growth as a research university and for our maturation into a first-rate research environment for our undergraduate and graduate students.

Faculty in the departments of Molecular and Cellular Biology, Chemistry and Biochemistry, Environmental Toxicology, and Computer Engineering have come together to discuss how biomedical research at UCSC can be enhanced. These discussions have resulted in the identification of three interdependent and mutually reinforcing goals that will improve the research environment. These goals are to:

- Exploit new research funding opportunities,
- Increase opportunities for collaborative, interdisciplinary research at UCSC, and
- Build a critical mass for our research program by recruiting the very best students, postdoctoral fellows and faculty to take part in biomedical research at UCSC.

One key to building a stronger research environment at UCSC is to facilitate faculty participation in larger scale collaborative and cross-disciplinary research projects that are increasingly essential to biomedical research. Individually, biomedical researchers at UCSC have enviable records in obtaining funding for their research. However, to be successful our biomedical researchers must be able to compete more effectively for NIH and other federal research funding that will allow their participation in integrated interdisciplinary, large-scale projects.

> ***". . . Excellent in disciplines, but also multidisciplinary in our approach to larger social challenges."***
> *M.R.C. Greenwood, October 2, 2001*

A particularly important consideration for future faculty hires in MCD Biology, Chemistry and Biochemistry, and Environmental Toxicology will be to focus searches on areas where the addition of one or two faculty will position us to submit applications for large program project grants. By implementing strategic departmental hiring plans, it is possible that the addition of a single faculty member in a high priority area will result in substantial increased funding.

In order to increase opportunities for program project grant funding we must also increase the number of researchers on campus who focus their studies specifically on human biology and health. This is necessary because an important goal of a program project grant is to translate the basic biological research into information that is likely to have an impact on human health. Targeted hiring of faculty in the fields of structural and vertebrate biology, environmental toxicology, and chemical genetics will be a priority over the next several years and is planned in order to achieve critical mass in this area.

Increased collaboration is also necessary if we are to build stronger biomedical research and education at UCSC. Many recent and critical discoveries in the biomedical sciences are at the interface between conventional scientific disciplines. Because of our relative youth as a campus and outstanding collegiality among faculty, UCSC is uniquely positioned to advance new areas of interdisciplinary biomedical research. Currently there are a number of highly exciting areas where UCSC researchers—including faculty, post-docs, graduate students, and undergraduates—have already come together, often across departmental and even divisional lines, to collaborate in exciting new fields of research. These include efforts in the structural and molecular biology of RNA, the genome project, chemical genetics, the environmental toxicology of metals and pathogens, and biomedical instrumentation.

Finally, to further the advancement of biomedical research at UCSC we must aggressively recruit the best students, postdoctoral fellows, and faculty to join us. The best advertising for new faculty and post-docs is the solid record of success of the current faculty. We must focus on building collaborative faculty groups with overlapping interests. In doing so we will strive to saturate particular fields of research with high quality work from UCSC research groups. Thus, by fostering collaborative and cross-disciplinary work and by the careful hiring of faculty to bridge key areas of existing strength, we will increase both funding levels and our visibility within the biomedical research community.

Organized Research Links in the Biomedical Sciences

Department plans in MCD Biology, Chemistry and Biochemistry, and Environmental Toxicology propose faculty hires that are consistent with and will actively support future growth and development of the organized research activities of the Center for Biomolecular Science and Engineering (CBSE) and the Center for the Molecular Biology of RNA. CBSE is the linkage point for UCSC and the Institute for Bioengineering, Biotechnology and Quantitative Biomedical Research (QB3). Through these organized research activities, Natural Sciences faculty will contribute to the further advancement of the research and educational mission of the centers.

- **Center for Biomolecular Science & Engineering:** Established last year, the Center for Biomolecular Science and Engineering at the University of California at Santa Cruz is the umbrella organization for an interdisciplinary research and education program that spans the School of Engineering and the Division of Natural Sciences. This program is intended to meet the challenges of the post-genomic era, ushered in by the completion of the Human Genome Project, and the related genome projects for model organisms. The revolutionary technologies that have recently been developed to gather and analyze genomic information will help to forge a new understanding of biology with widespread applications to medicine, agriculture, and ecology. These technologies have been made possible by developments in structural biology, engineering, and computer science, and their further advancement requires a new blend of computational analysis, micromechanical robotics, microfluidics, bioelectronic chips, imaging, and new laboratory functional genomics methods. Our proximity to Silicon Valley and Biotech Bay, our active collaborations in molecular biology, protein and RNA biochemistry, and computational biology make this a natural research and academic focus area for this division and the campus.

- **Center for the Molecular Biology of RNA (RNA Center):** The Center for Molecular Biology of RNA was established at UCSC in 1992 to promote interdisciplinary research on the molecular structure and biological function of RNA. The Center has grown to comprise eight research groups spanning the Departments of Biology, Chemistry and Biochemistry and Computer Sciences. UCSC scientists study the diverse functions of RNA at the molecular level. Such research will have a significant impact on understanding the roles of RNA in health, agriculture, and biotechnology. Center scientists have earned an international reputation for their creative contributions to RNA molecular biology.

Areas of Departmental Strength/Excellence in Biomedical Research

- **Chemistry and Biochemistry, MCD Biology, Environmental Toxicology:** We have a very strong inter-departmental group focused upon the structure and function of biological macromolecules including proteins, RNA, and RNA-protein complexes of critical functional importance such as the ribosome and the spliceosome. UCSC is home to the internationally recognized Center for the Molecular Biology of RNA. There are a number of outstanding UCSC researchers who study the structure and dynamic features of proteins. This research on biomolecular structure and function will become even more important as the data from the Human Genome project is utilized to produce interesting protein research targets.

- **MCD Biology, Environmental Toxicology, Computer Engineering:** UCSC scientists are world leaders in the development of computational tools to understand and manipulate the vast information produced by the Human Genome Project. We have built on this strength by embarking on novel research programs that explore the use of emerging technologies such as DNA microarrays. Further development in the area of experimental genomics will help us attract the very best faculty, postdoctoral fellows, and graduate students interested in the data analysis and instrumentation issues underlying genomics.

- **Chemistry and Biochemistry, Environmental Toxicology, Social Sciences:** The symbiotic interaction between the quality of our environment and human health is a critical area of biomedical research. The long-term goal is to establish Natural Science faculty as national leaders in trace metal toxicity and nutrition. The recent Keck Foundation award for trace metals instrumentation well positions us to establish a center for the study of trace metal nutrition and toxicity.

- **Chemistry and Biochemistry, MCD Biology:** Chemical-based research at the interface of bio-organic chemistry and cell biology offers a number of exciting prospects for future biomedical research. We view the field of chemical genetics as the discovery platform for identifying the next generation of materials that will serve as both new therapeutics and unique molecular tools. An interdisciplinary team of science faculty have come together to plan collaborative research that focuses on biomolecules, biocomplexity and bioprocesses in the context of chemical genetics. A strong UCSC group in this area offers exciting opportunities for industry collaboration.

- **MCD Biology, Environmental Toxicology:** Current strengths include exceptional research expertise in non-vertebrate model systems, such as fruit flies, nematodes, and yeast. The current lack of faculty doing research in vertebrate systems hampers progress and limits

funding opportunities. Discoveries from the study of simple model systems form the basis for most of the work carried out by vertebrate biologists, and there will be strong interactions between the two groups. If we are to achieve the research and educational goals described in this document, it will be essential to increase the emphasis placed on vertebrate biology and human disease. Faculty expertise in this area is critical to support an increased emphasis on courses relevant to human health in the undergraduate curriculum.

3.2 Excellence in Research: Environmental Sciences

OBJECTIVE: Link global and regional environmental processes.

Human health depends upon ecosystem health, and ecosystem health depends upon the processes linking the earth's ecosystems. The long-term health of our societies therefore requires that we understand those linkages much better than we do now. Every recent national task force on environmental research has emphasized this crucial research need. Meeting that need requires development of innovative scientific approaches, technological and engineering tools, and environmental policy that becomes integrated into our societies.

As I worked over the past few years to encourage comprehensive planning within the division, I remained concerned about our environmental science programs and the future of this critical area of instruction and research at UCSC. Although there is important work being done in this area at UCSC, the instruction and research activities are spread over several departments in two different divisions and therefore are not coordinated in a way that maximizes their effectiveness or their reputation. Dean Chemers and I agreed that collaborative planning work was needed. In May of 2000 we charged an interdivisional ad-hoc committee to consider the future of environmental science at UCSC and to propose comprehensive environmental science programs for the campus. The preliminary work of the committee has evolved over time and has resulted in the delivery of a proposal to establish STEPS: An Institute for Innovation in Environmental Research (Science, Technology, Engineering, Policy and Society). The goal of the STEPS Institute is to foster research linking global and regional environmental processes. In meeting the goal, the focus will be on two of the greatest environmental research problems facing our societies:

- Integration of global biodiversity research from genes to ecosystems, and
- Integration of research linking water, environment, and society across land and sea.

Recent reports of all national task forces on the environmental sciences have identified integration of global and regional scale environmental processes as one of the greatest challenges facing environmental research. For example, the environmental dynamics of California epitomize the need for linking global and regional environmental processes. California's environment is being reshaped by El Niño/La Niña cycles. These cycles originate in the oceans and through changes in precipitation that arise from global warming. Yet we are only now beginning to understand how these global physical processes affect the genetic and ecological dynamics of plant, animal, and microbial populations and the cycling of nutrients and water through ecosystems.

We also now know that California's environments are increasingly dominated by invasive species introduced from other continents. These species have disrupted interactions between native species that are important for ecosystem health. Some of the causes of the spread of invasive species are regional, resulting from alteration and fragmentation of local environments, making its ecosystems susceptible to invasion. But similar invasions by some of the same species are occurring worldwide, and the problem can be understood only in a global context.

Environmental research is poised to make major advances in the next decade, and it is clear that the greatest advances will come from approaches that link global and regional environmental processes. We are poised to implement such an approach. UCSC has a tradition of fostering interdisciplinary research. We are expanding our environmental research departments and centers, and we have created two new environmental sciences departments within the past two years. We have created a new School of Engineering, which will develop in ways that complement research in the Divisions of Natural Sciences and Social Sciences. We are developing new environmental research clusters at the interface of modeling and measurement across multiple spatial scales. This is a critical time to continue investment in this area if we are to take advantage of our existing strengths to build programs that have the potential to greatly influence our future.

Within UCSC we have research groups in the physical, biological, and social sciences, engineering, and environmental policy addressing a wide range of environmental processes across multiple spatial scales. These include laboratories that study the global and regional patterns in physical processes in marine and terrestrial environments and environmental toxicological processes across multiple spatial scales. Our scientists investigate the structure of biological communities from local to continent-wide and ocean-wide scales, the genetic structuring of species and species interactions across broad geographic landscapes. We are working to develop and employ remote sensing technologies to monitor an increasing array of environmental processes and study societal responses to environmental policies that cross political boundaries. Major advances in linking global and regional environmental processes will require crossing traditional disciplinary boundaries in truly integrated ways. It will require innovative links among science, technology, engineering, policy, and society.

> ***". . . We want faculty from different fields to know each other, to explore new ideas together. . . ."***
> *M.R.C. Greenwood, October 2, 2001*

As UCSC continues its current growth, it is poised to push its tradition of interdisciplinary research to a higher level. The STEPS Institute will provide a direct mechanism to focus a major part of that growth in innovative ways. The Division of Natural Sciences is committed to pursuing this vision to expand the coordination and development of environmental research. Full development of the STEPS proposal will require close cooperation and collaboration among the Divisions of Natural Sciences, Social Sciences and Engineering. True integration requires linking people and committing to a substantial development effort.

Organized Research Links in the Environmental Sciences

As mentioned previously, a number of environmental initiatives are in place at UCSC. The STEPS Institute will help to coordinate the active research and education across departments and divisions. Each of the following efforts involves Natural Sciences faculty members in integrating environmental sciences in different ways across regional and global scales. The departments of Ecology and Evolutionary Biology, Chemistry and Biochemistry, Earth Sciences, Environmental Toxicology, and Ocean Sciences propose hiring plans that are consistent with and will actively support future growth and development of these organized research activities in the environmental sciences. In particular, departmental plans have been well coordinated with the planned development of the IGPP initiative and the continued expansion of the Institute of Marine Sciences. The emphasis on integrative coastal ecology within the Ecology and Evolutionary Biology Department will also contribute to growth in this area.

- **Institute for Geophysics and Planetary Physics (IGPP):** The UCSC branch of the Institute of Geophysics and Planetary Physics was officially established during the 1999-2000 academic year. The mission of the IGPP is to promote and coordinate basic research on the understanding of the origin, structure and evolution of Earth, the Solar System, and the Universe, and on the prediction of future changes as they affect human life.

  The UCSC IGPP branch now includes three interdisciplinary research centers. **The Center for Dynamics and Evolution of the Land-Sea Interface (C.DELSI)** coordinates interdisciplinary research on the complex ocean, atmosphere, and continental systems that impact regional climate, marine and freshwater resources, agriculture, fisheries, and natural hazards. **The Center for Origin, Dynamics and Evolution of Planets (CODEP)** focuses on research activities related to the origin, dynamics and evolution of planetary bodies in our Solar System and around other stars. **The Center for the Study of Imaging and Dynamics of the Earth (CSIDE)** coordinates research aimed at understanding the formation, evolution, and dynamics of planet Earth. IGPP plans to establish a **Center for Remote Sensing**, emphasizing application of remote sensing information to environmental change and natural hazards of California and coastal regions. This is coordinated with UC systemwide efforts to advance research on environmental monitoring of California.

- **Institute of Marine Sciences (IMS):** The Institute of Marine Sciences, our longest established ORU, is aimed at integrating research in marine environmental programs. IMS facilitates research on a wide range of research related to marine vertebrate biology, coastal biology, fisheries and fishery management, oceanography and ocean processes, marine geology and geophysics, environmental toxicology, paleoceanography, paleoclimatology and global change. IMS provides opportunities and support for collaborations among scientists within the Institute and with other marine research institutions. The U.S. Geological Survey has eight scientists on the UCSC campus who collaborate with faculty and graduate students on diverse projects including coastal and near-shore processes, shoreline erosion and coastal hazards. IMS faculty and researchers also collaborate with the Monterey Bay Aquarium Research Institute (MBARI), Moss Landing Marine Laboratories, Hopkins Marine Station, University of California, Santa Barbara, the California Department of Fish and Game, the National Marine Fisheries Service (NMFS), the National Oceanic and Atmospheric Administration (NOAA), and other research organizations.

- **Center for Marine Protected Areas (MPA):** The newly established Center for Marine Protected Areas will coordinate the nationwide effort to develop a system of MPA research centers throughout U.S. waters. The UCSC part of the effort will collaborate with agency and non-governmental partners in developing the science-based framework needed to design and effectively manage MPAs.

- **Partnership for Interdisciplinary Study of Coastal Oceans (PISCO):** PISCO, established through major funding from the David and Lucille Packard Foundation, is a large multi-university effort. It is designed to develop a systematic understanding of the biodiversity of marine environments in the Pacific Ocean across multiple spatial scales. Much of the PISCO work on community ecology and the genetic structure of populations is spearheaded through work at UCSC.

- **Coast Ranges Oak Woodlands Network (CROWN):** Related efforts are underway on large-scale initiatives in terrestrial environments that complement the efforts underway for marine environments. The multi-campus CROWN is one example. The UCSC components of this work are on the genetic structuring of plant and animal species across large geographic scales and on the problems of implementing environmental policy across large scales. UCSC is therefore poised to be one the few universities capable of integrating global and regional environmental processes across the land/sea interface.

Areas of Departmental Strength/Excellence in Environmental Research

Numerous Natural Sciences departments, research units, and individual researchers have national and international reputations for their water-related research. Examples include:

- **Earth Sciences:** Historical (paleontological) dynamics of biodiversity; research in geology, geochemistry, and geophysics, including issues related to the storage, flow, and quality of surface and sub-surface water both inland and at fresh water/saltwater boundaries, as well as long-term modeling of climate change, including changes in precipitation and surface temperature at the regional level.

- **Ecology and Evolutionary Biology:** Ecological and genetic dynamics of populations across broad geographic scales, the structure and dynamics of biological communities, co-evolution of species, and the evolution of diversity in physiology and behavior; research on population and community ecology, population genetics, rapid evolution and co-evolution of species, physiology, behavior, systematics, and biodiversity spanning marine mammals, fish, pelagic bird, invertebrates, and plants and algae.

- **Environmental Toxicology:** Diversity of responses of organisms to environmental toxins; research on the biogeochemical cycling of toxins and pathogenic organisms in fresh water, saltwater, and mixed systems; the bioremediation of polluted aquifers; and the bioavailability, metabolism and toxicity of natural and anthropogenic contaminants.

- **Ocean Sciences**: Research in biological oceanography and marine microbial ecology, chemical oceanography and marine biogeochemistry, ocean circulation and coupled biological-physical interactions, and paleoceanography and paleoclimatology.

3.3 Excellence in Research: Technology

More than half of the nation's economic productivity growth in the last 50 years is attributable to technological innovation and the science that supported it. Technological innovation and scientific discovery have created millions of high-skill, high-wage jobs and improved our quality of life.

Technology is identified as the division's third area of emphasis. The knowledge and understanding produced by basic research helps to determine the means by which a recognized and specific need may be met. The development and application of new technologies that fuel scientific advancement stretch the imagination when thinking about future possibilities.

OBJECTIVE: Develop and apply new technologies to fuel scientific advancement.

During the next decade it will be feasible to determine the fundamental parameters of our universe—its age, mass, expansion rate, and future. Space-based observatories will study the universe in all its emissions—radio, microwave, infrared, optical, ultraviolet, x-rays, and gamma-rays. In the sub-mm and infrared wavelengths, telescopes will peer deeper than ever before into the star and planet forming regions of our galaxy. New extra-solar planets will be discovered at an accelerating rate. Theoretical modes for galaxies, stars, planets, and astronomical explosions will be calculated on computers at least 100 times faster and with 100 times the active memory of today's supercomputers. Current research will help us to understand the properties of compounds of intermediate size between molecules and solid state, and this knowledge will be used to produce microscopic devices with properties unlike any that have come before. Individually tailored small molecules will be created as unique pharmaceuticals. Further advancement in the areas of remote sensing and data management will be applied to better understand the complexity and predict the future of our critical environmental systems, including coastal waters, agricultural regions, surface water distribution systems, atmospheric and climate systems, and active fault systems. Research into nanoscale electronic and magnetic switches will ultimately create more powerful computer hardware and highly sensitive sensors. Biophysicists are developing new physical simulation techniques to study protein folding that aid in the design and development of new drugs.

Strength in these areas of science will be important for strong programs in environmental and biomedical sciences. Maximal advancement in these areas will require new technologies and new paradigms for obtaining and analyzing large amounts of data. For example, the development of chip technologies has greatly accelerated the discovery of new drugs. The same approaches will be important to our understanding of environmental issues. Such developments will result in the production of huge amounts of data that can accelerate our understanding of environmental processes if we have efficient data analysis approaches to take advantage of this data. Astronomers and high-energy physicists have faced this challenge for some time, and the

technologies they create should be transferable to environmental and biomedical applications. By remaining on the forefront of these areas of technology and facilitating interactions that introduce forefront technologies into biomedical and environmental sciences, we can create new paradigms that enable us to be leaders in these fields—each of which is important to society.

Organized Research Links in the Technological Sciences

Department plans in Astronomy and Astrophysics, Chemistry and Biochemistry, Earth Sciences, Ocean Sciences, Physics, and Mathematics propose faculty hiring plans that are consistent with and will actively support future growth and development of research activities in the technological sciences. In particular, departmental plans have been well coordinated with the planned development of the IGPP initiative, the Center for Biomolecular Science and Engineering, the ongoing research activities of the Santa Cruz Institute for Particle Physics, and UCO/Lick Observatory. Through these organized research activities, Natural Sciences faculty will contribute to the further advancement of the research and educational mission of the centers.

- **Institute or Geophysics and Planetary Physics (IGPP):** The UCSC branch of the Institute of Geophysics and Planetary Physics was officially established during the 1999-2000 academic year. The mission of the IGPP is to promote and coordinate basic research on the understanding of the origin, structure and evolution of Earth, the Solar System, and the Universe, and on the prediction of future changes as they affect human life.

  The UCSC IGPP Branch now includes three interdisciplinary research centers. **The Center for Dynamics and Evolution of the Land-Sea Interface (C.DELSI)** coordinates interdisciplinary research on the complex ocean, atmosphere, and continental systems that impact regional climate, marine and freshwater resources, agriculture, fisheries, and natural hazards. **The Center for Origin, Dynamics and Evolution of Planets (CODEP)** focuses on research activities related to the origin, dynamics and evolution of planetary bodies in our Solar System and around other stars. **The Center for the Study of Imaging and Dynamics of the Earth (CSIDE)** coordinates research aimed at understanding the formation, evolution, and dynamics of planet Earth.

  IGPP is actively engaged in high-performance computing and is establishing a massive parallel computer system for analysis of complex dynamical problems relevant to Earth's environment and evolution, as well as for astrophysics. Graduate training in programming and utilization of high-performance parallel computing is a critical technological frontier.

- **Santa Cruz Institute for Particle Physics (SCIPP):** The Santa Cruz Institute for Particle Physics (SCIPP), an ORU at UCSC, is home to a permanent scientific and technical staff including faculty, senior research physicists, graduate students and postdoctoral fellows. Within the Institute, pursuits are diverse. SCIPP experimentalists are involved in a number of efforts at premier high-energy physics facilities around the world. This includes electron-positron colliders (the SLC and PEP-II colliders at the Stanford Linear Accelerator Center, and the LEP collider at CERN in Geneva, Switzerland), the HERA electron--proton collider in Hamburg Germany, and the future LHC proton--proton collider at CERN.

The long term SCIPP experimental program has three major elements. The first emphasizes projects already underway in accelerator-based particle physics and gamma-ray particle astrophysics. The second focuses on work toward the next major accelerator now being planned. The last focuses on a partnership with the Physics Department and the Astronomy and Astrophysics Department to develop more fully a program in Particle Astrophysics and Cosmology.

- **Center for Biomolecular Science & Engineering:** Established last year, the Center for Biomolecular Science and Engineering at the University of California at Santa Cruz is the umbrella organization for an interdisciplinary research and education program that spans the School of Engineering and the Division of Natural Sciences. This program is intended to meet the challenges of the post-genomic era, ushered in by the completion of the Human Genome Project, and the related genome projects for model organisms. The revolutionary technologies that have recently been developed to gather and analyze genomic information will help to forge a new understanding of biology with widespread applications to medicine, agriculture, and ecology. These technologies have been made possible by developments in structural biology, engineering, and computer science, and their further advancement requires a new blend of computational analysis, micromechanical robotics, microfluidics, bioelectronic chips, imaging, and new laboratory functional genomics methods. Our proximity to Silicon Valley and Biotech Bay, our active collaborations in molecular biology, protein and RNA biochemistry, and computational biology make this a natural research and academic focus area for this division and the campus.

- **Center for Adaptive Optics (CfAO):** UCSC is headquarters for The Center for Adaptive Optics that serves to advance and disseminate the technology of adaptive optics in service to science, health care, industry and education. The CfAO was established in 2000 as a Science and Technology Center (STC) funded by the National Science Foundation. The Center for Adaptive Optics will concentrate on astronomical and vision science applications of adaptive optics. It will develop new instruments optimized for adaptive optics.

- **UCO Lick Observatory:** Headquartered at UCSC, this world-renowned multi-campus research unit supports research and training of astronomers, researchers, graduate and undergraduate students throughout the UC system. UCO provides technical resources to design and fabricate state-of-the-art instrumentation, optics, programming and detectors. A managing partner of the W.M. Keck Observatory on Mauna Kea in Hawaii, UCO also operates Lick Observatory on Mt. Hamilton, conducting both research and public programs.

Areas of Departmental Strength/Excellence in Technological Research

- **Astronomy and Astrophysics, Physics:** The departments of Astronomy and Astrophysics and Physics are planning to expand research efforts in the areas at the boundary between the two fields. This includes areas such as particle astrophysics, theoretical and observational cosmology, and high-energy astrophysics.

- **Astronomy and Astrophysics, Earth Sciences:** The focused research initiatives within Earth Sciences on the origins and dynamical evolution of planets (CODEP) and other aspects of planetary physics mesh well with interest in star and planet formation within the

Astronomy and Astrophysics Department. Proposed expansion in theory and non-optical astronomy positions UCSC to become the world's center for detecting, observing, and modeling the evolution and appearance of extra-solar planets.

- **Astronomy and Astrophysics, Earth Sciences, Ocean Sciences, Applied Mathematics and Statistics:** Recent faculty appointments in Earth Sciences, Ocean Sciences, and Applied Mathematics and Statistics provide interdisciplinary strength in areas of astrophysics that involve fluid mechanics, dynamics, and numerical simulation.

- **Chemistry and Biochemistry, Physics, Electrical Engineering:** A research program in complex materials aspires to distinguish UCSC as a leading institution in the development, characterization, and application of complex materials. Areas proposed for future development include: organic hybrid materials and devices, nanoparticle and nanostructure devices, strongly correlated systems, interfacial interactions and degradation mechanisms, and applications of complex materials.

- **Earth Sciences, Environmental Toxicology, Ocean Sciences, Engineering:** Many faculty and researchers at UCSC are conducting research on the California environment in which various remote sensing data sets play critical roles. Particular strengths of the UCSC program include near real-time monitoring of the environment in both the terrestrial and off-shore environments of the state. Relevant research activities are conducted in numerous departments.

4.0 Divisional Instructional Objectives

The Division of Natural Sciences will address the educational expectations of a growing and changing student population by sustaining and creating compelling instructional programs that will train students to be leaders and innovators in our increasingly technological society. Further, the division is committed to continued support of co-curricular academic activities that complement the academic programs of our departments, support students in the attainment of their academic goals, and seek to increase the diversity of science graduates.

One of the biggest challenges we currently face is enrollment management. Divisional enrollments have been relatively flat for a number of years, following a sharp decline from 94-95 to 95-96. A slight increase was realized this year. We must find ways to preserve the existing strengths of our programs while at the same time extending or leveraging these enterprises to support our instructional and enrollment management objectives. Department plans include strategies for new program development and curricular enhancements designed to meet these objectives.

4.1 Excellence in Instruction: Biomedical Sciences/Health Sciences

- **B.S. Degree Program in Health Sciences:** The Molecular, Cell and Developmental Biology Department, in cooperation with Chemistry and Biochemistry and Environmental Toxicology, has proposed a unique, interdisciplinary program for education in the health sciences. This program will require the hiring of additional faculty with expertise in human biology, the expansion of undergraduate and graduate course offerings, and the development of a health sciences internship and community service program. As a first step toward this goal, the department has carefully constructed a plan for faculty recruitment that leverages the Biology positions associated with the Center for Biomolecular Science and Engineering. **A degree program proposal for a new undergraduate major in Health Sciences has been finalized and is currently in review at the division level.**

- **B.A./B.S. Degree Programs in Neuroscience and Behavior:** Newly established degree programs in Neuroscience and Behavior were approved for Fall 2001. Administered by the Biological Sciences Departments, the new major replaces the former Psychobiology BA degree program. Neuroscience is a growing field within the biological sciences. The new major modernizes the educational approach to the field and is designed to provide students a more rigorous preparation for graduate school or research careers.

- **Interdivisional Program in Health Sciences:** Faculty members in three divisions are considering elements of a broad-based health sciences program, including preparation for medicine, nursing, community-based health care, and health research. A cross-departmental committee in Natural Sciences is meeting to discuss science-based opportunities beyond pre-med. Parallel discussions are happening in the Humanities and the Social Sciences. After divisional discussions occur, a cross-divisional group will be brought together to discuss common themes, junctures to consider, etc., for an interdisciplinary approach to health sciences, and next steps will be determined.

At the undergraduate level, the Health Sciences Initiative seeks to recruit students specifically interested in careers in the biomedical sciences. This initiative represents a significant opportunity to seek out students who currently are likely to avoid UCSC since our campus does not have a medical school and does not currently offer programs specifically tailored for students with an interest in the health sciences. At the graduate level, increased funding will position us to greatly increase the size of our graduate programs. Growth of our programs is well justified given that all of our students so far have enjoyed success in securing appropriate scientific positions in academics, biotechnology or the pharmaceutical industry.

- **Biomedical Graduate Group:** To perform biomedical research at its highest level, we must have vigorous graduate programs. Our campus has key weaknesses that put us at a competitive disadvantage when recruiting prospective graduate students with an interest in biomedicine. First, there are fewer faculty carrying out biomedical research at UCSC than at other research universities, leaving our students with fewer choices than are available at competing universities. Second, although we have built a number of world-class programs in basic biomedical research, we have relatively few faculty whose work is directly related to human biology. It is clear that for many prospective graduate students, the opportunity to work in a vertebrate or human-focused lab is an important consideration in their choice of graduate programs. Third, we need to enhance our program in proteomics and leverage our strength in the human genome project to position ourselves to be leaders in these emerging fields and thus attract the best students to UCSC.

  Although not yet fully developed, faculty within Chemistry and Biochemistry, Molecular and Cellular Biology, and Environmental Toxicology are actively engaged in preliminary discussions to develop a proposal for a graduate group in the biomedical sciences. Department hiring plans support the development of this program. Establishment of this program will greatly enhance the visibility of our excellence in biomedical research and enhance our ability to attract top-notch graduate students.

- **Bioinformatics Graduate Program:** The Natural Sciences Division strongly supports the proposed M.S. and Ph.D. programs in Bioinformatics, essentially a combination of biology and computer science. The programs have been developed by a group of faculty that spans several departments and two divisions (Engineering and Natural Sciences), who are committed to providing a high-quality, interdisciplinary education in this burgeoning field. The Chemistry and Biochemistry and MCD Biology departments are providing required courses for the programs and have faculty representatives serving as initial members of the Program Faculty.

4.2 Excellence in Instruction: Environmental Sciences

Student interest in the environmental sciences has been strong and is likely to increase. The departments of Chemistry and Biochemistry, Earth Sciences and Ecology and Evolutionary Biology have recently established educational options for students interested in environmental science. New programs are currently under consideration by department faculty and the

enhancement of educational activities is further supported by the growth of research activity in this area.

- **Environmental Health:** The Ecology and Evolutionary Biology Department, in cooperation with Environmental Toxicology, Earth Sciences, and Chemistry and Biochemistry, is developing a new undergraduate concentration in Environmental Health. This program will provide advanced lecture and laboratory coursework to undergraduates who will go on to pursue career/graduate studies in environmental health-related fields, such as environmental toxicology, environmental chemistry, public health, and environmental resource use and management.

- **Undergraduate Degree Options in Ocean Sciences:** The Ocean Sciences Department is currently evaluating undergraduate degree options. They seek to design a high-quality, rigorous science major in ocean sciences—a program that would be distinct in the UC system.

- **Institute of Geophysics and Planetary Physics (IGPP):** The Institute members, as principal investigators, are involved in research activities and the dissertation research of graduate students. They contribute to graduate education by utilizing available resources and facilities in cooperation with other units in the UC system. In addition, two centers under the IGPP enrich the academic environment for students. The Center for Dynamics and Evolution of the Land-Sea Surface facilitates interdisciplinary research and also offers undergraduate and graduate thesis awards and sponsors a seminar series. The Center for the Study of Imaging and Dynamics of the Earth promotes and contributes to graduate education in many sub-disciplines (i.e., seismology, geodynamics, hydrogeology, etc.). The Center for Origin, Dynamics, and Evolution of Planets sponsors a seminar series as well.

- **Science, Technology, Engineering, Policy, and Society (STEPS):** The development of the STEPS Institute will support innovation in environmental research. This institute will enhance the training of undergraduate and graduate students in ways that will give them the conceptual and methodological tools needed to become highly informed regional and national leaders as environmental scientists and decision-makers.

4.3 Excellence in Instruction: Technology

Historically we have had strong educational programs in the physical sciences and now wish to expand these to attract students interested in the area of astronomy, where our reputation is superb, and in areas of more applied aspects of the physical sciences where student interest is keen.

- **Applied Physics Degree Program:** The Physics Department is actively developing a program leading to a degree in Applied Physics. This program will prepare students who intend to seek work in industry after completing their degree. The program will be developed in cooperation with the School of Engineering, as it is expected that students will be required to take courses offered by Engineering as well as courses in other Natural

Sciences' disciplines. A draft proposal has been completed, and is undergoing further review at the department level.

- **Astrophysics Degree Program:** In cooperation with the Astronomy and Astrophysics Department, the Physics Department recently received approval to begin admitting students to a Bachelor of Science degree program in Astrophysics. The program will provide students with experience in observational astronomy as well as experimental skills in the detection and processing of electromagnetic radiation from radio waves through gamma-ray radiation.

- **Complex Materials:** A joint initiative of the Chemistry and Biochemistry, Physics, and Electrical Engineering Departments, a program in Complex Materials aspires to distinguish UCSC as a leading institution in the development, characterization, and application of complex materials. UCSC is well situated to contribute to the understanding of novel materials and the development of materials for new technologies. The development of a program in complex materials will provide opportunities to expand graduate education in an area that should attract highly qualified students.

- **Graduate Group in Planetary Sciences:** The departments of Astronomy and Astrophysics and Earth Sciences are exploring the establishment of a graduate group supporting graduate degree programs in Planetary Sciences. As key strengths of the UCSC faculty in planetary sciences emphasize dynamical modeling, a major element of such graduate education will involve utilization of high-performance computing, remote sensing information, and astrophysical observations, all at the technological frontiers in Planetary Sciences.

- **Science, Medicine, and Technology Studies:** An inter-divisional initiative emanating from the Humanities Division, the program is conceived initially as an undergraduate major and a minor together with a significant doctoral program. We welcome the opportunity to collaborate on the development of these programs, should they remain a high priority for Humanities.

4.4 Summer Quarter

In response to a request from EVC Simpson this spring the science departments submitted preliminary plans for a fourth quarter curriculum. Most departments proposed an expansion of their core curriculum in order to best serve the needs of students by delivering core courses that will facilitate student progress and shorten time to degree. Several departments have identified opportunities to make productive use of a formal summer quarter:

The Astronomy and Astrophysics Department proposed to offer two sections of their extremely popular course, "Overview of the Universe".

The Biological Sciences Department would expand core offerings to include the required laboratory course 20L. They propose to offer at least one upper division course selection from each of the three main distribution areas—biochemistry, genetics, and evolution. "Female Physiology and Gynecology", a topical course that draws extremely healthy enrollments, is also

proposed. Biology faculty are particularly interested in developing increased opportunities for independent study experiences for undergraduates.

The Chemistry and Biochemistry Department already offers introductory courses in the summer and participates in numerous outreach programs. More summer offerings may be feasible with an opportunity for considered planning.

Earth Sciences proposes to offer 1-2 lower division courses in 2002 increasing to 2-3 lower division offerings in 2003. In 2002 this will probably be a summer offering of "Earthquakes, You and Society" and/or a summer offering of "Dinosaurs". In 2003, they plan to add a course which would provide an introduction to the major, most likely "Environmental Geology".

Environmental Toxicology has proposed offering a summer course in aquatic toxicology to capitalize on the Center for Ocean Health facilities and other resources at Long Marine Lab. This will be the first suite of planned summer courses that are designed to expose undergraduates from UCSC and other universities to the graduate program in Environmental Toxicology. It is modeled after the University of Washington's summer program at Friday Harbor, which has proven to be an outstanding mechanism for recruiting truly exceptional graduate students to that university. In addition, the department is investigating the possibility of moving the systemwide summer short course in Coastal Toxicology that is now being taught through UC Davis at Bodega Marine Laboratory to further enhance the reputation of the campus in this emerging field.

The Mathematics Department has been running a successful summer program for a number of years. They propose to increase a number of their service course offerings that would significantly enhance student progress as our enrollments increase. This summer the department has collaborated with the education department to develop a new course aimed at providing continuing education for local mathematics teachers. The summer also provides a good opportunity for incoming freshmen to complete preparatory math courses before beginning their first quarter. Key to this will be developing a more efficient method of administering placement exams so they can be delivered to admitted students prior to the end of the senior year in high school. The division has provided course relief funds to a current Mathematics lecturer so that he can investigate how the exam can be delivered more efficiently.

Ocean Sciences will be limited in their ability to participate in summer offerings given the limited size of their faculty. However, in future years they are interested in offering lower division courses that meet general education requirements and would draw significant student interest. Their introductory course, "The Oceans", or their topical course, "Life in the Sea", are proposed as potential offerings.

Physics currently offers many of their service courses through summer session but state that a 10-week format, taught by ladder faculty, is necessary. Physics is also prepared to teach their undergraduate lab courses in the summer and to consider developing a course for physics teachers in California who do not have a physics degree. These teachers would receive guidance and disciplinary enrichment to increase their teaching effectiveness. A new course is proposed aimed at preparing transfer students to transition into upper division coursework.

The Science Communication Program has proposed the offering of a series of eight classes in science illustration to be offered four per summer on alternate years, plus a ninth class that would be offered every year. The current illustration classes offered through summer session are extremely popular with local community members, as well as with current art majors who cannot get into the classes that are open to undergraduates during the academic year.

4.5 Academic Support Activities

The educational mission of the Division of Natural Sciences strives to integrate the national vision of scientific literacy embodied in the National Science Education Standards with California's efforts to insure the success of our increasingly diverse student population. The Division seeks students from all backgrounds and communities and welcomes the contributions that these future scientists will make to California's increasingly technological economy. Divisional academic support programs are designed to bring diversity into science fields by enhancing educational opportunities for students with historically low eligibility for college and low rates of enrollment.

The Division of Natural Sciences is committed to the many programs that support undergraduate excellence and student success. Our largest financial commitment is to the Academic Excellence Honors Program, a well-established and nationally recognized program. The division also funds the Health Sciences Advising program. The other programs are largely supported by federal dollars. However, I believe that it is important to note our commitment to the full range of programs, as they represent a significant investment when viewed in terms of faculty and staff time. The programs, their faculty sponsors, and the staff coordinators all share the common goal of contributing to student aspiration, motivation and learning within the sciences.

- **Academic Excellence Honors Program (ACE):** ACE is designed to increase the diversity of UCSC graduates in math and science. ACE offers workshop-style discussion sections and academic peer mentoring for mathematics and science courses. The program combines collaborative learning techniques with high expectations, enhanced content, and personalized guidance. The program serves approximately 300 students per year

  The ACE program was a recipient of the 1999 Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring. This award is administered by the National Science Foundation and presented by the White House to programs that have demonstrated sustained success in mentoring underrepresented students.

- **Minority Access to Research Careers / Minority Biomedical Research Support Program (MARC/MBRS):** These programs are designed to give targeted minority students an opportunity to gain experience in laboratory research and to interact more closely with the world of academic science. Students carry out their own research project, present their research at professional scientific conferences, publish their results in professional scientific journals, and work with professional scientists and faculty.

- **California Alliance for Minority Participation (CAMP):** CAMP is part of a statewide program, funded by NSF, which supports and encourages undergraduates from

underrepresented minorities to complete the B.S. degree in a science, engineering, or math discipline. CAMP programs include cooperative learning opportunities, internships, faculty mentored summer research experience, and travel opportunities to professional conferences.

- **Community Teaching Fellowships in Math and Science:** Mathematics, biology, earth sciences, and physics students observe and work in "partnership" school classrooms in the Monterey Bay and San Jose regions. Students participate for two quarters with several schools while also attending a weekly seminar at UC Santa Cruz.

- **The SURF Fellowship Program:** The Department of Chemistry and Biochemistry administers the SURF Fellowship program. As NSF Fellowship recipients, undergraduate students take part in a group research effort under close faculty supervision. Students first study a research problem, and then learn the necessary techniques or strategies to vigorously pursue the problem during the summer program. Students have an opportunity to interact with graduate students and postdoctoral fellows and to express their research ideas.

- **UC LEADS:** Administered through the Division of Graduate Studies, this state funded program is designed to identify educationally or economically disadvantaged undergraduates pursuing courses of study in science, math, or engineering who are likely to succeed in graduate school. Program activities include undergraduate mentorship experience, academic career planning and development of research skills, a summer research program experience at home institution plus a second summer at another UC campus, involvement in professional and scientific societies, and travel opportunities.

- **Health Science Career Advising:** Health Science Career Advising is a comprehensive support system for students who plan to apply to professional schools. The program provides drop-in advising, individual advising, workshops, and a career library.

4.6 K-14 Educational Outreach Activities

- **The California State Summer School in Mathematics and Science (COSMOS)**
(Professor Donald Smith, Department of Environmental Toxicology)
http://epc.ucsc.edu/cosmos/index.html

  Administered by the UCSC Educational Partnership Center, COSMOS is a new pre-college residential program that gives participating high school students access to the laboratories of UCSC scientists and engineers, enabling them to explore advanced topics not traditionally offered in high school curricula. The short courses, not traditionally taught in high school, include astronomy, earth sciences, mathematics, ocean sciences, and more.

  Talented high school students work with Natural Sciences faculty, graduate and undergraduate students, master high school teachers, and industry partners. Our faculty and researchers have created courses in exciting topics from astronomy to ocean sciences just for COSMOS. Students have interactive and hands-on experiences in university facilities, and learn from the experts in the fields.

- **Mathematics, Engineering, Science Achievement Schools Program (MESA)**
  (Dean David S. Kliger, Division of Natural Sciences)
  http://mesa.ucsc.edu/default.html

  The Division of Natural Sciences is the UC host for the regional MESA Schools Program. The division provides space and operational support to the program. MESA serves disadvantaged students with a primary focus on students from groups with low rates of college eligibility. The service area of the UCSC program is the tri-county area of Santa Cruz, Monterey, and San Benito counties. The majority of students served are Hispanic, economically and educationally disadvantaged, and with limited career expectations. Currently the program is in 11 high school and middle schools, working with teachers to provide an enrichment program that develops academic and personal skills, raises educational and career expectations, promotes success, and instills confidence in the MESA students.

- **Santa Cruz Institute for Particle Physics – K-12 Outreach**
  (Professor Hartmut Sadrozinski, Department of Physics)
  http://scipp.ucsc.edu

  The SCIPP K–12 Outreach Project is an initiative to strengthen the scientific background of K–12 teachers of science. The target audience includes science teachers in K-12 schools of the San Francisco Bay and Monterey Bay regions. The program also gets K-12 students electrified about learning physics using a 1,000,000-volt Tesla Coil that generates electric arcs up to 5 feet in length. Local area schools can schedule a Tesla Coil Demonstration and watch Zorro fight the coil with a sword, the Florescent Light Display, and the star of the show, the "Tin Man", as he is zapped by the coil from all directions.

  The SCIPP program has worked closely with 16 high school teachers on science and curriculum questions. This effort has reached about 2000 students. Workshops have been provided to approximately 50 more teachers. About 2,000 students have seen the Tesla demonstration and had opportunity to see, hear and interact with UCSC scientists and students. In 2001-01 the program will visit 1-2 schools per month, with 300-500 students attending per visit.

- **ACCESS: Baccalaureate Bridge to the Biomedical Sciences**
  (Professor Phil Crews, Department of Chemistry and Biochemistry)
  http://www.chemistry.ucsc.edu/ACCESS/

  This program is a partnership between UCSC and four community colleges: Cabrillo, Gavilan, Hartnell, and Monterey Peninsula College. The program is designed to increase transfer rates of underrepresented students and offers services to all community college students. The program includes study sessions for science courses, seminars and workshops, lab tours at UCSC, and a summer internship program at UCSC.

- **Monterey Bay Area Diagnostic Testing Project (MBA-MDTP)**
  (Professor Bruce Cooperstein, Mathematics Department)

  The Monterey Bay Area Mathematics Diagnostic Testing Project (MBA-MDTP) is one of ten regional sites in California (sponsored by the California Academic Partnership Program [CAPP]), which offer local middle school and secondary teachers free mathematics achievement, diagnostic testing and analysis services for their students. The UC Santa Cruz site of the MBA-MDTP serves North Monterey and Santa Cruz counties. The MDTP tests are designed to assist teachers in measuring student readiness for a broad range of mathematics courses. The diagnostic information provided enhances the teachers' ability to strengthen their curricula.

- **Monterey Bay Area Mathematics Project**
  (Professor Bruce Cooperstein and Professor Tony Tromba, Mathematics Department)

  The Monterey Bay Area Mathematics Project (MBAMP) is one of 17 sites of the California Mathematics Project (CMP), which provide professional development opportunities for teachers of mathematics in grades K-14. The project works with mathematics teachers to enhance their subject matter preparation and teaching strategies. MBAMP serves teachers in Monterey, San Benito, and Santa Cruz counties.

5.0 Silicon Valley Center

In the early stages of discussions for development of the Silicon Valley Center, our departments were asked to propose activities that would be extensions of our on-campus departments. Certainly there exists potential for the development of exciting new programs and research activities in proximity to the Silicon Valley. Natural Sciences faculty would be key players in taking advantage of potential opportunities. However, because there was much uncertainty regarding the proposed development of the center, potential ideas were proposed but were not fully developed. The following summary is what departments suggested at that time. The most recent plans now target the development of a stand-alone campus, a concept significantly different that what was originally envisioned. As the final plans for the Center are solidified, departmental contributions from the Natural Sciences Division will need to be reconsidered.

Astronomy and Astrophysics envisions a research related role leveraged by their interaction with NASA Ames and the SETI Institute.

Several faculty in Earth Sciences, in collaboration with colleagues in Ocean Sciences and Ecology and Evolutionary Biology, have developed two ideas for the Center: 1) a Geobiology program (the study of how organisms interact with the physical and chemical environment), with primary research areas in microbiology, environmental biogeochemistry, and environmental, and 2) a Center for Remote Sensing. These proposals represent the most thoughtful and fully developed ideas submitted for potential Natural Sciences participation in the Center. Both proposals leverage interdisciplinary collaborations between several departments at UCSC with potentially strong ties to the interests of other partners in the Silicon Valley Center. Both proposals also provide instructional opportunities for undergraduates and graduate students, as well as research foci.

Environmental Toxicology believes the development of the center provides opportunity for the department to be actively involved in three potential areas: environmental toxicology graduate curriculum and internships; pharmacology undergraduate and graduate curriculum and internships; and remote sensing and computer modeling of contaminants. The Center should also foster additional collaborations with other universities and state and federal agencies investigating various and complementary aspects of environmental toxicology and human health.

The Mathematics Department's initial plans for Silicon Valley Center propose to establish a small working group of researchers dedicated both to discrete mathematics (mathematical theory concerned with the processing and understanding of discrete mathematical systems and data sets, including the combinatorial and mathematical side of Information Sciences) and to improving the knowledge base through course offerings. However, should current discussions result in a merger with the Applied Math and Statistics Department, plans for the Center would be reconsidered in light of the new departmental strength in applied areas.

The Physics Department has considered locating part of the Applied Physics program at the Center, possibly an internship quarter for students if it could be combined with a teaching program. A masters and doctoral program in instrumentation might benefit from being located

in Silicon Valley, though this would represent a major undertaking by one or more senior faculty.

6.0 Divisional Priorities

While faculty positions are allocated to departments, interdisciplinary research and instructional activities provide the context for much of the interdepartmental coordination on faculty planning. This has had a positive influence on departmental planning activities. In several cases departmental plans have evolved to take advantage of the synergism between departments that previously played a lesser role in our strategic planning. This has not been a superficial engagement, as demonstrated by the fact that the very highest priority positions for new faculty recruitments correspond to high-priority positions identified as necessary to advance the organized research efforts. This is not a result of opportunistic compromise to jump on a bandwagon, but is the positive consequence of what are now several years of interaction, discussion, and integration of departmental plans. I am very proud of this effort that has resulted from serious and coordinated departmental planning over the past several years.

> ***". . . We must now focus more attention on the first part of our mission statement, to become 'an outstanding public research institution,' a goal that, among other things, will require considerable emphasis on fostering graduate program growth."***
>
> *M.R.C. Greenwood, October 2, 2001*

While our planning has assumed a maximum availability of resources, the priorities I discuss here have been considered in light of the current fiscal climate.

6.1 Size Distribution of Departments

As discussed above, growth in the Natural Sciences will emphasize three main thrusts: health sciences, environmental sciences, and sciences which create new technologies. Appropriate departmental sizes at full growth were planned with this in mind. These departmental sizes are shown in Appendix 1. The numbers shown for the ultimate size of each department are rough approximations, both because we do not know how large the Natural Sciences Division will grow until the campus planning process is complete and because we cannot predict future opportunities that might cause us to alter these plans. What is most likely to be realized from this table is the relative size of faculty in each of the three areas of emphasis rather than the specific size of each department. Thus, we have assumed that the department size numbers might be accurate to perhaps 10 percent, and we plan to hold back a certain percentage of the new FTE in order to provide flexibility for future opportunities.

Keeping in mind this relative uncertainty, Appendix 2 shows the projected size of each department and the areas of planned growth in each department as we reach our full growth.

The Department of Astronomy and Astrophysics would grow from 10.8 to about 14.6 FTE. This growth would be used to strengthen our program in theoretical astrophysics and expand into areas of non-optical astronomy, both critical if this department is to maintain its leading position in astronomy.

The Department of Ecology and Evolutionary Biology would grow from 15 to 26 FTE. This large growth is warranted since this is a critical department for strengthening our environmental

science emphasis. This growth will fill critical holes that will be important to establish the department's focus on Integrated Coastal Ecology programs as well as provide core strength to the STEPS Institute.

The Department of Molecular, Cell, and Developmental Biology would grow from 21 to 32 FTE. The large growth of this department is important if we are to create a credible program in the health sciences on this campus. The growth will strengthen the program in RNA biology and will also create strength in neurobiology, structural biology, and other human health-related fields to support the CBSE program.

The Department of Chemistry and Biochemistry would grow from 21 to 31 FTE. This is also a significant growth, warranted because this department is critical for a strong campus emphasis in biomedical sciences and also will be a critical department to support a complex materials program for the campus. Accordingly, the new FTE for the department would be used to support biomedical programs related to CBSE and the emerging program in complex materials.

The Department of Earth Sciences would grow from 19.5 to 26.5 FTE. This department has played a pivotal role in the IGPP initiative and is critical in our plans for growth of the environmental sciences on campus. New FTE would predominantly be used to complete the planned programs described in the IGPP initiative.

The Department of Environmental Toxicology would grow from 5 to 10 FTE. This department is a key element of both our biomedical sciences program and our environmental sciences program and its growth would follow the plans for both the CBSE and the IGPP initiative.

The Department of Mathematics would grow from 15 to 20 FTE. With this growth the department will emphasize mathematics that is more applied than is evident in the department's current areas of emphasis. In fact, discussions are taking place now that could result in merging of the current departments of Mathematics and Applied Mathematics. Should this occur, the combined department would likely grow to 27 or 28 faculty, with 10 to 12 faculty in the area of applied mathematics.

The Department of Ocean Sciences would grow from 9 to 13 FTE. This is another important department for our growth in environmental sciences. The areas of growth would be those that support the IGPP initiative, the department's needs, including instructional initiatives in Ocean Sciences, and the needs of the broader UCSC marine/ocean sciences constituency.

The Department of Physics would grow from 18.25 to 25.25 FTE. The growth would be split between expansion of the program in astrophysics, to complement programs in the Astronomy Department, and in condensed matter physics, which would support the program in complex materials, create an applied physics program, and add strength in biophysics to support our biomedical sciences program.

The Science Communication Program is a nationally recognized program of distinction in both science writing and science illustration. The director of the program is a lecturer with security of employment who both directs the administration of the program and contributes to the teaching. It is expected that the program will maintain status quo in the future and retain approximately the same level of TAS resources.

6.2 Faculty FTE Priorities

Our research and instructional objectives present a case for the campus to promote and sustain a well-rounded and healthy science division. It is my hope that the resulting campus plan will recognize the wisdom of institutional investment in the sciences and will pursue a decisive strategy of aggressive growth to maximally support this plan.

I realize that in the short term, the current budgetary climate may not allow us to fully implement our plans in the timeframe of five to ten years. In fact, we have designed our plans to be flexible in order to respond to unanticipated fluctuations in funding streams. On the other hand, it is readily apparent that our planning has optimistically assumed resource availability consistent with a strong and growing state economy. That not being the case, it is important to identify the areas that present the most immediate opportunities to insure judicious and prudent investment of available resources in order to maximize return. I discuss these areas below, presented in priority order:

1. Molecular, Cellular and Developmental Biology

A high priority must be growth in the biomedical sciences. The NIH is slated for large budget increases under the current administration. No campus will be successful in their science programs without strong representation in the biomedical sciences. That being said, it is also critically important that our biomedical faculty continue to develop new courses and programs that will increase student enrollments in order to support the campus mission.

Of immediate critical importance in this area is a senior hire in Molecular, Cellular and Developmental Biology. The Department has experienced significant attrition over the last few years with younger faculty being recruited to more lucrative opportunities and a number of senior faculty members taking leave to assume full-time administrative positions. This has left the department in a difficult position without the critical mass of faculty members needed to realize the dramatic increase in graduate student enrollments and extramural funding that should be possible. The department would greatly benefit from a senior member with expertise in modern health-oriented programs who would provide leadership in building strong programs in the department. Such an appointment would serve the teaching needs of the Health Sciences program through an emphasis on human health. Depending on the area of expertise recruited, new interdisciplinary links to CBSE, Chemistry and Biochemistry, and Environmental Toxicology could be forged in microscopy, complex data analysis, or chemical genetics. There is also need for a second hire in this area, at a somewhat senior level, to insure that the recent faculty attrition will not compromise the long-term health and success of the department. I believe this strategy is crucial if we are to retain the excellent and extremely productive junior members of the department who have expressed serious concern regarding the current state of the department.

2. Chemistry and Biochemistry/Environmental Toxicology

A second direction that makes sense for immediate growth is in the department of Chemistry and Biochemistry and the department of Environmental Toxicology. The ongoing collaborations with Chemistry and Biochemistry, MCD Biology, and Environmental Toxicology will benefit from the clustering of research groups through careful space planning in the new Physical Sciences building and Sinsheimer Labs. Further, opportunity exists to build a strong complex materials group in collaboration with Physics and Engineering. However, timing is critical as our ability to provide start-up will prove to be challenging with the current budgetary situation. The completion of the Physical Sciences building provides an opportunity to leverage the initial complement equipment funds with matching money from federal grants to augment start-up packages for new faculty positions. This provides a unique opportunity to maximize resources by the careful timing of cluster hires in Chemistry and Biochemistry and Environmental Toxicology in 2002-03 and 2003-04. In Chemistry and Biochemistry the need for a critical biomedical position in the area of proteomics research has been identified and links to the planned development of CBSE. It is likely that the proteomics position will replace a faculty member currently on leave who is expected to resign at the end of this year. Two additional positions in the areas of synthetic inorganic chemistry and experimental physical chemistry not only address instructional needs within the department but also would be essential positions if we were to develop a focus in complex materials. Environmental Toxicology has identified potential future hires in the areas of microbial toxicology/remediation, proteomics, genetic toxicology, or risk assessment/epidemiology.

3. Environmental Sciences

Several high priority positions have been identified across departments to support this area. These positions were clearly articulated in the IGPP proposal that was supported through the initiative process, and several new faculty members have been appointed. Because this proposal was successful and resource allocation targeted, this area has received more resources in the recent past than other areas within the division. However, through the initiative process a commitment was made to support the ongoing development of the program to fully implement it and assure its success. This support must continue.

For future years, there are currently four positions identified in the IGPP plan related to environmental sciences through the C.DELSI. A high priority for the next recruitment would be in the area of theoretical biology/ecology, a position also identified as a priority by the Department of Ecology and Evolutionary Biology. Although the hiring sequence and details of position descriptions will continue to evolve in response to recent hires, the other areas targeted for future hires include: Geobiology (Earth Sciences), Ocean Climate/Dynamics (Ocean Sciences), and Biogeochemical Processes/Systems Modeler (Earth Sciences, Ecology and Evolutionary Biology, or Ocean Sciences).

There are an additional 5 positions associated with growth of IGPP/CODEP. These include positions in the departments of Astronomy and Astrophysics and Earth Sciences. We are poised to develop a world-class program in planetary sciences with distinctive

strength in planetary dynamical origins and evolution. Planetary science research involves technological frontiers in computer modeling, remote sensing, and astrophysical measurements and provides a superior training for graduate students in emerging scientific technologies.

One additional position is proposed within the third IGPP Center—CSIDE. This is a position with expertise in remote sensing of active tectonics. The position is clearly important to the long-range plans of the Earth Sciences Department and is proposed as a potential direction for a future Center for Remote Sensing within IGPP. Expertise in remote sensing will link with expanding research activities in environmental sciences and engineering.

IGPP is, in fact, only one of the exciting environmental science initiatives that will propel us to excellence in this area. IMS has a strong history of creating partnerships with external agencies that bring new opportunities to UCSC. Support of IMS-related departments will be important to continue this success. Growth in areas related to STEPS will also be important and may need to be provided in the near future to insure development efforts for this campuswide institute.

4. Complex Materials

Development of a strong program in complex materials remains a divisional priority. Department plans identify faculty hires in condensed matter physics and chemistry that will contribute to a complex materials program. However, Dean Kang and I both acknowledge that the successful development of a complex materials program is critically dependent on support and leadership emerging from within the School of Engineering. Thus, the timing of new hires and nature of additional positions associated with this program cannot be further defined until plans within Engineering are further developed.

5. Astrophysics and Cosmology

The campus and the division have made a commitment to add four new positions in this area to support the retention of a critical senior faculty member. The recruitment authorized in 2000-01 did not end successfully. A second candidate has been identified from that search and the file is currently under consideration for appointment.

This is an important area for the division as it links current areas of excellence within the Department of Astronomy and Astrophysics, the Department of Physics, and the Santa Cruz Institute for Particle Physics. Investment in this area will provide fruitful interactions with our very successful program in particle physics and will complement our excellence in observational astronomy. It is clear that high-energy astrophysics will be an area of active research in this decade. It is an area that is well funded by the DOE, NSF, and NASA.

6. Mathematics / Applied Mathematics

Serious negotiations are underway aimed at merging of the Departments of Mathematics and Applied Mathematics. This is a very important merger, and if successful, will result in dramatic improvement in the stability and strength of both departments. Such reorganization will also bring the pure and applied programs in line with the standard organization of mathematics programs at other universities.

A healthy and productive mathematics department is critical to any science program. I am committed to supporting Chair Tromba as he continues to work with Chair Draper to forge a new plan for our math programs. However, for this to be successful, it will be important to expand the applied mathematics presence on campus. The next several positions in math, should this merger happen, will be in applied mathematics.

6.3 Diversity

The Division of Natural Sciences is committed to recruiting, developing, promoting and retaining the highest quality faculty. Our goal is to increase both ethnic and gender diversity among the faculty to better reflect the ethnic and gender diversity of our students. To this end, outreach efforts in our recruitments aim to cast the broadest possible net and reach the largest possible audience. In addition, search committees in all departments continue to make personal and directed outreach a high priority.

As of August 2001, campus data indicated that when the composition of the current Natural Sciences faculty is compared with external availability and the promotion pool, we are short 15 tenured and 6 untenured women, 1 tenured African American, 1 untenured Chicano/Latino, and 4 Asian tenured faculty.

In order to maximize the diversity of the applicant pools, the division has focused attention on strategic outreach. Specific strategies have been described in detail in our affirmative action and departmental reports. Further, care is taken in the appointment of search committee members so that ethnic and gender diversity is present on all committees. Search committees are also required to have a member from outside of the department, giving a broader perspective to the search committee and promoting interdisciplinary hires whenever possible. We strive to define positions in the broadest possible terms in order to increase the size and diversity of applicant pools. To underscore the importance of proper training for search committee members, I attend many of the training sessions conducted by AHR and the EEO/Affirmative Action Office. I will continue to carefully monitor the recruitment process as I have in the past. In this way I hope to continue our strong record of attracting the top people in the fields while at the same time continuing to further diversify the faculty.

Specific problems have been noted that certainly hamper our efforts to increase diversity among the professorate. The diversity of the pools is challenging and is not specific to Santa Cruz, but rather a noted challenge across the country. However, this challenge is compounded at UCSC by the limited availability of start-up resources for science faculty positions. There exists a very competitive recruiting environment for minority and women scientists. UCSC does not fare well

when we compete with top-ranked institutions—particularly because our salary and start-up packages are simply not competitive.

One way that we can (and do) actively contribute to reversing this situation is to work at increasing the number of qualified minority men and women scientists who aspire to teach and conduct research in the university. Section 4.5 discusses the many programs supported at the undergraduate level that seek to increase the number of underrepresented students who obtain their bachelors degree in science or engineering. Beyond that, departments within the division continue to increase the number of minority and women Ph.D. recipients. The percent of our minority and women Ph.D. recipients appears to be consistent with, or perhaps higher, than the average produced across the country.

7.0 General Overview of Funding Strategies and Measures of Success

The Division of Natural Sciences has systematically and methodically worked to consider the full range of resources necessary to support a sound and effective infrastructure. The division has made every effort to focus on realistic planning goals, not to limit the range of possibilities or opportunities, but to stress the importance of a careful and measured assessment of what will be needed in order to accomplish these goals. Significant resources are necessary to maintain the combined excellence that is the foundation of the division as well as to realize the vision of the future that the planning priorities promise. The goal of the division is to position itself to take full advantage of the proposed new process of allocating resources by demonstrating that investment in the sciences is in the best interest of the campus at large. Section 6.2 identifies the FTE priorities and argues for the wisdom of institutional investment in the sciences as a sound investment in the campus.

> ***"Once higher education could simply add new activities to the old, but the current wisdom is that it must do more with less. We in academia must figure out what is really critical to us and what we are willing to give up."***
> *Arthur Levine, President, Teacher's College, Columbia University, March 13, 2000*

The identification of the best strategy for the long-term financial health of the division has certainly been clouded by the uncertainty about the level of new or growth resources that will be available to the division to fund the range of activities and the multitude of promising areas of development. The division expects to receive resources beyond those quoted as the "maximum of the range". This is central to our planning and to our success as a division devoted to excellence in both teaching and research. This is critical to maintaining the efforts that signify "service to society".

7.1 Measures of Success Despite Financial Uncertainty

Our faculty have posed a number of substantive questions. These serious and thoughtful questions get to the core of what the division needs to consider as we develop a model for reducing costs and building revenue. The irony of the situation is that while on the verge of implementing the new allocation process that was designed to offer us a certain level of resource predictability, we are suddenly faced with huge uncertainty and doubt about the level of resources the campus will receive. In order to confront this uncertainty and to constructively prepare for what may be a difficult period over the next few years, the division needs to evaluate funding strategies and resource management guidelines with the following in mind:

- How do we attract and retain outstanding faculty who will further our strength in and commitment to interdisciplinary cooperation and research? How do we meet the high cost of faculty start-up needs?

- How do we preserve and maintain momentum in building strong and vibrant programs that will increase student demand?

- How do we continue to invest in the development of the numerous promising and prospering initiatives such as the Institute for Geophysics and Planetary Physics (IGPP) and the Center for Biomolecular Science and Engineering (CBSE)?

- How has the division invested in instruction and research among the various programs? How has the division been successful? Will historical methods serve us now and in the future?

Despite the seriousness of the questions and the inability to identify easy answers, our efforts must not be dampened. On the contrary, it is clear that our planning efforts must continue in earnest, for it is essential to keep our faculty engaged in this process. The timing of the implementation of our plans may be delayed, but if we have assurance of the level of resources that we can expect, even if the timing of resource allocations is uncertain, we can continue to strengthen our efforts to articulate our priorities and engage our faculty in the process

The most intelligent approach to resource management remains the establishment of divisional priorities and principles that will guide our spending. Divisional priorities will guide key recruitments and will enable us to capitalize on the potential for promising programmatic opportunities, as well as research opportunities that significantly increase our ability to secure substantial outside funding. Maintaining financial flexibility will be key, especially given the current economic downturn. The division must strive to provide opportunities to weather financially grim situations without losing the momentum for supporting ambitious and promising programs. We will need to be able to shift resources in creative ways to support increased student demand and emerging opportunities. Establishing and maintaining a rational set of metrics by which the division will assess the distribution of our funding will achieve this objective.

I am convinced of the wisdom of this strategy as evidenced by the fact that instrumental campus and divisional investments to date have resulted in enhanced research endeavors and enhanced reputation, and that this is helping to stimulate interest and corresponding enrollment growth within the Natural Sciences. While the sciences have not lacked exciting ideas and opportunities for growth over the last several years, we have been challenged by a decline in both enrollments and majors. Specific measures targeted at enhancing the curriculum and degree pathways for students have resulted in a positive turnaround in the enrollments. Though the campus had predicted a 3 percent increase in enrollments for the division, recent reports of totals for 2000-01 show a 5 percent increase for Natural Sciences. The division is now on a path to realizing an increase to student/faculty ratios. It is imperative that we aggressively pursue the areas with the most potential for a UCSC "return on investment". Thus it is critical that we continue to focus our efforts as a campus on utilizing a system that allows for resource predictability while emphasizing ongoing reevaluation of existing resources in order to fund core academic enterprises.

Analyzing and Defining the Resources of the Division

As indicated previously, the collective programmatic and research objectives of the division are immense and require a significant level of resources. In fact, it is important to point out that the resources required to implement and sustain all of the proposed programs exceed any reasonable

expectation of what state-funded resources can support. This lends credence to our earlier claim that our ability to prioritize and to initiate new programs requires the development of rational and effective implementation strategies, including specifying multiple, viable funding sources. This will remain a focal point of our ongoing planning efforts.

. . . Our ability to prioritize and to initiate new programs requires the development of rational and effective implementation strategies, including specifying multiple, viable funding sources.

It must be acknowledged that while some level of new resources will be available to the division in relation to growth, long-range planning must include a thorough examination of the division's base budget and how resources are currently utilized. The division has made a concentrated effort to review and to assess how it is currently investing in instruction and in research. It is important to consider how current resources can be reallocated to fund critical needs. It is equally important to verify whether or not the funding strategies that served the division well in the past will well serve the division in the future.

In order to explore the various opportunities available to help secure sufficient resources and effectively redeploy existing resources, I asked that a series of major projects be undertaken and considered priorities for division staff:

- The Steering Committee for Academic Planning and Resource Management
- The Divisional Ad Hoc Space Committee
- The Staffing Analysis Project

I will address each of these key projects below, as they are central elements of our planning process.

Charged as an advisory body, **the Steering Committee for Academic Planning and Resource Management** was formed primarily to concentrate on the guidelines and intricacies of the decentralization of resources to departments. Committee members were charged to devise a resource allocation model that stresses effective resource management by emphasizing prioritization of and accountability for expenditures. The intent of the model is to provide chairs with the authority to utilize funds to best meet student demand and enhance the work of the program. This has been accomplished and is now incorporated into the division's annual allocation process for distributing temporary academic staffing monies.

It is important to note here that as the conversations within the Steering Committee broadened and progressed, focus shifted to how the division would successfully respond to a major change in the campus process of allocating resources as planned. A keen awareness of the lack of suitable analyses emerged and the result was the identification of the need to thoroughly dissect and display the entire division's budget. The committee was convinced that it was crucial to understand where current resources have been invested in order to consider how to apportion funds for priorities in the future. These discussions—and the request for more detailed information—morphed into an extensive review of the comparative funding and expenditure patterns of the division, by unit, by category, and complete with factors that measured investments by faculty FTE, student workload FTE, extramural fund awards, etc. A presentation

was developed to challenge myths regarding budget allocations and the perceived disparity of funding among departments, to develop a clear and shared understanding of how the division has allocated resources, as well as to enlist the help of the faculty to help with building the division's coffers such as pursuing extramural funding sources.

I have given a complete presentation to our chairs and ORU directors and am in the process of attending a faculty meeting in each of our departments in order to directly share the information with the faculty. This process has been illuminating and thought provoking and has positioned us well to further inform our planning and decision-making process. The efforts to prepare these critical analyses have reinforced our planning principles and did indeed support the fact that while our allocations are different for different categories, according to individual departmental needs, overall budgets seem reasonable relative to department productivity and needs. We now have data and the metrics that will help us to insure that our future funding is committed appropriately. Our analysis is evidence that the division has made conscious and deliberate decisions about investments based on key metrics, such as student workload FTE, and on promising research initiatives, such as IGPP and CBSE. We also have outcomes that indicate our decisions have been sound, for there is a direct correlation between increased faculty FTE and student workload and extramural fund awards. Appendix 4 provides the materials developed for the presentation.

Serious and careful divisional space planning efforts, in cooperation with the campus space planning process, need to take place at this time if the division is going to realize long-term goals, as well as lead the campus in its mission to double extramural funding and increase graduate student enrollments. The sciences will need to optimize both new and released space in order to support its research and programmatic objectives. To galvanize divisional space planning efforts, **the Divisional Ad Hoc Space Committee** was formed to gather data and help formulate a divisional space plan. Each department was asked to respond to a detailed survey and to keep in mind careful consideration of the needs of their teaching programs and the anticipated growth space necessary to support these programs. This requires a clear understanding of departmental and ORU space requirements necessary for supporting existing programs, building new programs, attracting new students, and fostering research efforts. An effective plan for faculty clustering, in order to encourage such collaborative and interdisciplinary interactions, was one of the central aims of the committee.

The results of the work of the committee combined with subsequent meetings with the department chairs is a draft space plan that plots the needs of the division over the years through build-out in 2010-11. A detailed map of Science Hill 2011 has been developed and will help guide the physical placement of programs and personnel. Utilizing the comprehensive plans of our programs and selected growth calculations, the division was able to project space needs at critical intervals over the next few years and devise a plan.

Another shadow that clouds even the best of space planning efforts is the challenge of funding major capital projects. I am concerned that some of our proposed and planned projects are in jeopardy due to lack of funding, especially in light of the current fiscal situation. Campus units need to anticipate that less-than-desirable solutions may be all we have to look forward to in the interim. If this is the case, then it is imperative that we discover a way to work collaboratively to solve problems. A copy of the draft plan is included for review in Appendix 5 and will be discussed further under Section 7.5 of this document.

Another significant part of forming an infrastructure that will reinforce the teaching and research mission of the division is creating and sustaining an effective administrative structure. The Division of Natural Sciences is currently conducting a **comprehensive staffing analysis** with the goal of providing information and plans for an administrative structure that is aligned with space and budget resources and provides for maximum investment in the instruction and research enterprise. Data have been gathered, specific concerns of divisional and academic department managers have been identified, and work is progressing on several of the associated projects.

Funding Strategies

I realize that for the division to help itself in order to realize the exciting goals we have laid out, we have to, in some ways, change our thinking about finance and financial strategies. While the division does count on receiving substantial growth dollars in order to realize our goals, currently the division does have control over significant resources. To this end, the division has made a serious effort to entertain a number of other meaningful ways that total division resources can be leveraged to support top priorities and seek maximum return. Ingenuity, creativity, and clarity of goals will help the division establish and maintain successful strategies for both effective resource management, as well as for garnering new resources—from both internal (growth funding) and outside (extramural funding) sources. The following examples provide illustration of our efforts and thinking to date.

Use of Temporary Academic Staffing Funds

- It is clear that a series of strategies to insure long-term financial health for the division must include efforts to systematically and carefully reallocate temporary academic staffing monies to be able to respond to areas of growth within the sciences, such as with the service programs. The budget analyses recently developed for the presentation to the chairs have been and will be utilized as primary resources to help move us further along in this endeavor. We have begun a systematic review of funding levels that will provide background and context for the process of allocating resources for next year.

- One significant example of our efforts to work diligently with departments in order to reduce dependency on temporary academic staffing funds is our work with Mathematics. The chair, in consultation with the faculty, has developed a draft plan that significantly lowers the total temporary dollars necessary to fund the curriculum. This draft curriculum plan promises to offer, through a selection of specific changes, enhanced teaching at both the undergraduate and graduate levels. By eliminating certain courses, increasing class size in targeted courses, and utilizing temporary instructors, the potential for savings for the division is substantial. In turn, these funds cans be redirected to meet other pressing enrollment needs such as those in Physics, while reducing the subsidy the division has traditionally had to underwrite in order to cover all of the temporary staffing costs across the disciplines.

- The division plans to hold open selected vacant faculty FTE positions in order to accrue salary savings that will build one-time funding to augment faculty start-up packages and to augment temporary academic staffing needs for curricular investment and development, such as funding course relief for faculty developing significant new programs and majors, funding

undergraduate research opportunities provided as enhancements to the teaching experience, and stellar co-curricular efforts. Strategic use of these temporary dollars can mean the development of programs and opportunities that will attract top-quality faculty and graduate students. These funds will make possible the recruitment of senior faculty who require significant start-up investments, but who promise the benefits of departmental leadership and substantial extramural funding.

Ongoing Resources

- This fall the division made a major change in procedure and went forward with the process of attaching fees to certain courses in order to defray operating costs. The decision was not made lightly, but as we researched what it would take for us to implement this, we discovered that many other institutions, including others in the UC system, had already made the move to charging reasonable fees to help offset the rising cost of consumable materials essential for introductory laboratory courses such as those in Biology and Chemistry and Biochemistry.

- The division must identify ways to secure adequate graduate student support, in order to realize goals for substantially increasing the number of graduate students. We need to actively seek fellowships and extramural funding opportunities, as well as continue our efforts to increase our undergraduate population and thus warrant the allocation of additional TAships. There has been considerable discussion about ways in which the division can develop multiple-year offers of support that will help us compete with other major institutions for the best and the brightest graduate students.

- The division needs to work on a development plan that promotes the aggressive pursuit of funding opportunities for endowed chairs. This promises significant benefits that facilitate the hiring and retention of outstanding faculty. The income generated by the endowments generally assures a continuing income flow to fund the research of the faculty member appointed to fill such a position. We will endeavor to pursue endowments that will pay the salary of the professor as well as offer research funding.

- Open permanent faculty provisions created by separations and retirements will be viewed as an opportunity to fund faculty positions that meet the division's highest priorities. It will be determined, with our plan as a guide and in consultation with the chairs, how the faculty provision will be deployed. We will also consider whether or not to delay permanently committing the provision for one to two years if it is determined that generating temporary savings would be the wisest course of action.

- We have considered how to implement and provide resources for comprehensive, integrated staffing structures that provide a stable and sustainable model for academic and administrative computing support throughout the sciences. It is our aim to continue to develop and maintain an organized and functional method for providing excellent computer support now and in the future.

Faculty Start-up and Core Facilities

- Another example of creative and collaborative problem solving is the successful second hire in the 2000-01 Biology faculty search. Although a high priority for the department, and obviously the division, we simply could not meet the costs of hiring and providing significant start-up resources for a second hire for Biology. However, by sitting down and determining the extent to which the department was willing to invest its own resources and how resources could be shared by the two hires, the total costs were covered and the new faculty member will take up residence at the end of this quarter. It took a variety of fund sources and several commitments on the part of both the department and the division, but with ingenuity and determination a viable agreement was reached.

- Of critical importance to the division is how to create a rich infrastructure to serve both teaching and research needs. Investing in equipment and in developing core facilities is integral to building and sustaining such an infrastructure. One recent challenge was securing sufficient funds necessary to provide the matching dollars for a major NSF proposal for a confocal microscope facility. The acquisition of the state-of-the-art instrumentation will establish a new core research facility on campus that will be of great value and support to multiple research programs and interdisciplinary efforts at UC Santa Cruz. I arranged a meeting of interested faculty and suggested a joint effort to collect the total matching funds needed for this proposal. With creativity and a little work, we have made going forward with this endeavor a reality. We are awaiting word on the outcome of the proposal, but I remain hopeful that it will be funded, for as we have identified, seeking opportunities that support Biomedical research is one of our highest priorities. In fact, the total divisional commitment to the purchase of this equipment and to the establishment of the new facility is substantial. It reflects our dedication to supporting the continued efforts of our faculty involved in significant research endeavors and in research training at the undergraduate, graduate, and postdoctoral levels.

- The division has considered how it can effectively apportion dedicated funds—such as Instructional Equipment Replacement Funds—to set up and enhance teaching centers. If we can identify key instrumentation to purchase with these funds as we plan for faculty hires in dominant disciplines, we can masterfully provide a mechanism to offset some of the rising costs that hamper our ability to offer competitive start-up packages for faculty. Included here would be ways to carefully utilize any initial complement funding provided for new buildings to specially equip core and common research space that would provide for infrastructure needs that could reduce the amount necessary for individual start-up investments.

- The division has sought ways to provide matching funds in support of major faculty proposals, such as National Science Foundation Major Research Instrumentation. These awards are vital to building vibrant research centers and core facilities that will offer faculty access to state-of-the art equipment, and thus also offer another way to leverage individual faculty start-up packages.

- The use of opportunity funds to seed proposals that garner significant outside funding and programs that promise increased enrollments at the undergraduate and graduate level is important to the long-term financial health of the division. This is a topic that is critically important to our faculty. As new methodologies for allocating these funds are explored, it is

important for us to keep mind that the return of these dollars to the faculty in turn stimulates efforts to attract additional outside funding. For Natural Sciences, this should be viewed as a reinvestment of outside resources that can increase total resources for everyone.

Requisite Resources

Effectively managing base resources is one component of the division's strategic financial plan. Reallocation and realignment of existing resources will be necessary to respond to fluctuations in enrollment trends and provide adequate teaching support for our faculty and programs, but another critical component is the level of growth funding received to support long-term plans and the expansion of the sciences.

It is inspiring to think what the division would be in a position to build over the next nine years if we have the wherewithal to implement and sustain these exciting plans. Therefore it is essential that the division receive sufficient resources in order to realize our long-term goals, and thus serve the campus; garner increased levels of extramural funding and thus increase the level of opportunity funds available to the campus; sustain highly ranked programs that enhance the reputation and prestige of the university; develop ways to meet the critical benchmarks necessary to achieve AAU status; and create and fund stellar interdisciplinary umbrella research centers that attract new faculty and students to the campus.

The financial forecast is detailed in Appendix 3. It has been developed taking several factors into consideration. FTE growth by department, competitive start-up needs, specialized infrastructure needs, equipment funding, and funding for curricular needs have been projected through build-out. We have provided information per unit where feasible. Several components, such as funds for staffing needs, instructional equipment, and matching funds remain central to the division to be apportioned accordingly. For example, it would be unwise for us to predict per department the necessary staffing resources. It would be based on two assumptions that will not serve us well in the coming years: 1) it assumes that our baseline number across departments and units is adequate, and 2) it assumes that we intend to conduct business as we do currently.

Over a significant number of years the division's permanent and ongoing resources have not kept pace with the growing demands of the division, especially in the areas of matching and seed funds, faculty start-up funds, networking and related computer costs, etc. (It must be noted that these investments are crucial components of our build-out plan and therefore need to be viewed as integral to the division's plan and overall funding strategy.) At the same time, the division has had significant temporary resources from funds carried forward that have been used to close the funding gap between actual expenditures and the base budget. The division expects these resources to be depleted within the next few years by current estimates. The plan is to use the new enrollment growth dollars to bring the budget to a realistic base.

Though in excess of the total level of funding proposed for us (in excess of our maximum range), the simple argument for providing the requisite funding for Natural Sciences' to achieve our collective, expressed goals, is the fact that the **campus** can reach its defined goals **only** if Natural Sciences is able to expand to build upon existing strengths, to seed new programs, to establish flourishing research endeavors. This will require key investments in faculty, equipment, and infrastructure. I do not mean to imply that other units on campus cannot help the campus reach its goals, for they do. It means that the sciences offer the most secure return on investment, and

this is a crucial factor in this current unstable budget climate. Though nothing ought to be considered a sure bet in these uncertain times, given our proven track record, investment in the sciences is prudent.

Overall the division is expecting a 45 percent increase from the existing base by 2011. The total ongoing resources needed at build-out are projected at $36 million, with an additional $18 million in one-time funds. This translates to a total increase of $10.7 million in new ongoing resources for the division. The division intends to utilize these funds to meet our highest priorities. Highlights include:

New Ongoing Resources	One-Time Resources
• $4.7 million to appoint nearly 73 new faculty. • $300,000 to increase matching funds and seed funds in order to support increased extramural funding opportunities. • $2.3 million to hire approximately 37 new staff with increased FTE focused in the areas of technical and research lab staff. • $250,000 to provide sufficient temporary academic staffing (TAS) dollars. Though a reduction of overall dependence on temporary funding is part of our financial strategy for a realignment of current resources to respond to enrollment growth and other pressing needs, there will still be a need for sufficient TAS to support curricular needs due to faculty leaves, Senate service, and administrative service, as well to provide course relief to faculty to develop new courses, funds to appoint visiting scholars in residence at UCSC for 1-2 years to enhance instruction, and to further collaborative research efforts. • $150,000 to create a predictable reserve for special requests, new opportunities, and emergencies. • $169,000 to provide additional funding for renovations and capital projects. • $150,000 to provide funding earmarked for recruiting and retaining staff, such as funds for equity increases, reclassifications, and the establishment of a local awards program. • $985,000 to provide increased TAs to support increased student enrollments.	• $17.4 million to offer competitive start-up packages. • $625,000 to establish and equip state-of-the-art core facilities to support research endeavors, effectively augmenting or supplementing individual faculty start-up needs, and leveraging outside funding to enhance both teaching and research, as well as provide IT infrastructure needs.

The $10.7 million increase for the next few years is vital for supporting our plans. It is important that the division implement a focused strategy that front-loads resources to capitalize on the momentum built over the last five years. Concentrated faculty efforts have resulted in seeding successful initiatives and new instructional programs. To stall the development of these efforts, to allow these to stagnate at this time would be detrimental to divisional goals and to campus

goals. The new ongoing resources, as well as significant one-time costs totaling $18 million will mean that the division can attract and retain new stellar faculty, create vibrant core facilities, and reach our expressed goals.

If our mission is to serve society by sustaining excellence in the three areas of concentration that we have—health, environment, and technology—the division needs to pursue a number of critical objectives from now through 2006. One example is appointing senior faculty for leadership in key departments, especially important as the division anticipates multiple faculty retirements over the next several years. These appointments will require significant start-up packages, investments in building the biomedical group in MCD Biology, the development of core facilities for teaching and research, and obtaining significant funds in order to leverage additional outside funding opportunities.

The division has taken seriously the charge to think broadly, creatively, and aggressively about future directions and the successful implementation of comprehensive programming ideas. The division intends to retain enough flexibility to forward-fund new programs yet to be developed but anticipated and which are based on new developments in the academic discipline, entrepreneurial opportunities, and successful research projects.

7.2 Extramural Funding Opportunities

The programmatic and research directions outlined in this document, in particular the initiatives cited above, position the Division of Natural Sciences to take advantage of funding priorities that have been proposed at the national level.

Health: The National Institutes of Health (NIH) serves the American public through the support and conduct of medical research. Continued improvements in the practice of medicine and health are possible, if as a nation, we are prepared to take advantage of the achievements in fundamental science and informatics, including advanced computing and imaging,

The Fund Year 2002 President's budget request reflects the Bush Administration's commitment to continue the five-year plan to double the NIH budget by FY 2003, with 2002 representing the fourth installment on the plan.

NIH Budget at a Glance

FY 2000 Actual	$17,857m	
FY 2001 Estimate	$20,298m	+13.7%
FY 2002 President's Budget	$23,042m	+13.5%

Generous increases in the last two budget cycles have allowed the NIH to begin many new programs. This ramped up investment in medical research will pay real dividends in the years to come in the form of new scientific knowledge, new medicines, new treatments, new diagnostic tools, new cures, and new ways to prevent disease. Initiatives underway at the NIH that will be continued in year 2002 include the following, all of which will provide excellent opportunities for funding UCSC based science research:

- Genetic Medicine: Recent advances in the Human Genome Project have resulted in a working draft of the full human genome. Scientists can use this information to find the genes involved in heart diseases, cancer, epilepsy, Alzheimer's, and psychiatric disorders. Companion activities, like developing genomic resources for organisms such as mice, rats, and fruit flies, will help speed the arrival of more precise medical interventions.

- Neurosciences: This is a particularly exciting time for expansion of research in fields of neuroscience, such as neurogenetics and imaging. In order to foster collaboration among the Institutes that support intramural research in this area, a total of $73 million is requested over two years to establish a new National Neuroscience Research Center.

- Biomedical Computing—Infrastructure and Enabling Technologies: The continued success of medical research is dependent upon sustained support for the scientific infrastructure and access to the best technologies by all researchers.

  As biomedical research generates more and more data, there continues to be a need for scientists with expertise in biocomputing and bioinformatics. In order to meet this increasing demand, NIH will significantly expand its current program in bioinformatics and computational biology. New research initiatives will include Centers of Excellence in Biocomputing and Bioinformatics, institutional postdoctoral training grants in bioinformatics and computational biology, a joint NIH/NSF program to support research in mathematical biology, and the identification and development of model biological systems for use in quantitative modeling and analysis.

Environment: At the request of NSF, the National Research Council sought to identify a small number of grand challenges in the environmental sciences. Their report, "Grand Challenges in the Environmental Sciences 2000", identified the following challenges:

- biogeochemical cycles
- biological diversity and ecosystem funding
- climate variability
- hydrologic forecasting
- infectious diseases and the environment
- institutions and resource use
- land-use dynamics, and
- reinventing the use of materials.

The report recommended that NSF make immediate investments in the areas of biological diversity and ecosystem funding, hydrologic forecasting, infectious diseases and the environment, and land use dynamics. One of the keystone recommendations of the National Science Board, in its report entitled "Environmental Science and Engineering for the 21st Century—The Role of the National Science Foundation", was that environmental research, education, and scientific assessment should be one of NSF's highest priorities. The report recommended that support for these areas at NSF be increased by an additional $1 billion, phased in over five years, to reach an annual expenditure of $1.6 billion. Scientific understanding of the environment, together with an informed citizenry, is essential to improving

the quality of life in the future. The excellence and strength of environmental-related research at UCSC positions us to be very successful in competing for support at the national level.

Technology: More than half of the nation's economic productivity growth in the last 50 years is attributable to technological innovation and the science that supported it. The private sector makes the largest investments in technology development, however, the federal General Science, Space and Technology budget will be at an all-time high in inflation-adjusted terms if the President's FY 2002 budget is approved. Within the General Science, Space and Technology function, the federal government supports areas of cutting-edge science through NASA, the NSF, and the DOE.

The budget proposes $13.6 billion for NASA activities working to expand frontiers in air and space and improve the quality of life on Earth. NASA pursues this research through five major programs: Space Science, Earth Science, Biological and Physical Research, Aero-Space Technology, and Human Exploration and Development of Space.

Under the President's budget, the NSF budget will grow by 15 percent to $4.5 billion. This significant increase is consistent with the President's support for increasing the federal investment in basic research and development and for funding NSF as the primary agency for supporting peer-reviewed, competitively awarded, long-term, high-risk research conducted through the university systems. The NSF supports nearly half of the non-medical basic research conducted at academic institutions and provides 30 percent of federal support for mathematics and science education.

The budget proposes $3.2 billion in 2002 for the DOE. The DOE's Office of Science is one of the nation's leading sources of support for basic research in the physical sciences, conducting research at universities and national laboratories. $1.0 million is proposed for Basic Energy Sciences that support basic research in materials science, chemistry, engineering, geoscience, plant biology, and microbiology. $443 million is targeted for Biological and Environmental Research which supports research to identify, understand, and anticipate the long-term health and environmental consequences of energy production, development and use—including understanding the global carbon cycle. $1.1 billion is targeted for High Energy and Nuclear Physics which supports research that seeks to understand the nature of matter and energy in terms of the most elementary particles and forces.

7.3 Graduate Growth

Excellent faculty, programs of distinction, and unique research facilities are the division's hallmarks of quality. As we are able to implement our plans to appoint new faculty we expect to be successful in expanding our graduate education programs. Our academic plans incorporate a substantial increase in numbers of graduate students over the next few years to build out at 2011. For purposes of this planning document, we have estimated graduate enrollments of 575 at target growth. This represents a 52 percent increase over our fall 2001 enrollment of 376 students. The incremental growth has been calculated using milestones such as the addition of new faculty and the development of rigorous programs of study.

Our success in increasing our graduate population is not only tied to our ability to garner extramural support—other factors present challenges that must be considered. Providing sufficient space to accommodate the projected increase in student numbers will certainly be a challenge. Further, we have acknowledged that the availability of sufficient graduate student support is a serious issue we must address. The Division of Natural Sciences has a proven record of success in obtaining outside funding that provides support for graduate students and graduate instruction. We fully expect that our record of success will continue, particularly as we a establish critical mass of faculty in targeted areas that will increase our ability to compete for large training grants. However, increased fellowship support is also needed. We currently lose many prospective students because at this point it remains difficult to fashion multi-year financial offers that are competitive with other top-ranked programs. This, combined with the expense of housing in Santa Cruz, has had a negative impact on our ability to successfully reach established enrollment targets.

We are committed to building programs of excellence that will help the campus reach its graduate enrollment goals. However, it is important that we carefully balance our ambitious enrollment targets with our desire to attract the very best students and sustain programs of excellence. The Superfellowship Program has certainly been a welcome recruitment tool and has helped to successfully recruit some of our best applicants. This strongly suggests that these types of competitive fellowship offers are exactly the types of strategies that must be employed if we are to increase our success in recruiting excellent students to our programs.

Our faculty are greatly encouraged by Chancellor Greenwood's recent remarks that placed priority on achieving stature as an outstanding public research institution, a goal that will require considerable expansion of our graduate programs. Such growth necessitates careful planning in order to meet the needs of an increasingly technological society that will demand a more highly educated workforce. The Natural Sciences departments have given serious consideration to this as reflected in our programmatic goals and objectives.

7.4 Staffing

The Division of Natural Sciences has invested a significant amount of faculty and staff time in long-range planning to look to the future and envision how our staff work force can benefit from and contribute to new opportunities that will be made available through anticipated campus growth. Staff members have been intimately involved in planning for academic program growth and are working to envision and create the appropriate administrative and technical infrastructure to support our programs. As a division we strive to:

1. maintain good quality of service
2. increase employee/faculty/student satisfaction
3. improve staff retention rate
4. improve productivity where possible
5. insure that processes and procedures are efficient and meet audit requirements
6. effectively manage expectations (student and faculty expectations of staff; staff expectations of one another; establish realistic timeframes to complete work, etc.).

7. always keep in mind the cost of collecting and analyzing data vs. the value of having the information.

Through the summer and fall of 2000, we began a study of how to provide an efficient and cost-effective administrative infrastructure, for now and for the future, in the face of substantial growth in student and faculty numbers. A retreat with division and department managers, as well as individual interviews with department managers, yielded a range of issues and concerns related to staffing. The number one concern raised by nearly all managers was how future staff augmentations will be allocated. Managers want to understand the criteria by which allocations will be made and when. Given that the timing of augmentations has been hard to predict, and is now even more uncertain as we face potential budget reductions, managers have been uncertain of how to develop realistic long-term staff plans. What is certain is that we will have to rely on the advice and talents of our managers if we are to develop a staffing infrastructure that will meet the needs of the future.

The next step, now that issues had been identified, was to provide managers with the information necessary to establish a common understanding of the divisional staffing budget and current allocations. The Dean's office staff developed a presentation for divisional managers and supervisors that detailed the division's staffing budget. With that knowledge as the basis for discussion, a follow-up session was conducted where managers and supervisors critiqued the effectiveness of the division's staffing and compensation practices. Discussion focused on how funds can best be utilized to support recruitment and retention of staff and how current and future funds should be allocated to meet the division's highest priorities. Consensus was reached on a number of key points, methods were proposed for addressing those concerns, and immediate and longer-term action steps were identified as summarized below:

- A quantitative analysis of our staffing structure yields very little information with which we can accurately plan the future. A thorough analysis of faculty/staff ratios, enrollments/staff ratios, operating budgets/staff + faculty ratios, although interesting, convinced us that a formulaic approach to staffing levels would not be possible for a number of reasons. Most importantly, a formulaic allocation methodology assumes that our current baseline is an accurate reflection of what will be needed in the future. It does not account for the change in work processes that will occur with new systems, it does not adjust for further decentralization of work to service centers and departments, nor does it acknowledge our increased need for highly trained, technical staff. Neither does it account for increased salary costs, as it is clear that salary requirements will be increasingly market-driven and difficult to predict. Criteria to determine staffing allocations must be qualitative as well as quantitative.

- Effective use of existing and new resources must be achieved. While a strong emphasis has been placed on how future resources will be allocated, we agreed that careful consideration of how existing resources are used must be a priority. Scrutiny of vacant staff positions has increased. There is no longer an assumption that as a position becomes vacant it will be filled in the same configuration as it was left—or that it will be filled at all. It is abundantly clear that staff workload is increasing as the campus grows, but we have not assumed that the existing staffing structure in each unit is necessarily the optimal structure to meet our current and future needs. Therefore department chairs, directors, and staff managers are asked to examine overall and future staffing needs as part of their justification when filling open positions.

  The dean's office staffing was restructured in 1999-00. As part of that reorganization, the division hired two senior-level analyst positions in summer 2000 to conduct analyses and projects on behalf of the divisional administration and academic departments. These two positions have made valuable contributions in the areas of financial analysis and planning, space planning, development of new majors, and support for a variety of change management endeavors. This has enabled the division to move forward on both long-standing and new efforts to insure the best use of our financial resources, space, and staffing.

  Divisional and department managers will be meeting this year to consider the feasibility of creating one or two similar positions to provide direct project support to units and to relieve individual managers of higher-level functional responsibilities on a short-term basis. We are also considering how one or two clerical positions across departments and divisional units may be able to provide specialized, economical, and space-conscious support.

- Natural Sciences staff members have long prided themselves on providing personalized service to students and faculty. There are countless examples of staff who extend themselves well beyond the definition of "good service" to assist students and faculty who find themselves in an administrative bind. In considering the inevitability of adjusting support to faculty and students and managing their expectations of staff, quality of service has been central to the discussions. We must assume that there will be less individual attention than there is now, owing to larger increases in students and faculty than in staff, but we may be able to retain an acceptable level of service by creating different methods of service delivery.

  In order to identify and implement changes to service delivery, our department managers began facilitated discussions to share internal best practices around key topics and areas of work. The goals have been to learn from each other and to identify areas that can be improved to benefit all. They have attempted to keep the focus on issues that are important, relatively easy to resolve, and generally within their control (i.e. AHR practices are currently under review). As campus practices are identified that seem to impede the departments' efficiency, those are being noted to raise at the appropriate levels.

  Discussions about what work we will do and what services we will provide now and in the future has included attention to what work is better centralized at the division level or decentralized to the department level. We have made no assumptions here, but will consider efficiency, quality of service and cost-effectiveness in our deliberations.

- All academic departments and two divisional offices have requested staffing augmentations, most to support immediate needs and some to support anticipated needs. At present, however, although we continue to fill vacated positions when necessary, we have made very few permanent augmentations and instead have offered temporary funding. Priorities for future staffing positions have not been established, but it's clear from departmental surveys that additional technical staff, teaching laboratory staff, and computer support staff will be critical to support anticipated student and faculty growth.

Divisional managers also identified a number of key challenges that must be considered as we consider staffing implementation plans:

- Compensation levels continue to be an issue as many of our staff salaries continue to lag the market. Competition with the external market has been significant in the past, but more recently, competition among units on campus has become a serious concern and may work against us in the future. Frequent staff turnover is costly—both in terms of real dollars and quality of service. We must examine compensation practices campuswide to insure that our internal policies and procedures are optimal for sustaining a well-trained and stable work force across the campus.

- While the division maintains no formal means of succession planning, we know that at present 42 percent of our administrative managers are at least 50 years old, and 83 are 45 and above. The average age of our divisional and department managers is 48. Clearly we will see significant turnover in key positions within the next 10 years. The high cost of living in Santa Cruz County as well as individual life plans will affect actual retirement age. A few of our central units are developing "career tracks" within the unit to insure continued development and advancement of key staff members. Similar planning across the division is necessary and will be key to our success in the future.

- It has been a conscious choice not to make specific projections of which positions will be added to which departments or units and when. While the projections of student growth have not changed and the University did establish an agreement with the State of California to create predictable funding, we have seen the spirit of that agreement collapse this past spring under the weight of other pressing priorities for State resources. As long as the funding stream remains uncertain, the best we can do is consult widely to understand staffing priorities from a variety of viewpoints, insure we are using our existing resources as wisely as possible, and be poised to act quickly when new funds do become available.

- The challenge of space is facing all segments of the campus community. What we know in Natural Sciences is that our ability to augment staffing is already constrained by lack of space, a situation that will only escalate with time. We are mindful that providing adequate space for our academic and research endeavors will be our highest priority, and this must include space for the staff members who support those endeavors.

- The work environment is continually changing and changing at a more rapid pace now than 10 years ago. Improvements in technology should improve the overall quality of the work, though past improvements have not necessarily increased our rate of completing transactions. We must accurately understand how new systems will impact work processes and ultimately

work load. For example, the new Academic Information System will provide students, faculty, and staff with more timely information and access to self-service, though it is unclear whether staff time will be saved in the short- or long-term. For example, while staff may spend less time with individual students, more of their time will be spent conceptualizing and developing content for electronic sources. This will require that we not only anticipate the change in how service will be delivered, but also consider the qualifications and classifications of staff positions necessary to support the new functions and adjust our staffing plans as necessary.

- Several campuswide processes and practices have posed significant challenges for the Natural Sciences Division, as well as for other campus units. One example is the training provided for the Financial Information System and the Payroll/Personnel System. Training as it is provided today is sorely inadequate in terms of timing and frequency of delivery. To more effectively meet the needs of the units being served, the training needs to move out of the classroom and onto an employee's desktop so it can be offered conveniently and whenever needed. This is especially important due to the high turnover rate on campus and especially problematic in service centers. There are many other examples that could be discussed here. We would greatly benefit from campus-wide discussion and examination of such issues.

- Decentralization of processes from central offices to divisions/departments continues to happen and continues to be a challenge to the service centers and departments that must absorb the work. Our managers continue to advocate that the decision to decentralize work must be coordinated by an administrative body charged with oversight of business practices, rather than through executive fiat. ***Service centers and academic departments cannot continue absorb the work that a central office decides it no longer has time or staffing to do, particularly when the function is critical to the instruction and research mission.*** Yes, campus leaders need to consider the best administrative level for work to be done in order to achieve the greatest efficiency and service, but the resource implications and work management issues are too often ignored or foisted off on the unit "receiving" the work. Resource realignments need to be considered in tandem with decentralizing processes.

Finding the appropriate balance of resource allocation between the growth of the academic and research programs and the staff required to support them will continue to be a challenge in the future, not only for the division but for the campus. We must not underestimate the contributions of staff members to the success of the institution. There are many issues in this area that could benefit from examination at the campus level in order to mitigate some of the more serious challenges we all face. This is an issue that must remain on the forefront of deliberations among the campus administrative committees, and becomes even more critical as we make decisions regarding how budget reductions will be assessed next year.

7.5 Space Planning

The division undertook a comprehensive space planning effort in the spring of 2000. Realizing that space planning, which encompasses the planning of major capital projects as well space utilization and management, is crucial in developing effective long-term academic plans, I

charged an ad hoc faculty committee with gathering data on departmental and ORU growth plans and associated space needs and formulating projections and recommendations to be vetted with the chairs and incorporated into our long-range planning process. The collected information in turn provided valuable analyses that were used to provide insight into the current space situation, highlight critical needs across departments such as graduate students space, as well as anticipated needs to meet the ambitious expansion plans of the division. This process served us well and has helped to focus on where resources are necessary in order to support existing programs, build new programs, enhance undergraduate and graduate teaching efforts, and propose effective plans for clustering faculty in order to foster interdisciplinary research efforts specifically and research endeavors in general.

The result of these concentrated efforts was the "Draft Space Plan" that was submitted in advance to Capital Planning and Space Management in order to present an argument for planned major building projects. This has become a true working document and is already undergoing revision in order to strengthen our argument for a new building project. Although some numbers have been and will be altered to reflect changes that have occurred very recently and that impact the overall physical layout of Science Hill in 2011, I include the draft plan as released last March as an appendix in order to detail the principles that guided our thinking and the resulting projections for divisional space needs at build-out. Though evolving, it does serve to detail the factors, considerations, and conditions that the division needs to address as we plan for a suitable infrastructure for our units.

Please note that not all of the appendices referenced in the draft space plan are included with this document, nevertheless, the material included should offer a clear and concise picture of the overall projected space needs for our programs. A summary of the needs of the division follows; please refer to Appendix 5, which contains details by department and research unit, as well divisional administrative units.

Excerpt from the Draft Space Plan

Natural Sciences is near critical capacity in terms of space. The severity of the problems facing the departments varies, however, and a great deal of the physical challenges fall into the category of the inefficient use of space that ill fits departmental needs. Department chairs have been extremely resourceful in working together to solve some of the more immediate space problems, but this has not been easily accomplished. A combination of problem-solving strategies will have to be utilized in order to meet the challenges we face in identifying space for expanding programs and housing new faculty. These strategies are being considered as part of our long range planning process. The goal is to fashion a final configuration that offers a chance to alleviate historical problems, as well as to address all reasonable space needs.

The division currently occupies over 319,000 asf within eight buildings (along with auxiliary space such as trailers) housing Astronomy and Astrophysics, Biological Sciences (EEB and MCD), Chemistry and Biochemistry, Earth Sciences, Mathematics, Ocean Sciences, Physics, Science Communication, as well the division's organized research units, administrative offices, and other research and instructional space. There are three major building projects in various planning and construction phases: Interdisciplinary Sciences Building (ISB), Center for Adaptive

Optics (CfAO), and the Physical Sciences Building (PSB). Though new buildings offer increased asf, the net gain for the division overall is reduced due to a loss of released space.

The conclusions drawn from growth calculations helped to formulate a space configuration that has been presented in the draft plan. The long-term space needs of the division necessary to accommodate faculty growth, the accelerating needs for teaching space, and serve to strategically cluster faculty to promote interdisciplinary collaborations.is projected to total nearly 500,000 asf.

7.6 Accountability Measures

I intend for this comprehensive planning document to accomplish two very important goals for the division. I intend to see that this plan serve as a thoughtful and feasible guide that offers programmatic direction for the division through build-out at 2011 and to present a cogent argument that the wisest investment for the campus is a significant investment in the Division of Natural Sciences.

What is it that allows me to say with complete confidence that the plan for the sciences is distinct and thus sets it apart from the other divisions? I expect that each of the divisions on campus will make the argument for the maximum range of resources available, what is it that allows me to say with complete confidence that the plan for the sciences is distinct and thus sets it apart from the other divisions? How do I make our argument for significant resources a successful one? How will the division measure progress and success in attaining our collective, ambitious goals?

"If we are to remain preeminent in transforming knowledge into economic value, America's system of higher education must remain the world's leader in generating scientific and technological breakthroughs and in meeting the challenge to educate workers."

Federal Reserve Board Chairman Alan Greenspan, February 16, 1999

I rely on our designated outcome measures, our accountability measures, to provide the convincing evidence that our academic planning efforts align with the campus's vision and goals. Combined with our overall objectives in instruction and research, these will successfully defend our argument for full funding as requested. Consistent with the campus goals and measures of institutional success, the division's accountability measures will be aimed at increasing enrollments, extramural funding, student/faculty ratios, and degrees awarded. Throughout our plan I draw attention to the fact that our goals align with the expressed overarching goals of the campus. These outcome measures are categorized as Strategic Enrollment Management, Extramural Funding, AAU Membership, and the Millennium Committee Calls to Action.

These outcome measures are categorized as: Strategic Enrollment Management, Extramural Funding, AAU membership, and Millennium Committee Calls To Action.

- Strategic Enrollment Management: Although the division experienced a decline in enrollments beginning in 1995-96, the downward trend is apparently reversing. The campus

had predicted an additional 3 percent growth for the Natural Sciences in 2000-01. In fact, the division realized a 5 percent overall increase in total enrollments. This is encouraging news and can be correlated with the specific measures taken by departments to attract new enrollments, such as offering new courses, sponsoring multiple offerings of historically popular courses, and promoting exciting interdisciplinary undergraduate pathways as options for students. The division plans to continue to develop and implement strategies to increase enrollments, as this is a key outcome measure for the division.

Over the past few years the campus has focused on admissions and marketing strategies that have brought substantial enrollment growth—new students and resulting growth resources. As we move into a different period on our campus, it is time to consider the implementation of strategic enrollment management. A document recently distributed at the Advisory Committee on Academic Support discusses enrollment management as a complex and comprehensive campuswide process that analyzes and influences enrollment and focuses on support of the long-range plans of the campus. I was intrigued by the phrase "a student body by design rather than by chance", as it embodies our aim in the sciences of attracting and retaining new students and of sustaining enrollment growth overall. This is a very important issue for our faculty, and the division must consider ways in which we can shape the enrollments in the sciences. For example, expected growth as a result of the new Health Sciences major will increase the student/faculty ratio in the Biological Sciences and reverse the steady decline in enrollments and majors the Biological Sciences have experienced the last few years. Attracting new students to campus and to the sciences with the advent of this new pathway will provide much-needed stimulation for the departments and insure that resources remain in tact.

The long-range student/faculty ratio for the division is targeted at 18:1, given the fact that we will experience a corresponding increase in enrollments as a result of appointing new faculty. In the short-term, we expect that the ratios may drop. The division plans to convene a faculty committee to work closely with Office of Admissions Outreach in order to develop a targeted action plan that will promote the sciences to prospective students. Overall, we must continue our comprehensive planning efforts and devote time to determining how we can support department efforts to increase enrollments. By identifying variables that positively affect enrollment trends, we can target resources as an investment in realizing and sustaining healthy student/faculty ratios.

- AAU Benchmarks: In a recent white paper that profiled the characteristics of Association of American Universities (AAU) member institutions, essential criteria are outlined. These include the caliber of faculty and the number of postdoctoral appointments in science, engineering, and health fields, as well as the total research dollars awarded. Focus on these measures will serve the campus goal of achieving AAU status. With increased numbers of faculty in the sciences, come increased numbers of postdoctoral appointments. The campus benefits from these outstanding academic appointments as they contribute to the success of the research enterprise and to the potential for significantly increasing outside funding awarded to UCSC.

- Extramural Funding: Through implementation of the proposed academic plan, the division is poised to make a major impact in obtaining substantial extramural funding. In 1999-2000,

the division received $27.5 million in extramural funding. In 2000-01, the division received $35.6 million in extramural funding, representing an increase of 29.5 percent. This increase demonstrates our argument that investments made in the sciences via the campus Initiative Process are already paying healthy dividends. Much more should be possible with maximum growth, enabling us to create research clusters that will be effective in competing for large project funding. With increased numbers of faculty, it is conceivable that the Division of Natural Sciences could exceed $75 million dollars annually in extramural receipts. Increased totals in opportunity funds accompany increased levels of extramural funding and go to fund a variety of endeavors across the campus.

- Millennium Committee Calls to Action—Alignment of Academic Planning with Campus Vision and Goals: The Millennium Committee process identified a number of invitations to action through which the campus's vision of its future would be realized. These recommendations can stand as accountability measures that help define the desired outcomes to be utilized for campus allocation processes. Early on in the division's planning process I emphasized selected imperatives culled from the Millennium Committee report and included them in materials provided for the department chairs to help frame our strategic planning process and to provide campus context for our planning efforts. As our planning process has developed over time, we have come to view these as articulated accountability measures. Charting progress and measuring success utilizing these imperatives gives credence to our claim that investment in the sciences serves the campus's objectives, goals, and mission.

  I have selected imperatives relevant to the academic planning process and to our definition of accountability measures as we intend to apply them. As you review them, you will note that these correlate to our planning principles and to the framework in which we have developed our funding strategy.

  Undergraduate Education

  Raise retention and graduation rates. We must retain the best students and ensure that students graduate in a timely fashion. The division has committed to implementing strategic enrollment plans, creating new programs, and seeking viable ways to enrich the curriculum that are expected to improve the retention rates of our undergraduates.

  Graduate Education

  Support graduate growth: funding and research opportunities. Assure that graduate enrollment growth is accompanied by appropriate resources to provide financial support and research opportunities for additional graduate students. The division is committed to helping the campus reach is goal of doubling graduate enrollments by attracting stellar grads with new programs and vital research units. We predict a substantial increase in enrollments, but this is viable as we add new faculty.

  Facilitate multi-year offers to improve yield without requiring more money up front, but rather by judicious forecasting on the basis of current student/fund ratios. Increase graduate fellowship dollars to make it possible to offer fellowships to more students, thus improving our yield on offers to top students and providing better support for all

students. Sufficient graduate student support is critical if the campus is to realize increased enrollments. The division plans to pursue ways in which block funding and other sources can be used develop competitive multi-year offers and fellowships. The Division of Natural Sciences' ability to garner extramural support provides promise that sufficient support for the best and the brightest graduate students will be available.

Production of Knowledge (Research)

Set aside venture funding for research development and develop matching funds available for research. The division has used a significant percentage of our discretionary funds for this purpose and has been effective in seeding successful endeavors such as IGPP, PISCO, and the Core Molecular Facility. This is a critical funding need for the division and has been factored into the requisite resources through build-out.

Application of Knowledge

Improve coordination and increase the number of student internships. The division supports a number of programs that provide internship opportunities for undergraduates. These programs are described in detail in Section 4.5 of this document. Internship opportunities have also been developed within departmental programs. Two notable examples include the internship program established by the Department of Earth Sciences and the internship requirement that will be part of the new Health Sciences major proposed in Biological Sciences. VP/Dean of Undergraduate Education Goff has proposed that internships and undergraduate research opportunities might benefit from central coordination at the campus level. We remain committed to working cooperatively with Vice Provost Goff in this endeavor.

Continue outreach efforts to areas under-represented at UCSC. Division faculty and staff remain active and committed to the many programs and activities that serve underrepresented student populations and K-14 education. A full description of our commitment to this area is included in Section 4.6.

The Working Environment

Enhance communication across units and seek input from staff at all levels, particularly "first-line" staff. Staff workload will increase with growth, and this change must be planned and provided for in a careful manner. The division works hard and will continue to implement efforts to improve the working environment for our staff members. We continue to implement a variety of strategies aimed at improving communication and involving staff more directly in the management of the division. More detailed discussion is found in Section 7.4.

Encourage appropriate decentralization, and provide appropriate resources to support it. Decentralization should make us more nimble and responsive so that we should always seek the most effective level for decision-making, even if at times it increases costs to do this. This continues to be a campus challenge. The division is willing and ready to work

with campus units to effect constructive processes that mitigate workload impact and support this goal.

Continue to streamline business practices. Review and eliminate nonessential internal administrative reporting requirements and unnecessary meetings, and simplify approval processes. The division has established a "best practices" program that promises to identify and implement new procedures to streamline business practices across divisional units. The New Business Architecture Report provides the framework for our best practices program.

8.0 In Conclusion

I do not want to repeat in this conclusion section what has already been said in this divisional planning document. If you have reached this point in reading through this lengthy narrative, you will already see that we have asked for a lot of resources, relative to what the campus has suggested as a range of resources that we might expect to come with campus growth. We have also argued that those resources are required for the division to meet its ambitious goals—objectives that, in return, are crucial if the campus is to meet its stated goals.

It might be noted that the whole divisional plan may sound ambitious in terms of asking for maximum resources indicated to be feasible by CP/EVC Simpson earlier this year. However, this is actually a quite conservative plan relative to science programs on other campuses. Even if all the resources requested here were provided by the campus, we are likely to remain the smallest Natural Sciences program in the UC system. To counteract the negative effects of this size disadvantage, we have focused our plans to create centers of excellence at UCSC rather than push for growth in all areas.

Even if all the resources requested here were provided by the campus, we are likely to remain the smallest Natural Sciences program in the UC system.

One might ask whether investment of the magnitude we propose would really achieve the goals we have set. One should look to history to predict the answer to that question. One need only go to catalogs of other UC campuses to see that, with the exception of Earth Sciences and Astronomy and Astrophysics, our science departments are the smallest in the system. You can go to the UC Davis report on faculty salaries to see that our faculty are the lowest paid in the system. You can look at start-up expenditures and see that we can only provide one-third to one-half of the start-up offered by other campuses. You can look at space formulas and see that we have the worst space allocations of any campus by CPEC standards.

With all these disadvantages, we have managed to create an academic division ranked best in the world, by the standard of citations index, in the physical sciences. This is an extraordinary accomplishment. Now we are being asked to translate that accomplishment into dramatically increased extramural and private gift revenues. We can do it, but the campus must partner with us by providing the investment needed to make this happen. Together we can succeed in creating dramatic advances that will serve the division, the campus, and society.

9.0 Appendices

Appendix 1: Distribution of Divisional Faculty at Target Growth

Appendix 2: FTE Planning Tables

Appendix 3: Cost Projections and Funding Sources at Build-Out

Appendix 4: Budget Presentation to Department Chairs

Appendix 5: Excerpt from Divisional Space Plan

Appendix 6: Executive Summaries of Departmental Plans

Appendix 7: Executive Summaries of Organized Research Units

Appendix 8: STEPS Proposal

Academic Plan 2001-02 to 2010-11

Division of Natural Sciences
Appendix 1 - Initial Framework for Planning
Distribution of Faculty FTE at Target Growth

		Linear growth (16,900/12,650 = 1.34) Increase of 47.45 FTE				30% campus projected growth at 18.7 Increase of 67.45 FTE				
Faculty Now*		0th order	% growth	1st order*	% growth	0th order	% growth	**1st order***	% growth	
MCD Biology	21.00	28	34%	31	48%	31	48%	**32.00**	52%	
Chemistry	21.00	28	34%	29	38%	31	50%	**31.00**	41%	HEALTH
ETOX	5.00	7	34%	7	40%	7	40%	**10.00**	100%	
EEB Biology	15.00	20	34%	24	60%	22	47%	**26.00**	73%	
Ocean Sciences	9.00	12	34%	11	22%	13	44%	**13.00**	44%	ENVIRONMENT
Earth Sciences	19.50	26	34%	24	23%	29	49%	**26.50**	36%	
Astronomy	10.80	14	34%	13	20%	16	48%	**14.60**	35%	
Physics	18.25	24	34%	24	32%	27	48%	**25.25**	38%	TECHNOLOGY
Math	15.00	20	34%	19	27%	22	47%	**20.00**	33%	
Science Comm	1.00	1		1		1		**1.00**		
Division	4.00	5		4		6		**7.65**		
Total:	139.55	187		187		207		**207.00**		
				Range = plus or minus 10%				Range = plus or minus 10%		

Appendix 1 reflects anticipated departmental growth based on a total campus population of 16,900. The first table assumes linear growth based on current enrollments and faculty numbers. The second table assumes that Natural Sciences will capture a 30% share of the total campus enrollment growth. The table discplays the apporximate distribution of faculty FTE within the departments based on the total counts of 187 FTE to 207 FTE (47.45 to 67.45 new FTE). Zeroth order reflects linear growth. First order reflects numbers adjusted to appropriate levels given anticipated changes in the directions of science and divisional priorities. The specific numbers attached to departments are expected to change in response to emerging research opportunities.

**NOTE: THESE NUMBERS PROVIDED INITIAL FRAMEWORK FOR PLANNING - THE FINAL PLAN NUMBERS ARE REVISED.

Academic Plan 2001-02 to 2010-11
FTE Planning Document as of 12/3/01
Appendix 2

Department	Current FTE	Dept. Instructional & Research Emphases	Organized Research	Interdisciplinary Links	Authorized/Pending Recruitments	Possible areas for future hires	Projected FTE 2010
Astronomy & Astrophysics	10.8	Advanced Instrumentation Multi-wavelength astronomy Theory and simulation Optical observations	UCO Lick Observatory CODEP/IGPP SCIPP Particle Astrophysics & Cosmology Center for Adaptive Optics	Physics Earth Sciences Applied Math and Computer Science		Multi-wavelength (far IR) Theory High energy astrophysics	14.6
Ecology and Evolutionary Biology	15	Linking Marine and Terrestrial Ecosystem studies: Evolution and Behavior Physiological Ecology Ecological Studies	C. DELSI/IGPP Institute for Marine Sciences / Ocean Health PISCO MBRS Center for Conservation Studies & Policy STEPS	Earth Sciences Environmental Toxicology Ocean Sciences Environmental Studies		Evolutionary theorist Mathematical biologist Plant evolutionist Population geneticist Neurophysiologist/Behaviorial Ecologist Marine vertebrate biologist Plant physiological ecologist Community ecologist Coastal ecosystem processes Freshwater ecologist Marine conservation biologist	26
Molecular, Cellular and Developmental Biology	21	Molecular Biology of RNA Cell & developmental biology Model genetic systems Neurobiology Genomics & structural biology	RNA Center Center for Biomolecular Science & Eng.	Chemistry and Biochemistry Environmental Toxicology School of Engineering		Cell and developmental biologists Structural biology Plant molecular biology (genomics) Cancer cell biology	31
Chemistry & Biochemistry	21	Biomedical Research Environmental Health Complex materials	Center for Biomolecular Science & Eng. Complex Materials Environmental Health Institute of Marine Sciences STEPS	Earth Sciences Ecology and Evolutionary Biology Environmental Toxicology Molecular, Cellular and Dev. Biology Ocean Sciences Physics School of Engineering		Synthetic inorganic chemistry Experimental physical chemistry Proteomics research Protein structure determination/NMR Protein crystallographer Combinatorial biology and biosynthesis	32

Department	Current FTE	Research Emphases	Organized Research	Interdisciplinary Links	Authorized/Pending Recruitments	Planned FTE 2010	FTE 2010
Earth Sciences	19.5	Surface processes Earth history/global change Solid earth system Planetary sciences	IGPP/CDELSI, CODEP,CSIDE STEPS	Astronomy and Astrophysics Chemistry and Biochemistry Ecology and Evolutionary Biology Environmental Toxicology Ocean Sciences Physics Applied Mathematics and Statistics School of Engineering Environmental Studies		Planetary Science: Atmospheres Geology/Geochemistry Geology/Paleobiology Planetary: Atmospheric Chem. or Dynamics Remote Sensing of Active Tectonics Planetary Lithospheric Dynamicist Biogeochemical Processes/Systems Modeler	26.5
Environmental Toxicology	5	Biological effects Ecotoxicology Biogeochemical transport Environmental fate Public policy	IGPP/C. DELSI Center for Biomolecular Science & Eng. Institute of Marine Sciences/Ocean Health STEPS	Chemistry and Biochemistry Earth Sciences Ecology and Evolutionary Biology Molecular,Cellular and Dev. Biology Ocean Sciences Environmental Studies School of Engineering	Ecological Toxicology (#565) Auth. 2001-02	Ecological toxicology Microbial toxicology Proteomics Genetic Toxicology Risk Assessment/Epidemiology	10
Mathematics	15	Pure mathematics Computational mathematics Math/Science education	Math Education Nonlinear ORU Discrete Mathemantics	Physics Applied Mathematics and Statistics Education	Analysis (#570) Auth. 2000-01 re-recruitment Quantum Mechanics (#0039) *Both pending CPEVC approval	FTE in general areas of discrete math, analysis, non-linear, science education	20
Ocean Sciences	9	Biological oceanography Marine microbial ecology Chemical oceanography Marine biogeochemistry Ocean circulation Paleoceanography Paleoclimatology	Institute for Marine Sciences/Ocean Health IGPP/CDELSI STEPS	Earth Sciences Ecology and Evolutionary Biology Environmental Toxicology Environmental Studies		Ocean climate dynamics Oceanic food web dynamics Marine sedimentary organic geochemistry Biochemical oceanography	13
Physics	18.25	Particle physics Astrophysics Condensed matter Wave propagation	SCIPP Particle Astrophysics and Cosmology	Astronomy and Astrophysics Chemistry and Biochemistry School of Engineering	Astrophysics (#566) Auth. 2001-02 Astrophysics (#449) Auth. 2000-01	Condensed matter / Advanced materials Nanostructures Biophysics	25.25
Sci Comm	1						1
Division	5						14
Total FTE:	140.55						213.35

Appendix 3: Cost Projections and Funding Sources at Build-Out

TABLE 1.A
DETAIL OF PROGRAMS AND ACTIVITIES
DIVISION OF NATURAL SCIENCES
DIVISIONAL SUMMARY

	Existing Base [1]		PROPOSED CHANGES 2005-06			Total thru 2005-06		PROPOSED CHANGES 2010-11			Total thru 2010-11		TOTAL PROPOSED CHANGES		
	FTE	On-Going	One-Time/Start-up	FTE	On-Going	FTE	On-Going	One-Time/Start-up	FTE	On-Going	FTE	On-Going	One-Time	FTE	On-Going
TOTAL ACADEMIC DEPARTMENTS (exludes staff - see below)															
Faculty FTE [2]	140.55	11,547,630	12,556,750	52.80	3,402,044	193.35	14,949,674	4,837,000	20.00	1,330,754	213.35	16,280,428	17,393,750	72.80	4,732,798
Academic Specialists	4.34	256,805	-	-	-	4.34	256,805			-	4.34	256,805	-	-	-
General Assistance	-	63,513	-	-	6,353		69,866			3,493	-	73,359	-	-	9,846
Teaching Assistants	-	2,183,894	-	-	532,090		2,715,984			452,475	-	3,168,459	-	-	984,565
Non-salary costs	-	675,530	-	-	117,390		792,920			70,190	-	863,110	-	-	187,580
Total	144.89	14,727,372	12,556,750	52.80	4,057,877	197.69	18,785,249	4,837,000	20.00	1,856,912	217.69	20,642,161	17,393,750	72.80	5,914,789
TOTAL MRU/ORU'S (exludes staff - see below)															
Faculty FTE	0.50	70,950	-	-	-	0.50	70,950	-	-	-	0.50	70,950	-	-	-
Admin Stipend/Etc	0.05	36,775	-	-	-	0.05	36,775	-	-	-	0.05	36,775	-	-	-
Academic Specialists	5.84	642,915	-	-	-	5.84	642,915	-	-	-	5.84	642,915	-	-	-
General Assistance	-	5,082	-	-	-	-	5,082	-	-	-	-	5,082	-	-	-
Non-salary costs	-	(6,834)	-	-	21,741	-	14,907	-	-	1,087	-	15,994	-	-	22,828
Other	-	113,575	-	-	-	-	113,575	-	-	-	-	113,575	-	-	-
Totals	6.39	862,463	-	-	21,741	6.39	884,204	-	-	1,087	6.39	885,291	-	-	22,828
TOTAL ACADEMIC SUPPORT (exludes staff - see below)															
Faculty FTE	1.00	71,232	-	-	-	1.00	71,232	-	-	-	1.00	71,232	-	-	-
General Assistance	-	25,028	-	-	5,998	-	31,026	-	-	2,299	-	33,325	-	-	8,297
Benefits (non-state supported)	-	29,440	-	-	-	-	29,440	-	-	-	-	29,440	-	-	-
Non-salary costs	-	737,894	-	-	193,333	-	931,227	-	-	109,986	-	1,041,213	-	-	303,319
Other	-	27,000	-	-	4,050	-	31,050	-	-	1,553	-	32,603	-	-	5,603
Totals	1.00	890,594	-	-	203,381	1.00	1,093,975	-	-	113,838	1.00	1,207,813	-	-	317,219
TOTAL ADMINISTRATION (exludes staff - see below)															
Faculty FTE	1.00	167,500	-	-	-	1.00	167,500	-	-	-	1.00	167,500	-	-	-
General Assistance	-	7,450	-	-	1,118	-	8,568	-	-	428	-	8,996	-	-	1,546
Non-salary costs	-	143,946	-	-	21,592	-	165,538	-	-	16,554	-	182,092	-	-	38,146
Totals	1.00	318,896	-	-	22,709	1.00	341,605	-	-	16,982	1.00	358,588	-	-	39,692
NATURAL RESERVE (exludes staff - see below)															
Faculty FTE	0.75	69,924				0.75	69,924				0.75	69,924	-	-	-
Non-salary costs		64,973				-	64,973				-	64,973	-	-	-
Other		25,600				-	25,600				-	25,600	-	-	-
Totals	0.75	160,497	-	-	-	0.75	160,497	-	-	-	0.75	160,497	-	-	-

	Existing Base [1]		PROPOSED CHANGES 2005-06			Total thru 2005-06		PROPOSED CHANGES 2010-11			Total thru 2010-11		TOTAL PROPOSED CHANGES		
	FTE	On-Going	One-Time/Start-up	FTE	On-Going	FTE	On-Going	One-Time/Start-up	FTE	On-Going	FTE	On-Going	One-Time	FTE	On-Going
TOTAL STAFF															
MANAGEMENT PROFESSIONALS	5.49	441,237		1.00	102,305	6.49	543,542		-	-	6.49	543,542	-	1.00	102,305
PROFESSIONAL SUPPORT STAFF	39.51	1,845,967		6.00	345,464	45.51	2,191,431		2.00	129,395	47.51	2,320,826	-	8.00	474,859
CLERICAL SUPPORT STAFF	60.26	2,068,773		9.00	380,302	69.26	2,449,075		3.00	142,151	72.26	2,591,226	-	12.00	522,453
RESEARCH - LAB STAFF	27.89	1,204,725		6.00	319,738	33.89	1,524,463		1.00	62,272	34.89	1,586,735	-	7.00	382,010
SR RESEARCH LAB STAFF	-	-		2.00	137,230	2.00	137,230		1.00	77,434	3.00	214,664	-	3.00	214,664
COMPUTER TECHNICAL STAFF				-	-	-	-		-	-	-	-	-	-	-
TECH SUPPORT	5.00	196,656		1.50	76,313	6.50	272,969		0.50	30,840	7.00	303,809	-	2.00	107,153
TECH PROFESSIONAL SUPPORT	3.90	222,543		2.00	143,351	5.90	365,894		-	-	5.90	365,894	-	2.00	143,351
TECH MANAGEMENT SUPPORT	3.00	242,126		1.00	102,716	4.00	344,842		-	-	4.00	344,842	-	1.00	102,716
EH&S	1.93	115,660		1.00	77,445	2.93	193,105		-	-	2.93	193,105	-	1.00	77,445
SHOP SPECIALISTS	11.59	566,448		-	-	11.59	566,448		-	-	11.59	566,448	-	-	-
STAFF RECRUITMENT & RETENTION					75,000		75,000			75,000		150,000			150,000
TOTAL STAFF	158.57	6,904,135		29.50	1,759,864	188.07	8,663,999		7.50	517,093	195.57	9,181,091	-	37.00	2,276,956
CENTRAL DIVISIONAL RESOURCES															
IER		561,000			287,924		848,924			91,602		940,526	-	-	379,526
FACILITIES SPECIAL		250,000			128,308		378,308			40,821		419,129	-	-	169,129
EH&S - HAZARDOUS WASTE		85,000			43,625		128,625			13,879		142,504	-	-	57,504
MATCHING FUNDS		300,000			150,000		450,000			150,000		600,000	-	-	300,000
CONTINGENCY		150,000			75,000		225,000			75,000		300,000	-	-	150,000
CORE INFRASTRUCTURE NEEDS		-	500,000		-		-	125,000		-		-	625,000		-
(SEED CORE FACILITIEYS & IT NEEDS)		-			-		-			-		-	-	-	-
TEMPORARY ACADEMIC STAFFING		900,000			125,000		1,025,000			125,000		1,150,000	-	-	250,000
TOTAL		2,246,000	500,000	-	809,857		3,055,857	125,000	-	496,302		3,552,160	625,000	-	1,306,160
SUBTOTAL	312.60	26,109,957	13,056,750	82.30	6,875,430	394.90	32,985,387	4,962,000	27.50	3,002,214	422.40	35,987,601	18,018,750	109.80	9,877,644
ADJUSTMENT TO BASE [3]		(1,000,000)			1,000,000	-	-	-	-	-	-	-	-	-	1,000,000
TOTAL	312.60	25,109,957	13,056,750	82	7,875,430	394.90	32,985,387	4,962,000	27.50	3,002,214	422.40	35,987,601	18,018,750	109.80	10,877,644

[1] *"Existing base" is defined as the division's projection of current* ***on-going expenditures*** *including those covered by permanent as well as temporary resources.*

[2] *Includes FTE approved for 2000-01 recruitments that are currently being held centrally.*

[3] *As outlined in the plan, carry forward funds and current year savings have been used to cover some* ***on-going*** *costs, but the division expects the remaining carry forward funds to be used within the next few years.*

TABLE 1.B
DETAIL OF PROGRAMS AND ACTIVITIES
DIVISION OF NATURAL SCIENCES
ACADEMIC DEPARTMENTS

	Existing Base		PROPOSED CHANGES 2005-06			Total thru 2005-06		PROPOSED CHANGES 2010-11			Total thru 2010-11	
	FTE		One-Time/Start-up	FTE	On-Going	FTE	On-Going	One-Time/Start-up	FTE	On-Going	FTE	On-Going
ASTRONOMY												
Faculty FTE	10.80	1,225,435	570,000	3.80	207,608	14.60	1,433,043	-			14.60	1,433,043
Staff FTE *1*	1.75	62,829				1.75	62,829				1.75	62,829
Teaching Assistants	19 TAships	75,064			23,000		98,064				-	98,064
Non-salary costs		36,619			8,400		45,019				-	45,019
Totals	12.55	1,399,947	570,000	3.80	239,008	16.35	1,638,955	-	-	-	16.35	1,638,955
BIOLOGY - EEB												
Faculty FTE	15.00	1,097,345	1,353,000	6.00	337,355	21.00	1,434,700	1,127,500	5.00	340,031	26.00	1,774,731
Staff FTE *1*	1.95	70,899				1.95	70,899				1.95	70,899
Teaching Assistants	-						-				-	-
Non-salary costs	-						-				-	-
Totals	16.95	1,168,244	1,353,000	6.00	337,355	22.95	1,505,599	1,127,500	5.00	340,031	27.95	1,845,630
BIOLOGY - MCD												
Faculty FTE	21.00	1,547,795	2,150,000	6.00	411,545	27.00	1,959,340	1,650,000	5.00	340,031	32.00	2,299,371
Staff FTE *1*	2.00	70,852				2.00	70,852				2.00	70,852
Teaching Assistants	-						-				-	-
Non-salary costs	-						-				-	-
Totals	23.00	1,618,647	2,150,000	6.00	411,545	29.00	2,030,192	1,650,000	5.00	340,031	34.00	2,370,223
BIOLOGY - CORE												
Faculty FTE	-	-				-	-				-	-
Staff FTE*1*	13.09	538,704				13.09	538,704				13.09	538,704
General Assistance		17,653			1,767	-	19,420			971	-	20,390
Teaching Assistants	110 TAships	516,065			236,500		752,565			298,300	-	1,050,865
Non-salary costs		221,574			41,360		262,934			44,760	-	307,694
Totals	13.09	1,293,996	-	-	279,627	13.09	1,573,623	-	-	344,031	13.09	1,917,653
CHEMISTRY AND BIOCHEMISTRY												
Faculty FTE	21.00	1,749,140	1,848,000	6.00	346,288	27.00	2,095,428	1,232,000	4.00	263,873	31.00	2,359,301
Staff FTE *1*	10.00	437,669				10.00	437,669				10.00	437,669
General Assistance		19,050			1,905	-	20,955			1,048	-	22,003
Teaching Assistants	122 TAships	572,363			124,440		696,803			73,500	-	770,303
Non-salary costs		130,795			18,360		149,155			11,520	-	160,675
Totals	31.00	2,909,017	1,848,000	6.00	490,993	37.00	3,400,010	1,232,000	4.00	349,941	41.00	3,749,951
EARTH SCIENCES												
Faculty FTE	19.50	1,705,645	550,000	4.00	227,881	23.50	1,933,526	412,500	3.00	195,971	26.50	2,129,497
Academic Specialists	4.34	256,805				4.34	256,805				4.34	256,805
Staff FTE *1*	4.64	172,798				4.64	172,798				4.64	172,798
General Assistance		9,660			966		10,626			531.30	-	11,157
Teaching Assistants	49 TAships	229,884			63,455		293,339			62,000	-	355,339
Non-salary costs		64,917			11,040		75,957			9,400	-	85,357
Totals	28.48	2,439,709	550,000	4.00	303,342	32.48	2,743,051	412,500	3.00	267,902	35.48	3,010,953

	Existing Base		PROPOSED CHANGES 2005-06			Total thru 2005-06		PROPOSED CHANGES 2010-11			Total thru 2010-11	
	FTE		One-Time/Start-up	FTE	On-Going	FTE	On-Going	One-Time/Start-up	FTE	On-Going	FTE	On-Going
ENVIRONMENTAL TOXICOLOGY												
Faculty FTE	5.00	316,050	1,253,750	5.00	353,771	10.00	669,821	-	-		10.00	669,821
Staff FTE *1*	1.00	41,175				1.00	41,175				1.00	41,175
Teaching Assistants	3 TAships	14,075			10,005		24,080			6,675	-	30,755
Non-salary costs		15,000			8,340		23,340			560	-	23,900
Totals	6.00	386,300	1,253,750	5.00	372,116	11.00	758,416	-	-	7,235	11.00	765,651
MATHEMATICS												
Faculty FTE	15.00	1,232,140	240,000	5.00	347,253	20.00	1,579,393	-	-		20.00	1,579,393
Staff FTE *1*	4.98	172,586				4.98	172,586				4.98	172,586
General Assistance		2,500			250	-	2,750			137.50	-	2,888
Teaching Assistants	92 TAships	431,618			7,820		439,438				-	439,438
Non-salary costs		63,162			8,100		71,262				-	71,262
Totals	19.98	1,902,006	240,000	5.00	363,423	24.98	2,265,429	-	-	138	24.98	2,265,567
OCEAN SCIENCES												
Faculty FTE	9.00	632,050	792,000	4.00	227,881	13.00	859,931	-	-		13.00	859,931
Staff FTE *1*	2.90	111,771				2.90	111,771				2.90	111,771
General Assistance		1,050			105	-	1,155			58	-	1,213
Teaching Assistants	16 TAships	75,064			28,800		103,864			12,000	-	115,864
Non-salary costs		72,293			9,150		81,443			1,330	-	82,773
Totals	11.90	892,228	792,000	4.00	265,936	15.90	1,158,164	-	-	13,388	15.90	1,171,552
PHYSICS												
Faculty FTE	18.25	1,692,370	1,200,000	6.00	333,245	24.25	2,025,615	165,000	1.00	62,779	25.25	2,088,394
Staff FTE *1*	6.19	223,035				6.19	223,035				6.19	223,035
General Assistance		13,600			1,360	-	14,960			748	-	15,708
Teaching Assistants	54 TAships	253,341			38,070		291,411				-	291,411
Non-salary costs		55,997			12,640		68,637			2,620	-	71,257
Totals	24.44	2,238,343	1,200,000	6.00	385,315	30.44	2,623,658	165,000	1.00	66,147	31.44	2,689,805
SCIENCE COMMUNICATION												
Faculty FTE	1.00	108,360		-		1.00	108,360		-		1.00	108,360
Staff FTE *1*	0.83	31,565				0.83	31,565				0.83	31,565
Teaching Assistants	2.5 TAships	16,420					16,420				-	16,420
Non-salary costs		15,173					15,173				-	15,173
Totals	1.83	171,518	-	-	-	1.83	171,518	-	-	-	1.83	171,518
DIVISIONAL												
Faculty FTE	5.00	241,300	2,600,000	7.00	609,217	12.00	850,517	250,000	2.00	128,069	14.00	978,586
TOTAL ACADEMIC DEPARTMENTS												
Faculty FTE	140.55	11,547,630	12,556,750	52.80	3,402,044	193.35	14,949,674	4,837,000	20.00	1,330,754	213.35	16,280,428
Academic Specialists	4.34	256,805			-	4.34	256,805			-	4.34	256,805
Staff FTE *1*	49.33	1,933,883				49.33	1,933,883				49.33	1,933,883
General Assistance		63,513			6,353		69,866			3,493	-	73,359
Teaching Assistants		2,183,894			532,090		2,715,984			452,475	-	3,168,459
Non-salary costs		675,530			117,390		792,920			70,190	-	863,110
Totals	194.22	16,661,255	12,556,750	52.80	4,057,877	247.02	20,719,132	4,837,000	20.00	1,856,912	267.02	22,576,044

1 *Staff FTE changes are consolidated on "Divisional Summary" Table 1.A*

TABLE 1.C
DETAIL OF PROGRAMS AND ACTIVITIES
DIVISION OF NATURAL SCIENCES
MRU/ORU's

	Existing Base		PROPOSED CHANGES 2005-06			Total thru 2005-06		PROPOSED CHANGES 2010-11			Total thru 2010-11	
	FTE		One-Time	FTE	On-Going	FTE	On-Going	One-Time	FTE	On-Going	FTE	On-Going
IGPP												
Admin Stipend		5,000				-	5,000	-			-	5,000
Academic Specialists	1.90	164,859				1.90	164,859				1.90	164,859
Staff FTE*1*	1.25	37,113				1.25	37,113				1.25	37,113
Non-salary costs		11,500					11,500				-	11,500
Totals	3.15	218,472	-	-	-	3.15	218,472	-	-	-	3.15	218,472
IMS												
Faculty FTE	0.50	70,950				0.50	70,950				0.50	70,950
Admin Stipend/Admin	0.05	20,825					20,825					20,825
Staff FTE*1*	14.75	675,770				14.75	675,770				14.75	675,770
General Assistance		5,082					5,082				-	5,082
Non-salary costs		(2,301)					(2,301)				-	(2,301)
Other		113,575					113,575					113,575
Totals	15.30	883,901	-	-	-	15.25	883,901	-	-	-	15.25	883,901
SCIPP												
Admin Stipend		10,950				-	10,950				-	10,950
Academic specialists	3.94	478,056				3.94	478,056				3.94	478,056
Staff FTE*1*	0.50	25,807					25,807				-	25,807
Non-salary costs		(16,033)					(16,033)				-	(16,033)
Totals	4.44	498,780	-	-	-	3.94	498,780	-	-	-	3.94	498,780
Overall increase to Non-salary costs					21,741		21,741			1,087.05		22,828
TOTAL MRU/ORU'S												
Faculty FTE	0.50	70,950	-	-	-	0.50	70,950	-	-	-	0.50	70,950
Admin Stipend/Etc	0.05	36,775			-	0.05	36,775			-	0.05	36,775
Academic Specialists	5.84	642,915				5.84	642,915			-	5.84	642,915
Staff FTE	16.50	738,690	(See Overall Division for staffing chgs)				738,690	(See Overall Division for staf		-	-	738,690
General Assistance	-	5,082			-		5,082			-	-	5,082
Non-salary costs		(6,834)			21,741		14,907			1,087	-	15,994
Other		113,575			-		113,575			-		113,575
Totals	22.89	1,601,153	-	-	21,741	6.39	1,622,894	-	-	1,087	6.39	1,623,981

1 *Staff FTE changes are consolidated on "Divisional Summary" Table 1.A*

TABLE 1.D
DETAIL OF PROGRAMS AND ACTIVITIES
DIVISION OF NATURAL SCIENCES
ACADEMIC SUPPORT

	Existing Base		PROPOSED CHANGES 2005-06			Total thru 2005-06		PROPOSED CHANGES 2010-11			Total thru 2010-11	
	FTE		One-Time	FTE	On-Going	FTE	On-Going	One-Time	FTE	On-Going	FTE	On-Going
ADMIN/ACADEMIC COMPUTING												
Staff FTE *1*	11.70	669,788				11.70	669,788				11.70	669,788
Non-salary costs (Network Connections & workstation costs)		525,000			183,750		708,750			106,313	-	815,063
Totals	11.70	1,194,788	-	-	183,750	11.70	1,378,538	-	-	106,313	11.70	1,484,851
SHOP/STOCKROOM												
Faculty FTE	1.00	71,232				1.00	71,232				1.00	71,232
Staff FTE *1*	11.59	566,448				11.59	566,448				11.59	566,448
Benefits (non-state supported)		21,370					21,370					
General Assistance		(10,451)					(10,451)				-	(10,451)
Non-salary costs		149,006					149,006				-	149,006
Totals	12.59	797,605	-	-	-	12.59	797,605	-	-	-	12.59	776,235
ACE												
Staff FTE *1*	5.76	233,892				5.76	233,892				5.76	233,892
General Assistance		38,101			5,715		43,816			2,191	-	46,007
Non-salary costs		12,000			1,800		13,800			690	-	14,490
Totals	5.76	283,993	-	-	7,515	5.76	291,508	-	-	2,881	5.76	294,389
HEALTH CAREERS												
Staff FTE *1*	1.15	51,746				1.15	51,746				1.15	51,746
General Assistance		1,886			283	-	2,169			108	-	2,277
Totals	1.15	53,632	-	-	283	1.15	53,915	-	-	108	1.15	54,023
VIVARIUM/ANIMAL RESEARCH												
Staff FTE *1*	4.15	181,545				4.15	181,545				4.15	181,545
General Assistance		(4,508)				-	(4,508)				-	(4,508)
Benefits (non-state supported)		8,070					8,070				-	8,070
Non-salary costs		36,988			5,548		42,536			2,127	-	44,663
Other		27,000			4,050		31,050			1,553		32,603
Totals	4.15	249,095	-	-	9,598	4.15	258,693	-	-	3,679	4.15	262,373
SCIENCE DEVELOPMENT												
Staff FTE *1*	2.21	140,863				2.21	140,863				2.21	140,863
General Assistance		-					-				-	-
Non-salary costs		4,900			735		5,635			282	-	5,917
Totals	2.21	145,763	-	-	735	2.21	146,498	-	-	282	2.21	146,780
MISC												
Non-salary costs		10,000			1,500		11,500			575	-	12,075
Totals	-	10,000	-	-	1,500	-	11,500	-	-	575	-	12,075
TOTAL ACADEMIC SUPPORT												
Faculty FTE	1.00	71,232	-	-	-	1.00	71,232	-	-	-	1.00	71,232
Staff FTE *1*	36.56	1,844,282				36.56	1,844,282				36.56	1,844,282
General Assistance		25,028			5,998		31,026			2,299	-	33,325
Benefits (non-state supported)		29,440			-		29,440			-	-	29,440
Non-salary costs		737,894			193,333		931,227			109,986	-	1,041,213
Other		27,000			4,050		31,050			1,553		32,603
Totals	37.56	2,734,876	-	-	203,381	37.56	2,938,257	-	-	113,838	37.56	3,052,095

1 Staff FTE changes are consolidated on "Divisional Summary" Table 1.A

TABLE 1.E
DETAIL OF PROGRAMS AND ACTIVITIES
DIVISION OF NATURAL SCIENCES
ADMINISTRATION

	Existing Base		PROPOSED CHANGES 2005-06			Total thru 2005-06		PROPOSED CHANGES 2010-11			Total thru 2010-11	
	FTE		One-Time	FTE	On-Going	FTE	On-Going	One-Time	FTE	On-Going	FTE	On-Going
DEAN'S OFFICE												
Faculty FTE	1.00	167,500				1.00	167,500				1.00	167,500
Staff FTE *1*	10.70	547,245				10.70	547,245				10.70	547,245
General Assistance		600			90		690			35	-	725
Non-salary costs		104,046			15,607		119,653			5,983	-	125,636
Totals	11.70	819,391	-	-	15,697	11.70	835,088	-	-	6,017	11.70	841,105
HR/PAYROLL												
Staff FTE *1*	9.10	389,753				9.10	389,753				9.10	389,753
General Assistance		5,220			783		6,003			300	-	6,303
Non-salary costs		9,450			1,418		10,868			543	-	11,411
Totals	9.10	404,423	-	-	2,201	9.10	406,624	-	-	844	9.10	407,467
FACILITIES												
Staff FTE *1*	6.30	304,277				6.30	304,277				6.30	304,277
General Assistance		100			15		115			6	-	121
Non-salary costs		6,300			945		7,245			362	-	7,607
Totals	6.30	310,677	-	-	960	6.30	311,637	-	-	368	6.30	312,005
PURCHASING												
Staff FTE *1*	5.00	206,870				5.00	206,870				5.00	206,870
General Assistance		-				-	-				-	-
Non-salary costs		5,250			788		6,038			302		6,339
Totals	5.00	212,120	-	-	788	5.00	212,908	-	-	302	5.00	213,209
RESEARCH ACCOUNTING												
Staff FTE *1*	9.00	375,604				9.00	375,604				9.00	375,604
General Assistance		1,105			166	-	1,271			64	-	1,334
Non-salary costs		9,450			1,418		10,868			543	-	11,411
Totals	9.00	386,159	-	-	1,583	9.00	387,742	-	-	607	9.00	388,349
DIVISIONAL RESOURCES												
Staff FTE *1*	9.18	353,274				9.18	353,274				9.18	353,274
General Assistance		425			64		489			24	-	513
Non-salary costs		9,450			1,418		10,868			543	-	11,411
Totals	9.18	363,149	-	-	1,481	9.18	364,630	-	-	568	9.18	365,198
OTHER (holding)												
Staff FTE	1.00	32,604				1.00	32,604				1.00	32,604
Totals	1.00	32,604	-	-	-	1.00	32,604	-	-	-	1.00	32,604
TOTAL ADMINISTRATION												
Faculty FTE	1.00	167,500	-	-	-	1.00	167,500	-	-	-	1.00	167,500
Staff FTE *1*	50.28	2,209,627			-	50.28	2,209,627			-	50.28	2,209,627
General Assistance		7,450			1,118		8,568			428	-	8,996
Non-salary costs		143,946			21,592		165,538			16,554	-	182,092
Totals	51.28	2,528,523	-	-	22,709	51.28	2,551,232	-	-	16,982	51.28	2,568,215

	Existing Base		PROPOSED CHANGES 2005-06			Total thru 2005-06		PROPOSED CHANGES 2010-11			Total thru 2010-11	
	FTE		One-Time	FTE	On-Going	FTE	On-Going	One-Time	FTE	On-Going	FTE	On-Going
NATURAL RESERVE												
Faculty FTE	0.75	69,924				0.75	69,924				0.75	69,924
Staff FTE ***1***	2.56	99,141					99,141				-	99,141
Non-salary costs		64,973			9,746		74,719			3,736	-	78,455
Other		25,600			3,840		29,440			1,472		30,912
Totals	3.31	259,638	-	-	9,746	0.75	273,224	-	-	3,736	0.75	278,432

1 *Staff FTE changes are consolidated on "Divisional Summary" Table 1.A*

TABLE 2
DIVISION OF NATURAL SCIENCES
PROPOSED FUNDING SOURCES

		2005-06		2010-11		
	Existing Base	One-Time/Start-Up	On-Going	2006-2011 One-Time/Start-Up	Total One-Time/ Start-Up	On-Going
PROJECTED EXPENDITURES	26,109,957	13,056,750	32,985,387	4,962,000	18,018,750	35,987,601
PROPOSED DIVISIONAL FUNDING SOURCES						
Existing Divisional Resources						
Permanent Resources	23,808,708		23,808,708			23,808,708
On-Going Resources	1,081,135		1,110,000			1,120,000
(TAS, Research Opportunity Funds, Gift Activity Center Funds)						
Temporary						
Prior Yr Carry Forward Funds	1,000,000 [1]	800,000 [2]	-	800,000	1,600,000	
Current Year Salary/Leave Savings	220,000		250,000			250,000
New Divisional Resources						
Enrollment Growth			7,730,429			10,713,893
Course Fee Income			86,250			95,000
Central Resources		12,256,750		4,162,000	16,418,750	
Support from other campus units		[3]				
TOTAL PROPOSED FUNDING SOURCES	26,109,843	13,056,750	32,985,387	4,962,000	18,018,750	35,987,601

NOTES

[1] *As outlined in the plan, carry forward funds and current year savings have been used to cover some on-going costs, but the division expects the remaining carry forward funds to be used within the next few years.*

[2] *With the addition of new FTE, the division anticipates the accrual of some salary savings that could be applied to start-up costs.*

[3] *Potential for compensation for other campus units to support major interdisciplinary collaborations.*

Divisional Resources: Who is getting the money that is rightfully yours

Division of Natural Sciences

UC Santa Cruz

Fall 2001

Introduction

Campus

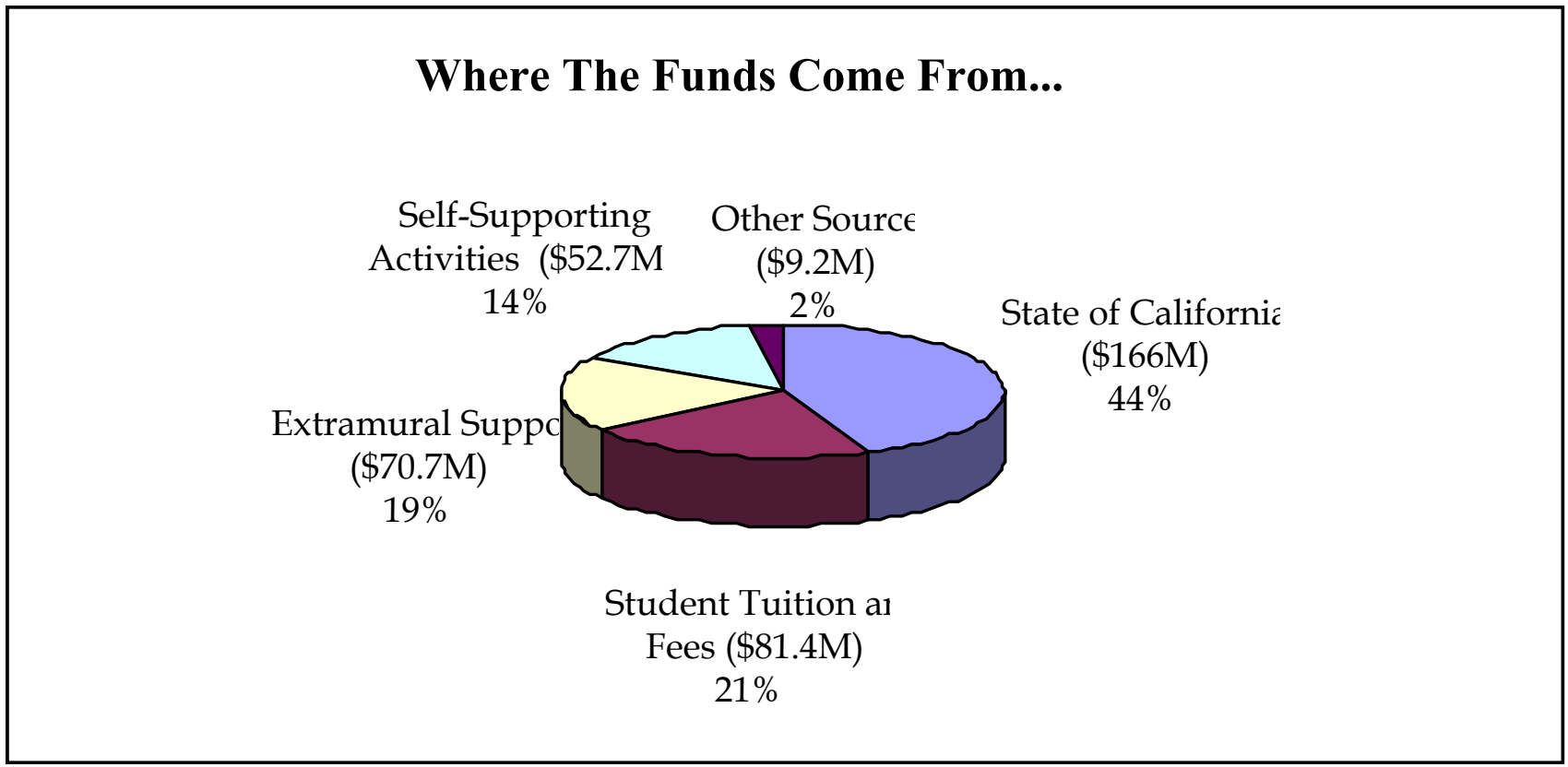
- How the campus receives funds
- How the campus expends funds

Division

- How the division expends funds
- Comparisons by departments

UCSC's 2001-02 Budget

$380.0 Million



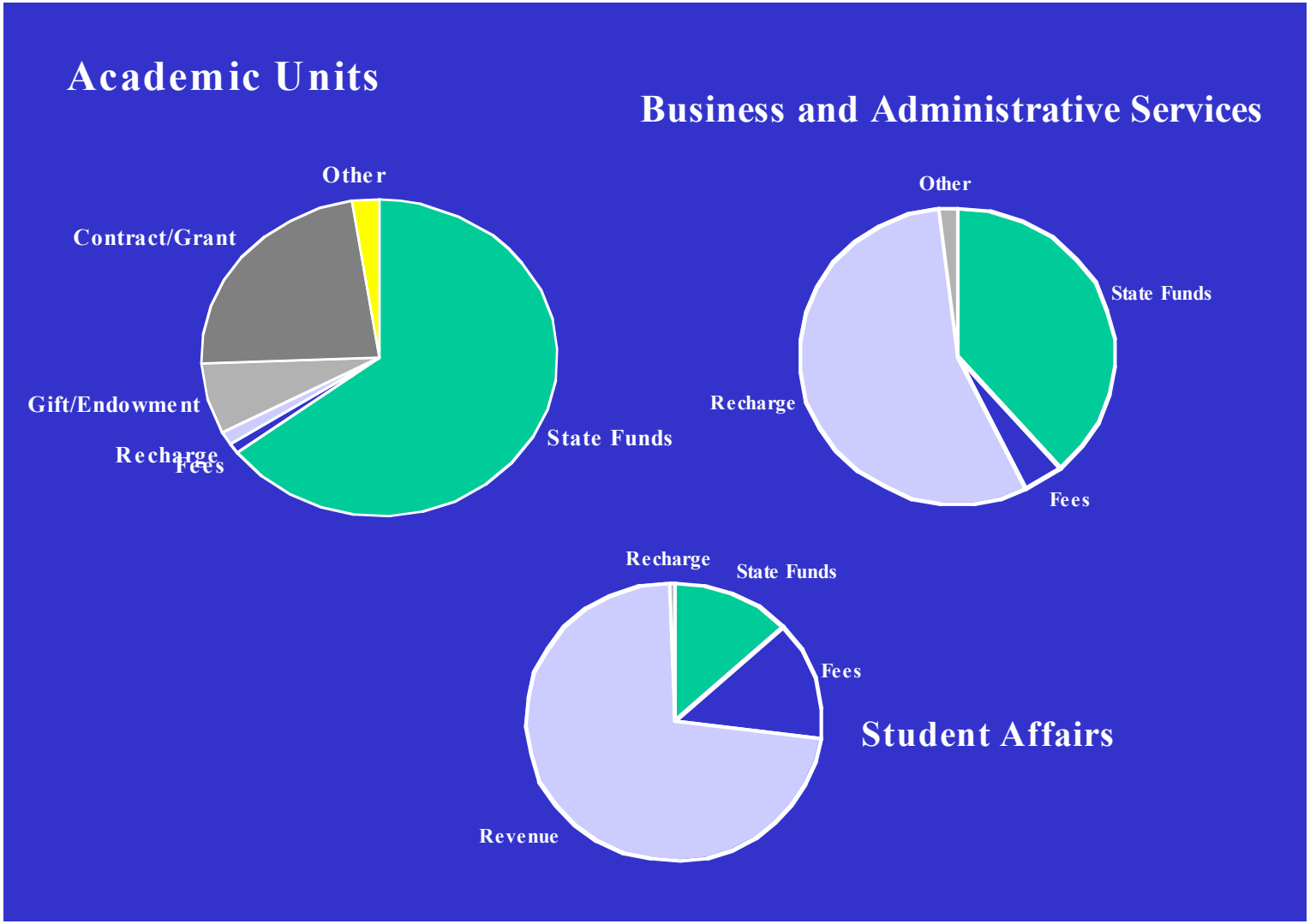
UCSC's 2001-02 Budget

Primary Expense Categories

Academic Salaries	$64.3M
Staff Salaries	103.0M
Benefits	29.9M
Supplies/Equipment	129.3M
Special Outlays	86.7M
--less Recharges	-33.2M
	$380.0M

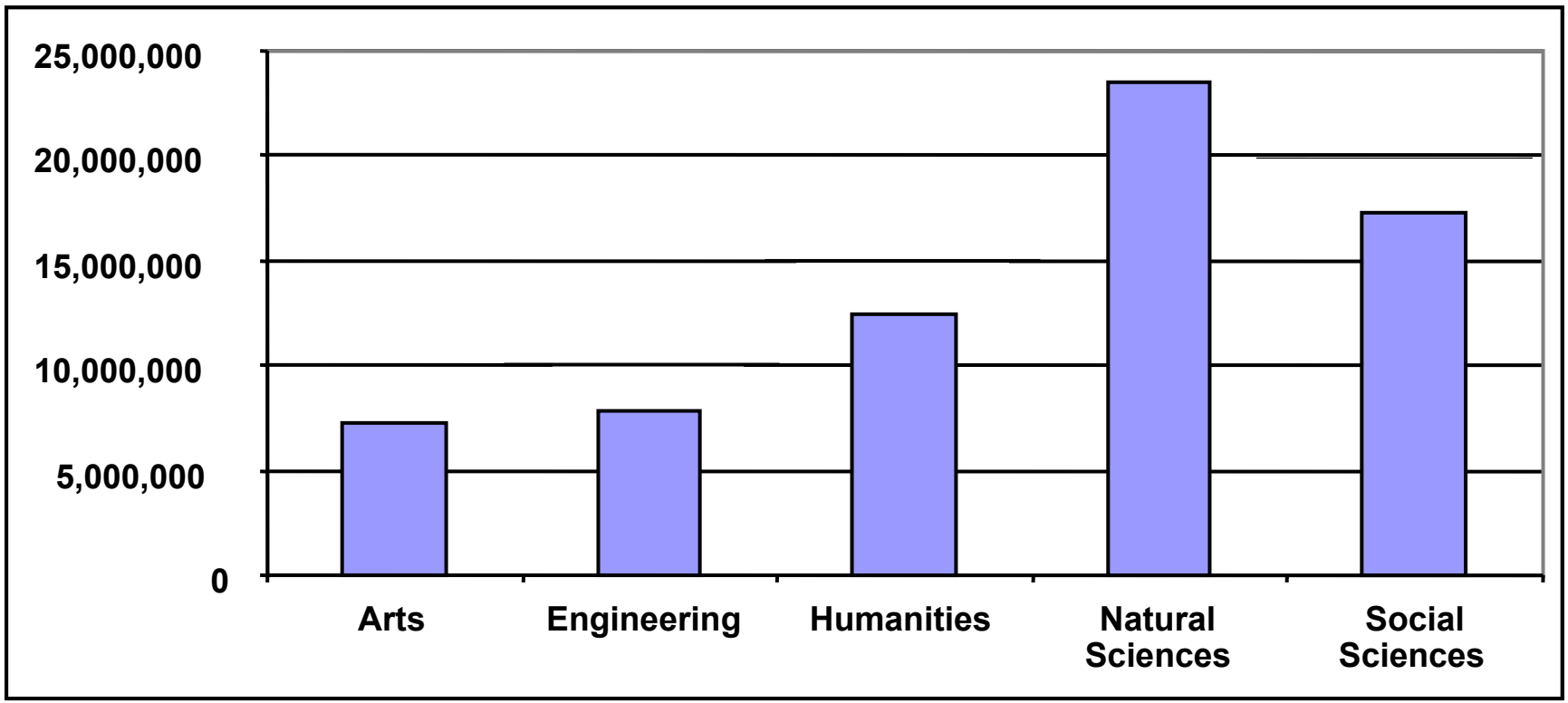
UCSC's 2001-02 Budget

Funds by Major Areas



2001-02 Permanent Budget

Comparison of the 2001-02 permanent budget for each academic division based on the July 1 "snapshot"

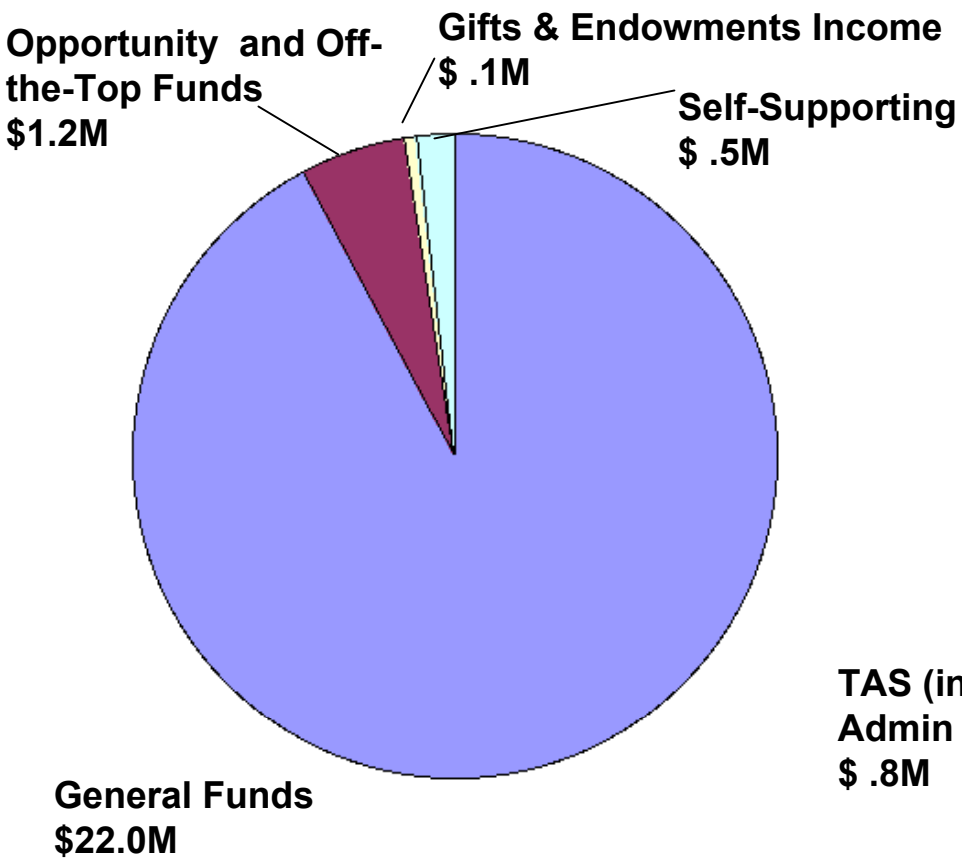


Division of Natural Sciences 2001-02

Total Funds: $24.9M

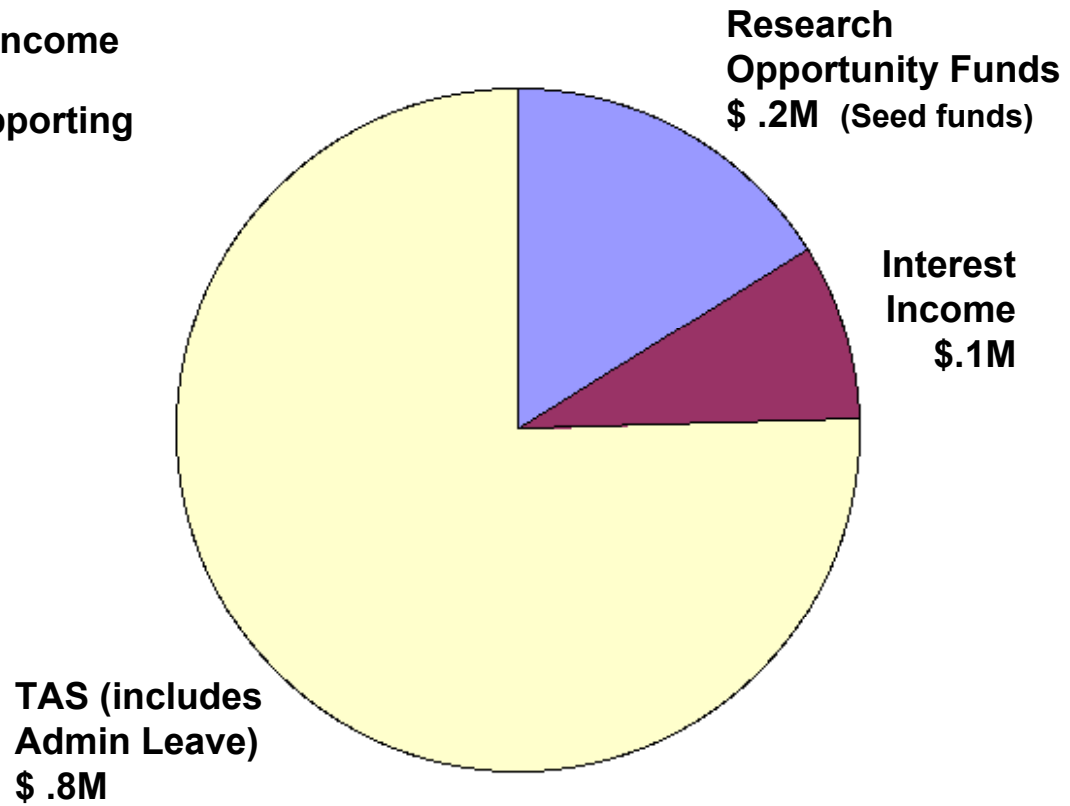
Permanent Funds: $23.8M

% by Source

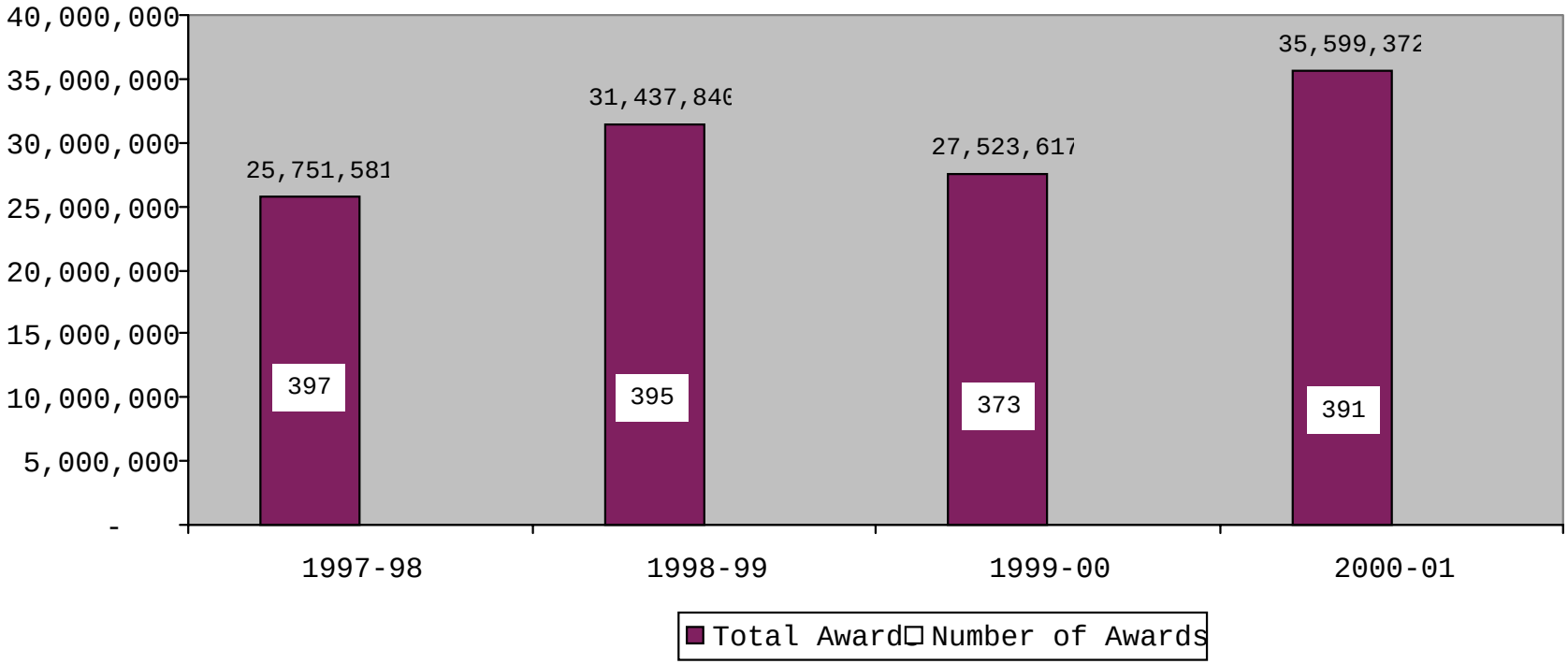


On-Going/Temp. Funds: $1.1M

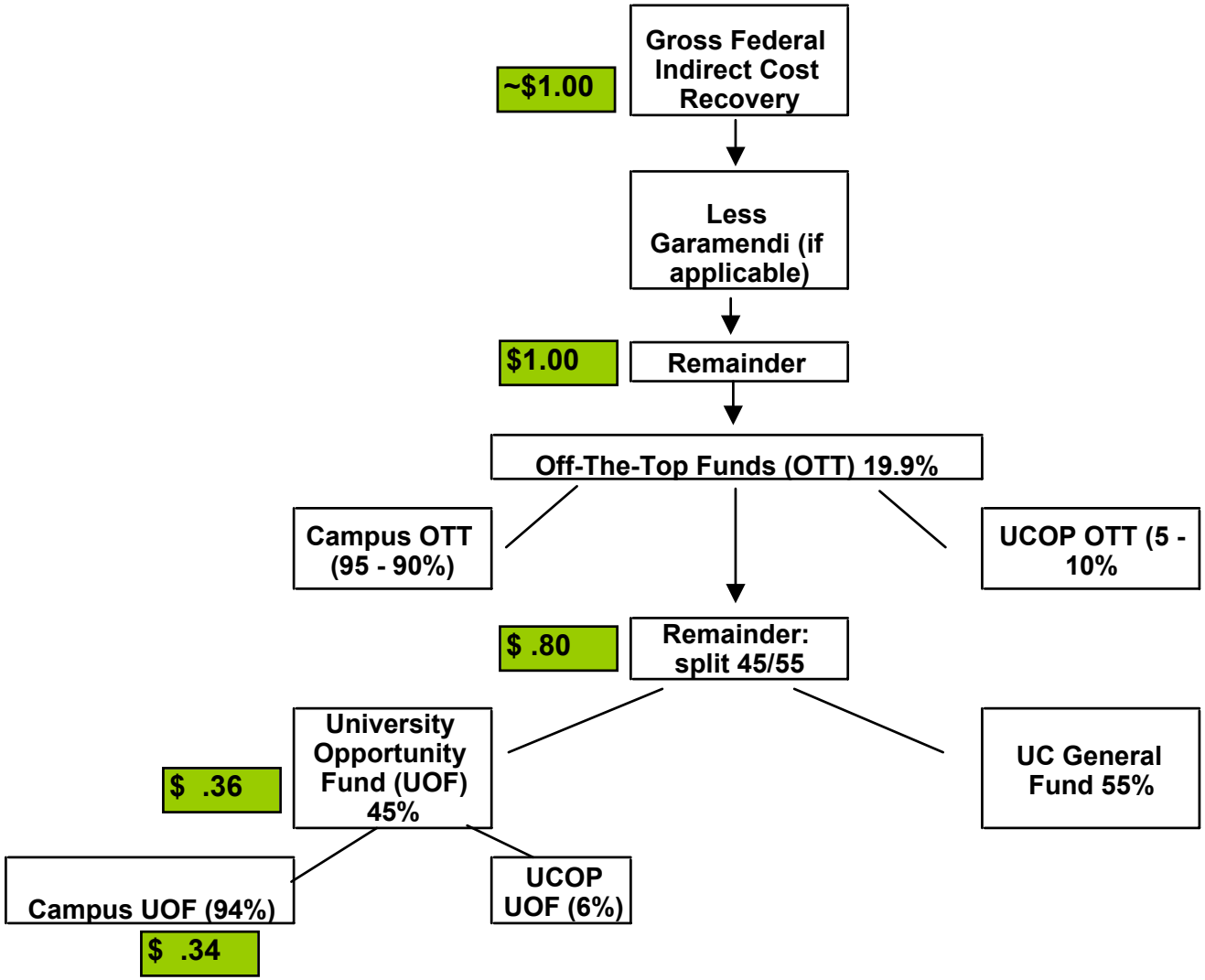
% by Source



Division of Natural Sciences
Extramural Fund Awards
Four-Year History



Flow of Federal Indirect Cost Recovery



Division of Natural Sciences 2001-02

Total Projected Expenditures by Category

Academic salaries	$12.9M	49%	
Staff/tech salaries	6.9M	26%	*86% Salaries*
TA's	2.1M	8%	
TAS	.9M*	3%	
Supplies/equipment	2.1M	8%	
IER	.5M	2%	*14% Non-Salary*
Dean's provisional accounts (Research opportunity, matching, start-up, etc.)	1.0M	4%	
Total	26.4M		

**Augmented by current year and prior year leave savings: ~$400K/year*

Division of Natural Sciences 2001-02

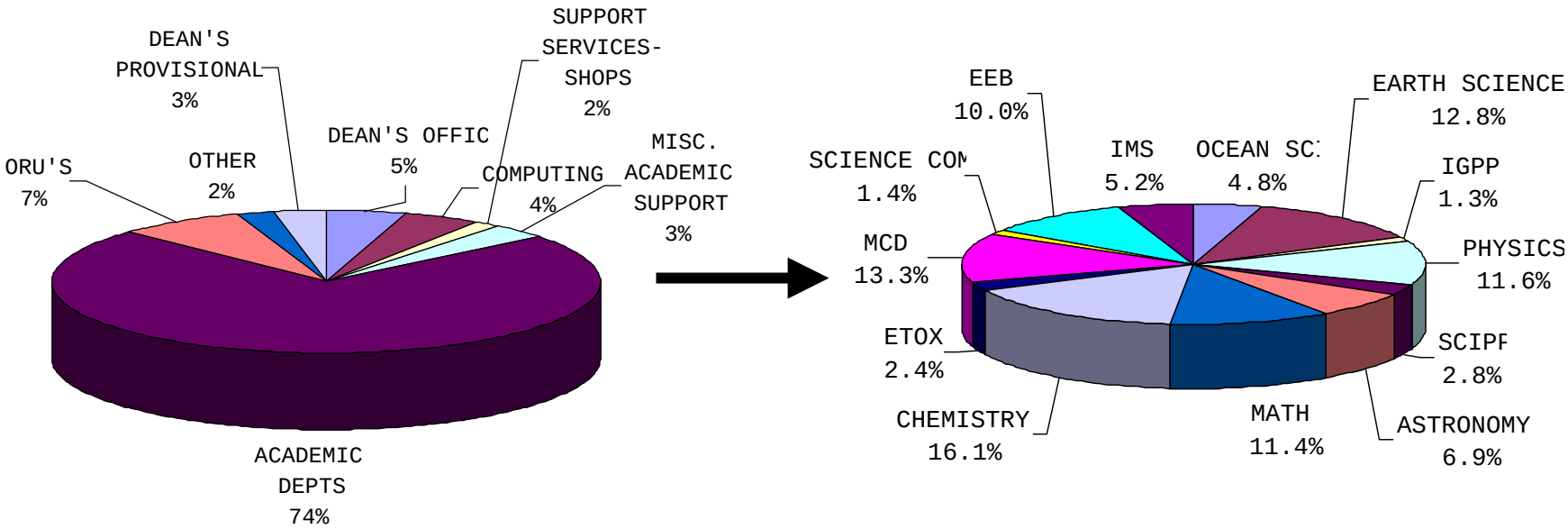
Budget Summary

• Total permanent/on-going budget	$24.9M
• Total projected expenditures	
• Current year projected shortfall	26.4M
– A portion of the shortfall is covered from current year staff salary savings. Leave savings are redistributed to academic departments in the TAS allocation.	($1.5M)

The Division's <u>temporary funds</u> (in the form of prior year carry forward funds and current year savings) are used to cover the shortfall between permanent/on-going resources and projected expenditures. The major areas funded from this source are: start-up funds, matching funds, administrative and academic computing, facilities.

Division of Natural Sciences 2001-02

Percent of Budget by Unit/Department



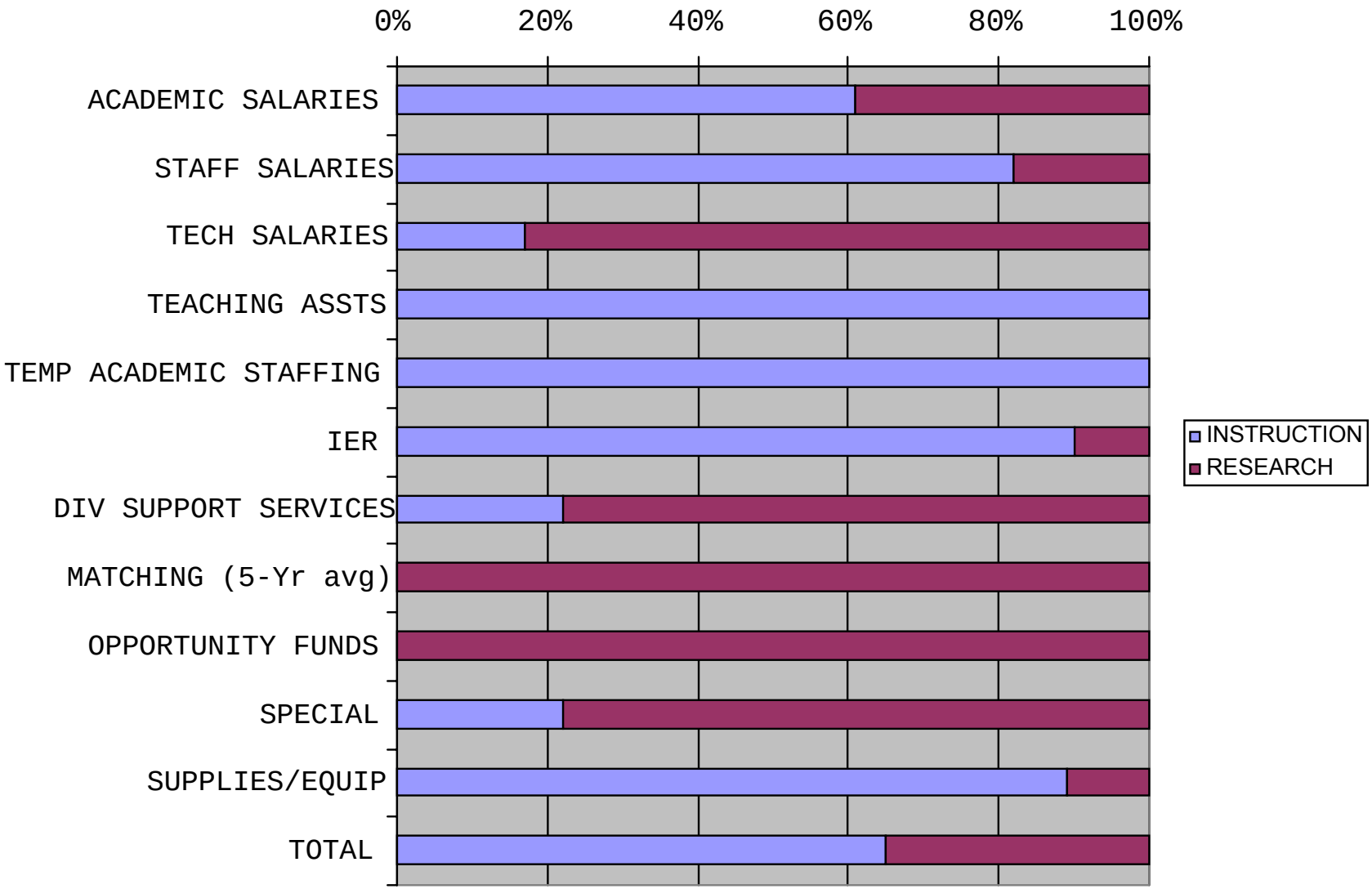
Division Investment Overall:		
Total $		*$26.4M*
Instruction	*56.4%*	*14.9M*
Research	*43.6%*	*11.5M*

Division of Natural Sciences 2001-02

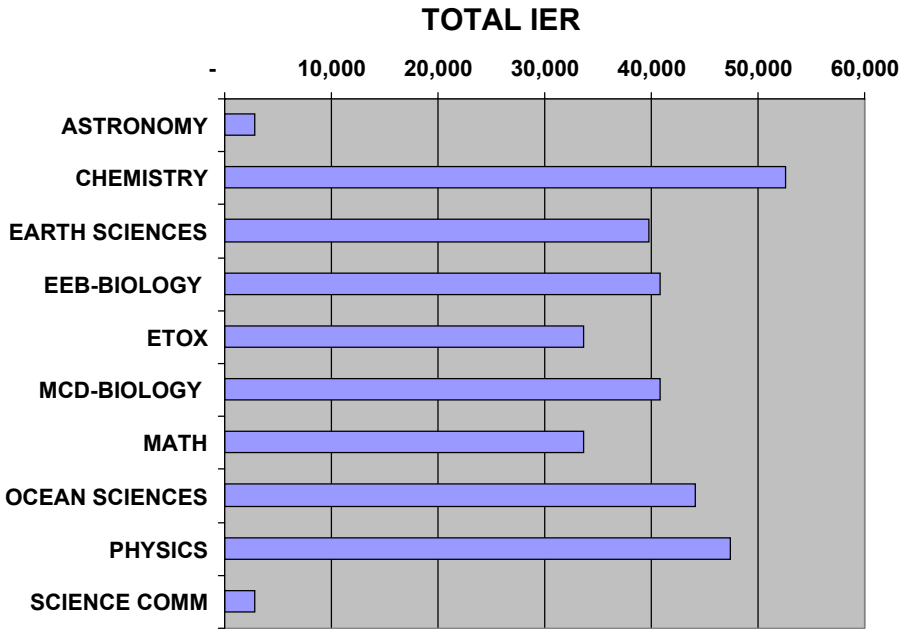
Departmental Investment by Research & Instruction

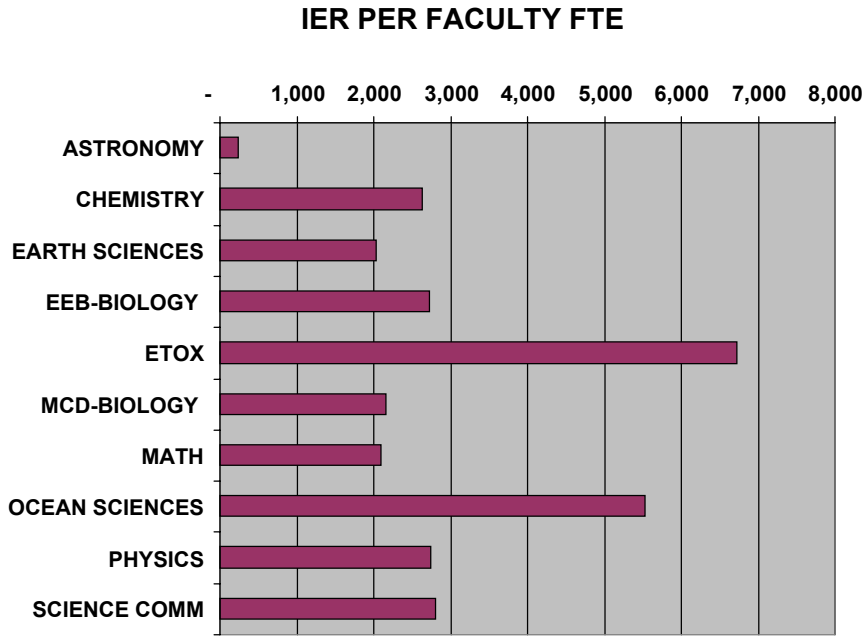
	Instruction %	Research %	Total $
Astronomy	64%	36%	1,498,626
Chemistry	62%	38%	3,472,634
Earth Sciences	58%	42%	2,759,431
EEB	63%	37%	2,168,688
ETOX	62%	38%	520,560
Math	87%	13%	2,457,145
MCD	57%	43%	2,869,826
Ocean Sciences	60%	40%	1,041,010
Physics	64%	36%	2,514,311
Science Com	100%	0%	305,115
Total Academic Departments	65%	35%	19,607,346

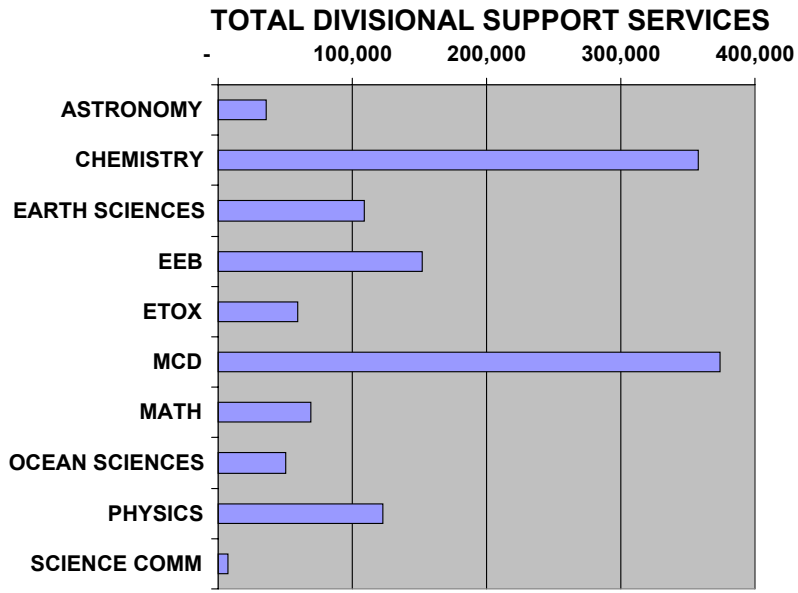
DIVISION OF NATURAL SCIENCES
ACADEMIC DEPARTMENTS
EXPENSE CATEGORIES BY INSTRUCTION/RESEARCH PERCENTAG

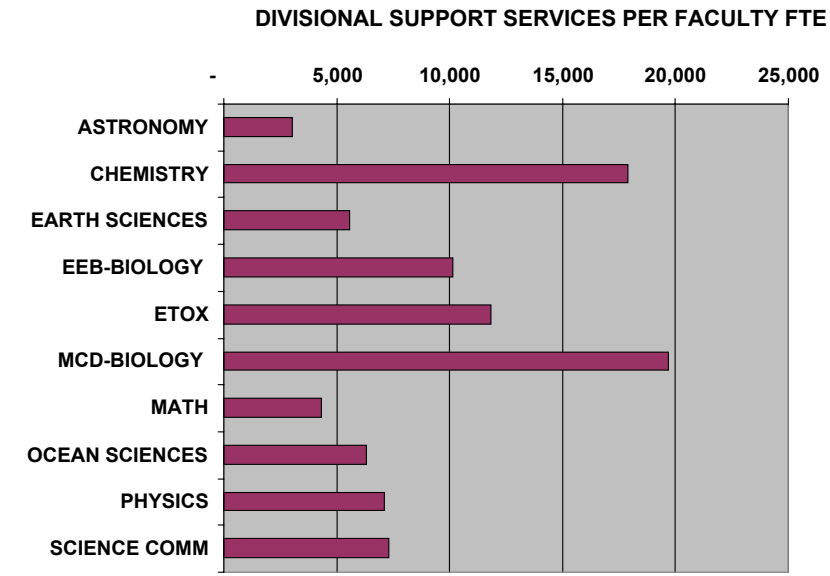


Division of Natural Sciences - 2001-02
Department Comparisons by Expenditure Category

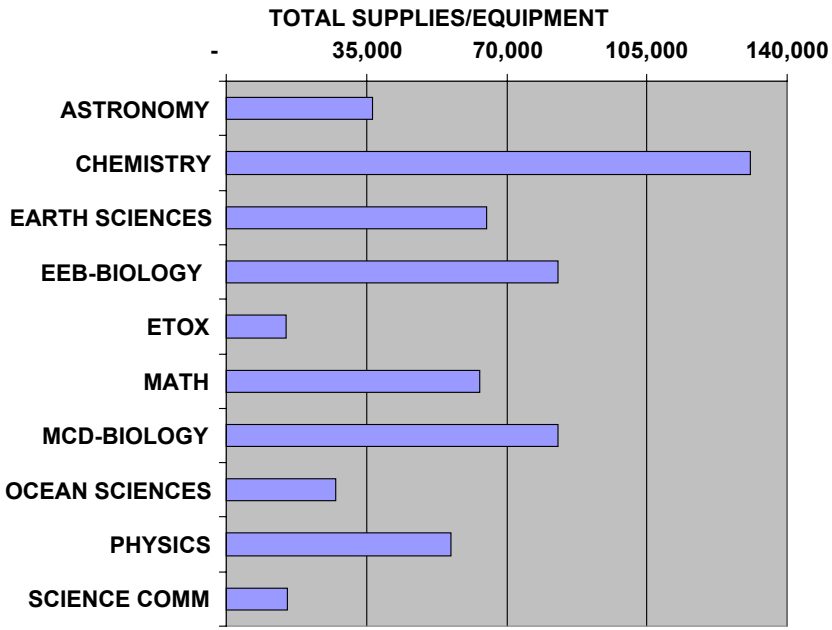


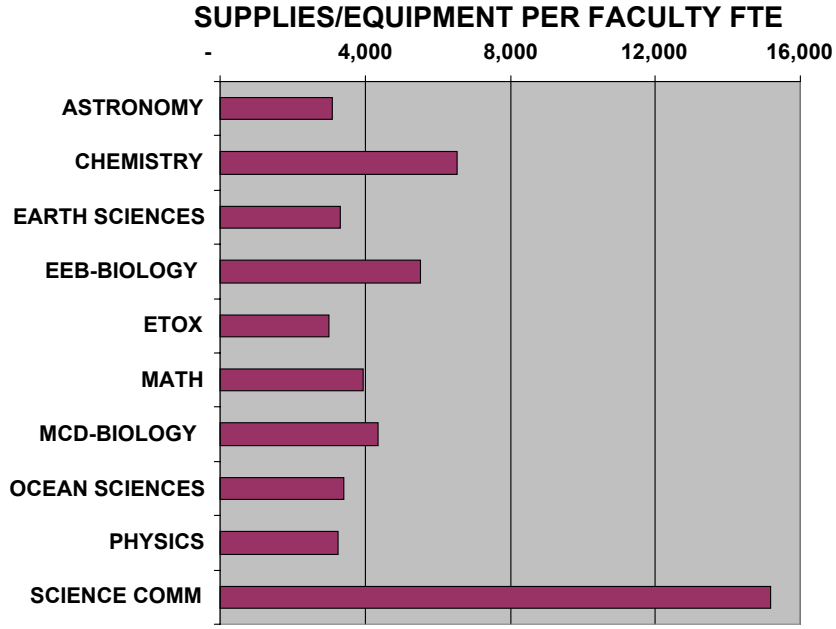


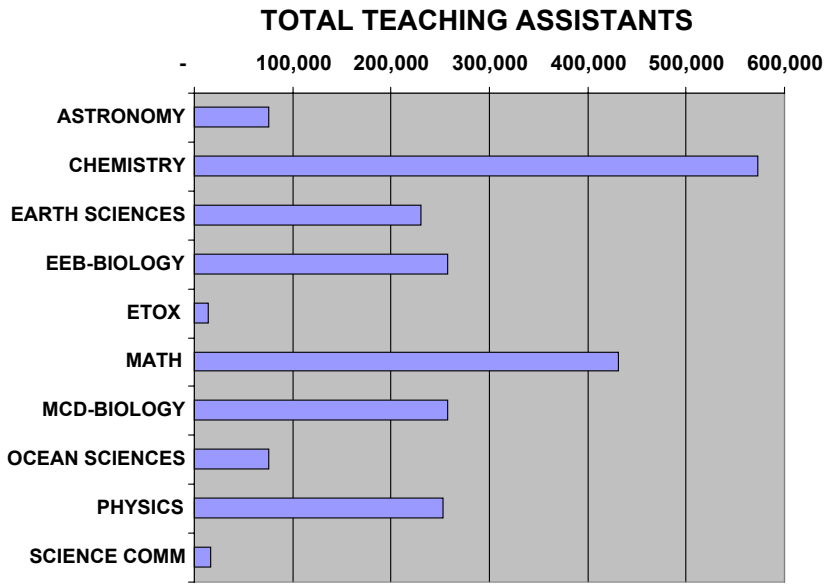


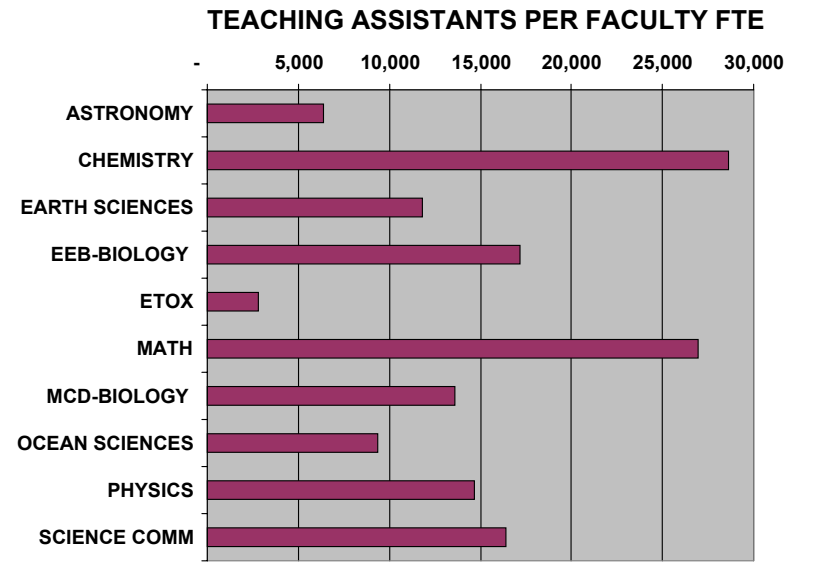


Division of Natural Sciences - 2001-02
Department Comparisons Continued

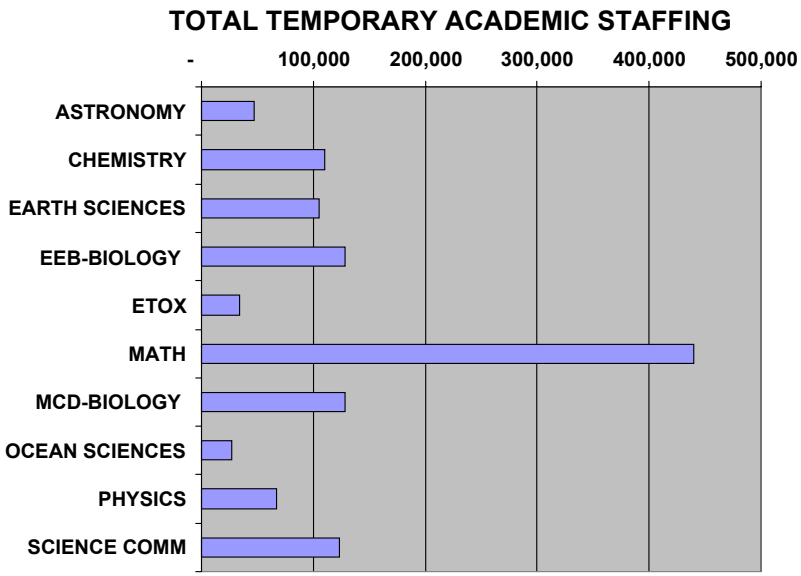


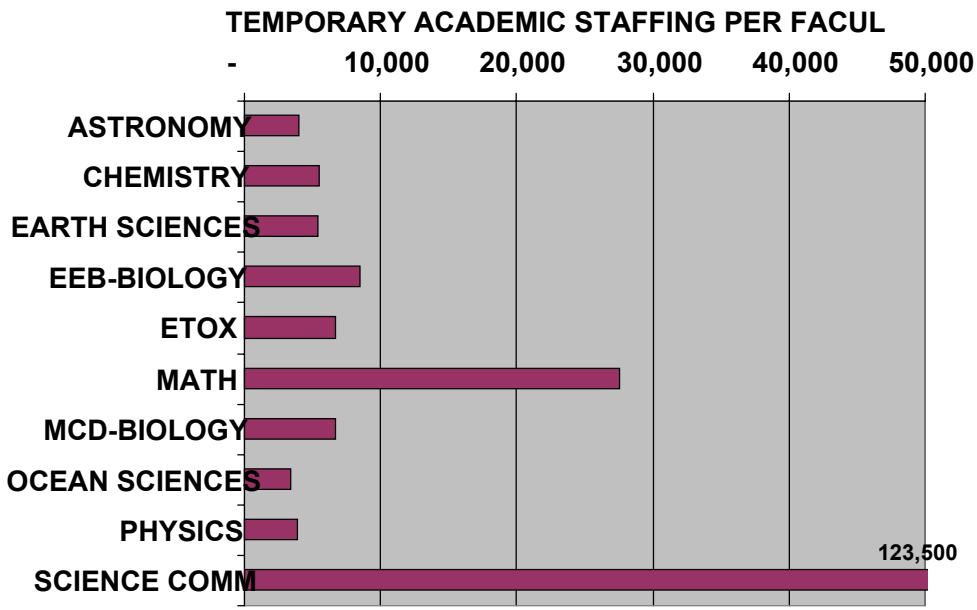


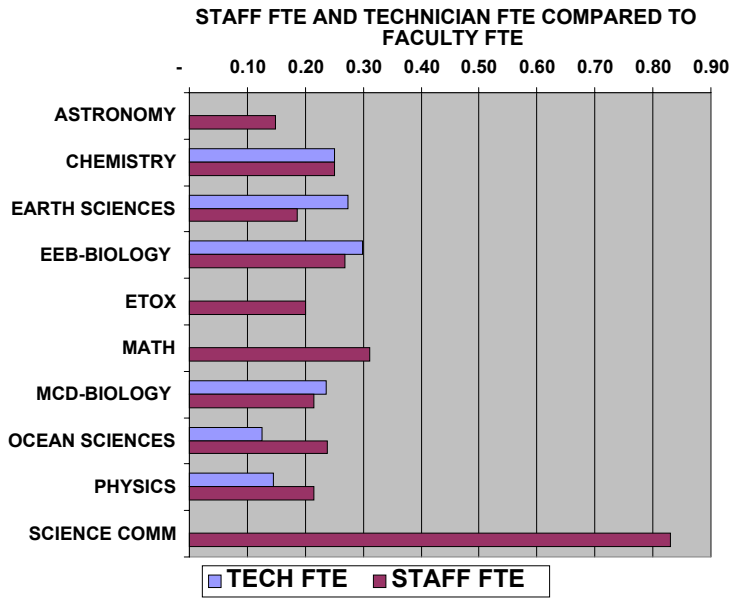




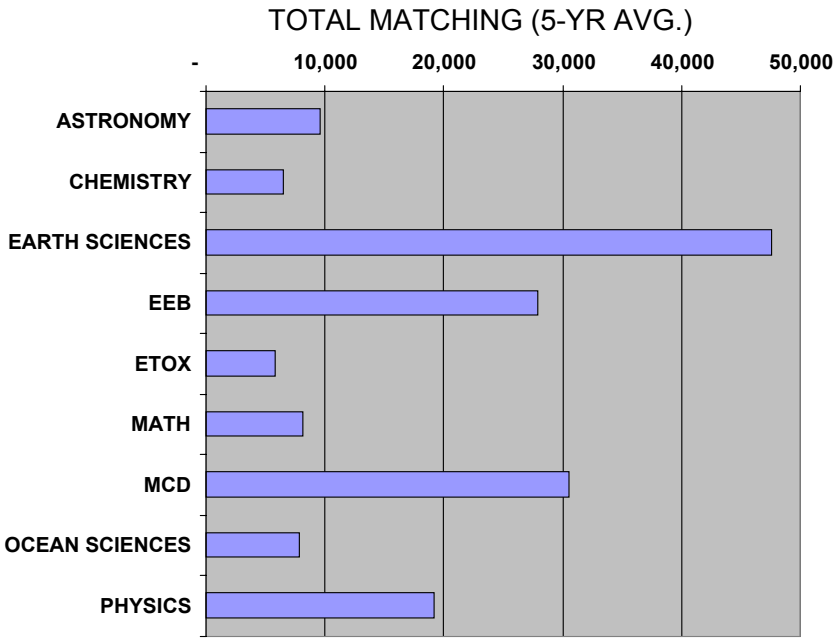
Division of Natural Sciences - 2001-02
Department Comparisons Continued

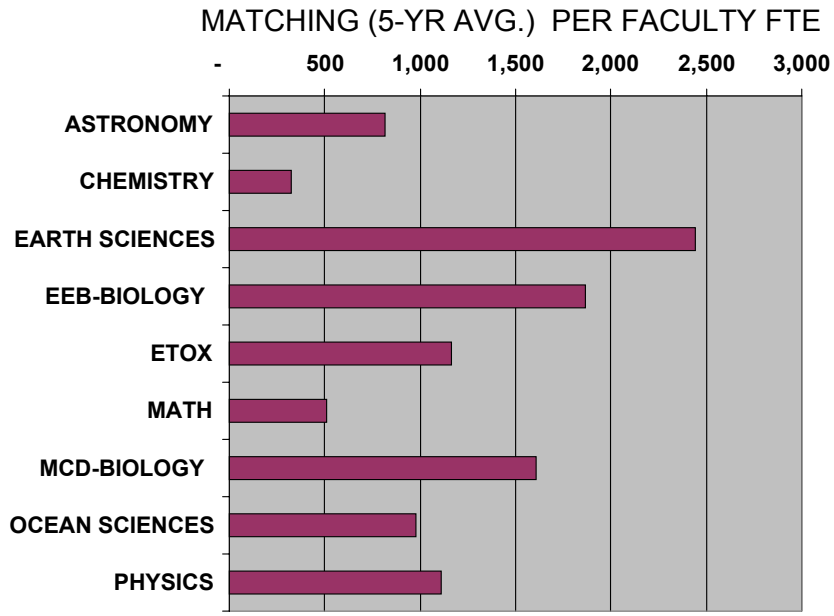


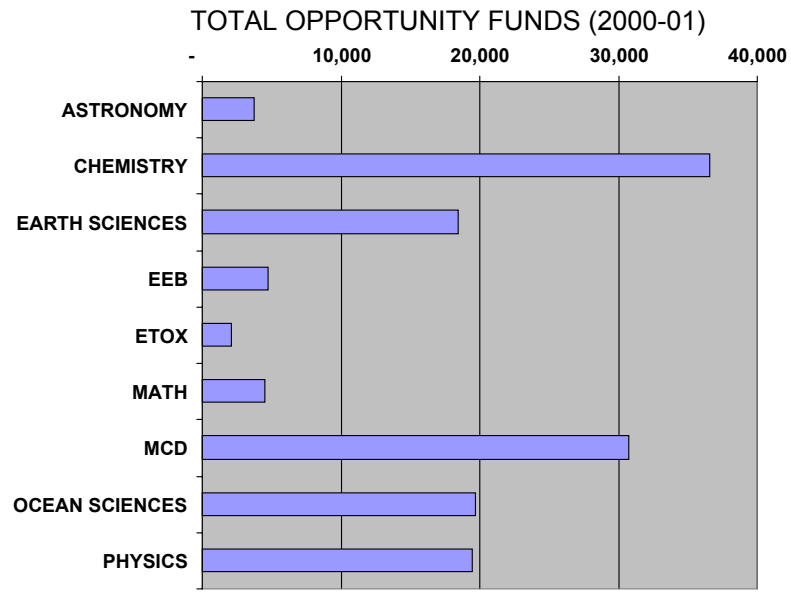


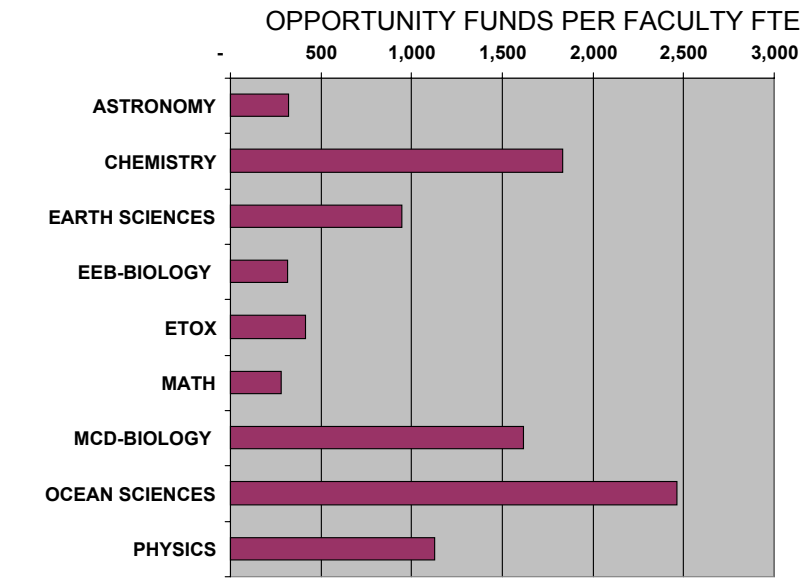


Division of Natural Sciences - 2001-02
Department Comparisons Continued



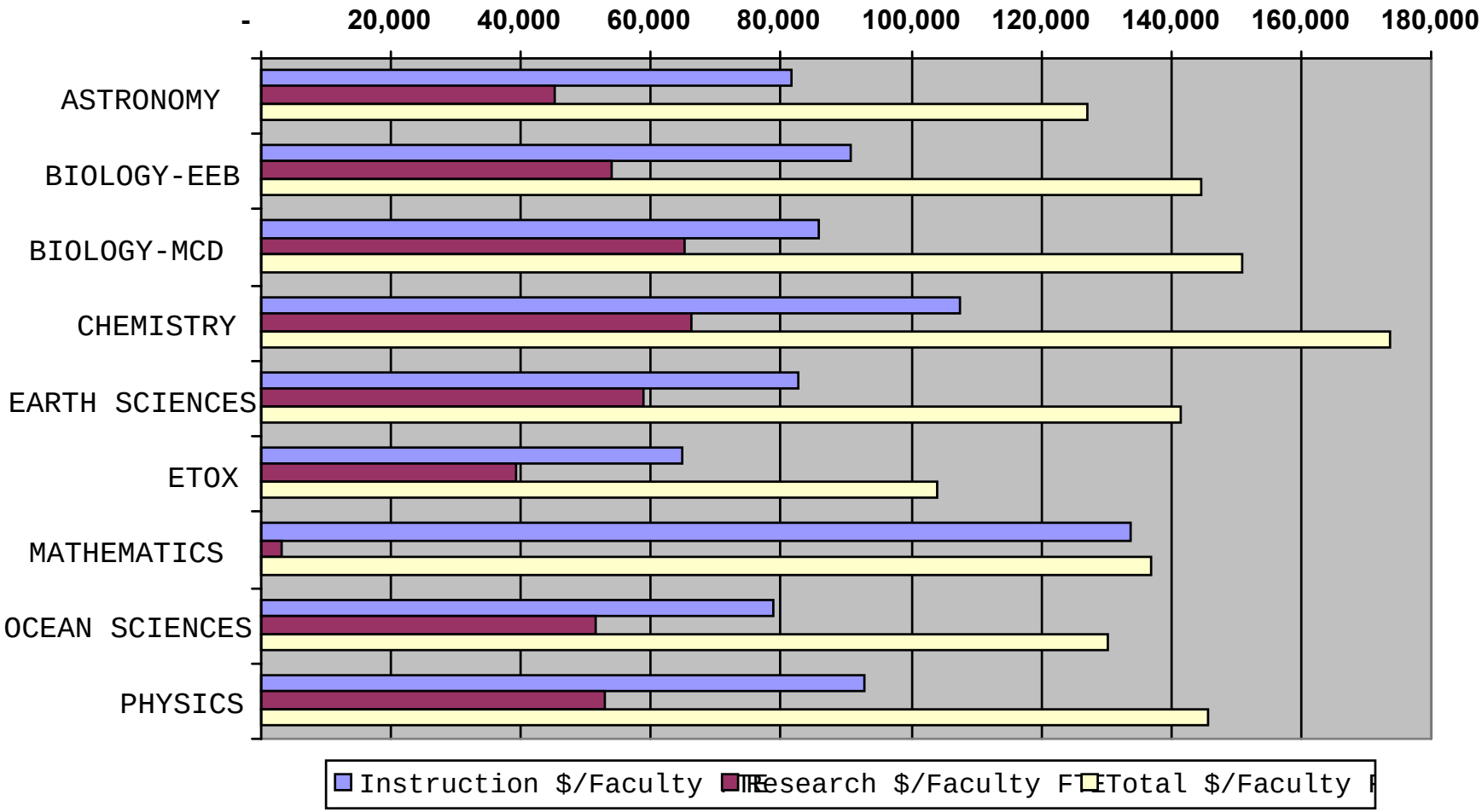




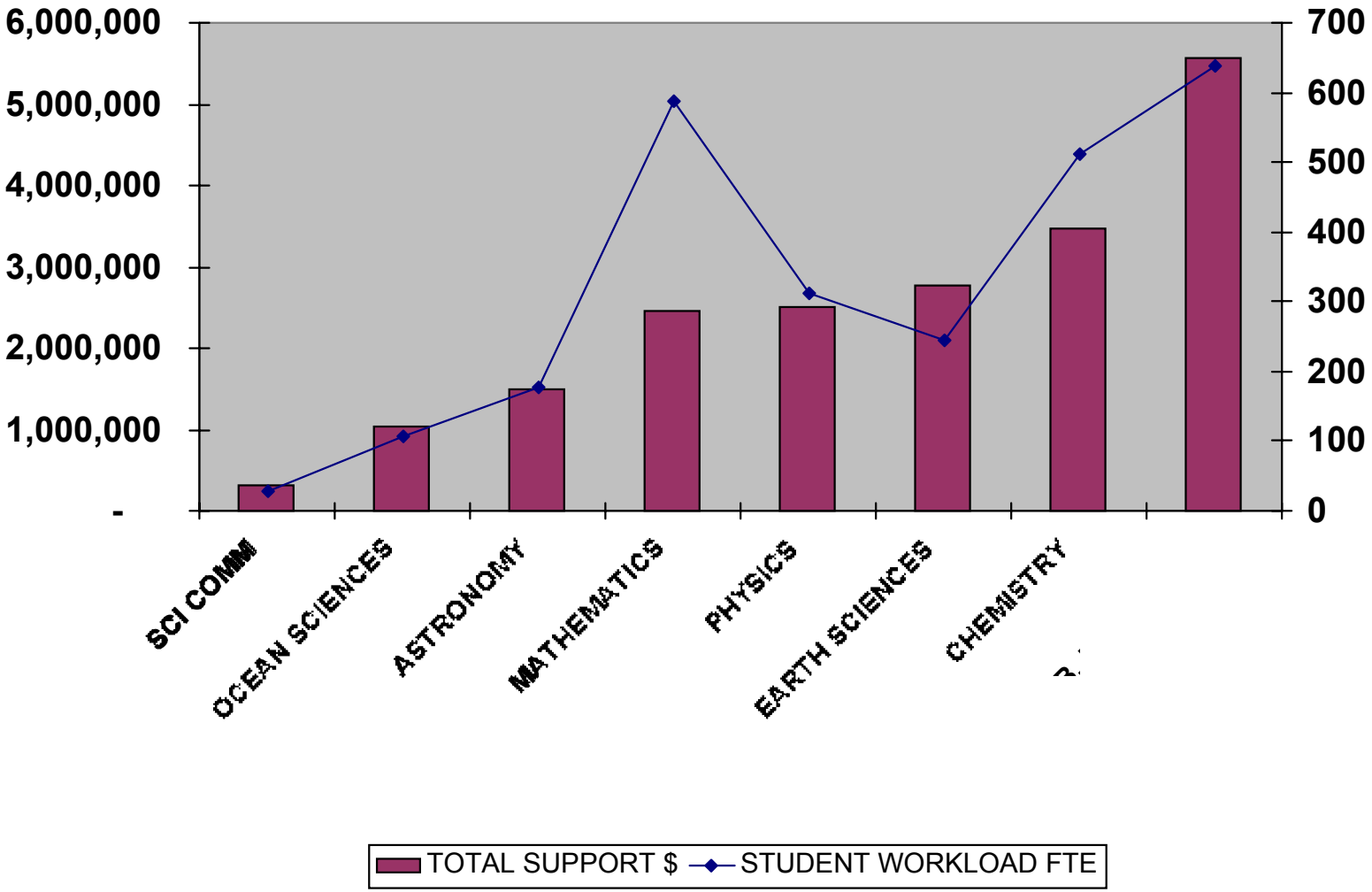


DEPARTMENT INSTRUCTION AND RESEARCH SUPPORT

Per Faculty FTE

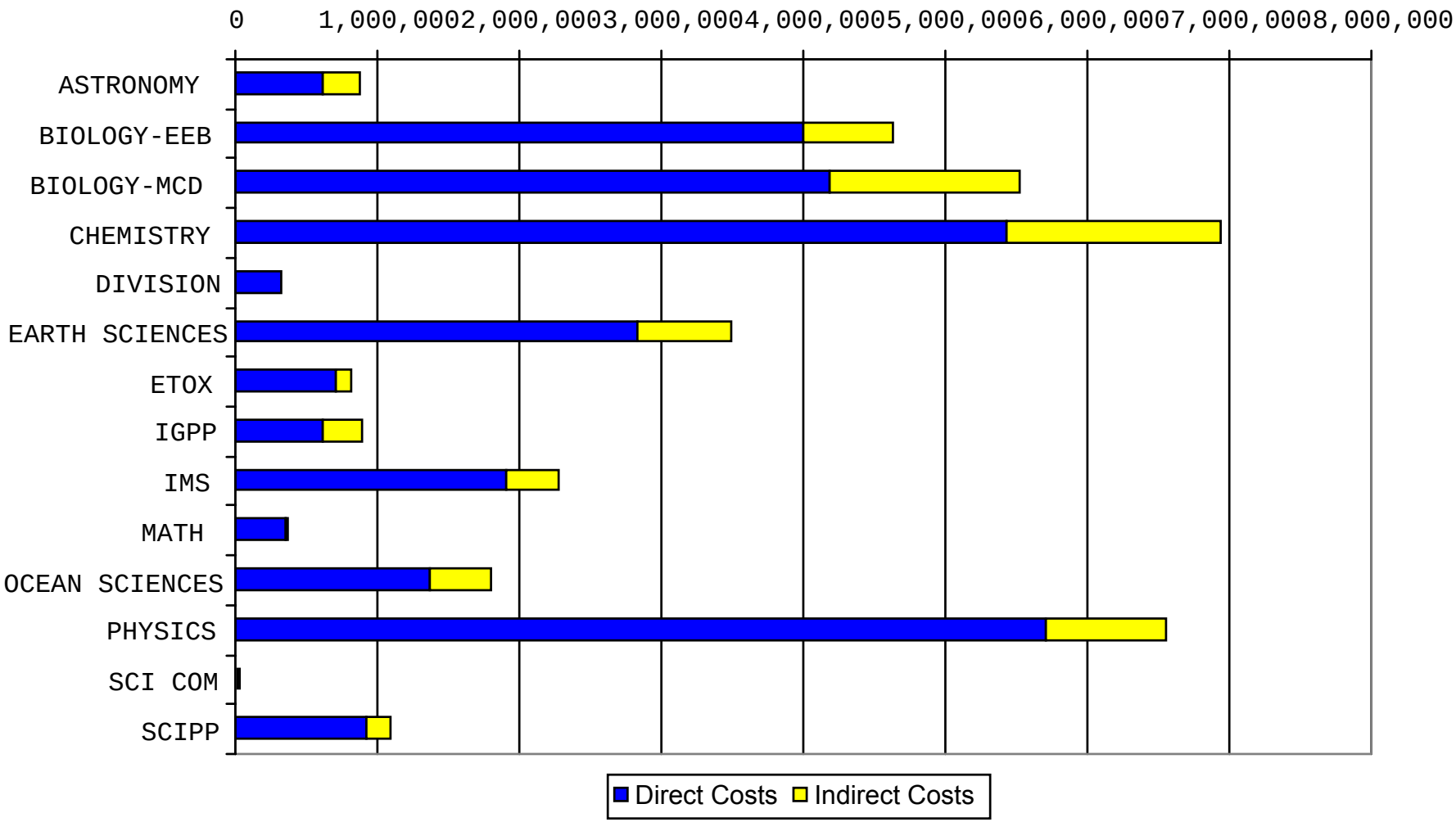


Division of Natural Sciences 2001-02
Total Support $ Compared to Student Workload FTE

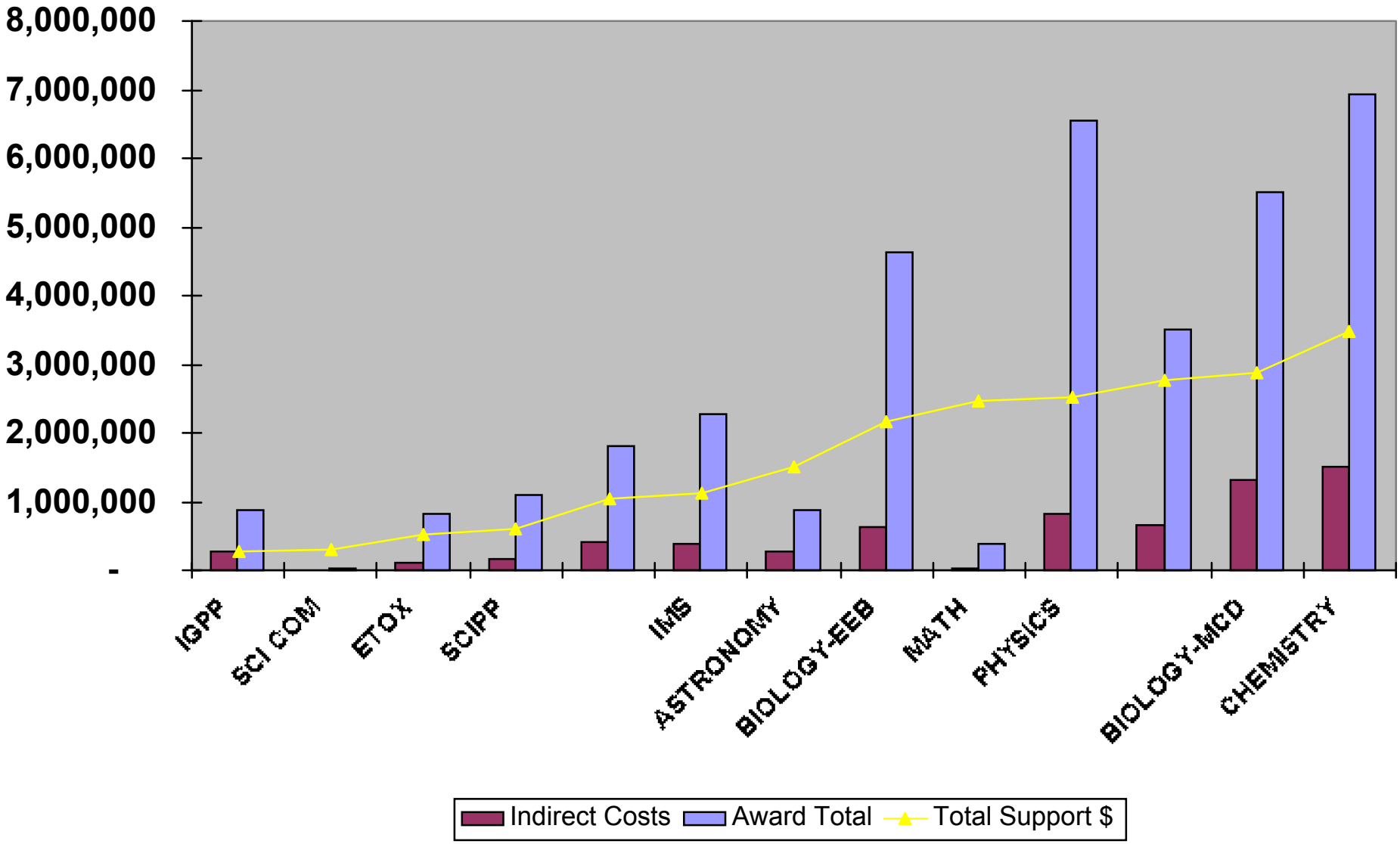


*1999-00 Student Workload

Extramural Fund Awards



Total Support $
Compared to 2000-01 Total Extramural Fund Awards



Take Home Messages

- ***The budget is complicated***
- ***We must support department needs for teaching and research***
- ***Allocations are different for different categories, according to individual department needs***
- ***Overall, budgets seem reasonable relative to department productivity and needs***
- ***We need more students and extramural and private funds to generate more resources***
- ***We must look for efficiencies to maximize funding and ways to reallocate current resources to fund critical priorities***

DRAFT : THE NATURAL SCIENCES SPACE PLAN 2001-02 – 2010-11
SPRING, 2001

Introduction

As part of the campus' long-range planning process, the Division of Natural Sciences is immersed in a comprehensive and strategic course of action designed to culminate with a well-developed academic plan. The programmatic directions of the disciplines form the tactical plans that define the vision for the natural sciences at UCSC.

This undertaking must include serious consideration of the full range of resources necessary to support a sound and effective infrastructure. The division has made every effort to focus on realistic planning goals, not to limit the range of possibilities or opportunities, but to stress the importance of a careful and measured assessment of what will be needed in order to accomplish these goals.

One of the challenges that must be faced during this period of rapid campus growth is coping with limited space and multiple needs. Current planning must recognize and account for significant changes to the academic programs over recent years that have had an impact on original campus plans and key areas of development, such as Science Hill. For example, the establishment and development of a School of Engineering and the inclusion of Environmental Sciences faculty on Science Hill has created tremendous opportunities for interdisciplinary collaborations. Careful consideration of essential faculty clustering at this time could establish a fortuitous thematic flow of the physical landscape of Science Hill and its surroundings.

The divisional approach to space planning began last spring with a call to departments to complete a detailed survey for review by an Ad Hoc Space Committee charged with preparing recommendations for the dean. Critical data were collected from the responses to questions regarding planned faculty hires, expected faculty retirements, new staff and technical support anticipated, classroom needs, and so on. The committee subsequently studied the various reports produced utilizing the information gathered and submitted observations and recommendations that have become the basis of the division's space plan. Appendices B1-B14 include the original request of departments and selected summary reports.

Since this time, the departments have prepared submittals that have shaped the current divisional 2001-2010 Academic Planning Executive Summary. These submittals provide further details regarding programmatic expansion, faculty recruitments, and core research endeavors and serve to reinforce data extrapolated from survey results. A copy of the summary has been included as Appendix D.

Current Situation and Utilization

Currently the division occupies over 319,000 ASF within eight buildings (along with auxiliary space such as trailers) housing Astronomy, Biology (EEB and MCD), Chemistry, Earth Sciences, Environmental Toxicology, Mathematics, Ocean Sciences, Physics, Science Communication, as well as the division's organized research units, administrative offices, and other research and

instructional space. There are three major building projects in various planning and construction phases: Interdisciplinary Sciences Building (ISB), Center for Adaptive Optics (CfAO), and the Physical Sciences Building (PSB). Though new buildings offer increased ASF, the net gain for the division overall is reduced due to a loss of released space. An estimated timeline with project details, as well as ASF gains and losses, is included as Appendix C.

Natural Sciences is near critical capacity in terms of space. The severity of the problems facing the departments varies, however, and a great deal of the physical challenges fall into the category of the inefficient use of space that ill fits departmental needs. Several of our departments are on the brink of hardship given the number of faculty recruitments conducted over the past two years. Finding suitable office and laboratory space has been and will be very difficult for some departments. Department chairs have been extremely resourceful in working together to solve some of the more immediate space problems, but this has not been easily accomplished. It has simply postponed what the division will have to come to terms with within the next five years: either a moratorium on faculty hires, moving selected (administrative) units to off-campus space, or requiring departments to reconfigure existing laboratories to carve out space for new faculty. It is conceivable that a combination of these would need to be employed as problem solving strategies.

Chairs have been asked to prepare for such an eventuality as squeezing or cramming into existing space allotments, and there is certainly a possibility that thoughtful reorganization and resourceful utilization of selected existing space would offer some ease to the current crush. It is effective and thoughtful long-range planning, however, that will put the division in a position to fashion a final configuration that offers a chance to alleviate historical problems, as well as to address all reasonable space needs.

There are special factors that present unique problems for Natural Sciences and further complicate the lack of adequate space. In approximately two years, the division will be required to vacate trailer space located behind the Baskin Engineering Building, when the process of building the new Engineering Building begins. Alternative space will be necessary for twenty-five people performing critical divisional functions that range from computing support to academic advising. A loss of the trailer space further exacerbates the total divisional space shortfall. It is understood that a portion, but not all, of this space will be returned to the division in Baskin Engineering. An additional 10,000 ASF must be built into construction projects in order to rectify this.

Long-term Planning

The campus at large and the division in particular will not be served by hasty and stopgap planning that inevitably does not meet the division's long-term programmatic needs. It is important to stress the need to avoid recommendations that will ultimately result in costly double moves. Therefore, long-range planning will be addressed first, in order to determine how the division will position itself to meet overall space needs given the time constraints of major projects and faculty hiring.

Critical Factors, Assumptions, and Methodology

The significant issues dominant in effective and realistic divisional planning include the following:

- Shortage of aggregate space: The division anticipates a critical shortage of aggregate space during the expansion phase and this will have a major impact on the addition of new faculty. The aggregate space constraints will have a strong temporal dependence, easing marginally as buildings are completed and tightening in succeeding years. The effect on different departments will vary substantially, depending on which departments are slated to move into completed buildings.

- Need for specialized space: The need for specialized space is vital for supporting the scientists' research endeavors. Essential laboratory space necessary to support faculty research totals more than six times the ASF required for office space. Although expansion of the Natural Sciences and investments in specialized research and teaching space is a costly endeavor for the campus, it is vital to the campus to build the necessary infrastructure to support the faculty who will help realize substantial increases in extramural funding and help to increase the number of graduate students entering UCSC doctoral programs. Departments estimated that additional space for specialized instruction and qualified technicians would be necessary to support the expected enrollment growth in the sciences over the next ten years. Computer labs, dry labs, and wet labs will be necessary to accommodate more students seeking instruction in the sciences at both the lower division and upper division level.

- Released space results in minimal gain of ASF: While the division has three major building projects underway in various stages - Interdisciplinary Sciences Building, the Center for Adaptive Optics, and the Physical Sciences Building - there is no substantial net increase of square footage until the completion of the Physical Sciences Building. This is misleading, however, as the released space in Thimann Laboratories made possible by the Physical Sciences Building coming on-line, must be held vacant in order to allow for housing faculty and staff who will be displaced once the Sinsheimer Seismic Project begins. The Seismic project is estimated as one-year in length, which means that permanent occupancy in Thimann will not be available until 2006 at the earliest.

- Stalled recruitments may result from space shortage: Even with the completion of the Physical Sciences Building in 2003-04 (presuming that completion remains within the current timeline), the shortfall in the very next year will prevent any further hires in the Natural Sciences. It is estimated that the division will only be able to add around two dozen faculty before being fully constrained by lack of space. This leaves roughly two thirds of the planned hires in limbo and would halt most programmatic development efforts by the mid-way mark in the timeline through 2010. Stalled recruitments means stalled growth for the sciences. This will have a direct negative impact on the areas that the division sees growing and that offer the most promise in securing new levels of outside funding.

In order to address the above issues and create model/models that could be used to develop effective space plans, growth patterns were used that would provide the adequate square footage necessary to sustain the collective efforts of the division when the campus reaches its goal of 15,000 students. Two different models, based on total numbers of faculty, researchers, post-docs and graduate students, have been used to calculate aggregate space needs.

Calculations were based on linear growth projections using two different baselines: "doable space" and "80% of CPEC guidelines", taking into account completed building projects over the next few years. Serious shortfalls are projected as early as 2004-05, based on departmental plans and corresponding space needs. The problem grows significantly over the next years to build-out and culminates in a shortfall of over 90,000 ASF or 146,000 ASF depending on the measure utilized.

Selected charts (Attachments 1-3) attached to this report present graphically the space shortfalls predicted by 2010. These help to depict the needs of the division each year until 2010 based on planning to date and as compared to total ASF gained (and lost) once construction projects are completed.

The conclusions drawn from the growth calculations help to formulate a final space configuration for the division. The building of the Earth and Marine Sciences Annex, even with the additional 42,000 ASF, can be viewed as a band-aid or limited solution only to the lack of overall space for the sciences. The long-term space needs of the division indicate that a large building, estimated at 110,000+ ASF is necessary to accommodate faculty growth, the accelerating needs for teaching space, and serve to strategically cluster faculty to promote interdisciplinary collaborations. Thus, constructing a large, cost effective building, namely Natural Sciences 6, ahead of a planned addition to Earth and Marine Sciences, is a sensible solution that helps to meet the overall needs of the division and allows for growth in support of instruction and research. It must be noted that the addition to Earth and Marine Sciences remains important to the division and should appear in out years on the 5-Year Major Capital Improvement List.

Science Hill 2010

The current strength of the division exists in the faculty who are working on important research that promises significant advances in the areas of health, the environment, and new technologies that will fuel the economy. Many science faculty are working as part of interdisciplinary clusters to promote both research collaboration as well as new academic programs that will attract and retain new students. New resources that become available to the division must be directed to insure that existing programs remain vital and yet provide opportunity for expansion into new and exciting research areas. Developing strategies for faculty hiring will allow proposed programs to flourish, will sustain strength in the departments, and will provide opportunities to expand research into new areas. Investment in this strategy will produce a balanced contemporary curriculum that will provide students with rigorous training in the core disciplines and an opportunity for exposure to interdisciplinary approaches in the sciences. The vision for Science Hill in 2010 is a picture of faculty, programs, and research units clustered to make the

most of collaboration. Programs will be shaped to take advantage of new developments and new discoveries.

By forecasting the distribution of new faculty within the sciences it is possible to understand the range of new initiatives and programs that the division can fully support at target growth as well as inform effective space planning efforts. The division plans to link exciting new research areas with established programs to insure the viability of instructional programs and to promote research activities of the highest caliber. Maintaining a healthy, productive science enterprise is vital for the campus in its quest to bring the external resources necessary to reach our campus goals that center on achieving status as an AAU institution. Specific AAU benchmarks include external grants, contracts, and fellowships per faculty FTE, graduate credit hours per faculty FTE, graduate majors per faculty FTE, number of Ph.D. students per faculty FTE, Ph.D. degrees awarded per faculty FTE, just to mention a few. The Division of Natural Sciences can lead the campus in its mission to double extramural funding and increase the number of graduate students, if the division could adequately house and provide for new faculty and students. This obviously requires careful and thoughtful space planning in cooperation with the campus space planning process in order to make optimal use of existing and planned space.

The build out plan envisioned for Science Hill in 2010 is detailed in Attachment 4 and 5. The division is proposing that the Earth and Marine Sciences Annex be supplanted by Natural Sciences 6. The plan hinges on the completion of Natural Sciences 6 and assumes that the subsequent released space made available in Earth and Marine Sciences, ISB, Natural Sciences II, PSB, and Sinsheimer remains division-controlled space (see Attachment 6). Interdisciplinary collaboration was a prime factor influencing the topographical design of the Science Hill of the future. A modest space allocation for Environmental Studies has been proposed based on the reasoning that the released space made possible with the completion of Natural Sciences 6 should help alleviate some of the space problems faced by other divisions, as well as foster and "institutionalize" interdisciplinary collaborations.

Attachment 7 is a conceptual view of divisional departments in 2010 along with projected square footage. Consistent with our academic planning approach of clustering departments by areas of concentration, the space plan has been developed to maximize the interactions within the three dominant areas of science: health, the environment, and technology.

The estimated total increase in faculty FTE at build-out in 2010 is 202. This calculates to an increase of 70 from current numbers. This appears at first a remarkably high number and representative of an ambitious growth plan. It is in fact ambitious, but actually when dissected to incremental changes over the next nine years, seems reasonable and ultimately achievable. First, seven to eight faculty recruitments per year is not unreasonable, especially when one reviews the last few years where the division has averaged nearly one per department.

This does mean that the division will have to plan seriously and strategically to increase enrollments in order to sustain the current workload ratio. To sustain a student/faculty workload ratio of 18:1 with a total of 201 faculty, the total student workload FTE will have to rise to 3618. In 1999, the division total was 2611. This represents a 39% increase, and a dramatic increase in

student credit hours. Roughly speaking, this means a cumulative increase of 9000 enrollments, or approximately 1000 enrollments each year.

Though a bold plan and a bold projection, when the enrollment gain from new programs is considered it seems promising. Applied Physics, Astrophysics, and Health Sciences, for example, loom as key areas of programmatic strength and student demand.

Selected highlights of programmatic developments—many of them interdisciplinary and all of them aligned with the division's three thematic areas of concentration along with projected needs for assigned square footage—are presented in the following section.

Astronomy and Astrophysics

A total of 18,304 ASF is projected as necessary to support the department in 2010 with 14.6 total faculty FTE along with associated students and researchers. CODEP related activities form the priorities for faculty hires over the next few years. Though a graduate program only, the department typically offers several large lecture courses at the undergraduate level. These have increased in popularity and thus have increased the total student workload ratio to an impressive 19:1 in 1999-00. In fact, there has been a steady increase in the student/faculty ratio since 1996-97. A reasonable incremental change in total enrollments will sustain healthy ratios even with increased numbers of faculty. Increased enrollments are expected as a result of the requirements associated with the new B.S. degree offered through Physics.

Biological Sciences:

The Evolutionary and Ecological Biology Department

The Molecular, Cellular and Developmental Biology Department

A total of 60 ladder faculty FTE is projected for 2010, up 24 from a current total of 36. Space needs for the combined faculty growth, as well as associated graduate students, post-docs, and researchers are estimated at 127,011 ASF.

Student workload FTE totaled 639 in 1999-00. Although the Biological Sciences have experiencing declining enrollments over the past several years, there is indication of a solid positive turn-around. Both departments plan exciting and unique programs that promise to bring new students to campus and to greatly stimulate the overall enrollments in the Biological Sciences. Though the division's overall health will be strengthened with an overall increase in the student/faculty ratio in the Biological Sciences, to simply sustain the current workload ratio of 16:1 with 60 faculty FTE requires a 50% increase in total student workload FTE by 2010. This is certainly ambitious, however, given plans for such vibrant programs as Health Sciences, proposed as a unique interdisciplinary program that will expand the undergraduate and graduate course offerings, this is definitely achievable. Other interdisciplinary collaborations such as developing an undergraduate concentration in Environmental Health in cooperation with Earth Sciences, Environmental Toxicology, and Chemistry promise increased enrollments for socially relevant and topical programs.

Chemistry and Biochemistry

Currently the department of Chemistry and Biochemistry has a total of 21 ladder faculty FTE. The proposed total for 2010 is 31, or an increase of 10. The department envisions new faculty hires to support two major initiatives: Complex Materials and the Center for Biomolecular Science and Engineering. Proposed aggregate space needs total 81,579 ASF.

The student/faculty workload ratio in the department has tended to be among the highest within the division. Assuming that Chemistry maintains a 23.5:1 ratio with 31 faculty, means bringing the total student workload FTE up from a current 512 to 729. This 42% increase over nine years is probable given the direct curricular connection to other campus programs and a projected increase in the total number of Chemistry majors at UCSC.

Earth Sciences

A total increase of 8 faculty FTE are proposed for Earth Sciences, moving the department from a current total of 19 to a projected total of 27. Corresponding space needs are projected at 59,641 ASF.

Investments in the successful IGPP initiative promise to build the total number of graduate students, draw undergraduates to exciting new larger lecture classes and subsequently build enrollments. Earth Sciences' student/faculty workload ratio dropped sharply in 1999-00, but current year totals indicate a slight trend upward. It is expected that over the next nine years the department will climb to a ratio of 15:1. This will mean a 64% increase in total student workload FTE.

Environmental Toxicology

Environmental Toxicology is a growing graduate program. Faculty FTE are slated to grow by 6 for a total of 10. Corresponding space needs, with allowances for graduate students and researchers, total 17,287 ASF. Environmental Toxicology is involved in several new curricular and research endeavors, and increased enrollments credited to ETOX faculty are projected.

As of next year, enrollments for the program will be teased out of the Biological Sciences total, as they appear now, and used to create a new section in the Instructional Load Summary. This will allow for effective enrollment tracking and workload ratio calculations.

Mathematics

The addition of 4 new faculty is expected in the department by 2010, bringing the total faculty FTE to 20. Projected space needs total 18,564 ASF. Enrollment patterns have been fluctuating in the department despite an expected steady climb due to incoming Engineering students. Still, the overall student/faculty ratio remains high at 22:1.

To maintain this ratio with a total of 20 faculty means virtually little increase in total enrollments, as the department has had to rely on a relatively large number of temporary faculty to help mount the curriculum. Additional ladder faculty appointments will correlate to fewer temporary faculty needed to teach, and thus a modest cumulative enrollment increase over the next nine years will mean that healthy student/faculty ratios will be maintained.

Ocean Sciences

Though currently a graduate program only, the department is currently evaluating undergraduate degree options. They seek to design a distinctive, high-quality and rigorous science major in ocean sciences. Total faculty FTE expected in 2010 is 13, up from a current total of 8. The total ASF required to support the department and associated personnel is projected at 21,865.

Along with significant developments in research endeavors such as C.DELSI, a Center under the umbrella of the IGPP MRU, total enrollments in Ocean Sciences have been steadily increasing. In 1999-00 the student/faculty workload ratio was 17:1, up from 16:1 in the prior year. To maintain this ratio with a total of 13 faculty means more than doubling the total student workload FTE from current levels. It is conceivable, however, that a sharp increase in enrollments could be realized with the development of a superior undergraduate program.

Physics

A total of 26.25 faculty FTE is proposed for 2010 with an associated 36,843 ASF necessary to support the program. This means an overall increase of 8 faculty. Successful interdisciplinary collaborations with Engineering and with Astronomy and Astrophysics promise new degree options for UCSC students, which in turn promise increased enrollments.

Over the last two years the department has realized a dramatic upswing in enrollments, particularly in undergraduate enrollments. The overall student/faculty ratio increased to 17:1 in 1999-00. With new and exciting degree programs planned, there is no reason to expect that this pattern will change. To maintain a 17:1 ratio with 26.25 faculty the department will have to realize a 44% increase in total student workload FTE by 2010.

Related Research Units and Endeavors

CFAO, IGPP, IMS, UCOLick, and SCIPP currently comprise the research units under the Natural Sciences. Each of these ORUs/MRUs are engaged in activities that bring and are bringing enormous distinction to the sciences. The various research objectives linked with these research centers provide a focal point for funding and serve to attract and retain the best faculty and students.

The division anticipates that these activities will grow over the next few years and require a total of 71,893 ASF to meet projected needs by 2010. As proposed, the Natural Sciences 6 building will be a visible physical testament to the benefit of effective faculty clustering that promotes vibrant interdisciplinary interaction. Designed to incorporate CFAO, Astronomy, Physics, SCIPP, UCOLick, and Math and house them in close proximity to the Engineering faculty, this building promises to be a model for successful programmatic and research collaboration.

An additional 8,000 ASF is proposed for Environmental Studies/Sciences. Tremendous effort has been put into developing a vision in this area and given the obvious links and ties to the program located on Science Hill, warrants some benefit from the released space made possible by the completion of Natural Sciences 6.

The Division Enterprise and Related Support Functions

The total projected ASF necessary for the full range of business and academic support functions of the Division of Natural Sciences is estimated at 46,421. This includes the dean's office and business office, as well as the Vivaria.

Short-term Planning

Two central issues confound the long-range space planning process and must be addressed separately. The first is the necessity to relocate the personnel currently housed in modular units (trailers) behind the Baskin Engineering Building. Siting for the new Engineering Building will begin in approximately two years, and this will require that the trailers be vacated. Temporary administrative space for twenty-five personnel must be located, and this certainly requires some creative problem solving. There are tremendous limitations facing both the central campus and the Division of Natural Sciences when considering viable options, especially when one reviews the total lack of administrative space on campus and the various units competing for space.

The second central issue is the best or wisest utilization of the 19,000 ASF released in Thimann Labs upon completion of the new Physical Sciences Building. It is the considered opinion of the division that although the long-range plan for use of Thimann should be centered around creating an undergraduate teaching center on Science Hill, in the near-term the space must be preserved for new faculty hires. The anticipated growth in the sciences and the campus goal of increasing extramural funding and graduate students will translate to a pressing need for additional science faculty in key academic concentrations.

Another complicating factor that must be addressed is the need to (temporarily) relocate approximately forty faculty and staff offices when the Sinsheimer Seismic Project gets underway. Designated faculty and staff will be moved from Sinsheimer and housed in Thimann Labs for the duration of the project. As far as is known at this time, this is the only available space large enough to accommodate relocation such as this. The estimated duration of the project is approximately one year and thus means delaying the implementation of long-term plans for the building. It is expected that some Thimann space will have to be held aside as surge space for new faculty hires until subsequent new buildings are completed or released space becomes available to the division.

Conclusions/Recommendations

The Earth and Marine Sciences Annex is the next project in line for the division, and one that offers a large net increase of assigned square footage. Though a good idea when originally conceived and proposed, especially considering the expansion needs of programs such as Evolutionary and Ecological Biology and Ocean Sciences, the division finds that given the serious space shortage, a larger building project approved for the 5-Year State Funded Major Capital Improvement Program is imperative. Charged to approach space planning with a new perspective and fresh ideas, and based on the information gathered and analysis prepared, it seems logical to defend a large building project go forward as the next project for Natural Sciences. The released space that will be made available will serve most of the growth needs of the sciences and allow for continued investment and expansion in exciting areas such as

Biomolecular research. A modest amount of released space has been factored into the division's plan in order to help address other critical campus space needs.

The division envisions that such a building could be sited behind the Baskin Engineering Building and be designed for the Astronomy, Physics, Math, and associated research units. This space would be cost effective to build when comparing costs of building wet lab space, particularly at this time, and thus an important consideration for the campus as a whole. Locating the Astronomy and Physics faculty in close proximity to Engineering space makes excellent programmatic sense and enhances the opportunities for interdisciplinary collaboration.

The subsequent released space in the affected buildings would be utilized for faculty expansion needs in each of the science departments and to programs in Social Sciences with interdisciplinary links to Natural Sciences (Environmental Studies expansion).

The division would best be served by the following actions:

- Successfully negotiate that the next Natural Sciences building project on the 5-Year State Funded Major Capital Improvement Program be designated as Natural Sciences 6. This would supplant the Earth and Marine Sciences Annex project for the time being and offers the division a substantial gain in space that will see the division through expansion years. This building could be sited behind the Baskin Engineering Building (see Attachment 8) and should total over 110,000 square feet.

- Successfully negotiate that Thimann released space, made available at the completion of the Physical Sciences Building, remain within Natural Sciences and be utilized for growth space for divisional science departments. The specialized wet lab space can serve the expansion needs of the new faculty hired to support long term academic plans and interdisciplinary programs in the sciences.

- Plan for the implementation of a long-range vision of Thimann Labs to be developed as an undergraduate teaching hub. The building would make an ideal center for undergraduate instruction and associated student support services, such as advising units and some selected Student Affairs units.

- Work with staff from Capital Planning to designate a viable plan for the relocation of staff currently housed in the trailers behind the Baskin Engineering Building. The committee has researched several options and recommends that Kerr Hall released space be considered a reasonable and effective solution to the problem. This keeps important divisional staff in close proximity to the main divisional offices. The renovation costs would be minimal given that administrative staff would be occupying the space and this would result in considerable cost savings to the campus. It would also mean that space released in the Baskin Engineering Building would be available to help ease the pressing space needs of a fast growing School of Engineering.

DIVISION OF NATURAL SCIENCES
SPACE USAGE AT CAMPUS BUILD-OUT - 2010

DEPT	BASKIN	EMS	CFAO	PSB	SINSHEIMER	THIMANN	THIMANN LEC	NS&ISB	NAT SCI 6	PALEO LAB	THIMANN/ GREENHOUSE	THIMAN STOCKROOM	WOODSHOP	STORAGE - NS2 ANNEX	SURGE	Misc	EMS Annex	?	Grand Total
ASTRONOMY									18,304										18,304
BIOLOGY		22,700			59,844	21,150					2,611						20,706	-	127,011
CHEMISTRY				45,000		14,800		8,400				1,204						12,175	81,579
EARTH SCIENCES		17,000						33,687		943							8,011	-	59,641
ETOX				15,000														2,287	17,287
MATHEMATICS	15,085								3,479									-	18,564
OCEAN SCI		21,865																	21,865
PHYSICS						4,517			32,326										36,843
CFAO									3,575										3,575
IGPP								5,341											5,341
IMS		16,566															1,368	-	17,934
LICK						1,104			20,937										22,041
SCIPP									23,002										23,002
																			-
																			-
GEN DIVISION	16,732		4,735		639	263								1,384	1,769				25,522
GEN NAT SCI ACAD						7,349							2,979					1,585	11,913
NAT RESERVE								848											848
VIVARIA						5,945												2,193	8,138
SUBTOTAL	31,817	78,131	4,735	60,000	60,483	55,128		48,276	101,623	943	2,611	1,204	2,979	1,384	1,769	-	30,085	18,240	499,408
ENVIRONMENTAL STUDIES								8,000											8,000
Grand Total	31,817	78,131	4,735	60,000	60,483	55,128		56,276	101,623	943	2,611	1,204	2,979	1,384	1,769	-	30,085	18,240	507,408
Actual Building ASF available to Nat Sci	31,817	78,131	4,735	60,000	60,483	55,856	725	55,554	100,000	943	2,611	1,204	2,359	4,456	1,769	363	42,000	-	503,006
ASF Balance By Building	-	-	-	-	-	728	725	(722)	(1,623)	-	-	-	(620)	3,072	-	363	11,915	(18,240)	(4,402)

POSSIBLE CLUSTERING OF DISCIPLINES AT CAMPUS BUILD-OUT

SCIENCE HILL 2010

NOTE: Document under revision as of 12/03/01

NAT SCI 6	
ASTRONOMY	17,864
MATHEMATICS	3,479
PHYSICS	31,550
CFAO	3,575
LICK	20,937
SCIPP	22,441
Classroom Space	1,800
TOTAL	101,646

BASKIN	
GENERAL DIVISION ADMIN AND ACADEMIC SUPPORT	16,732
MATHEMATICS	15,085

PSB	
CHEMISTRY	45,000
ETOX	15,000
TOTAL	60,000

SINSHEIMER	
MCD Biology	46,525 ASF
Biomedical	13,958
Total	60,483

NAT SCI 2 & ISB	
ENV STUDIES (new growth space)	8,000
EEB	22,700
ACADEMIC SUPPORT (ACE, MBRS, HEALTH SCIENCES ADV, ACAD COMPUTING)	7,349
TOTAL	38,049

THIMANN (TEACHING LABS AND ACADEMIC SUPPORT)	
BIOLOGY	35,108
CHEMISTRY	14,800
VIVARIA	5,945
PHYSICS	4,517
LICK	1,104
MISC.	263
TOTAL	55,128

CFAO	
GEN DIVISION	4,735

EMS	
EARTH SCIENCES	33,687
IGPP	5,347
OCEAN SCI	21,865
EARTH SCI (Specialized Labs, etc)	17,000
TOTAL	77,899

EMS ANNEX
Biology, Earth Sciences, IMS
30,085

Unassigned
32,198 ASF

Appendix 6
Executive Summaries of Departmental Plans
December 2001

DEPARTMENT OF ASTRONOMY AND ASTROPHYSICS
http://www.astro.ucsc.edu/

Overview: The Department of Astronomy and Astrophysics continues to rank among the top programs in the country. The strength of the faculty and strong connections to UCO/Lick Observatory have created unprecedented collaborations. Links to the IGPP and the Center for Adaptive Optics are further enhancing existing strengths. The program has excelled in studies of extragalactic astronomy, cosmology, active galactic nuclei, the detection of extra-solar planets, star and planet formation, stellar evolution, supernovae, nucleosynthesis, and advanced instrumentation. Astronomy and Astrophysics faculty conduct a highly successful graduate program and make meaningful contributions to undergraduate teaching via the substantial role they play in the Astrophysics B.S. major, administered by the Physics Department.

DEPARTMENT PROFILE

	Baseline *	2005-06	2010-11
Faculty FTE	10.80	14.60	14.60
TAS	.38	.75	.75
Budgeted Faculty FTE	11.18	15.35	15.35
Graduate Students	29.00	35.00	40.00
Postdocs/Researchers	20.00	36.00	40.00
Student Workload FTE	180.00	230.00	230.00
Workload Ratios	16.1:1	15.0:1	15.0:1
Last Official Workload Ratios from 1999-00: 19.3:1			
*Baseline includes 1999-00 FTE + 2000-01 recruitments			

Though officially a graduate program, the department offers many large lecture courses at the undergraduate level. These have increased in popularity and total student workload ratios have increased since 1996-97 to an impressive 19.3:1 in 1999-00. It is expected that the ratio will level off at 15.0:1 over the next few years.

Vision: The goal of Astronomy and Astrophysics is to remain in the forefront of the fields they have traditionally dominated, while developing moderate expansion into areas of theory, numerical stimulation, and non-optical observation. The department's plan to expand in non-optical observational astronomy was recommended by the spring 2000 external review committee and will allow the faculty to take advantage of opportunities for research and funding in new large space and ground-based facilities. In addition, the department wants to strengthen its base in theory in order to provide a firm foundation in interpreting all the new data and thus take advantage of the developing field of computational astrophysics.

The department currently has 10.8 faculty. Projected growth of the department by 2010 will bring the number of faculty to 14.6. Department priorities for faculty hires align programmatic needs with planned research activities in CODEP and UCO/Lick. The department will be seeking strengths in multi-wavelength, theory, and high-energy astrophysics.

Instruction: The prestigious graduate program continues to draw a large number of applicants. For fall 2001, 101 students applied, 36 were admitted, and 7 accepted. The department has

found that the acceptance rate is significantly hampered by the greater support packages available and more affordable cost of living at the best graduate schools, their chief competition.

Several recent curricular revisions were implemented with the goal of increasing graduate enrollment. The graduate curriculum was revised to put most courses on a two-year cycle with a full year of "galaxies" alternating with a full-year of "stars" (star formation, evolution, death). A recurring cycle of courses called "The Physics of Astrophysics" was instituted, and the department will be adding courses on "Astronomical Instrumentation."

Student interest in the department's undergraduate offerings has continued to rise. A new Astrophysics B.S. major, an upgrade to the former Astrophysics pathway in Physics, received approval to begin accepting students in winter 2002. Though administered by the Physics Department, this rigorous interdepartmental major includes at least three upper-division courses in astrophysics, an upper-division laboratory in astrophysics, and a senior thesis in astrophysics. Astronomy and Astrophysics faculty will serve as the thesis advisors.

Organized Research/Interdisciplinary Links: The strongest and most visible research connections are with UCO/Lick Observatory. The observational opportunities afforded by the telescopes on Mauna Kea (the world's largest) and Mt. Hamilton attract and help to keep first-rate faculty and graduate students. The presence of UCO/Lick faculty, postdocs, and technical staff enrich the academic and research environment for the Astronomy and Astrophysics Department. All of the UCO/Lick faculty and astronomers teach for the department and supervise graduate students and post-docs.

Strong connections have been made with the IGPP, particularly the CODEP group. Some graduate students are jointly supervised, and a group of CODEP, Astronomy and Astrophysics, and Physics faculty are building, with NSF support, a major Beowulf computer for computational astrophysics. The most recent faculty hire and other future hires are expected to contribute to a potential Ph.D. program in Planetary Sciences, now in the early stages of discussion with Earth Sciences faculty. Hiring non-optical observers, especially sub-mm and far infrared, will also help break out of the limitations of UCO/Lick as an "optical-only" observatory and enable leading-edge research in extra-solar planets.

A research initiative under serious development is the interdisciplinary effort in Particle Astrophysics and Cosmology, spanning areas in the Physics Department as well as the Astronomy and Astrophysics Department. Areas targeted for development are gamma ray astrophysics and an experimental program aimed at answering fundamental questions in cosmology such as the geometry of space-time and the nature of the recently discovered "dark energy." The vitality of the field is leading to a large expansion of activity supported by the NSF, DOE, and NASA.

Silicon Valley Center: Astronomy and Astrophysics envisions a research-related role in the SVC, leveraged by their interaction with NASA Ames and the SETI Institute. A teaching staff of approximately five could be maintained by cycling those UCSC Astronomy faculty who want to go to Santa Clara for stay of at least one quarter, adjunct appointments with NASA Ames and the SETI Institute, visiting appointments, and new hires. The research centerpiece would be a very large computer, perhaps a showcase for Silicon Valley, where one of the world's fastest

machines could be applied to leading-edge problems in physics, among them astrophysical simulation. There would also be an appreciable research interaction with the Astrobiology Institute at NASA Ames and the Stratospheric Observatory for Infrared Astronomy (SOFIA).

Summer Quarter: Astronomy and Astrophysics plans to continue offering Astronomy 2, Overview of the Universe. This is a very popular course, one that has drawn healthy enrollments when offered through Summer Session. They have proposed to offer two sections in Summer 2002, anticipating a five-week format with one section offered each session.

BIOLOGICAL SCIENCES

http://www.biology.ucsc.edu

The Department of Biology was formally split into two departments in spring 2000. The new structure was developed in order to address the divergent modern approaches of the discipline and to better support the scientific cultures that affect both methods and approaches for teaching and research. The ***Department of Ecology and Evolutionary Biology*** *and the* ***Department of Molecular, Cell, and Developmental Biology*** *share a core administrative staff and undergraduate advising office while directly administering their own graduate programs and general support. Though members of separate departments with common interests, the faculty continue to collaborate on issues of research, curriculum, facilities and equipment, and general administration.*

DEPARTMENT PROFILE

	Baseline *	2005-06	2010-11
Faculty FTE			
EEB Biology	15.00	21.00	26.00
MCD Biology	21.00	27.00	32.00
TAS	4.69	4.00	4.00
Budgeted Faculty FTE	40.69	52.00	62.00
Graduate Students	87.00	110.00	135.00
Postdocs/Researchers	40.00	60.00	85.00
Student Workload FTE	643.00	936.00	1302.00
Workload Ratios	15.8:1	18.0:1	21.0:1

Last Official Workload Ratios from 1999-00: 15.8:1
*Baseline includes 1999-00 FTE + 2000-01 recruitments

Student workload FTE in the Biological Sciences totaled 639 in 1999-00. Although the departments have experienced declining enrollments over the past several years, there is solid evidence of a positive turn-around (fall 2001 enrollment is up 11.9% from fall 2000). To increase the workload ratio to 21.0:1 by 2010-11 will require a 100% increase in total student workload FTE. Though ambitious, it may be achieved given plans for undergraduate programs in health sciences and environmental health.

ECOLOGY AND EVOLUTIONARY BIOLOGY

http://www.biology.ucsc.edu/eeb/index.html

Overview: The Ecology and Evolutionary Biology Department focuses on developing interdisciplinary approaches to understanding and conserving coastal ecological systems. This approach conceptually unifies the current strengths of the department by integrating terrestrial and marine conservation science in the coastal environment and by linking with other relevant campus programs (e.g., Ocean Sciences, Environmental Toxicology, Environmental Studies). This direction responds to the need for a deep appreciation of why conserving coastal ecological systems is important and to the recognition that future environmental policy decisions will be made by students being trained today. The department seeks to establish a nucleus for research, education, service, and outreach. The integrated marine-terrestrial approach is unique and positions UCSC to be a premier research and training institution in coastal ecosystems.

Vision: Long-range plans for the Department of Ecology and Evolutionary Biology focus on developing an initiative in Integrative Coastal Ecology (ICE) with the ultimate goal of establishing an integrated research and education program that will provide a solid conceptual and factual basis for conservation biology across the land-sea interface. ICE is built around a clear need for scientific progress in conservation, the expected increase in available financial resources to deal with difficult conservation problems, and an integrated program linking land and sea through conceptual approaches of ecology, genetics, and physiology. The three groups

that form the core of EEB represent three disciplinary approaches to different aspects of common issues: interactions of organisms with their environments, understanding human impacts on organisms and ecological systems, and applying fundamental knowledge to reducing those impacts. These approaches span a continuum of time scales from organismal physiology and behavior to ecological interactions and long-term evolutionary changes.

The department currently has 15 faculty who sort into three main groups around the disciplinary approaches to their work: evolution and behavior, physiological ecology, and ecological studies. Several faculty are engaged with more than one group. The department plans to grow to 26 faculty at build-out. The most immediate hiring priorities are for positions in evolutionary theory (related to C.DELSI), mathematical biology, plant evolution, population genetics, and neurophysiology/behavioral ecology.

Instruction: A key component of ICE involves curriculum development that aims to train the next generation of scientists in integrated theoretical and practical skills that are necessary to solve the pressing real-world problems of conservation and basic research. EE Biology faculty have outlined several possibilities for developing new interdepartmental courses, including modeling courses that integrate theory with empirical approaches and applied conservation that compare conservation theory and practice for marine and terrestrial ecosystems.

With colleagues in MCD Biology, the faculty are working to reverse the recent downward trend in undergraduate enrollments for Biology. Two new majors were approved in 1999-2000, which should prove attractive to students. The B.A./B.S. degree in Neuroscience and Behavior replaces and modernizes the former Psychobiology B.A. major. The Plant Sciences B.S. degree formalizes and enhances the former Plant Sciences pathway. In addition, the Health Sciences B.S. degree proposal is being submitted for formal review, a program anticipated to be a significant draw for students. Both Biological Sciences departments are administering these majors jointly.

Organized Research/Interdisciplinary Links: Faculty in EE Biology have close research ties to colleagues in Environmental Toxicology, Ocean Sciences, Earth Sciences, and Environmental Studies. Various agencies, foundations, and off-campus institutions have recognized the strength and coherence of UCSC's coastal ecology theme by funding numerous interdisciplinary projects.

Two EE Biology faculty serve as co-PIs for the Partnership for Interdisciplinary Study of Coastal Oceans (PISCO), a collaboration of four west-coast universities. This large-scale marine research program focuses on understanding the near-shore ecosystems of the U.S. by monitoring ecological and oceanographic processes at dozens of coastal sites. EE Biology faculty also participate extensively with the Institute of Marine Sciences as members of the cluster groups for marine vertebrate biology, coastal biology, and fisheries and fisheries management and are participating in development of the STEPS Institute for Innovation in Environmental Research.

Silicon Valley Center: Several EE Biology faculty members, in collaboration with colleagues in Ocean Sciences and Earth Sciences, have developed two ideas for the Center: 1) a Geobiology program (the study of how organisms interact with the physical and chemical environment), with primary research areas in microbiology, environmental biogeochemistry, and

environmental, and 2) a Center for Remote Sensing. Both proposals represent interdisciplinary collaborations between several departments at UCSC with potentially strong ties to the interests of other partners in the Silicon Valley Center. Both proposals also provide instructional opportunities for undergraduates and graduate students, as well as research foci.

Summer Quarter: The Biological Sciences faculty plan to continue their current summer course offerings. The introductory sequence, Biology 20A, 20B, and 20C, will be offered and will be expanded next summer to include one or two sections of Biology 20L. Upper division requirements to be offered will include Biology 100 (Biochemistry), Biology 105 (Genetics), and Biology 175 (Evolution). Elective courses proposed for next summer are Biology 119 (Microbiology), Biology 136 (Invertebrate Zoology), Biology 139 (Biology of Marine Mammals), and Biology 140 (Behavioral Ecology). To attract enrollments, the departments have also proposed to teach an extremely popular topical course, Biology 80A (Female Physiology and Gynecology).

MOLECULAR, CELL, AND DEVELOPMENTAL BIOLOGY

http://www.biology.ucsc.edu/mcd/index.html

Overview: The Molecular, Cell, and Developmental Biology Department has developed plans for growth that will both allow them to redefine the cutting edge of biomedical research and create top-flight graduate and undergraduate programs. Research in the fields of molecular biology, cell biology, and developmental biology have undergone extraordinary changes in the last decade. These changes are due to: 1) improvements in instrumentation that have enabled entirely new sets of questions to be addressed, 2) the explosion of information from the genome project, and 3) increasing research focused on questions directly related to human health. To date, the department has built core strengths in structure and function of protein-nucleic acid complexes, developmental genetics, and cell signaling and neurobiology. The department's plans, already underway, complement their existing strengths while building new strengths in the emerging fields of biological research, especially where interdisciplinary activity can be augmented.

Vision: The MCD Biology Department has ambitious plans for growth in numbers of faculty and graduate students and in dramatic expansion of their programs in biomedical research and education. They plan to build by adding faculty whose work complements that of existing MCD faculty, lends itself to interdisciplinary activity, and is in one of the growth areas of biological research. With sufficient new faculty FTE, the department will be able to make significant contributions to interdisciplinary and interdivisional biomedical research programs and participate in the formation of an interdivisional biomedical sciences graduate group.

The department currently has 21 faculty. The division's plans call for growth to 32 FTE at build-out. Future hires will be focused on individuals that will strengthen or expand interdisciplinary research programs at UCSC. The most pressing needs are for one or two senior positions in health sciences areas to provide senior leadership for the department. Other high priorities are for positions in structural biology, benefiting health sciences, the RNA Center, CBSE, and Chemistry and Biochemistry; plant molecular biology, (genomics), benefiting health sciences,

plant sciences, and the CBSE; and cancer cell biology (using genomic approaches to study cancer) to benefit health sciences, the CBSE, and Chemistry and Biochemistry.

Instruction: The MCD Biology department anticipates that a significant increase in the number of faculty engaged in biomedical research will result in a dramatic increase in graduate students. It would permit the department to administer "rotation programs" to provide graduate students with much broader training than a traditional graduate program, allowing the department to be more competitive for the best students. Additionally, the rotation model is essential for any program that has training grant support from the NIH. To help build the necessary critical mass, MCD Biology is exploring the possibility of developing a multi-departmental graduate group in biomedical sciences.

With colleagues in EE Biology, the faculty are working to reverse the recent downward trend in undergraduate enrollments for Biology. Two new majors were approved in 1999-2000, which should prove attractive to students. The B.A./B.S. degree in Neuroscience and Behavior replaces and modernizes the former Psychobiology B.A. major. The Plant Sciences B.S. degree formalizes and enhances the former Plant Sciences pathway. In addition, the Health Sciences B.S. degree proposal is being submitted for formal review to begin accepting students in spring 2002, a program anticipated to be a significant draw for students. Both Biological Sciences departments are administering these majors jointly.

Organized Research/Interdisciplinary Links: MCD faculty carry out joint research programs with faculty in Chemistry and Biochemistry, Environmental Toxicology, and Engineering. These collaborative interactions have led to the creation of several successful interdisciplinary research clusters, including the Center for the Molecular Biology of RNA and the Center for Biomolecular Science and Engineering. Preliminary ideas for developing programs in biomedical research that cross departmental and divisional boundaries are outlined in the Integrated Biomedical Sciences Proposals (IBSP), which was prepared by a group of faculty from MCD Biology, Chemistry and Biochemistry, and Environmental Toxicology.

Individually, biomedical researchers at UCSC have outstanding records in obtaining funding for their research, the majority of which comes from the National Institutes of Health. Their focus on biomedical research and human health puts them in a unique position to obtain funding from private sources and biotechnology companies, and they are pleased that the new Vice Chancellor for Research, Bob Miller, is interested in working to find new sources of support for biomedical research.

With growth in number of faculty, the department looks forward to participating in larger-scale collaborative and interdisciplinary research projects, therefore creating the critical mass necessary for receipt of program project grants. There are several areas where the department is close to achieving that critical mass. One area, the study of the molecular basis of gene expression and signaling, is especially significant because about half of all known drugs work by affecting these processes. Almost all known cancer-causing genes affect gene expression or signaling. Another area where the department is close to critical mass, in collaboration with their colleagues in Chemistry and Biochemistry, is in macromolecular structure-function relationships, especially in protein-nucleic acid complexes. This area of research provides the basis for understanding how drugs work and for designing new drugs.

Summer Quarter: The Biological Sciences faculty plan to continue their current summer course offerings. The introductory sequence, Biology 20A, 20B, and 20C, will be offered and will be expanded next summer to include one or two sections of Biology 20L. Upper division requirements to be offered will include Biology 100 (Biochemistry), Biology 105 (Genetics), and Biology 175 (Evolution). Elective courses proposed for next summer are Biology 119 (Microbiology), Biology 136 (Invertebrate Zoology), Biology 139 (Biology of Marine Mammals), and Biology 140 (Behavioral Ecology). To attract enrollments, the departments have also proposed to teach an extremely popular topical course, Biology 80A (Female Physiology and Gynecology).

DEPARTMENT OF CHEMISTRY AND BIOCHEMISTRY

http://www.chemistry.ucsc.edu/

Overview: Chemistry is the science that investigates and manipulates the nature of matter at the molecular level, and as such, stands at the nexus of biological physical, and environmental research and development. Research areas of the Department of Chemistry and Biochemistry divide into three distinct topics, although there is overlap among the people and ideas: complex materials, biomedical research, and environmental health. The Biochemistry and Molecular Biology (BMB) program, administered by Chemistry and Biochemistry, includes faculty from MCD Biology. The department eagerly anticipates the completion of the Physical Sciences Building for the enhanced space it will provide and for the opportunity to improve major equipment by leveraging state funds with matching funds from grants—both of which will aid in recruitment and retention of faculty.

DEPARTMENT PROFILE

	Baseline *	2005-06	2010-11
Faculty FTE	21.00	27.00	31.00
TAS	2.38	2.00	2.00
Budgeted Faculty FTE	23.38	29.00	33.00
Graduate Students	73.00	85.00	110.00
Postdocs/Researchers	30.00	44.00	56.00
Student Workload FTE	549.00	667.00	759.00
Workload Ratios	23.5:1	23.0:1	23.0:1
Last Official Workload Ratios from 1999-00: 23.5:1			
*Baseline includes 1999-00 FTE + 2000-01 recruitments			

The student/faculty workload ratio in the department has consistently been one of the highest in the division. The department is projected to maintain a 23.0:1 ratio after 2005-06.

Vision: In common with other departments in the Natural Sciences Division, the Chemistry and Biochemistry Department continues to support the core topics in the discipline while bolstering support for emerging areas—particularly those likely to garner significant external funding.

Currently the department consists of 21 faculty. Additional new faculty members will be strategically grouped into exciting research areas while grounded in the fundamental teaching disciplines of the science, ensuring the continued health of those programs that rely on Chemistry and Biochemistry instruction for their own success. Projected growth of the department by 2010-11 will bring the number of faculty to 31. The most immediate FTE needs to support Complex Materials are in synthetic inorganic chemistry (focused on synthesis of novel inorganic and/or composite inorganic, organic, or biological materials) and experimental physical chemistry (focused on structural and surface characterization of materials). Positions in proteomics research, protein structure determination by NMR spectroscopy, and protein crystallography are key needs for biomedical research. And an important need in support of chemical genetics is in the area of combinatorial biology and biosynthesis.

Instruction: Chemistry and Biochemistry has an especially rich array of undergraduate research opportunities. In fact, during the 2000-01 academic year, 70 percent of all undergraduate majors were engaged in undergraduate research, demonstrating outstanding quality of research. Department faculty actively participate in a variety of undergraduate research support programs (MARC, MBRS, ACCESS, CAMP, etc.). Chemistry and Biochemistry's educational program purposefully blurs the distinction between graduate and undergraduate students in order to present a comprehensive research environment, unique to UCSC.

In support of undergraduate education, the current sub-disciplines of organic chemistry, biochemistry, inorganic chemistry, and physical chemistry will remain. This is consistent with the realistic curriculum designed by the American Chemistry Society to prepare students for the next level of scientific investigation and employment.

Organized Research/Interdisciplinary Links: There are strong collaborations between faculty in Chemistry and Biochemistry and faculty from other departments including Biology, Environmental Toxicology, Physics, and Electrical Engineering, as well as with the Center for Biomolecular Science and Engineering. Particularly strong connections exist between several departments where faculty are key players in both established and emerging initiatives of the campus's biomedical research program. Chemical genetics is another rising area attracting a great deal of attention and involving faculty from Chemistry and Biochemistry as well as MCD Biology, and with prospective links to the nearby biotechnology industry. With the recent $1M W. M. Keck Foundation award for instrumentation, faculty from several departments are perfectly situated to establish a center on the study of trace metal nutrition and toxicity.

Our proximity to Silicon Valley and high-tech companies in the Bay Area provides excellent opportunities for collaboration with industry, especially as some of our expertise has no counterpart at other universities in the region. Departments have already established strong collaborations with scientists from other universities, national labs, and private industry (e.g., UC Davis, Lawrence Livermore National Lab, and IBM).

Silicon Valley Center: Department faculty have had extensive discussions about potential opportunities at the Silicon Valley Center. While faculty are generally interested in the SVC, most require immediate access to specialized laboratory facilities. In addition, they have close working relationships with faculty colleagues and graduate students here at UCSC and are concerned about potential negative consequences of a geographical split. On the other hand, a regional facility for specialized equipment that would be used intensely for short periods of time has some appeal. For now, a strong presence by Chemistry and Biochemistry faculty is not likely.

Summer Quarter: In summer 2002, the department will be prepared to offer the same slate of courses in two five-week sessions that they have offered over the past several years in Summer Session. The proposed courses are the most heavily subscribed during the regular session and represent the core of required chemistry courses for most science majors: Chemistry 1A, 1B, 1C, 1M and 1N (General Chemistry with labs) and Chemistry 108A, 108B, 108L and 108M (Organic Chemistry with labs).

DEPARTMENT OF EARTH SCIENCES

http://www.es.ucsc.edu/

Overview: Modern Earth Science involves quantification of the processes and history of the Earth system, requiring faculty research and teaching expertise in field observations, laboratory experimentation, and quantitative modeling. Core knowledge from a variety of disciplines is required, and as such the Earth Sciences Department has built highly effective collaborative relationships with Applied Mathematics, Astronomy and Astrophysics, Biology, Chemistry and Biochemistry, Computer Sciences, Electrical Engineering, Environmental Studies, Environmental Toxicology, IMS, MBARI, NASA Ames, Ocean Sciences, and Physics. The program actively participates in and directly supports the UCSC branch of the Institute of Geophysics and Planetary Physics (IGPP) and its affiliated research centers: the Center for Dynamics and Evolution of the Land-Sea Surface (C.DELSI), Center for Origin, Dynamics and Evolution of Planets (CODEP), and the Center for the Study of Imaging and Dynamics of the Earth (CSIDE). Earth Sciences faculty are leading the effort to develop a new center under the IGPP, the Center for Remote Sensing (CRS), and to dedicate a new Massive Computer Simulations facility this year.

DEPARTMENT PROFILE

	Baseline *	2005-06	2010-11
Faculty FTE	19.50	23.50	26.50
TAS	1.40	1.00	1.00
Budgeted Faculty FTE	20.90	24.50	27.50
Graduate Students	58.00	70.00	85.00
Postdocs/Researchers	17.00	26.00	34.00
Student Workload FTE	272.00	343.00	413.00
Workload Ratios	13.0:1	14.0:1	15.0:1
Last Official Workload Ratios from 1999-00: 12.7:1			
*Baseline includes 1999-00 FTE + 2000-01 recruitments			

The IGPP initiative promises to build the total number of graduate students, draw undergraduates to new larger lecture classes and subsequently build enrollments. The student faculty ratio dropped sharply in 1999-00, but there was an upward trend in 2000-01 (8.6% enrollment increase). It is expected that the department will achieve a student faculty ratio of 15:1—this will require a 52% increase in total student workload FTE.

Vision: Growth in the Earth Sciences will provide new campus strengths in the areas of regional climate change, planetary discovery and processes, and environmental sciences. By creating new interdisciplinary centers of excellence and targeting growth areas of substantial societal interest and career potential for undergraduate and graduate students, the department hopes to leverage off-campus resources. One of the department's goals for this 10-year period is to reach a national ranking in the top 10 of all U.S. university Earth Sciences programs and the top five of public institutions.

The Earth Sciences department plans to grow from the current 19.5 faculty to 26.5 at the end of the planning period. The current short-range hiring priorities are for the following positions: 1) planetary science (atmospheres), which will provide a link between CODEP and C.DELSI; 2) geology/geochemistry, a replacement that will support the field program; 3) geobiology/paleobiology, related to C.DELSI; and 4) planetary science, a CODEP position. The second and third priority positions would complement one another. All of the positions are integrated with the goals of the Earth Science Department and the various research initiatives.

Instruction: In recent years, the department has undertaken several major initiatives aimed at increasing the number of majors and enhancing the sense of community in their undergraduate

program. A new combined major with Environmental Studies, a new pathway in the Earth Sciences degree program emphasizing Ocean Sciences, as well as helping lead the interdisciplinary discussions toward an Environmental Sciences program are examples of the efforts toward meeting the needs of students and broadening the opportunities available to them. Several years ago the department undertook a major curriculum revision to modernize and consolidate classes. An internship program has been established that provides opportunities for undergraduates and graduate students to gain practical work experience in preparation for seeking employment in the industrial and governmental job market.

Organized Research/Interdisciplinary Links: Virtually all of the Earth Sciences faculty have extensive organized research and interdisciplinary links. It is, therefore, a priority for the department to develop the necessary critical mass for the CODEP, C.DELSI, and CSIDE initiatives to be fully viable. It is also important that an additional proposed interdisciplinary center, the Center for Remote Sensing (CRS), receive adequate funding. The department views each of these three multi-departmental initiatives as capturing the key areas for Earth Sciences growth for the next decade as they capitalize on existing strengths, resonate with scientific excitement, and they envision the collection of foci of excellence as a sure means of enhancing their program stature.

Silicon Valley Center: Several Earth Sciences faculty members, in collaboration with colleagues in Ocean Sciences and EE Biology, have developed two ideas for the Center: 1) a Geobiology program (the study of how organisms interact with the physical and chemical environment), with primary research areas in microbiology, environmental biogeochemistry, and environmental, and 2) a Center for Remote Sensing. Both proposals represent interdisciplinary collaborations between several departments at UCSC with potentially strong ties to the interests of other partners in the Silicon Valley Center. Both proposals also provide instructional opportunities for undergraduates and graduate students, as well as research foci.

Summer Quarter: Beginning in summer 2002, Earth Sciences will offer one to two of its most popular lower division courses, likely increasing to two to three lower division offerings in summer 2003. The summer 2002 courses will be Earth Sciences 80B (Earthquakes: You, the Earth, and Society) and/or a summer offering of Earth Sciences 65 (Natural History of Dinosaurs). Earth Sciences 20 (Environmental Geology), to be added in summer 2003, would provide an introduction to the major.

DEPARTMENT OF ENVIRONMENTAL TOXICOLOGY

http://www.etox.ucsc.edu/

Overview: The newest department in the Division of Natural Sciences, the Environmental Toxicology Department has just completed its first year of operation (2000-01). The department's establishment was aided and supported by the willingness of other divisional departments to release resources to support this interdisciplinary initiative, focused on understanding the mechanisms by which the environment and organisms interact. The growing graduate program has already successfully competed for top faculty and graduate students. Recently the campus received a $1M award from the W. M. Keck Foundation for state-of-the-art equipment for conducting trace metals research, a multi-departmental effort led by the Environmental Toxicology Department.

DEPARTMENT PROFILE

	Baseline *	2005-06	2010-11
Faculty FTE	5.00	10.00	10.00
TAS	0.00	.38	.38
Budgeted Faculty FTE	5.00	10.38	10.38
Graduate Students	2.00	17.00	25.00
Postdocs/Researchers	1.00	4.00	6.00
Student Workload FTE	10.00	30.00	38.00
Workload Ratios	2.0:1	2.9:1	3.7:1
Last Official Workload Ratios from 1999-00: ---			
*Baseline includes 1999-00 FTE + 2000-01 recruitments			

Environmental Toxicology faculty are involved in several new curricular and research endeavors, and increased enrollments credited to ETOX faculty are projected.

Vision: A small department with 5 faculty at present, Environmental Toxicology anticipates doubling the size of their faculty to 10 by 2005-06 and remaining at that size through 2010-11. The current immediate FTE priorities are for positions in ecological toxicology, related to C.DELSI and tentatively authorized for recruitment in 2001-02; microbial toxicology; and proteomics (neurobiology). Faculty strengths in metals and microbiology are consistent with departmental emphases and augment other campus expertise in trace metals in the environment and organisms. In fact, planned hires in IGPP (the C.DELSI group), Biological Sciences, Chemistry and Biochemistry, Earth Sciences, and Ocean Sciences will complement department strengths and goals. As well, current and proposed developments by IMS, such as the recent opening of the Center for Ocean Health and the location of other research facilities at Long Marine Lab, will directly benefit faculty, postdoctoral researchers, and graduate students.

Environmental Toxicology faculty have made extensive efforts to increase the funding for graduate students, which will help them continue to attract and admit the best students. Their funding strategies include submitting proposals for a GAANN and an NIH/NIEHS graduate student training grant within the next 4 to 5 years as their faculty numbers grow.

The department plans to include postdoctoral researchers as an increasingly important component of their program. Such researchers will be able to contribute to undergraduate and graduate education, original research, and extramural funding—with limited financial, lab, or office facilities required to support them.

Instruction: In terms of curricular goals, the department's first priority is to fully develop its graduate curriculum, which will depend on new faculty recruitments and available

instrumentation. A generous number of broad-based graduate courses were available during 2000-01, evidence of the faculty's commitment to developing a rigorous graduate curriculum. As the Environmental Toxicology program grew out of other departments, specifically Biological Sciences, careful consideration is being given to the administrative mechanisms to fairly allocate resources and track enrollments.

Contributions to the division's undergraduate curricula follow the model of the Department of Ocean Sciences where the graduate degree program offers popular undergraduate courses as well. Environmental Toxicology offered five undergraduate courses in 2000-01 and has plans to further broaden the undergraduate curriculum, consistent with the report of the UCSC Environmental Sciences Task Force.

Organized Research/Interdisciplinary Links: The Environmental Toxicology Department was a *de facto* department for many years before it received official designation. Prior to its inaugural year in 2000-01, faculty were housed in other departments (Biological Sciences, Chemistry and Biochemistry, and Earth Sciences) and welcomed into the IMS ORU, and graduate students were accepted into other programs. The formation of a full-fledged department does not diminish these long-standing interdisciplinary collaborations.

Other research links are found with IGPP, CBSE, Health Sciences, and the Environmental Sciences Institute. The interdisciplinary nature of the department positions it to make major contributions in advancing the research priorities, particularly in the areas of biomedical sciences, environmental sciences, computational sciences, remote sensing, and nanotechnology.

This year the department provided leadership in the development of a proposal to the W. M. Keck Foundation, resulting in a $1,000,000 award to fund critical instrumentation that will support research efforts of faculty in Environmental Toxicology, Chemistry and Biochemistry, Biological Sciences, Earth Sciences, and Ocean Sciences.

Silicon Valley: Environmental Toxicology intends to be actively involved in three areas at the Center: environmental toxicology graduate curriculum and internships; pharmacology undergraduate and graduate curriculum and internships; and remote sensing and computer modeling of contaminants and pathogens in the environment.

Summer Quarter: The department is planning a curriculum for the summer quarter, using the COSMOS program as a model for a course in Aquatic Toxicology. This would complement or replace the short course in Coastal Toxicology that is taught through Bodega Marine Laboratory (UC Davis) for the UC Toxic Substances Research and Teaching Program. The development of this curriculum is designed to further promote the presence of the new graduate program in Environmental Toxicology and attract outstanding students to the campus.

DEPARTMENT OF MATHEMATICS

http://www.math.ucsc.edu/

Overview: The Department of Mathematics provides undergraduate and graduate instruction that is valued both in its own right and as a central tool in the study of biology, chemistry, computer engineering, computer science, Earth sciences, economics, electrical engineering, information systems management, physics, and psychology. The undergraduate program offers concentrations in pure mathematics, computational mathematics, and mathematics education. There are concentrations in pure and applied mathematics leading to the M.A. degree. The Ph.D. program has course work and research opportunities in pure, applied, and computational math.

DEPARTMENT PROFILE

	Baseline *	2005-06	2010-11
Faculty FTE	15.00	20.00	20.00
TAS	10.40	6.00	6.00
Budgeted Faculty FTE	25.40	26.00	26.00
Graduate Students	44.00	55.00	65.00
Postdocs/Researchers	2.00	4.00	6.00
Student Workload FTE	580.00	610.00	610.00
Workload Ratios	22.8:1	23.5:1	23.5:1
Last Official Workload Ratios from 1999-00: 22.1:1			
*Baseline includes 1999-00 FTE + 2000-01 recruitments			

Enrollment patterns in Mathematics have fluctuated despite an expected climb due to incoming Engineering students. The overall student faculty ratio is projected to remain high, climbing to 23.5:1 at build-out. Curricular cooperation with Applied Mathematics will impact long-term plans.

Vision: The Math Department currently has 15 faculty FTE with plans to grow to 20 at build-out. The faculty have been reevaluating the curriculum with the goal of reducing reliance on a relatively large number of temporary faculty to help mount the curriculum. Additional ladder faculty appointments will correlate to fewer temporary faculty needed to teach, and thus a modest cumulative enrollment increase over the next nine years will mean that healthy student/faculty ratios will be maintained.

The department has begun cross-divisional conversations with the School of Engineering about mutual opportunities in pure and applied math and statistics. Discussions are focused on the most effective ways to offer the core mathematics classes that are central to nearly all of the departments in both the Natural Sciences and Engineering divisions.

Instruction: The Math Department has made substantial changes to their undergraduate program this past year. Faculty have worked cooperatively and proactively with the division to reduce the department's dependence on temporary academic staffing funds. Proposed changes to the curriculum will increase the efficiency of instruction at the lower-division level, enhance instruction at the upper-division level, and expand graduate course offerings. These revisions address concerns expressed in previous external reviews. In addition, faculty are working cooperatively with the Applied Mathematics Department to development a joint plan for optimal delivery of applied math, especially the calculus courses required for science and engineering majors. These achievements have been accomplished while increasing overall fiscal accountability.

Organized Research/Interdisciplinary Links: The department hopes to develop a research group in discrete mathematics, the mathematical theory concerned with the processing and understanding of discrete mathematical systems and data sets. There is interest from the

worlds of technology development, government agencies (e.g., National Security Agency), and research groups in mathematical biology (related to the genome project). This could be a unique niche for Santa Cruz and would be enhanced by the close interaction with appropriate engineering faculty. Significant funding opportunities are available in this area. The faculty also encouraged a modest reactivization of the nonlinear ORU to provide interdisciplinary career training for graduate students.

Silicon Valley Center: Early discussions about prospects at the SVC indicated that the above-mentioned proposed research group in discrete mathematics might be well situated at the Center. As plans for the Center have evolved toward more of a campus model, Math faculty will want to reconsider the nature of their participation.

Summer Quarter: The proposed Mathematics curriculum also builds on the courses that have been successfully offered in Summer Session. Proposed courses include Math 3 (Precalculus), Math 11A and 11B (Calculus with Applications), Math 19A and B (Calculus for Science, Engineering, and Mathematics), Math 21 (Linear Algebra), Math 22 (Introduction to Calculus of Several Variables), Math 24 (Ordinary Differential Equations), and Math 100 (Introduction to Proof and Problem Solving).

With the exception of Math 100, all proposed lower division courses are heavily subscribed during the regular academic year. Math 100 is a required introductory course for Mathematics majors, and enrollment in this course in limited to 40.

In succeeding years, the department foresees the offering of additional courses to serve junior and senior level students. Examples of such courses are Math 103 (Complex Variables) or Math 111A (Abstract Algebra). They will also explore the idea of course offerings that are aimed at specific groups of potential students, such as a course for local math teachers built around the department's current Mathematics Education program.

DEPARTMENT OF OCEAN SCIENCES

http://oceansci.ucsc.edu/

***Overview**:* Ocean Sciences, a focus of excellence at UCSC nearly since its inception, is an appropriate and strongly justifiable emphasis given the placement of our campus on Monterey Bay and the growth in marine and ocean science initiatives and institutions in this region. Academic strength in Ocean Sciences is required for sustaining UCSC's leadership role. Ocean Sciences Department faculty are engaged in research and teaching at the frontiers of oceanography, including biological oceanography and marine microbial ecology, chemical oceanography and marine biogeochemistry, ocean circulation and coupled biological-physical interactions, and paleoceanography and paleoclimatology. Ocean Sciences faculty members serve as core faculty for two interdisciplinary graduate programs: the Marine Sciences master's program[1] and the Ocean Sciences Ph.D. Program (approved and initiated).

DEPARTMENT PROFILE

	Baseline *	2005-06	2010-11
Faculty FTE	9.00	13.00	13.00
TAS	.43	.50	.50
Budgeted Faculty FTE	9.43	13.50	13.50
Graduate Students	23.00	27.00	35.00
Postdocs/Researchers	8.00	14.00	16.00
Student Workload FTE	121.00	170.00	189.00
Workload Ratios	12.8:1	12.6:1	14.0:1
Last Official Workload Ratios from 1999-00: 17.1:1			
*Baseline includes 1999-00 FTE + 2000-01 recruitments			

Total enrollments in Ocean Sciences have been steadily increasing. In 1999-00 the student/faculty workload ratio was 17:1, up from 16:1 in the prior year. Realistically the department ratio should drop. Projections at build-out are for a 14.0:1 ratio. This does mean a sharp increase in enrollment, but this should be realized with planned development of high-quality options in undergraduate education.

***Vision**:* The UCSC Ocean Sciences department vision is to be at the forefront of ocean sciences research, teaching, and service at the campus, national, and international levels. They have identified three thematic areas of emphasis: ocean biogeochemistry, ocean circulation and climate, and ocean ecology. There is a focus on ocean processes of global significance in departmental research and teaching, and they have integrated data-based and modeling-based approaches to understanding present and past oceans. Although small in size relative to the major schools of oceanography in the U.S., the Santa Cruz department enjoys a reputation of distinction. The department is distinguished by high-quality faculty, by existing and growing world-class research facilities, and by the integration of graduate education with undergraduate education in ocean sciences and the related fundamental science disciplines. In addition, the department is strengthened by interdisciplinary ties to the related fundamental science departments on campus and by existing and growing disciplinary ties to other marine-related institutions in the Monterey Bay region. The program is an integral part of the Institute of Marine Sciences and of the Institute of Geophysics and Planetary Physics (IGPP) Center for the Dynamics and Evolution of the Land-Sea Interface (C.DELSI).

[1] We anticipate changing the name of the *Marine Sciences Master's Program* to the *Ocean Sciences Master's Program*. The current name is an 'historical artifact' of our earlier history as the Committee of Studies in Marine Sciences. We intend to maintain this program as a high-quality, research-based master's program, complementing the Ocean Sciences Ph.D. program.

The current size of the department is 9 faculty FTE. Further growth to 13 faculty members is envisioned, with the goal of adding four additional faculty over the next four academic years. The highest and most immediate priority for the next recruitment will be a position in the area of ocean-climate dynamics, crucial to developing core strength in ocean circulation and climate. The areas of research specialization for the three additional positions are (listed in order of current priorities): oceanic food web dynamics**,** marine sedimentary organic geochemistry, and biochemical oceanography.

Instruction: The recently instituted doctoral program is attracting high-quality applicants, students are making excellent academic progress, and the department has been successful in increasing avenues of external fellowship support (e.g., ARCS, GAANN). Higher levels of external funds for graduate student support are being sought, and graduate education partnerships with nearby marine sciences institutions are currently being explored (Naval Postgraduate School, National Marine Fisheries Service, Moss Landing Marine Laboratories). The master's program continues successfully, although it has been decreased in size by the Ph.D. program. In addition, the Ph.D. program is developing a more distinctive oceanographic focus, and this has influenced the master's program as well. The department has focused attention on improving outreach and recruitment activities and implementing more aggressive advertisement of the program. Plans are underway to develop a summer internship program for rising juniors and seniors that will expose more students to the quality and unique features of our graduate programs.

The department is also investigating possibilities for undergraduate degree options in ocean sciences. If a high-quality undergraduate major can be designed, it would be distinct in the UC system. Because the ocean sciences discipline is in an environmental science that is inherently interdisciplinary, this is a logical issue to investigate. New degree options, including a major, have the potential to draw new students to UCSC and to the Natural Sciences Division.

Organized Research/Interdisciplinary Links*:* Ocean Sciences academic ties to other UCSC departments are complemented by participation in two UCSC organized research units: 1) the Institute of Marine Sciences (IMS), an ORU fostering interdisciplinary collaboration in the marine and ocean sciences, and 2) the Institute of Geophysics and Planetary Physics (IGPP), a multi-campus research unit, and its Center for the Dynamics and Evolution of the Land-Sea Interface (C.DELSI). Ocean Sciences faculty are founding and continuing members of the Center.

The department has existing and developing ties to neighboring marine-related institutions including the Monterey Bay Aquarium Research Institute (MBARI), the Naval Postgraduate School (NPS), the National Marine Fisheries Service (NMFS), and the Moss Landing Marine Laboratories (MLML).

Silicon Valley: As a relatively small and focused program in oceanographic research, currently emphasizing the graduate level, the department views its ability to participate in the Silicon Valley Center as limited. Complementary faculty positions can be envisioned (in areas like marine environmental genomics, marine geobiology, or estuarine biogeosciences) that could be housed at the SVC. It may be appropriate for these individuals to have their faculty

appointments in Ocean Sciences, however this would not replace the need for the core faculty positions described earlier.

Summer Quarter: It is possible that the field-intensive nature of the ocean sciences faculty members' research, typically determined by national and international scheduling agencies, not by the academic year, could be better accommodated by more flexible teaching schedules. However, the size of the department will be a limiting factor in its ability to contribute to ladder rank faculty instruction in the summer. Currently the department does not have much extra depth in covering upper-division and graduate curricular needs. Insuring student progress to degree remains a top priority in curriculum planning.

DEPARTMENT OF PHYSICS

http://physics.ucsc.edu/

Overview: The study of physics is fundamental to all science and technology. Condensed matter physics has led to an astounding number of innovations that have dramatically changed society, providing much of the basis of modern technology. These technological advances are underpinned by an understanding of the fundamental physics behind them, allowing a fluid exchange of ideas across different sub-disciplines ranging from semiconductors to plastics and polymers. Research strengths at UCSC are in the study of fundamental particles and interactions (high-energy physics) and the study of the properties of materials (condensed matter physics). Efforts in high-energy physics are enhanced by the presence of the Santa Cruz Institute for Particle Physics (SCIPP), with connections to the some of the major accelerator labs in the world. Additionally, there are close collaborations with a strong astrophysics group from the Astronomy and Astrophysics Department. UCO/Lick Observatories also provides opportunities for collaboration between researchers in Physics and Astronomy.

DEPARTMENT PROFILE

	Baseline *	2005-06	2010-11
Faculty FTE	18.25	24.25	25.25
TAS	1.40	1.00	1.00
Budgeted Faculty FTE	19.65	25.25	26.25
Graduate Students	41.00	50.00	60.00
Postdocs/Researchers	12.00	23.00	24.00
Student Workload FTE	334.60	404.00	420.00
Workload Ratios	17.0:1	16.0:1	16.0:1
Last Official Workload Ratios from 1999-00: 17.2:1			
*Baseline includes 1999-00 FTE + 2000-01 recruitments			

Over the last few years the department has realized a substantial increase in enrollments, particularly at the undergraduate level. The overall student/faculty ratio increased in 1999-00 to 17:1. With planned new programs, there is no reason to expect that this trend will reverse, but with increased faculty numbers the projected student/faculty ratio is 16.0:1.

Vision: The Physics Department currently has 18.25 faculty, with growth to 25.25 anticipated by the end of this planning period. The areas of advanced materials, nanostructures, and biophysics are promising areas for growth given their fundamental, scientific importance and their impact on other disciplines. Building a top-notch program in condensed matter physics will improve collaborations with the biomolecular and bioinformatics research programs and the growing electrical engineering program.

The department is conscious of leveraging new faculty hires to create synergies. New hires, especially the experimentalists and theorists, may be allied with Astronomy and Astrophysics, thereby contributing to both departments and potentially fostering joint efforts. New hires in condensed matter may link to Chemistry and Biochemistry and contribute to the complex materials program. They would also like to make hires that engender interaction with nearby industry and utilize the exceptional facilities available in the Bay Area. The highest FTE priorities are for a theorist in quantum condensed matter physics, one or two experimentalists in biophysics (novel imaging methods; spectroscopy of single molecules; cell division and differentiation, tubulin networks, and cellular motors), and one or two people in nanostructures (nanoscale electronic devices and their integration into architectures, new physical phenomena at the nanoscale, nanotubes, or quantum computing).

Instruction: The new Astrophysics major was developed in collaboration with faculty in Astronomy and Astrophysics, who will continue to play an active role in administration of the major. The major offers undergraduates an opportunity to share in one of UCSC's most nationally eminent research and graduate programs and provides hands-on optical observatory experience with oversight from leading scientists. An Applied Physics pathway is under development, beneficial for students who take positions in industry after graduation and potentially helpful in attracting minority students to the undergraduate program. The department has made their master's degree requirements more formal and made a more deliberate effort to recruit master's students by emphasizing their strengths in device physics and materials physics, suitable training for work in industry and government.

The Physics Department hopes to expand both their undergraduate and graduate course offerings. At the undergraduate level, they lack sufficient breadth in the curriculum and need to offer their service courses quarterly to improve time to degree. At the graduate level, the offerings are narrower than is optimal, hampering their recruitment efforts. Graduate students simply have more choices at other comparable institutions. New faculty are needed in order to expand the curriculum.

Organized Research/Interdisciplinary Links: Physics faculty are collaborating with colleagues in a variety of areas. The most obvious connections are with the astrophysicists and with faculty, researchers, and programs under SCIPP. In partnership with the Astronomy and Astrophysics Department and SCIPP, Physics faculty are working to develop more fully a program in Particle Astrophysics and Cosmology. The Complex Materials program (development, characterization, and application of complex materials) is a joint initiative of the Physics, Chemistry and Biochemistry, and Electrical Engineering Departments. In addition, the condensed matter physics group has ongoing collaborations with faculty in Biology and Chemistry and Biochemistry.

Silicon Valley Center: The Physics Department has considered locating part of the Applied Physics program at the Center, possibly an internship quarter for students if it could be combined with a teaching program. A master's and doctoral program in instrumentation might benefit from being located in Silicon Valley, though this would represent a major undertaking by one or more senior faculty. Faculty in Physics are concerned, as are faculty from other departments, about the potential for fragmentation and isolation should departmental faculty be located a significant distance from one another.

Summer Quarter: Physics has been successful in offering the Physics 7A, 7B, 7L and 7M (Elementary Physics with labs) in Summer Session. This course sequence is designed for students with less mathematical preparation and does not require calculus—it provides an adequate background for most health sciences programs and has been well subscribed in the summer. The department proposes to expand its traditional summer offerings with the addition of Physics 6A and 6L (Introductory Physics with lab), the first course of a calculus-based sequence that provides a strong background for premedical students and students majoring in science disciplines other than physics. The department has also proposed the development of a new course sequence for summer quarter, designed specifically to serve transfer students who frequently require additional physics preparation (beyond the community college courses) before

entering as juniors in fall quarter. This course will also serve four-year students who decide to major in Physics late in their sophomore year and who find that they have not taken the correct prerequisites in order to complete the major in four years.

SCIENCE COMMUNICATION

http://scicom.ucsc.edu/

Overview: The internationally recognized and highly selective Science Communication Program offers two tracks leading to the graduate certificate: 1) the science writing track, available only to graduate students, and 2) the science illustration track, available to graduate students and undergraduates.

Vision: If resources permitted, the Science Communication Program could envision new programmatic directions to which their expertise could be applied (see below). Otherwise, the program will focus on continuous improvement.

DEPARTMENT PROFILE

	Baseline *	2005-06	2010-11
Faculty FTE	1.00	1.00	1.00
TAS	1.80	1.80	1.80
Budgeted Faculty FTE	2.80	2.80	2.80
Graduate Students	20.00	20.00	20.00
Postdocs/Researchers	0	0	0
Student Workload FTE	27.90	27.90	27.90
Workload Ratios	9.8:1	9.8:1	9.8:1

Last Official Workload Ratios from 1999-00: 9.8:1
*Baseline includes 1999-00 FTE + 2000-01 recruitments

Instruction: As illustrated by the department profile above, the program should experience steady-state enrollment and workload through 2010-11. The program accepts 20 students per year, 10 in the writing track and 10 in the illustration track. Courses in science writing are strictly limited to graduate students accepted into the Science Communication Program. Some of the science illustration courses are open to undergraduates. Future consideration of an illustration minor is proposed. There is strong evidence that it would attract unusually accomplished undergraduate science majors to the campus.

Silicon Valley Center: The Science Communication Program does not anticipate playing a significant role in the development of the Silicon Valley Center. The program has been placing interns at NASA Ames Research Center for 18 years.

Summer Quarter: The Science Communication Program proposes to expand summer course offerings in science illustration. The current Summer Session illustration classes are extremely popular in the local community as well as with UCSC students who cannot get into the classes that are open to undergraduates during the regular year. The program proposes to offer a series of eight classes that would be taught either every year or in alternate years. At least five courses would be offered each summer. Course enrollments are restricted to 18 owing to the physical limitation of the science illustration classrooms.

Appendix 7
Executive Summaries of Organized Research Units
December 2001

Units with an institutional reporting relationship to the Division of Natural Sciences

INSTITUTE OF GEOPHYSICS AND PLANETARY PHYSICS

The UCSC branch of the Institute of Geophysics and Planetary Physics (IGPP) was officially established during the 1999-2000 academic year. The mission of the IGPP Multi-Campus Research Unit is to promote and coordinate basic research on the understanding of the origin, structure and evolution of Earth, the Solar System, and the Universe, and on the prediction of future changes as they affect human life. In practice, this mandate spans topics from the early accretion, orbital dynamics and internal structure of planetary bodies through to the present dynamics of the terrestrial hydrosphere and atmosphere. As such, the IGPP mission encompasses aspects of the traditional academic disciplines of astronomy, earth sciences, and ocean/atmospheric sciences. All of the latter disciplines are actively engaged in the IGPP branch at UCSC.

The UCSC IGPP Branch now includes three interdisciplinary research centers with over 50 faculty and professional researchers drawn from eight UCSC Departments (Anthropology, Astronomy and Astrophysics, Earth Sciences, Ecology and Evolutionary Biology, Environmental Studies, Environmental Toxicology, Ocean Sciences, Physics) participating in the effort. Brief descriptions of the established research centers follow.

Center for Dynamics and Evolution of the Land-Sea Interface (C.DELSI)

C.DELSI will enhance interdisciplinary research on the complex ocean, atmosphere, and continental systems that impact regional climate, marine and freshwater resources, agriculture, fisheries, and natural hazards. Research efforts of the center have placed UCSC at the scientific forefront of research on the dynamics of marine and terrestrial processes, particularly as they relate to the land-sea interface. Graduate students and postdoctoral scholars are educated in a broadly interdisciplinary context that is essential to the next generation of researchers addressing the challenges of climatic and environmental change. Center activities also enhance the educational experience for undergraduate students pursuing degrees in Environmental Sciences or related fields. The initial five-year effort of the Center is focused on the long- and short-term dynamics of the global and regional scale climate change and their impact on ocean circulation, landscapes, geochemical cycles, and marine and terrestrial ecology at the land-sea interface. This effort involves faculty from at least five departments with expertise in the following areas: paleoclimatology, paleoceanography, geomorphology, hydrology, biogeochemistry, aquatic toxicology, marine ecology and biology, and ecological economics and policy.

Center for Origin, Dynamics and Evolution of Planets (CODEP)

The primary mission of CODEP is to coordinate and promote campus activities related to the origin, dynamics, and evolution of planetary bodies in our Solar System and around other stars. Planetary science is undergoing dynamic and profound advances. UCSC is well poised to contribute to significant advances in observational, theoretical, experimental, and computational planetary science. As such, the Planetary Sciences research program coordinated through CODEP is helping UCSC position itself to take part in the discoveries, missions, and data returns of the coming decades. Fundamental scientific challenges abound regarding planetary formation, dynamics, and evolution; these require an interdisciplinary effort bridging the interests of several of the leading UCSC science departments. By enhancing research coordination across several units, CODEP is broadening UCSC's graduate research programs, preparing a new generation of scientists to address the planetary research topics of a new century. As a center under IGPP, CODEP is also enhancing interactions in Planetary Sciences with IGPP branches at UCLA, UCSD, UCR, LANL and LLNL.

Center for the Study of Imaging and Dynamics of the Earth (CSIDE)

One of the premier intellectual endeavors of the past century has been a concerted effort to understand the formation, evolution, and dynamics of planet Earth. The newly formed CSIDE is the successor to the former Institute of Tectonics at UCSC, an organized research unit with a 15-year history of important multidisciplinary research into the dynamics of the Earth system. The primary focus of the newly reorganized CSIDE is to conduct basic multidisciplinary research on terrestrial imaging and the dynamics of the near surface, crust, mantle, and core. The Center engages with other research programs of the IGPP to enhance the multidisciplinary research on physical and chemical process affecting land-sea and land-atmosphere interactions on earth and other planets.

Subsequent expansion of the UCSC IGPP will include development of an additional research center, the Center for Remote Sensing (CRS), and the dedication of a Massive Computer Simulations facility.

INSTITUTE OF MARINE SCIENCES

The Institute of Marine Sciences (IMS) provides facilities and administrative and technical support of faculty, researchers, and students interested in marine sciences. Faculty from several disciplines in the natural and social sciences are associated with IMS. During 2000-01, the Institute had 10 research specialists, 17 researchers, and 42 affiliated faculty from six different academic departments. Established in 1972, the institute now supports a variety of research activities in many areas.

The Center for Ocean Health, through the Institute of Marine Sciences ORU, is intended to create a model structure for the integration of interdisciplinary marine sciences research, environmental policy, and public education, all focusing on the health of the world's oceans. The Center provides a focal point for UCSC's marine sciences research programs in marine

mammal biology, near-shore ecological processes, marine biogeochemistry, and environmental toxicology.

IMS provides research support facilities for over 50 faculty and researchers specializing in marine-related research. Their research is conducted at the University, at Long Marine Lab, and throughout the world oceans. Scientists affiliated with the Institute work in many fields: continental margin tectonics, ocean processes and paleoceanography, coastal processes and hazards, ocean acoustics, marine biotechnology, marine bacteriology, phycology, biological oceanography, and molecular biodiversity and evolution. They also teach undergraduate and graduate classes in marine chemistry and toxicology, marine biology, molecular biology, physics, marine geochemistry, paleoclimatology, and physical, chemical, biological and geological oceanography.

The institute's facilities on campus and at Long Marine Lab are a magnet to which other marine programs are attracted to advance cooperative research projects. The U.S. Geological Survey has scientists on the UCSC campus who collaborate with faculty and graduate students on diverse projects including coastal and near-shore processes, shoreline erosion and coastal hazards. IMS faculty and researchers also collaborate with the Monterey Bay Aquarium Research Institute (MBARI), Moss Landing Marine Laboratories, Hopkins Marine Station, University of California, Santa Barbara, the California Department of Fish and Game, the National Marine Fisheries Service (NMFS), the National Oceanic and Atmospheric Administration (NOAA), and other research organizations.

At the Long Marine Laboratory site, state and federal research organizations have joined the groundswell of opportunities available through collaborative research. In 1997, the California Department of Fish and Game opened a $5.5 million Marine Wildlife Veterinary Care and Research Center located on the lab property. An Oiled Seabird Research Center has also been developed on site. The NMFS relocated its Tiburon Lab to the Long Marine Lab site. A new 53,000-square-foot facility was completed in 2000 and now accommodates over 50 NMFS scientists and staff members.

The Institute also conducts an exemplary outreach and public education program. The Seymour Marine Discovery Center opened in March of 2000 and has become a major educational success. The new facility is extensively used by both campus and off-campus groups. Over 56,000 people visited the Seymour Center during its first 12 months of operation. This number includes over 7,000 school children. In addition to the 11 staff members employed at the Center, approximately 175 trained community volunteers form a critical part of the education and support staff that make this educational facility a success. Operating expenses are raised with the assistance of a public support group and come from a combination of income generating sources including entry fees, membership fees, fund-raising events, facility rental, grants, and University support.

CENTER FOR THE MOLECULAR BIOLOGY OF RNA (RNA CENTER)

The Center, established in 1992, brings together an interdisciplinary group of researchers whose common interest is to understand the molecular basis of action of RNA in biological systems.

An important goal is to promote interaction between structural biologists on the one hand and molecular geneticists and biochemists on the other; thus, members of the Center comprise faculty from Biology, Chemistry and Biochemistry, and Computer Science.

Motivation for creation of the Center has come from many exciting developments in the molecular biology of RNA in recent years. It is now known that RNA can have enzymatic activity and has the ability to catalyze specific biochemical reactions. Accordingly, many molecular biologists now believe that RNA may have preceded both protein and DNA in the early molecular evolution of life. It is becoming apparent that RNA, like protein, can fold into complex and unusual three-dimensional structures and that this is crucial for its ability to carry out enzymatic functions. A better grasp of the fundamental properties of RNA will benefit a wide range of medical research projects, and understanding RNA viruses—such as HIV—has become a national priority.

Among the research areas currently under investigation by members of the Center are RNA processing, translation, mRNA stability and structure, ribonucleoprotein assembly, RNA-protein recognition, three-dimensional structures of RNA and RNA-protein complexes (including the ribosome), the mechanism of action of functional RNAs, in vitro evolution of novel catalytic RNAs, and RNA genomics. The Center's work has progressed to the point where researchers can describe the structure of the ribosome, a complex particle just one millionth of an inch in diameter, in sufficient detail to begin to understand how it works.

Major funding for the Center has come from grants from the Lucille P. Markey Charitable Trust and the W. M. Keck Foundation, as well as individual research grants from the National Institutes of Health, the National Science Foundation, and other sources available to members of the Center.

SANTA CRUZ INSTITUTE OF PARTICLE PHYSICS (SCIPP)

Research in particle physics has progressed to the point where we now have an excellent understanding of the strong, electromagnetic and weak forces, as well as the basic constituents making up the visible matter around us. Present research has turned to the next layer of questions: For example, why is there more matter than antimatter? What gives the particles their masses? Can the interactions be unified in some way? What is the invisible dark matter? With the help of new instruments, scientists are rapidly determining the cosmological parameters, and thus answering the questions raised early in the 20^{th} century by Einstein's General Relativity and Hubble's discovery of the expansion of the universe. The next step in cosmology will focus both on the origin of structure within the universe and the role of the particles and forces in generating both the structure and the geometry of the cosmos. The Santa Cruz Institute for Particle Physics is home to a permanent scientific and technical staff including faculty, senior research physicists, graduate students and postdoctoral fellows whose research programs aim to answer these questions. Within the Institute, pursuits are diverse.

SCIPP has a prominent role in four major international projects. These are long-term efforts taking several years for planning and construction and then several more years to reap the scientific benefits. These projects are the BaBar detector for the B-factory accelerator at the

Stanford Linear Accelerator Center; the Milagro Gamma-Ray Observatory recently completed in Los Alamos, New Mexico; the ATLAS detector for the Large Hadron Collider at CERN in Geneva, Switzerland; and the GLAST Gamma-Ray Large Area Space Telescope to be launched into space by NASA. The first two projects should provide exciting new physics results through 2001, and the last two should continue past 2010. The present program includes extramural funding from the Department of Energy, NSF and NASA at a level that exceeds $4 million per year. SCIPP has both major technical and scientific roles in each of these projects. In addition, SCIPP hosts a first-rate detector research and development program. This program benefits from close proximity to the vast technical resources of Silicon Valley. In particular, SCIPP is recognized as a leader in the development of custom readout electronics and module design for state-of-the-art particle detection systems.

SCIPP experimentalists are involved in a number of efforts at premier high-energy physics facilities around the world. This includes electron-positron colliders (the SLC and PEP-II colliders at the Stanford Linear Accelerator Center, and the LEP collider at CERN in Geneva, Switzerland), the HERA electron-proton collider in Hamburg Germany, and the future LHC proton-proton collider at CERN.

The theoretical physicists with SCIPP conduct research in a broad range of areas. The group maintains internationally recognized research programs in the phenomenology of the standard model (particularly Higgs physics), supersymmetry phenomenology and model building, superstring theory, and cosmology, including both early universe issues (inflation, symmetry breaking, baryon asymmetry generation) and building and testing dark matter cosmological models against laboratory and astrophysical data.

UCO/LICK OBSERVATORIES

University of California Observatories/Lick Observatory conducts leading-edge research to answer the most profound questions in observational astronomy. Headquartered at UCSC, this multi-campus research unit supports research and training of astronomers, researchers, graduate and undergraduate students throughout the UC system. UCO provides technical resources to design and fabricate state-of-the-art instrumentation, optics, programming, and detectors. A managing partner of the W. M. Keck Observatory on Mauna Kea in Hawaii, UCO also operates Lick Observatory on Mt. Hamilton, conducting both research and public programs.

Scientists at UCO/Lick maintain a vigorous program of research. Examples of notable achievements include:

The Study of the Astrophysics of Globular Clusters in Extragalactic Systems: The focus of this project is to investigate the formation and evolution of globular clusters and their host galaxies. This problem is tackled using high resolution imaging from the Hubble Space Telescope, combined with ground-based imaging and multi-object spectroscopy with the Keck Telescopes. The information obtained through this project can help answer several important open questions about both GC and galaxy formation and evolution.

The DEEP Project: The Deep Extragalactic Evolutionary Probe (DEEP) is a multi-year program which uses the twin 10-m W. M. Keck Telescopes and the Hubble Space Telescope to conduct a truly large-scale survey of distant, faint, field galaxies. The broad scientific goals include: understanding the formation and evolution of galaxies, the origin of large-scale structure, the nature of the dark matter, and the geometry of the Universe. This project is led by Lick Observatory at UCSC in collaboration with UC Berkeley, UH Manoa, Johns Hopkins University, University of Chicago, and California Institute of Technology.

The DEIMOS Project: The Deep Imaging Multi-Object Spectrograph (DEIMOS) is a powerful new spectrograph for the Keck II telescope that will magnify the telescope's capacity by a factor of seven for faint-galaxy optical spectroscopy. The DEEP Survey, made possible by DEIMOS, will create the first comprehensive map of the distant Universe. DEIMOS and DEEP will, for the first time, allow astronomers to verify their theories about the origin of the universe.

CENTER FOR ADAPTIVE OPTICS (CFAO)

UCSC is headquarters for The Center for Adaptive Optics (CfAO) that serves to advance and disseminate the technology of adaptive optics in service to science, health care, industry, and education. The CfAO was established in 2000 as a Science and Technology Center (STC) funded by the National Science Foundation. The goal of the NSF STC centers is to fund basic research and education activities and to encourage technology transfer and innovative approaches to interdisciplinary programs. A new 4,000 square foot building to house the CfAO is nearing completion and will be ready for occupancy in 2001.

Adaptive optics is a method for removing the blurring of images caused by changing distortions within optical systems. Turbulence in the Earth's atmosphere causes blurring of astronomical images. In an analogous manner, internal imperfections and fluids in the eye cause blurring of images striking the retina. The use of adaptive optics allows ground-based telescopes to see as clearly as if they were in space, and these techniques, when used to look at the retina of the human eye, dramatically sharpen images of the retina.

The Center for Adaptive Optics (CfAO) will concentrate on astronomical and vision science applications of adaptive optics and will reach out to other adaptive optics communities to share technologies. It will develop new instruments optimized for adaptive optics. Examples from astronomy include "integral-field" spectrographs that take spectra of thousands of tiny contiguous regions of the sky simultaneously (for studies of distant galaxies and proto-solar-systems), as well as coronagraphs to image very faint objects close to bright ones (for studies of black holes in galaxies and planets around nearby stars). Instruments to be developed for vision science include a confocal scanning laser opthalmoscope, achieves high-depth resolution as well as lateral resolution. This instrument will make possible high-resolution 3-D reconstruction of retinal blood vessels and of optic nerve fibers that carry signals to the brain.

Organized Research Links with the School of Engineering

CENTER FOR BIOMOLECULAR SCIENCE AND ENGINEERING (CBSE)

Established last year, the Center for Biomolecular Science and Engineering at the University of California at Santa Cruz is the umbrella organization for an interdisciplinary research and education program that spans the School of Engineering and the Division of Natural Sciences. Our proximity to Silicon Valley and Biotech Bay, our active collaborations in molecular biology, protein and RNA biochemistry, and computational biology make this a natural research and academic focus area for this division and the campus.

INSTITUTE FOR BIOENGINEERING, BIOTECHNOLOGY AND QUANTITATIVE BIOMEDICAL RESEARCH (QB3)

This Institute joins the physical, engineering, and biomedical sciences in an innovative project to improve human health and create dynamic new technologies. The Institute builds on the engineering and physical sciences at UCB, the mathematical sciences at UCSC, and the medical sciences at UCSF and will bring existing graduate programs on all three campuses together into an overarching Program in Quantitative Biomedical Research (QBR). QBR will foster connections between the component programs on different campuses, sponsor symposia and annual meetings, and establish an Institute-wide seminar series that will be web-cast to all sites

Organized Research Link with the Social Sciences/Engineering

STEPS: AN INSTITUTE FOR INNOVATION IN ENVIRONMENTAL RESEARCH (SCIENCE, TECHNOLOGY, ENGINEERING, POLICY, AND ENVIRONMENT)—UNDER DEVELOPMENT

The goal of STEPS is to foster research linking global and regional environmental processes. In meeting the goal, the focus will be on two of the greatest environmental research problems facing our societies: 1) integration of global biodiversity research from genes to ecosystems, and 2) integration of research linking water, environment, and society across land and sea.

STEPS

Institute for Innovation In Environmental Research

Science, Technology, Engineering, Policy, & Society

Fostering Research Linking Global and Regional Environmental Processes

The STEPS Approach:
Science, Technology, Engineering, Policy, & Society

Table of Contents

Executive Summary

Goal: Foster research linking global and regional environmental processes

Research Themes: In meeting the goal, will focus on two of the greatest environmental research problems facing our societies:

- Integration of global biodiversity research from genes to ecosystems
- Integration of research linking water, environment, and society across land and sea

Approach: Major advances in these research themes require interdisciplinary research — the STEPS approach.

- STEPS: Science, Technology, Engineering, Policy, and Society

Why this goal, these themes, and this approach

Environmental research is poised to make major advances in the next decade, but the greatest advances will come from approaches that link global and regional environmental processes. Global warming, El Niño events, and North Atlantic Oscillations are all global scale processes that have direct effects on our regional environments and are having increasing effects on our societies. At the same time, fragmentation and genetic restructuring of ecosystems are now occurring on a global scale, as our societies alter all the earth's landscapes and move genes and species among continents and oceans. Invasive species introduced from other parts of the world within the past one hundred years now dominate many ecosystems on all continents. These rapid changes are profoundly altering environmental processes, as they reshape global patterns of biodiversity and the earth's water cycles.

Human health depends upon ecosystem health, and ecosystem health depends upon the processes linking the earth's ecosystems. The long-term health of our societies therefore requires that we understand those linkages much better than we do now. Every recent national task force on environmental research has emphasized this crucial research need. Meeting that need requires development of innovative scientific approaches, technological and engineering tools, and environmental policy that becomes integrated into our societies—the STEPS approach.

Why UCSC?

- UCSC has a tradition of fostering interdisciplinary research.
- We are expanding our environmental research departments and centers, and we have created two new environmental sciences departments within the past two years.
- We have created a new School of Engineering, which will develop in ways that complement research in the Divisions of Natural Sciences and Social Sciences.
- We are developing new environmental research clusters at the interface of modelling and measurement across multiple spatial scales.

The Goal of the STEPS Institute:
Foster Research Linking Global and Regional Environmental Processes

The most difficult questions we now face in environmental research are those that link global environmental processes to regional processes and patterns. Global warming, El Niño events, and North Atlantic Oscillations are all global scale processes that have direct effects on regional environments. At the same time, global changes in biodiversity are completely reshaping regional environments. Our societies have already altered the genetic structure of almost every ecosystem worldwide by moving genes and species among continents in oceans. Many ecosystems are now dominated by groups of species moved from other continents by human activity over the past one hundred years. In addition, our activities have fragmented the landscapes of almost all ecosystems, changing regional ecosystem processes and their global links. Nevertheless, most environmental research remains at the level of either fine-grained local studies or coarse-grained global models, with few connections between them.

All recent national task forces on the environmental sciences have identified integration of global and regional scale environmental processes as one of greatest challenges facing environmental research. These task forces have included the National Research Council report on the Grand Challenges in the Environmental Sciences, the National Science Board Report on Environmental Science and Engineering the 21st Century, the National Science Foundation Whitepaper on the Frontiers of Ecology, and the NSF Geosciences Beyond 2000 Report on Understanding and Predicting Earth's Environment and Habitability.

Examples: The environmental dynamics of California epitomize the need for linking global and regional environmental processes. California's environments are being reshaped by El Niño/La Niña cycles that originate in the oceans and by changes in precipitation that arise from global warming. Yet we are only now beginning to undersigned how these global physical processes affect the genetic and ecological dynamics of plant, animal, and microbial populations and the cycling of nutrients and water through ecosystems.

We also now know that California's environments are increasingly dominated by invasive species introduced from other continents. These species have disrupted coevolved interactions between native species that are important for ecosystem health. Some of the causes of the spread of invasive species are regional, resulting from alteration and fragmentation of local environments, making its ecosystems susceptible to invasion. But similar invasions by some of the same species are occurring worldwide, and the problem can be understood only in a global context.

Current Strengths: Within UCSC we have research groups in the physical, biological, and social sciences, engineering, and environmental policy addressing a wide range of environmental processes across multiple spatial scales. These include laboratories studying global and regional patterns in physical processes in marine and terrestrial environments, environmental toxicological processes across multiple spatial

scales, the structure of biological communities from local to continent-wide and ocean-wide scales, the genetic structuring of species and species interactions across broad geographic landscapes, remote sensing of an increasing array of environmental processes, and societal responses to environmental policies that cross political boundaries.

We already have a number of initiatives in place. The Institute of Geophysics and Planetary Physics (IGPP), the Center for Dynamics and Evolution of the Land/Sea Interface (C.DELSI), the Center for Marine Protected Areas (MPA), and the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) are examples of the kinds of current strengths that can provide the basis for future growth. Each of these efforts integrates environmental sciences in different ways across regional and global scales. IGPP was established at UCSC in 1999-2000 as part of a multi-university effort to develop large-scale planetary modelling with potential major collaborations with NASA Ames. The newly established Center for Marine Protected Areas will coordinate the nationwide effort to develop a system of MPA research centers throughout U.S. waters. The UCSC part of the effort will collaborate with agency and non-governmental partners in developing the science-based framework needed to design and effectively manage MPAs. Similarly, PISCO, which was established through major funding from the David and Lucille Packard Foundation, is a large multi-university effort. It is designed to develop a systematic understanding of the biodiversity of marine environments in the Pacific Ocean across multiple spatial scales. Much of the PISCO work on community ecology and the genetic structure of populations is being spearheaded through work at UCSC.

Related efforts are underway on large-scale initiatives in terrestrial environments that complement the efforts underway for marine environments. The multi-campus Coast Ranges Oak Woodlands Network (CROWN), which recently received a planning grant from the Packard Foundation, is one example of the kind of new initiative underway. The UCSC components of that work are on the genetic structuring of plant and animal species arose large geographic scales and on the problems of implementing environmental policy across large scales. UCSC is therefore poised to be one the few universities capable of integrating global and regional environmental processes across the land/sea interface.

Research Theme 1: Global Biodiversity from Genes to Ecosystems

Justification*:* Biodiversity encompasses the richness of species, species interactions, and the full range of genetic diversity they harbor. Through parasitism, predation, competition, and mutualism, species form genetic networks that organize the earth's ecosystems. These evolving genetic networks of interacting species drive fluctuations in population numbers, shape global patterns in human health, and connect ecosystems regionally and globally. Consequently, assessment of the maintenance, dynamics, and distribution of the genetic diversity of life is the core problem in linking biodiversity to environmental health. Environmental scientists are now developing the combination of approaches from the physical sciences, biological sciences, engineering, mathematics, and computer science needed to understand the breadth of the genetic diversity contained among the earth's estimated 5-10 million species. Through these efforts, environmental research can begin to assess rigorously how fluctuations in the richness of biodiversity affect the health of ecosystems. Getting answers will require the development of more precise genetic and mathematical tools for diversity assessment, detailed analyses of global and regional dynamics in diversity as shaped by physical and biological processes, innovative methods for understanding how the diversity of species interactions affects ecosystem processes, and novel approaches to conserving biodiversity amid the complex structure of human societies.

Examples: California composes a distinct biogeographic region that is considered to be one of the world's 25 most biologically rich but endangered terrestrial ecoregions. It harbors more plant species than central and northeastern US and Canada combined, and it includes over 30% of the known insect species north of Mexico. A recent assessment of the terrestrial ecoregions of North America listed California as a Class 1 conservation region: a globally outstanding ecoregion requiring immediate protection of remaining habitat and extensive restoration. Understanding the genetic diversity contained within that tremendous species diversity will require approaches that go far beyond the study of the genetics and ecology of single species one at a time or ecosystems one at a time.

Much of the biodiversity of California has complex geographic patterns. Most species have narrow environmental tolerances, which is both the source of California's biological richness and the cause of its fragility. California is isolated from similar ecoregions on other continents. This ecological uniqueness has generated high levels of native species endemism within the state. But its insularity has left California extraordinarily vulnerable to invading species, which have radically transformed its landscape. With habitat conversion and fragmentation also continuing at high rates, it is vitally important that we understand the global physical and biological processes shaping California's biodiversity and the threats to that diversity offered by invasive species, habitat conversion, fragmentation and changes in temperature and precipitation patterns.

Similar rapid changes in the structure of biodiversity are happening in oceanic environments, through fragmentation and loss of coral reefs, changes in the physical environments of nearshore regions, increased pressure on fisheries, and alteration of

marine genetic stocks through transplants. Until recently, research on the global and regional genetic structure of species in marine environments has lagged behind research on terrestrial species, making interpretation of biodiversity dynamics in marine environments difficult. Through improved DNA technologies, mathematical theory in population biology, and increasingly large-scale sampling efforts, analyses of the comparative genetic structure of biodiversity in terrestrial and marine environments and their effects on ecosystem processes are becoming feasible.

Current Strengths: UCSC has dozens of laboratories studying the ecological and genetic structure of species, the dynamics of biological communities, and the ways in which social policy and perception affect conservation efforts. Its location next to the Monterey Bay National Marine Sanctuary makes it one of the most strategically located universities for studies of marine and terrestrial biodiversity and the processes linking biodiversity across the land/sea interface. The newly established formal alliance with the California Academy of Sciences has created an important link with one of the best institutions worldwide inventorying the earth's biodiversity.

Those strengths span terrestrial and marine environments. Multiple partnerships to study biocomplexity across multiple geographic scales in terrestrial environments are underway. For marine environments, the Packard-funded Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) is explicitly a large scale effort to understand the structure and dynamics of marine biodiversity through ecological and evolutionary studies. The new Center for Ocean Health at the Long Marine Laboratory, the continued development of the UCSC Center for Agroecology and Sustainable Food Systems, the reinvigorated development of the UCSC Arboretum, the establishment of the UCSC Center for Conservation Science and Policy, the NOAA Center for Marine Protected Area Science, and the newly developed Molecular Ecology and Evolutionary Genetics Facility have all created opportunities for making UCSC one of our nation's and state's top centers for the study of biodiversity and its conservation.

Research in biodiversity at UCSC spans multiple departments and centers campus-wide. Examples include these:

Earth Sciences*:* Historical (paleontological) dynamics of biodiversity

Ecology and Evolutionary Biology: ecological and genetic dynamics of populations across broad geographic scales, the structure and dynamics of biological communities, coevolution of species, and the evolution of diversity in physiology and behavior

Environmental Studies: ecological structure of communities in temperate and tropical environments, the dynamics of species interactions, and environmental policy relating to biodiversity

Environmental Toxicology: diversity of responses of organisms to environmental toxins

***Ocean Sciences*:** analysis of the diversity of taxa responsible for major biogeochemical cycles, and the community dynamics of harmful algal blooms

Institute for Marine Sciences: fostering research in all aspects of marine science, including the dynamics of biodiversity

Research Theme 2: Water, Environment, and Society

Justification: Wholesale alteration of the earth's environments is having major effects on global and regional water cycles. Effective management of the earth's water resources is becoming a topic of central importance for regional, national, and multi-lateral leaders. Water management has always been a multi-disciplinary undertaking, but historically the disciplines involved were primarily connected with science and technology. Today, all the perspectives in *STEPS* are needed if critical decisions on water management are to be made well. UCSC is well positioned to become a leader in research and teaching related to critical water-management issues in the 21st century, because we already have strong research groups in place. For that reason, Water Research has been designated as one of the two research themes that UCSC will develop under the overall goal of linking global and regional scale environmental processes.

Examples*:* The increasingly large concentrations of human population along the world's coastlines demand research on how the earth's water resources span the land-sea boundary. That research must include development of a better understanding of how to protect inland sources of fresh water, maintain the dynamics of coastal zones where fresh and saltwater meet and mix, and link on-shore water processes to off-shore coastal and pelagic regions. To be useful to our societies, that research must be proceed in step with related studies of how our societies use water resources and how policies differ in their effectiveness in managing water resources.

For example, fresh water researchers in the UCSC Departments of Earth Sciences and Environmental Studies are attempting to link the time-scale at which urban water supply planning occurs (40 years) with the time scale presented in regional climate models that account for atmospheric carbon loading (~300 years, 1760 to 2060). In addition, researchers from Earth Sciences, Environmental Toxicology, and Environmental Studies are collaborating on an attempt to link models of climate-change, sub-surface hydrology, water quality, water rights, and land-use change. The Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) not only coordinates research activities on near-shore ocean environments, but it also communicates regularly with regional management agencies and policy makers. In each of these examples, important insights with practical implications for water management await breakthroughs in the matching scales of inquiry across disciplines.

Current Strengths: With diverse and successful research programs already underway throughout the campus, UC Santa Cruz is undertaking cutting-edge research on water issues of critical importance. Numerous UCSC departments, research units, and individual researchers have national and international reputations for their water-related research. Examples include these:

Earth Sciences, research in geology, geochemistry, and geophysics, including issues related to the storage, flow, and quality of surface and sub-surface water both inland and at fresh water/saltwater boundaries, as well as long-term modeling of

climate change, including changes in precipitation and surface temperature at the regional level.

Ecology and Evolutionary Biology, research on population and community ecology, population genetics, rapid evolution and coevolution of species, physiology, behavior, systematics, and biodiversity, spanning marine mammals, fish, pelagic bird, invertebrates, and plants and algae.

Environmental Studies, research on fresh water management, policy, and law, the role of water in ecological restoration and climate change, and quantitative modeling of riverine and ocean fisheries.

Environmental Toxicology, research on the biogeochemical cycling of toxins and pathogenic organisms in fresh water, saltwater, and mixed systems; the bioremediation of polluted aquifers; and the bioavailability, metabolism and toxicity of natural and anthropogenic contaminants.

Ocean Sciences, research on open-ocean biology and chemistry, trace-metal and stable isotope chemistry, marine biogeochemistry, marine microbiology, paleoceanography and paleoclimatology, sediment geochemistry, marine ecology, coral reef ecology, marine mammal behavior and migrations, continental margins, and natural products from marine organisms.

Center for the Dynamics and Evolution of the Land-Sea Interface (C-DELSI), research on the marine and terrestrial systems that constitute the land-sea interface and the processes that modify and couple these systems. These include climate processes that drives ocean circulation, geologic processes that help shape the margins of the continents and transport water and sediment from the mountains to the coastal ocean, and biogeochemical and biological processes that influence the cycling of carbon, nutrients, and other elements in these systems.

Institute of Marine Sciences, facilitating research on a wide range of research related to marine vertebrate biology, coastal biology, fisheries and fishery management, oceanography and ocean processes, marine geology and geophysics, environmental toxicology, paleoceanography, paleoclimatology and global change.

The STEPS Approach

Major advances in linking global and regional environmental processes will require crossing traditional disciplinary boundaries in truly integrated ways. It will require innovative links among science, technology, engineering, policy, and society.

As UCSC continues its current growth, it is poised to push its tradition of interdisciplinary research to a higher level. The STEPS Institute will provide a direct mechanism to focus a major part of that growth in innovative ways.

Initial development of STEPS will require meeting these needs:

- Endow the Directorship that will facilitate this campus-wide effort.
- Underwrite the STEPS interdisciplinary research facilities
- Support interdisciplinary training and collaboration.
- Fund buildings that will house the STEPS facilities.

Full development of the potential of STEPS will require meeting these needs:

- True integration requires linking people:
  - Fund director's office — to link environmental research disciplines
  - Endowed chairs — to attract and retain top researchers
  - Visiting fellows and professionals — to bring in additional expertise
  - Release time for faculty — to develop links across disciplines
  - Postdoctoral associates — to expand training in new directions
  - Graduate fellowships — to train students in the STEPS approach
  - Funds for outreach — to attract underrepresented groups
  - Funds for field training — to gets hands-on, real world understanding
  - Travel funds — to foster novel collaborations
  - Funds for STEPS working groups — to push the development of novel links
  - Technical and support staff — to make it possible to move forward quickly
  - Build STEPS research facilities — to fund innovative research
  - Maintain STEPS research facilities — to provide funding for long-term questions

STEPS Research Facilities
Current and Proposed(*)

***STEPS* Institute**

*****_STEPS_ Coordinating Office
*_STEPS_ Working Group and Workshop Facility

Environmental Genomics

Bioinformatics
Molecular Ecology and Evolutionary Genetics

Environmental Instrumentation and Engineering

*****Environmental Analysis
*Environmental Technology
Marine Analytical Laboratory
*Remote and Autonomous Sensing/GIS

Environmental Computing and Mathematics

*Mathematical and Statistical Modelling
*Envirometrics

Environmental Facilities Cluster

Agroecology Center
Arboretum
Center for Ocean Health
UCSC Reserves

Conclusions: Why Develop this Institute?

Through this coordinated, interdisciplinary effort, we will:

- Position UCSC firmly as one of the country's leading universities in integrated approaches to the environmental sciences.

- Confront directly one of the greatest challenges facing the environmental sciences.

- Develop innovative approaches to research and training on two of the major national priorities in the environmental sciences.

- Contribute directly to the other major research priorities identified by the recent national environmental science task forces.

- Address the environmental issues of our region in a broader context and become a model for how to address similar questions elsewhere worldwide.

- Train undergraduate and graduate students in ways that will give them the conceptual and methodological tools needed to become highly informed regional and national leaders as environmental scientists and decision makers.

- Contribute to the solution of maintaining healthy ecosystems, which are vital to human health.