Executive Summary

Ten years ago the School of Fisheries received a negative review that documented a number of problems largely tied to our Teaching Mission. Over the ensuing decade, the Faculty worked to correct those problems and, more strategically, analyzed what longer-term directions and opportunities the School should anticipate as means to improve and expand the degree program, research disciplines, and academic collaborations across campus. Emerging from these efforts was a Strategic Plan of objectives that have guided us into a new era as the **School of Aquatic and Fishery Sciences**. This report provides the information and data that we hope are seen by the Review Committee and the University at large as evidence of substantial change that now makes us a vigorous, growing department, and one that contributes in many ways to the University community. Highlights following summarize significant steps taken to change and improve our School in ways largely tied to our teaching mission, that clearly benefits from the scope of topics and wealth of funding derived from our Research Mission.

The School of Aquatic and Fishery Sciences (SAFS) is a vibrant academic program focused on the interface between the traditional disciplines of Biology, Oceanography, and Natural Resource Management. Currently composed of 26 faculty, only 15 of whom are Stated-funded teaching FTEs, SAFS spans the continuum between basic and applied science. Rather than focus simply on production and harvest, SAFS faculty specialize in fields ranging from field ecology, to conservation and management, to fish production. Our research venue runs from the watershed through the estuary and coastal ocean to the large marine ecosystems of the open Pacific, and our work includes local, national, and international issues. The diversity of our research approaches include field programs in behavior, ecology, and conservation; traditional wet lab science, including aquatic microbiology, diseases, reproduction and endocrinology, and a top-notch quantitative science program.

Diversity of faculty appointments and mandates provide a unique blend of teaching and research faculty, and makes possible a more flexible response to the changing needs of a traditional academic setting of undergraduate and graduate education, as well as needs, issues, and interactions of the broad agency community and the general public. In addition to State FTE faculty, we value a mix of research faculty whose external funding often reflects major issues and/or questions rooted in need for science to address public and industry resource allocation and policy formulation. This diversity of faculty lines has allowed SAFS to excel in salmon fisheries management, aquaculture, wetland restoration, and more recently in groundfish stock assessment and hydroacoustics. In addition, SAFS has been able to meet emerging needs and disciplines in aquatic sciences such as molecular genetics, conservation, ecosystem management, and an expanded focus on upper trophic species with recent State FTE faculty hires.

Regardless of the individual disciplines, SAFS fac-

ulty share a common theme of "real-world" relevance embedded within observational and experimental methods, and underpinned by theories and methods of basic science. This mix promotes interdisciplinary work across the SAFS Faculty and with colleagues in other UW departments (notably Biology and Oceanography) in programs like Alaska Salmon Program, PNCERS, GLOBEC, international fisheries management and conservation agencies, and extensive aquaculture industries. We benefit from deep ties of scientific collaboration and funding including those with NMFS science laboratories, and a variety of State resource agencies. In every way, ***collaboration is key to our success*** and widely appreciated as intellectual catalyst between our Faculty and numerous colleagues and collaborators.

This blend of SAFS faculty research expertise joined with significant management and conservation issues leads to a highly competitive funding base that is among the largest of science departments on campus. We effectively leverage annual State support into 3.5x more external funding, which exceeded $9M in FY2001-02. The context and scope of this funded research adds greatly to our teaching mission in ability to provide high quality experiential research opportunity for both UG and graduates students. This is evidenced, in part, by success in obtaining important UW funding from Tools for Transformation and the UW Honors Program to establish new teaching/research programs for UG majors.

The breadth of faculty disciplines has also contributed to an expanding and highly acclaimed graduate program with nearly 120 students about evenly split as MS and PhD. Our graduate students receive over $425,000 annually in endowment fellowships, and over $1,700,000 annually in G&C stipends and tuition, making SAFS one of the best-funded graduate programs in the University. Students come from a large diversity of backgrounds and countries that engenders a highly stimulating intellectual experience in one of the most internationally diverse programs in Natural Sciences at the UW. These students are mentored to ensure success, they publish in the peer-reviewed literature, and obtain prestigious and influential positions in academia, resource agencies, non-governmental agencies, and industries in Washington and around the world.

SAFS' attention to education has been most focused on our UG program, which has doubled in majors in the last four years to almost a 100 students. Students are motivated to major in SAFS because of our excellent recruitment courses in aquatic biology and ecology with emphases on critical thinking and strong skill sets, taught by a series of well known faculty who have won teaching awards at the College and University level. We promote opportunity to engage in participatory and experiential learning through a series of highly specialized courses and SAFS facilities and programs offering students a diversity of field and laboratory experience (Alaska camps, molecular ecology labs, on-campus research hatchery, internationally renowned fish collection, focused research at FHL, and many project affiliations with agency and industry scientists). SAFS majors finish their education with a capstone project, many of which are presented at the University's Undergraduate Research Symposium. In addition to this formative experience, almost 90 student quarters per AY are spent in specialized research in faculty laboratories, at field camps, and within agency intern programs. SAFS has dedicated $50,000 of endowment funds annually to support our undergraduate independent research efforts. Not only is the content and quality of our teaching better fitted to students' interests and expectations, the Faculty have greatly increased individual teaching (from 200 to 400 SCH/faculty FTE/AY since the early 1990s) within the School, we now provide about 25-40% of this effort as instruction in other, allied programs such as Biology, PoE, FHL, and CQS.

I. Context

Unit authorized to offer degrees

School of Aquatic and Fishery Sciences (SAFS)

College

Ocean and Fishery Sciences (COFS)

Exact Titles of degrees offered

Bachelor of Science in Aquatic and Fishery Sciences

Master of Science (Aquatic and Fishery Sciences)

Doctor of Philosophy (Aquatic and Fishery Sciences)

A. Year of Last Review and Perspective Now

The School of Fisheries (SOF) was formally reviewed in 1991. Because of a number of problems identified at that time, a mid-point review was conducted again in 1996. The present ***School of Aquatic and Fishery Sciences (SAFS)*** is the subject of this review. A change in name is emblematic of Faculty planning and response to pervasive shifts in the fields of teaching and research that are highlighted throughout this report. Many significant achievements are described that reflect strategic planning by the Faculty to move from an era of a more restricted "fishery" focus that implied harvest and production, to a different blend of values and issues that place aquatic and fishery resources in the broader context of conservation and sustainability. By most measures of achievement and professional production, our Faculty excels in teaching, research, and service to a broad range of constituents. We teach more students in higher enrollment courses while continuing to offer smaller, experiential learning opportunities than ever before. Course evaluations are very high, and our majors continue to grow in number. Research grants are increasing as is graduate program funding. Our service roles expand on behalf of local, regional, national, and international entities, spanning the spectrum of academic, government, and public sectors.

What surprises us as result of the extensive research undertaken to provide data for this report, is that the academic successes achieved by the School are based on the ***lowest faculty count (both State FTEs and research/WOT faculty) in the last 30 years*** of our history. In addition to the successes listed and quantified, there is also important historic context to convey that describes profound changes in the School over the last decade as a result of both planning and circumstance. In the broadest sense, these changes have revolved around our ***Undergraduate teaching mission***.

B. Roles and Responsibilities

The School of Aquatic and Fishery Sciences is known worldwide as a leader in education and research spanning a broad spectrum of scientific disciplines. Primary ecosystem focus ranges from nearshore shelf environments, through estuarine-river systems, to watersheds, streams and lakes. Geographic emphasis has historically been in the northeastern Pacific from Alaska to regions along the northern California Current system, throughout large watersheds such as the Wood River system in Alaska and the Columbia River

Basin in Washington and Oregon. In this respect, ***SAFS is a major regional resource in education, research, and service to people, agencies and governments in the Pacific Northwest.***

At the same time, we have extensive national and international roles in aquatic ecosystem research, stock assessment and management, and conservation. Faculty and students work and influence decision makers in the Indo-Pacific, South America, Africa, the Asian-Russian far east, and across wide ocean domains on topics related to huge capture fisheries, marine mammal protection, and other significant resource and habitat conservation issues (see Appendix D.2, Faculty service).

The School attracts students from around the country and the world to three degree tracks leading to the B.S., M.S., and Ph.D. It is important to recognize that our historic foundation was of great interest to students focused on fishery resource utilization and management. That arena continues to be important within the School, but is only part of a broader base of aquatic sciences that now attracts a majority of our students. Significant subject areas within aquatic sciences taught in our curriculum and provided in the context of experiential learning includes:

- quantitative tools in statistics, math, and modeling related to population dynamics, stock assessment and conservation
- species life history and habitat requirements, community ecology and ecosystem health
- genetics, molecular ecology, diseases, reproductive biology, and endocrinology that underpin aquacultural sciences (see Section V, Appendices C.2,3).

Our graduates from all three degree tracks play significant local roles in the Pacific Northwest as scientists at major State agencies (e.g. Washington Departments of Fish and Wildlife, Ecology, Natural Resources), for the Tribal Nations, the Federal government (NMFS; within Seattle Alaska Fishery Science Center, Northwest Fishery Science Center), and as business people in numerous consulting companies and aquaculture industries. Many of our graduates return to foreign home countries and become influential within their marine and freshwater resource agencies and as university faculty (see data and graphs in Section V).

Within the University of Washington community, SAFS is increasingly integrated with other academic units to provide richer teaching and research for undergraduate and graduate students interested in aquatic ecology, management, conservation, and harvest and production guided by the goals of sustainability, ecosystem health, and public involvement. The School integrates teaching with other academic departments in two primary ways:

1. Our majors are required and encouraged to take important subjects taught by other units that comprise a preface to our B.S. and are otherwise fundamental to the central focus areas across all our degrees (see Appendix C.1). For example, aquatic systems function and processes taught in Biology and Oceanography, quantitative subjects through Center for Quantitative Science (CQS), additional watershed ecology taught within the College of Forest Resources (CFR), resource policy, law, and economics give essential depth and greater context to our curriculum.
2. SAFS faculty contribute to teaching in other units based on our training and expertise. At present faculty teach some courses in Biology, CQS, Program on the Environment (PoE), at the Friday Harbor Labs (FHL), and co-teach across the College in a new Marine Biology/Honors Program.

The School's strong contribution in aquatic sciences also benefits the University through a growing number of interdisciplinary research enterprises. SAFS faculty are teamed with others from departments like Biology, Oceanography, Marine Affairs, Forestry, in molecular ecology, and other collaborative under-

takings that involve both undergraduate and graduate students. These research teams result in longer-term programs of higher, more stable funding that better support students, and clearly lead to a richer educational experience. Lines of separation fifteen years ago are now blurred and our teaching norm has shifted from a more provincial focus on fisheries to interdisciplinary depth gained from teaching collaboration across other departments, expanding the spectrum of aquatic sciences at the University. SAFS faculty are vocal advocates of this healthy teaching mixture that leads to better-informed future citizens (our students), who must weigh and analyze issues tangled in the inevitable mix of science, opinion, perception, self-motivation and common good.

While we were previously perceived as a very "applied" School, and there remains an applied component, it is one rooted in a strong theoretical base. More telling, those units perceived as rooted in "pure" science in years past, are increasingly turning toward the relevance inherent in aquatic sciences as motivation for important research collaboration and teaching.

C. Summary of Major Critical Findings in 1991 and Corrective Actions

The 1991 Review Committee underscored several dominant problems in the School that seemed to work against a healthy, vibrant academic program. In response, former Directors Landolt and Chew, and Armstrong presently, have worked with the Faculty to affect significant changes in key problem areas of that era:

Problem: Organizational structure that was deemed far too complex, expensive, and territorial. Faculty were seen as divided across disciplinary camps that limited positive interaction, and stifled curricular development and evolution. Major subjects areas were previously elevated to *de facto* status equivalent to "departments" within the School (four academic divisions in 1991), had "directors" and varying degrees of stand-alone administrative support.

Corrective Action: Such formal divisions and administrative structures have been eliminated. Faculty regard themselves as primarily committed to the School, but also linked to a number of other constructive academic programs that benefit the unit.

Problem: Faculty morale was characterized as very low with the result that leadership in fishery sciences was being constrained.

Corrective Action: Steps to eliminate divisions and institutes helped to re-focus faculty on the School as the unifying base of our teaching and research missions. From a qualitative standpoint, the Faculty are now, and have been for several years, a far more collegial group in ways that foster a spirit of constructive exchange and planning which carries over into the Graduate and Undergraduate populations within the School. People are enthusiastic, energized, and clearly committed to quality in the teaching and research missions.

Problem: The Undergraduate program was in trouble as evidenced by steep decline in declared majors, many low-enrollment courses, spotty quality of instruction, inadequate student advising, and too few experiential opportunities.

Corrective Action: Of all themes the Faculty has addressed, this is the most central over the last decade, and we are still in a process of transformation to provide the best undergraduate program possible. Examples of successful changes and outcomes include:

- Declared undergraduate (undergraduate) majors have doubled to about 100 since 1998 (see Section V; Fig. 5.1).
- The curriculum has been modified to reduce required credits and provide more flexibility to reflect individual interests (see Appendix C.1).
- Integrated teaching across subjects areas with

other allied science departments has been increased.

- Many low-enrollment courses have either been dropped or improved by change in subject content and quality of instruction. TA support has been shifted to higher-enrollment courses and/or designated experiential ones of lower enrollment.
- Focus on student skill-sets has been amplified across the curriculum.
- Experiential learning opportunities are greatly increased in some formal courses and in expanded "capstone" requirements.
- Substantial School endowment funding (ca. $50K/year) has been directed toward competitive research opportunities for undergraduate majors.
- Quality and responsiveness of student advising are among the highest priorities of the School.

Problem: The Graduate program was given low marks for variable and preferential admission policies, and poor student morale tied to strife within the Faculty.

Corrective Action: the Research, Admissions, and Scholarship Committee (**RASC**) tightened Admission standards (see Section V; Fig. 5.4) beginning in the early 1990s in order to subject applicants to a more objective and centralized evaluation process. Some propensity of faculty in years past to question committee evaluations that led to rejection of low-ranked applicants (low GREs, and GPAs) has been discouraged, with the result that the academic background and credentials of accepted graduate students has increased, funding commitment has been formalized as one requirement for admission which has greatly reduced uncertainty among students regarding support during their education, and larger amounts of SAFS endowment funds (see Fig.1.6) are provided as longer-term fellowships. A recent internal review of the School done by SAFS' graduate students indicates very positive regard for the Faculty as mentors, and the quality of their graduate education and training.

Problem: Ongoing budgetary stresses seemed to badly constrain program development including very limited upgrade of facilities and capacity to provide needed innovation in teaching and research. In retrospect, budgetary problems were a major cause of too few new faculty hires in the 1990s compared to retirements and other faculty attrition.

Corrective Action: As noted above, major reduction in *de facto* departmental structure and diffuse administrative support (SAFS historically had a high ratio of staff to Faculty which is now much reduced) provided means to shift School resources into a variety of other areas that have greatly enhanced our teaching mission including: 1) new faculty hires in several fields, 2) upgrade of teaching facilities including computer labs, the campus research hatchery, the Molecular Ecology Labs (MMBL), and Alaska field camps and, 3) provision of greater TA support for lower division core and upper division high-enrollment courses. Such realignment of School budgetary priorities has made us more competitive for short-term internal UW support from sources like Tools for Transformation and the UW Honors Program that has allowed us to create the Alaska Salmon Program and the Marine Biology Program.

Despite nearly a decade of painful cuts to the SAFS' state budget (due to a mix of UIF requirements and reduction of State funding to the UW during recent years), ***the Faculty are ever more productive on a per capita basis with respect to teaching (Student Credit Hours, SCH; course enrollment, graduate student supervision; see Section III A; Table 3.2; Figs. 3.2-4), and awards of research funds (see Figs. 3.8-10).*** This reflects not only the inherent high quality of the Fac-

ulty and support staff, but also the greater financial capacity and flexibility of the School to more often provide support for teaching and research innovations proposed by the Faculty.

As a result of the actions summarized above and presented in more detail throughout this report, the Faculty believe that members of the Review Committee will find evidence that the School has reversed problems of a decade past, and has made an effective transition to a different, dynamic academic program of Aquatic and Fishery Sciences that better meets its teaching and research missions, and better serves the State of Washington.

D. Relevant History and Evolution of the Program

The School was established in 1919 by visionary scientists to prepare people for practical work in the service of government, the State, and private industry related to propagation and marketing of fisheries products, and management of fishery resources. This mission served the School and its constituents well for over half a century. But compared to this historic version of harvest-based fisheries, there has been tremendous shift in emphasis and focus over the last 15 years that has addressed concerns faced by industries and raised by the public at large.

The Faculty recognized the need and opportunity to adjust SAFS' academic program to better mesh with the changing dimensions of aquatic resource and conservation sciences including, but not limited to fisheries. Beginning in 1999 and culminating in a 2000 Strategic Plan, we took inventory of our research focus to provide broader response for constituents concerned not only with harvest, but also with conservation, quality and integrity of ecological and biological systems. Since a time when we were primarily focused on harvest-based management of exploited stocks and fish propagation as both aquaculture and mitigation, we have now entered an era of greater emphasis on ecology, conservation, biodiversity, habitat protection and restoration, user conflicts and resolution, often approached with more advanced tools such as molecular techniques, and more integrated models of stocks, communities, and physical forcing.

Our current Faculty teach and conduct research on a blend of aquatic natural resource management and conservation issues including:

- Maintenance of species and genetic diversity,
- Means and effects of habitat restoration,
- Strategies for marine protected areas,
- User allocations and treaty rulings.

Our students expect their education and training will reflect these broader ecological and social dimensions across aquatic and fishery sciences. The School has changed its name to Aquatic and Fishery Sciences to better reflect current education and research in response to the plethora of ecological and social issues that require some balance between harvest, management, and conservation as basis of long-term sustainability.

E. Legacies and Strengths

The School has a long history of major contributions within scientific disciplines that have been central in our teaching and research missions for decades. Some fields in aquatic and fishery sciences have largely originated from SAFS faculty in decades past and continue to be important, whereas others have emerged in recent years within newer faculty programs.

Quantitative Resource Assessment and Modeling: The School has a long history of research and teaching in quantitative resource assessment that begins in the time of Gerald Paulik and Doug Chapman. These influential faculty initiated the intensive focus on quantitative resource assessment in the late 1960s by establishment of the graduate program in Biomathematics (1969) and the Center for Quantitative Science (CQS; 1968), both of which involved leadership and faculty

from the then School of Fisheries. More recently, SAFS faculty have been instrumental in establishing a graduate level program QERM (Quantitative Ecology and Resource Management) and are a major portion of the faculty across campus who supervise students interested in resource assessment and modeling.

Throughout its history, the School has been at the forefront of the resource assessment field. SAFS faculty and past SAFS graduate students are and have been members of the Scientific and Statistical Committees of the Pacific (Washington-California) and North Pacific (Alaska) Fishery Management Councils since their inception in 1976. Recently, SAFS faculty have participated in the Scientific Committees of the International Whaling Commission (IWC), the International Commission for the Conservation of Atlantic Tunas (ICCAT), and the Commission for the Conservation of Southern Bluefin Tuna (CCSBT). Integrated Analysis, the method of stock assessment on which the bulk of the fish stock assessments for US west coast fisheries and well as those off New Zealand, Australia and South Africa are based, was developed substantially by faculty and students of the School.

A research focus at the School in recent years has been to fully quantify the uncertainty associated with fish stock assessments, in particular the use of Bayesian techniques to represent uncertainty, and decision analysis to convey the implications of uncertainty to stakeholders and decision makers. The School has also played a leadership role in development and implementation of hydroacoustic methods in surveys of fishery resources. The technology is now widely used in estimating abundance of pollock, whiting, and salmonid stocks throughout the northeastern Pacific from California through Alaska.

Many of the leading stock assessment scientists at U.S. universities, National Marine Fisheries Service (NMFS) and northeastern Pacific state resource agencies who conduct stock assessments are SAFS graduates. School faculty and students collaborate with staff at the local National Marine Fisheries Service laboratories. The School has increased this collaboration since 2000 due to expanded funding though the NMFS Stock Assessment Improvement Plan, and an intensified hydroacoustic program. The number of graduate students in quantitative resource assessment has increased as have workshops organized jointly by the SAFS, the NWFSC (Northwest Fisheries Science Center) and the AFSC (Alaska Fisheries Science Center) to expose SAFS students and NMFS staff to actual stock assessment problems and the latest quantitative techniques. The capability brought by new faculty hires in these areas has added teaching depth to both undergraduate and graduate courses that are essential in the curriculum.

Large Marine Ecosystems and Physical Forcing: In the past decade there has been a major interdisciplinary focus on developing an understanding of the relationship between large scale climate forcing and the structure and dynamics of the large marine ecosystems of the NE Pacific. This effort has been collaborative with faculty and students from SAFS, School of Marine Affairs (SMA), Oceanography and Atmospheric Sciences. Major findings have included:

- The definition and description of a major interdecadal mode of climate variability (Pacific Decadal Oscillation, PDO) which has had major effects on NE Pacific marine ecosystems and their fisheries.
- The incorporation of the concept of “regime shifts” into the scientific bases for management of coastal marine fisheries from California to Alaska.
- The development of ecosystem scale mathematical models that enable investigation of the relative impacts of climate and fishing on regional marine ecosystems and their fisheries.

These models and analyses have been incorporated into the SAFS quantitative fishery science curriculum.

In addition, faculty, graduate and undergraduate students participate in instruction and multi-university effort to adapt these tools to modeling large marine ecosystems within the Pacific, conducted, in part, at the National Center for Ecological Synthesis. Most quantitative courses offered by SAFS (e.g. Fish 456, 458, 556, 557,558) include relevant case-studies as means to underscore analyses and models of systems and resources.

Marine Protected Areas: Traditional fisheries stock assessment and management has been quite successful for resources such as Alaska salmon, Alaska groundfish, Pacific halibut and Dungeness crab. However, intense pressure on fisheries resources, and a failure to manage them in a sustainable manner has resulted in the collapse of many fish stocks in the last decade. The most publicized collapses have occurred in the cod and groundfish stocks off of eastern Canada and New England, but our groundfish stocks off the Washington-California coasts and within Puget Sound have also collapsed. These failures in traditional management systems and institutions have prompted a strong support for networks of permanent no-fishing zones, or "Marine Protected Areas" (MPA) within the environmental and academic community. Several SAFS faculty and students have been involved in developing a theoretical basis for MPA networks and their implementation on a practical level. This approach includes integration of closed areas/MPAs with traditional management techniques by involvement of faculty in various regional management advisory groups, including debate concerning value of MPAs to enhance fishery yields. A series of undergraduate research apprenticeships in fish ecology and MPA design have been conducted in conjunction with Friday Harbor Marine Laboratories since 1999. Research conducted by these undergraduates has resulted in scientific reports that have helped to guide the development of a network of MPAs in the San Juan Islands, with the goal of rebuilding groundfish stocks there.

Aquatic Ecosystem Health and Restoration: SAFS faculty have been instrumental in developing criteria and methodology to assess overall ecosystem health of rivers, lakes, and wetlands, and applying restoration practices where possible. Significant work has been focused on marine eelgrass systems throughout Puget Sound and in coastal estuaries, and major regional rivers such as the Cedar River locally and as large as the Columbia River Basin. Breaching of dikes and impoundments have been means to restore essential juvenile salmonid habitats, including planting of native vegetation to enhance the process. The role and importance of large woody debris has been highlighted in SAFS research as one of many effective tools in rehabilitating degraded streams and wetlands.

Among environmental indicators developed to measure and convey "health" of aquatic systems, is the index of biological integrity (IBI), first developed for use in Midwestern rivers 20 years ago. These multimetric indexes are analogous to economic indicators, such as the index of leading economic indicators and the consumer price index, help to document the condition or health of Pacific Northwest Rivers and their landscapes. This robust measure of the biological dimensions of water-body condition has by now been applied to challenges in basic science, resource management, engineering, public policy, legal, and community volunteer arenas; on every continent except Antarctica; and in developing as well as developed nations. Adaptations of this multimetric index approach have now been developed for diverse taxonomic groups (fishes, aquatic and terrestrial invertebrates, algae and diatoms, birds, vascular plants), environment types (streams, wetlands, lakes, coastal areas, sagebrush steppe, and others), and even for physical and chemical measures of environmental condition.

Contribution to Aquaculture Sciences and Industries: SAFS has a long history of involvement with the Aquaculture Industry on both a regional and an

international scale. Much of the historic research has been focused on marine invertebrate species, which led to development of major shellfish enterprises in the northeastern Pacific including the Puget Sound Basin. Among principle themes and eventual contributions are research focused on "summer mortality" of the Pacific oysters, the primary shellfish species grown locally and globally. This research was instrumental in perfecting methods to produce ***triploid oysters*** to reduce summer mortality. These genetic strains are now used in many farms along the Pacific Coast of North America and in other regions. SAFS has also been instrumental in the development and expansion of technology for new aquaculture species such as bay mussels, abalone in California and Washington, and has developed hatchery technology for the manila and geoduck clam industries. Due to the reputation of SAFS in aquacultural and fisheries sciences, the school attracted a federal program, the Western Regional Aquaculture Consortium or WRAC, that integrates university researchers with industry to address problems with industry-wide applications.

SAFS has also had a long involvement with research on finfish culture and the trout and salmon industry. Genetics research developed a line of coho salmon with high growth rates. SAFS fish nutritionists have been involved in seeking alternate, less costly protein sources for fish feed ingredients such as rapeseed, cottonseed and soy proteins to evaluate their utility and flavor in trout culture. Fish nutritionists have also worked on developing low phosphorus feeds that can be used to reduce pollution by land-based trout culture facilities. Basic research on key salmonid diseases have led to the development and testing of vaccines and diagnostic tools that can be applied in the trout industry. Physiological studies on fish reproduction has led to refinements in the use of hormones to synchronize fish spawning thereby improving egg production. The SAFS hatchery, via widely attended public programs, has aided in public awareness and support for aquaculture. As noted in Section II C below, the School uses the freshwater research hatchery complex for extensive outreach activity related to Salmon in the Classroom on behalf of hundreds of K-12 students each year.

Managing Land–Water Interactions: Riparian Systems: Along the Northern Pacific Coast, riparian forests are floristically and structurally the most diverse communities of the region and their maintenance have become an integral component of tribal, county, state, and federal watershed management strategies. Since 1990 there have been significant advances in understanding the structure and dynamics of regional riparian communities, so much so that riparian zones are now key components of land and water management. This is reflected in personal and institutional perspectives as well as in management regulations. Many of the region's management guidelines are based on the scientific advances made by students and faculty in the School of Aquatic & Fishery Sciences as well as on our collaborations with researchers in affiliated UW departments, regional public and private agencies and corporations, and academia. The School has played a pivotal role in many of the scientific advances of the last decade toward understanding the ecology of riparian zones as well as in communicating the broader implications of how this understanding directly contributes to better stream and watershed management. Among many examples of the School's role in shaping public policy through research and education, are those that have led to strategies for management of federal forests, and management of regulated rivers:

- **Management of Federal Forests**. Stemming from President Clinton's Forest Conference in 1993 was the formation of an interdisciplinary scientific group, the Forest Ecosystem Management Assessment Team (FEMAT), whose charge was to help develop plans for both the long-term health of Pacific Northwest ecosystems and hu-

man socio-economic systems. A major outcome of this effort was an aquatic conservation strategy that established buffer requirements that were meant to ensure the long-term viability of aquatic and riparian species on federal lands within the range of the spotted owl.

- **Managing Regulated Rivers**. The improved understanding of riparian systems also played a role in the development of the concept of the 'normative' river. Many have emphasized the need to conserve, stabilize, enhance, and restore aquatic and riparian ecosystems to "normative" conditions – the restoration of ecosystem connections that permit as many natural processes to exist as possible, given other social and economic objectives. Today, there are four emerging trends in riparian management in the Pacific Northwest that continue to be guided by collaborative SAFS-UW research:
  - an emphasis on ecological function and natural riparian forest pattern
  - adoption of a landscape perspective of river networks
  - development of ecologically sound systems of restoring riparian ecosystem properties
  - attention to social needs for riparian resources

Salmon, the Icon: The full power of the U.S. Endangered Species Act has been applied to a number of salmon populations or complexes of populations that have been deemed threatened or endangered by the National Marine Fisheries Service. SAFS faculty have made substantial contributions by studying the natural and anthropogenic processes that threaten populations with extinction. Faculty research has also been at the forefront of the other perspective of conservation biology: how fast can new populations evolve? Research on natural populations of sockeye salmon in Bristol Bay, conducted for several decades by UW faculty and students, has revealed fascinating and complex adaptations for the patterns of natural and sexual selection unique to each spawning area. This research on natural patterns of population evolution was given new perspective by the investigations of the rate at which populations can adapt to new environments. Studies on sockeye salmon introduced to Lake Washington in the 1930s and chinook salmon introduced to New Zealand at the beginning of the 20th century revealed the rapidity with which salmon populations can evolve, and provide new perspectives on the concept of salmon populations, and also encourage restoration efforts. Across all such biological and ecological studies of several decades, results are incorporated into both fishery and conservation management plans.

Regulated Rivers Research: Major river systems in the West such as the Columbia, Sacramento, and the Colorado, are regulated; caring for these large systems is a multidimensional challenge. The School is historically and inextricably linked to research on regulated rivers, especially the Columbia River. In the 1940s SAFS faculty studied the effects of Hanford radiation on salmon, and developed an adult salmon bypass system for the first dam on the Columbia River. In the 1960s, faculty mounted a major study on the effects of light on fish passage at hydroelectric dams. Today the projects of the School's Columbia Basin Research Group (CBR) continue these efforts using mathematical and statistical models to study the passage of salmon through the Columbia River Hydrosystem, the effects of dredging in the river, and the effects of temperature on salmon spawning and early life history survival. Through their joint and complementary efforts, CBR has developed an internet accessible database of historical and up-to-date information on flow, water quality and fish passage through the Columbia River system, plus analysis tools to estimate and predict survival and movement of adult and juvenile salmon through the river system. Tools developed at CBR are routinely used by hydrosystem

and fishery managers to construct endangered species recovery plans.

F. Organization, Administration and Budget

Since 1998, the organizational structure of SAFS has been greatly ***simplified in order to reduce costs, assign more faculty time to teaching, strengthen Student Services, and reflect ongoing School priorities for staff support*** while accommodating several biennia of state budget and UIF (University Initiative Fund) reductions. Even at the mid-point review in 1996, and through to 1998, the administrative structure remained fairly complex. There were three associate directors of various functions (now one), and over 10 constituted faculty committees (now three highly active committees since many tasks have either been combined from previous committees, or shifted to staff). At present, the Organizational chart (Fig. 1.1) features the following components:

Director: Primary link between the Faculty, Dean, University Administration and external constituents. He/she (presently David Armstrong) helps lead discussion around issues of teaching focused on curricula, faculty load, coverage of subjects, use of resources to enhance instruction, priority areas for new hires, opportunities to expand SAFS's participation in allied UW teaching programs; strategic use of state and endowment funds to upgrade instructional support, field facilities, provide student stipends, travel, and research underpinning; promote more direct funding links to federal agencies, advise the Faculty on major budget expenditures to facilitate group planning; fosters and encourages innovation and pursuit of new directions proposed by faculty, students and staff.

Associate Director: She/he (presently Loveday Conquest) represent all interests of the School in the Director's absence, chairs the Recruitment, Admissions and Scholarship Committee (RASC), is ex-officio member of the Curriculum Committee and School Council, interfaces with professional staff in Student Services to resolve student issues as needed, helps lead new graduate student orientation each year, and advises our students.

Administrator: He/she (presently Gary Pedersen) is the School's chief financial officer and is responsible for oversight of the state budget, advises the Director about status and makes financial presentations to the Faculty, oversees SAFS' Business Office and professional staff in support of central School functions (e.g. computing, publication, hatchery, field camps, fish collection), and handles a multiplicity of issues related to personnel and resources.

Staff: The School employs approximately seventy-five permanent classified and professional staff. Approximately sixty of the staff work directly for a faculty member in support of his/her research program.

As can be viewed on the administrative organization chart (Figure 1.1), roughly fifteen staff serve School functions in support of the teaching and research programs. Of the fifteen, seven are associated with School administration. The administrative staff (formerly referred to as the Business Office) provide a wide range of support duties for the School covering payroll, equipment inventory, purchasing, G&C preparations, finances, etc.

The administrative staff, in conjunction with the arrival of a new administrator, gathered for a staff retreat at South Campus Center in the Fall of 2001, discussing the School and their roles in it. The retreat was received very well and by the staff and another is being planned for later this year.

Staff are encouraged to take training courses, funded by the School within reasonable limits. In fact, this winter, the administrator directed all front office administrative staff to take some time away from their job to attend a training class. In the opinion of the administrator, the work of the staff would be enhanced with a more

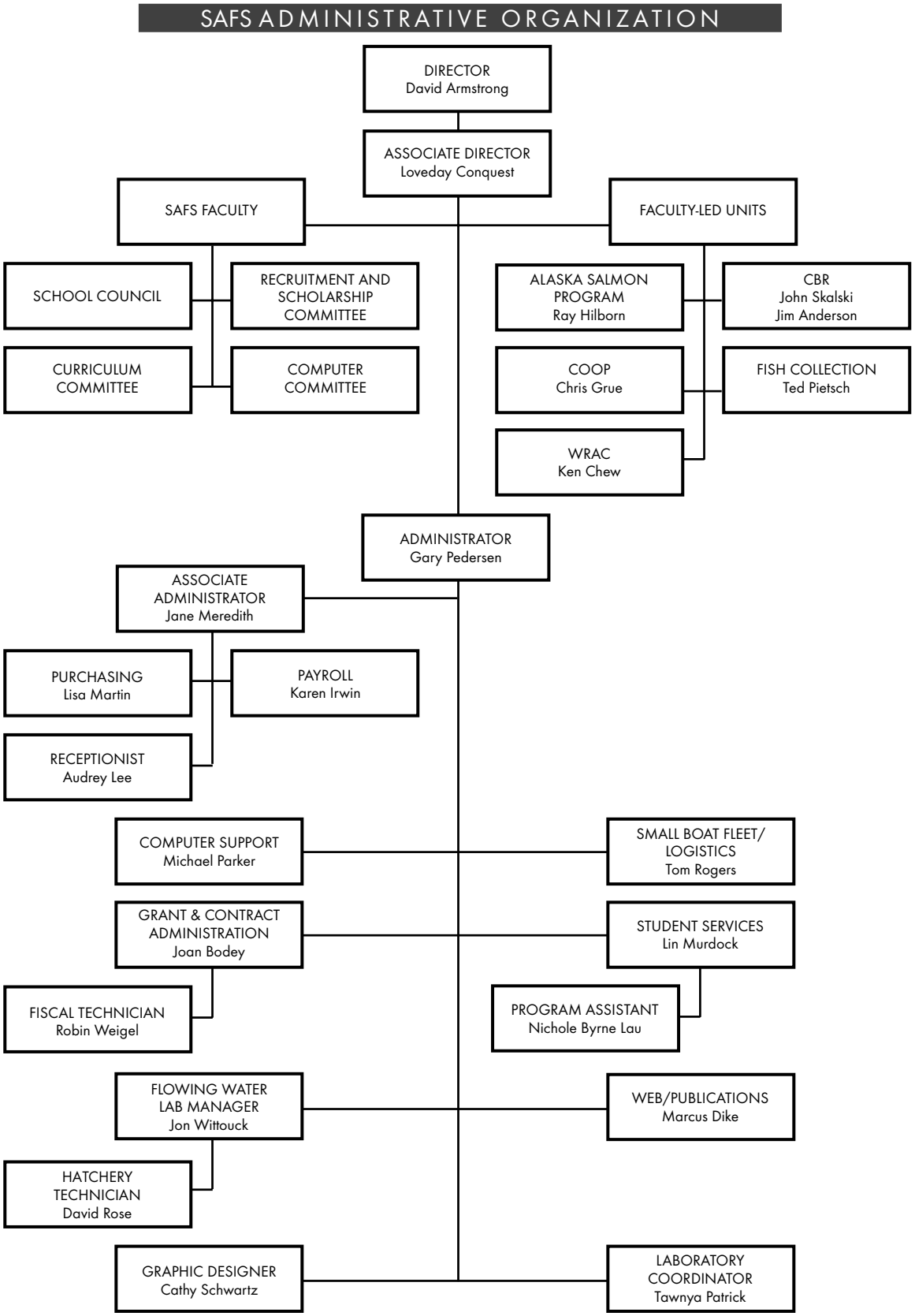

FIGURE 1.1—SAFS organizational chart. Note several "faculty-led" units that represent long-term external funding and support for major research programs that benefit students in all degree programs (B.S., M.S., Ph.D.). The current organizational structure is much simplified compared with years past in order to better direct time and resources to our teaching and research programs.

advanced application of the standard personal computer software (Word, Excel, Access, etc.). Given the shortage of staff positions in the School relative to other units on campus, particularly with respect to post-award grant and contract administration, it is critical that we place a yet higher emphasis on staff training.

It is clear from a reading of past documents prepared by the School ranging from the strategic plan to other descriptions of staffing, that in the early-mid 1990s, more staff were employed than the permanent budget could sustain, which led to budget shortfalls, and as a consequence, a halt in the hiring of Faculty. The situation was rectified 3-4 years ago by not refilling vacant staff positions, and Faculty hiring began again in earnest. In addition to the on-going UIF budget reductions resulting in the elimination of vacant staff positions, administrative staff numbers have been further reduced at three times during the past two years. First by conversion of a vacant full-time fiscal specialist to a 75% receptionist position; second by a reorganization which resulted in a reduction of one high-level staff position and; third as consequence of the severe UW mandated budget reductions last Spring, 2002, a further reduction of the administrative staff by one position. We are currently at a staffing level insufficient to support many of the amenities available to faculty in other departments across campus. As just two examples, there is no central secretarial support available in the School, and we offer only a minimal level of staff supported post-award grant and contract management***. This work and responsibility is relegated to our Faculty, which greatly affects their productivity relative to teaching and research.***

Pressures and Impediments

Ultimately, the School is constrained in further expansion of some functions by insufficient numbers of support staff. For example, expansion of G&C oversight, need for additional computer support tied to both undergraduate and graduate teaching, and pivotal coordination and oversight of labs and experiential activity provided by a lab coordinator are now very limited or impossible.

Faculty Committees: At present there are three very active School committees that meet on a regular basis, and two that meet as needed:

- **School Council**: This group of five faculty including the Associate Director, represents broad Faculty interests to advise the Director on a variety of issues including policy, budgets, and strategic opportunities. The Council also reviews annual activity reports submitted by the Faculty, recommends salary/merit increases, and reviews requests for affiliate and adjunct faculty appointments.
- **Curriculum Committee**: This group of eight people (including the staff head of Student Services, a graduate student representative, the Director and Associate Director *ex officio*) reviews the curriculum at all levels. In the past 5 years the CC has primarily worked to:
  - revise the undergraduate curriculum to reduce core requirements and define three “focus areas” to help direct student interests;
  - analyze extent and causes of low enrollment courses, recommending necessary changes or elimination;
  - set criteria of content and thresholds of enrollment as basis of assigning TAs to courses;
  - explore and promote new teaching programs and opportunities that have given rise to Marine Biology, an Honors program within COFS, and increased experiential courses and required funding;
  - play a key role in the interview process during searches for new faculty by discussing teaching approach, style, objectives, and syllabi for hypothetical courses;

- define objectives, structure and process for the expanded capstone requirement in the major and;
- work with other departments in implementing new courses that serve broader needs such as that in molecular genetics taught by SAFS and supported by Biology.

- **Recruitment, Admissions, and Scholarship Committee (RASC)**: This group of 5 faculty, chaired by the Associate Director, has responsibility to define and uphold criteria during review of applications for admission to the SAFS M.S. and Ph.D. programs. They provide faculty with evaluations, help direct faculty interest in and communication with prospective students, and advise on award of recruitment scholarships for top-ranked applicants. RASC solicits and reviews applications from continuing graduate and undergraduate students to award substantial annual endowment funds for research and stipends. Given the central role of RASC in review of graduate applications, they also advise the Director and the Faculty on subject areas of high student interest when open faculty positions are prioritized.

Committees that meet 2-3 times per AY include:

- **Promotion and Tenure Committee (PTC):** Beginning in 1998, the promotion and tenure process was changed to effectively make the Faculty a "committee of the whole". In this sense, each SAFS faculty eligible to vote on promotion and tenure as defined in the Faculty Handbook is responsible for careful evaluation of the candidate's full file. But a PTC composed of three full professors gives advice to any faculty seeking promotion about quality and scope of the person's credentials, advises the Director at an initial stage if, in their view, the person has a reasonable basis for promotion, works with the candidate to construct a file that best portrays achievements and contains required elements, and finally helps identify external reviewers who might provide evaluations of the candidate.
- **Computing Committee:** This group of faculty, the Administrator, and staff head of Computer Support meet as needed to discuss, plan, and make recommendations regarding a range of subjects related to computing capability within SAFS. Topics include upgrades for the teaching labs, new initiatives, forward thinking plans around new technology, and policy decisions regarding the nature and scope of support, constituents who benefit, and use of School funds to enhance learning.

Finally, two SAFS faculty are elected members of the COFS College Council that provides the Dean with analyses and recommendations on major decisions such as promotion and tenure.

Budget

The School is supported on an annual budget that is composed of about 25% State funds and 75% from a variety of external grant and contract (G&C) sources (Fig. 1.2; see Section III for details about Faculty G&C activity and major categories of expenditure). These proportions of State and external funding have been fairly constant for the last 9 fiscal years. When indirect costs returned to the School are added to the G&C value, State funds are reduced to about 20% of aggregate revenues (Fig. 1.3). About 70% of the State budget is expended in salaries including 40% as faculty support (Fig. 1.4). The balance of the State budget covers a number of services essential to our teaching and research mission including TAs, general operations, support of several main facilities and programs (hatchery, fish collection, Alaska Salmon Program; Fig. 1.5).

Endowments: The School is immensely fortunate in attracting numerous large endowments through the

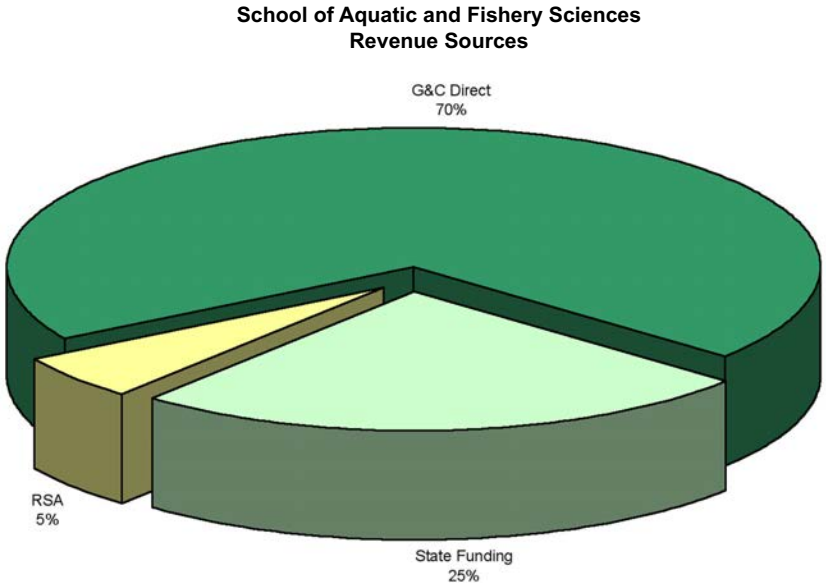

FIGURE 1.2—Comparison of State and external grant and contract (G&C) funds that support the School's teaching and research missions. RSA is a portion of G&C indirect costs that are returned to the School.

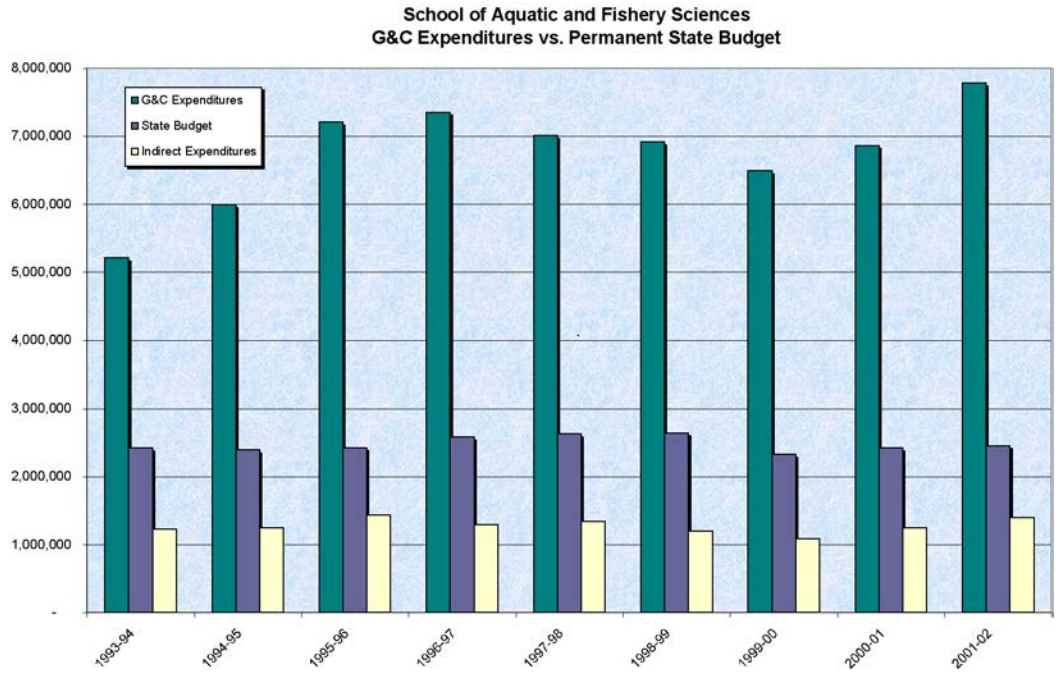

FIGURE 1.3—Comparison of annual revenues over the last nine fiscal years. The addition of G&C + indirect costs constitute ca. 80% of the total annual School budget (data not adjusted for inflation).

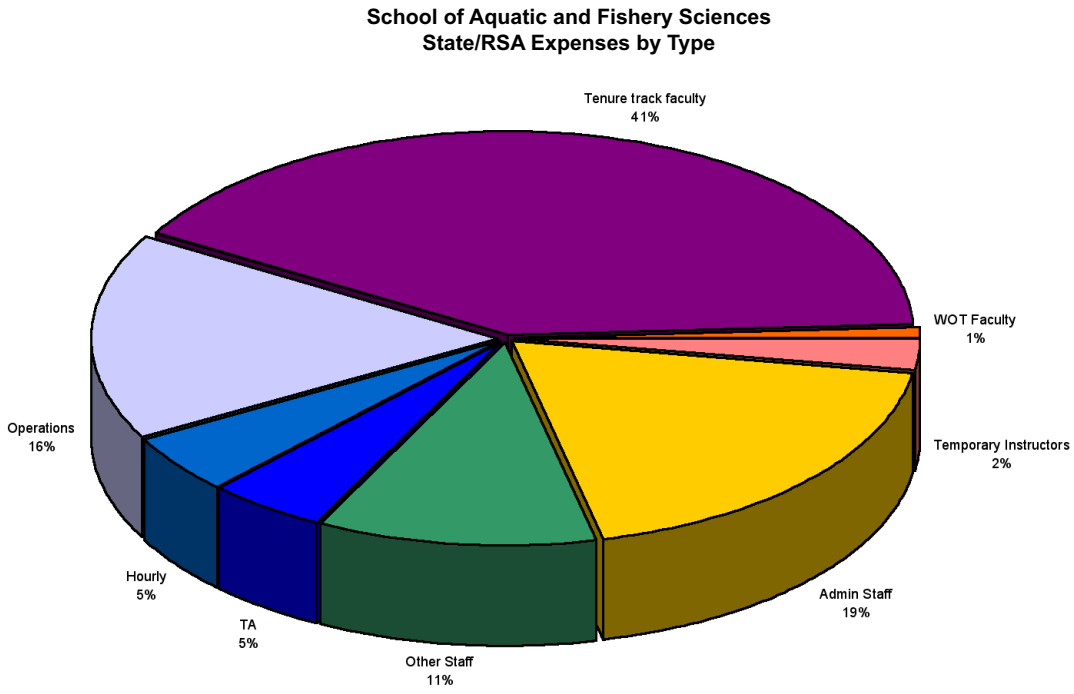

FIGURE 1.4—SAFS annual expenditures of the State budget across major categories.

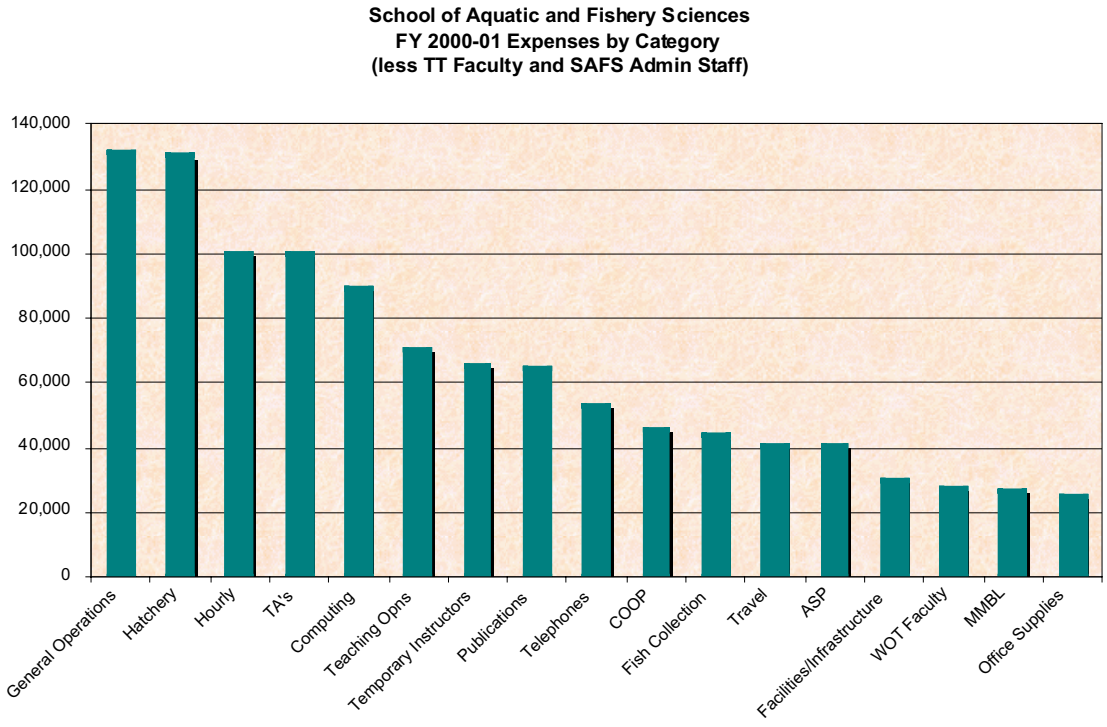

FIGURE 1.5—Distribution of SAFS State budget expenditures, less faculty and administrative staff salaries. All of these services support graduate and undergraduate teaching and research. See Section II for descriptions of units and roles for the hatchery, fish collection, Coop research unit, the Alaska Salmon Program (ASP), and the Molecular Biology Lab (MMBL).

hard work of faculty over the years. To a great extent, endowment giving reflects broad interest in and relevance of the program to many constituents. The most significant categories of giving have been closely aligned with our donors' interests in salmon biology and ecology, several fields in aquaculture sciences (shellfish and finfish), marine fish ecology, aquatic resource commodities broadly defined, education and training of students to be future leaders as scientists, managers and policy advisors. The aggregate principal of SAFS' endowments is such that the ***School receives and awards about $600K/yr*** (Fig. 1.6). As noted elsewhere in this report (see Section V about degree programs), the School is working to analyze present use of the endowment pool in order to shift a major portion into undergraduate experiential opportunities. At present, most awards to UG are contained within categories such as supplies and travel that support research. Included in the endowment pool are two professorships (the Keeler and Worthington) also used in large extent for student support.

G. Peer Institutions and Comparisons

Across sections of this report, various academic functions are compared between SAFS and several categories of "peer" groups. The School is unique in having such extensive teaching and research focus within aquatic and fishery sciences. There are not many other useful examples at U.S. universities of departments like SAFS, and those that come closest usually have wildlife and/or natural resources included with fisheries. In advance of this self-study report, we sent an extensive survey to about 20 academic departments in public universities around the country; 15 responses were received back. It was apparent that units vary substantially in scope of subjects taught and research of faculty. Three "peer" groups were composed from the responses (Appendix I): 1) "aquatic and fishery science" (5 departments at U. Alaska Fairbanks, U. Florida Gainesville, Oregon State, Texas A&M, U. Wisconsin); 2) "natural resources" (4 departments at U. Arizona, Colorado State, U. Michigan, and U. Minnesota) and; 3) "oceanogra-

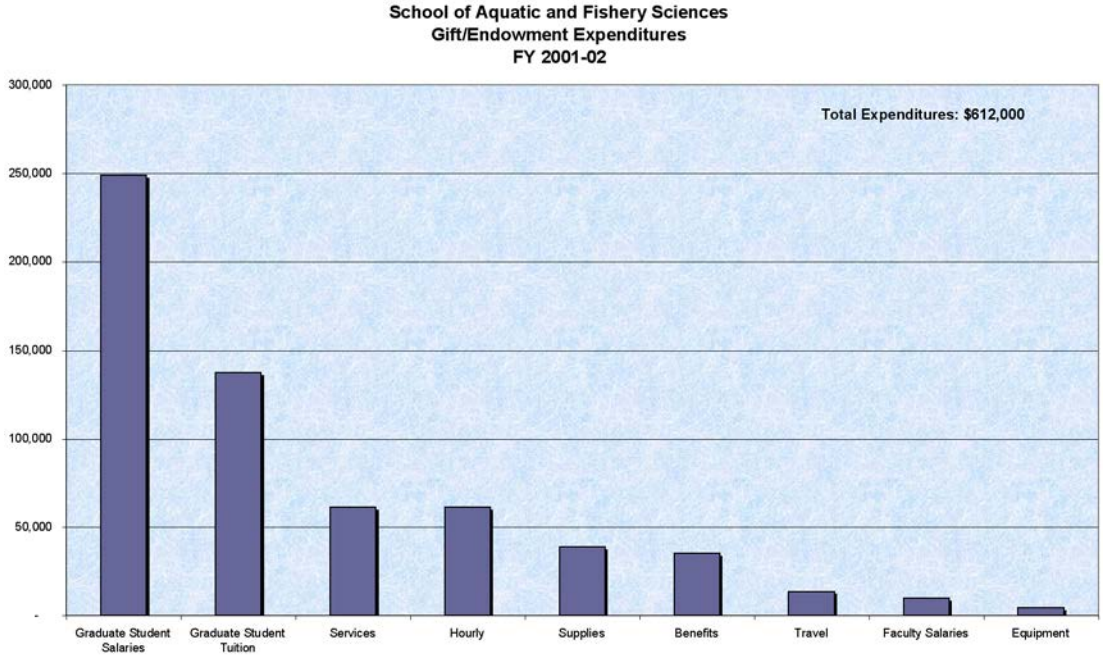

FIGURE 1.6—SAFS gift and endowment expenditures in FY 2001–02. Included are revenues for two professorships (the Keeler and Worthington combined generate ca. $70K/yr) that are largely directed toward students. Undergraduate support is generally contained in supplies, travel, and hourly.

phy" since there are many instances of subject overlap (5 departments from UC Santa Cruz, Scripps, U. Georgia, U. Maine, and North Carolina State).

The extensive data sets were distilled to make several per capita comparisons focused on faculty: grant and contract activity/faculty FTE, student credit hours (SCH) taught/FTE, staff/FTE, undergraduate majors/FTE, graduate students/FTE, and SCH/TA. In virtually all these comparisons to "peers", SAFS exceeds activity reported by the other units (Table 1.1); notably with respect to SCH taught/faculty, graduate students/faculty, and G&C funding/faculty (indicated by *). We feel that these comparisons are based on a conservative use of faculty FTE. In the SAFS data sets, two counts of faculty are used (see Section III; Fig. 3.7): actual State-funded FTEs for teaching comparisons of student credit hours and undergraduate majors/FTE, but a higher count of total active faculty PIs for measures relative to research funding and graduate student supervision. A number of the peer responses do not fully account for the "research" faculty within their department, and for those, the value for research funding and graduate supervision per capita are likely inflated.

TABLE 1.1—Peer study analysis. A portion of data collected to compare SAFS to several other "peers" grouped in three categories of "aquatic and fishery sciences" (closest to SAFS), "natural resources", and "oceanography", all of which contain major elements of SAFS' research and teaching programs (see Appendix I for detailed survey information). SAFS comparisons are conservative in categories of G&C dollars/faculty, and graduate students/faculty relative to the peers. The SAFS total faculty count (see Fig. 3.7) includes Research Faculty, who raise funds and support students, whereas many of the peer responses did not include "research" faculty.

Metrics per faculty FTE	UW Aq & Fish Sci	Avg of all peers	UW percent of avg	Aquatic & Fish peers	UW percent	Nat Res peers	UW percent	Ocean peers	UW percent
G&C dollars*	352,973	420,658	84%	343,846	103%	133,930	264%	648,815	54%
SCH*	576	232	249%	343	168%	181	318%	255	226%
Staff	1	1	107%	1	114%	1	174%	1	88%
UG majors	6	9	70%	16	37%	9	69%	3	214%
Grad students*	5	4	128%	7	74%	5	94%	2	203%
SCH/TA	1,962	663	296%	922	213%	585	335%	1,431	137%

II. Relationships With Other Departments, Institutes and Centers

The School has formal relationships with a variety of academic departments and non-UW institutions. These relationships reflect the inherent multi-faceted nature of contemporary issues in aquatic conservation and fisheries.

A. Joint-Listed Courses

The School cooperates with other academic departments in offering a number of courses that are jointly listed to aid majors in learning of subjects across units, and gaining proper credit hours within the majors required for their degree. At present, the School has joint-listed courses with seven other academic units as follows:

- School of Oceanography (6 courses)
- College of Forest Resources (6)
- Department of Civil Engineering (2)
- Center for Quantitative Science (6)
- School of Marine Affairs (3)
- Biology/Zoology (6)
- Program on the Environment (4)

B. SAFS programs and University Affiliations

1. **Center for Quantitative Science in Forestry, Fisheries and Wildlife**, Office of Undergraduate Education: CQS was started in 1968 with a grant from the Ford Foundation. It is an interdisciplinary teaching program that is staffed by faculty from the School of Aquatic and Fishery Sciences and the College of Forest Resources. CQS offers Quantitative Science (QSci) courses in calculus, probability and statistics, statistical inference, experimental design, population dynamics, stock assessment, spatial statistics and other topics. QSci courses are frequently cross-listed with SAFS, Forestry or Statistics courses. Students are derived from the parent units and from the College of Arts and Sciences. The program was moved from its historic SAFS-Forestry home in 1996 to the Office of Undergraduate Education.

2. Quantitative Ecology & Resource Management Program: QERM is an interdisciplinary program of the Graduate School that leads to M.S. and Ph.D. degrees. The program provides a unique opportunity for students to study the application of statistical, mathematical and decision sciences to a broad array of terrestrial and marine ecology, natural resource management, biometrical and mathematical biology problems. The QERM program draws its faculty from 14 academic departments, including the School of Aquatic and Fishery Sciences. From its inception until 1996, QERM was administered by CQS. When that program was moved into the Office of Undergraduate Education, QERM was given its own director. At the present time, 7 QERM students have SAFS faculty as their major professor.

3. Center for Water and Watershed Studies: **CWWS** is an interdisciplinary program that was initially created as the Center for Streamside Studies (CSS) in 1987. It is a unique partnership of state and federal agencies, Native American tribes, environmental organizations, the forest products industry and the University. It is administered under the auspices of the School of Aquatic and Fishery Sciences and the College of Forest Resources. Faculty are drawn from those and other units. The mission of CWWS is to provide information needed to resolve management issues related to the production and protection of forest, fish, wildlife and water resources associated with the streams and rivers of the Pacific Northwest. CWWS faculty and staff conduct research, offer graduate training, and sponsor continuing education courses. CWWS was created from the merger of CSS with the Center for Urban Water Resource Management in fall 2002.

4. Olympic Natural Resources Center: **ONRC** is an interdisciplinary research and education program related to the marine and forest resources of the Olympic Peninsula of Washington. It was created by the State Legislature in 1989. The intent of the program is to support the continued development of sound resource management practices, emphasizing a balance between the maintenance of ecological values and sustainable commodity production. The Center involves personnel from SAFS, COFS, the College of Forest Resources and the Washington Department of Natural Resources.

5. Washington Cooperative Fish and Wildlife Research Unit: The **Coop** Unit is sponsored by the U.S. Geological Survey (USGS), Biological Resources Division. Official cooperators include USGS, SAFS, and three State resource agencies (Fish and Wildlife; Ecology; Natural Resources). Affiliate cooperators include the UW College of Forest Resources and the Washington State University Department of Natural Resource Sciences. Coop Unit personnel conduct research, offer graduate training, and teach formal courses.

6. Wetlands Ecosystem Team: **WET** is an interdisciplinary research group that draws its membership from the School of Aquatic and Fishery Sciences, Department of Civil Engineering, College of Forest Resources, Center for Urban Horticulture and School of Marine Affairs. The goal of WET is to conduct research on estuaries and fresh water wetlands. The research includes long-term ecological studies, investigations of unintentionally introduced species, and restoration ecology.

7. Marine Molecular Biotechnology Laboratory: **MMBL** is an interdisciplinary research facility that is administered by the Schools of Aquatic and Fishery Sciences and Oceanography. The laboratory provides faculty, staff and students with access to state-of-the-art-instrumentation. Faculty associated with MMBL offer lecture and laboratory courses on the application of molecular techniques to fisheries and oceanographic research. Since the time of last review, tenure-track faculty have been doubled from two to four (Hauser and Naish from SAFS; and two faculty from Oceanography).

8. Western Regional Aquaculture Center: **WRAC** is multi-university consortium that is funded by the U.S. Department of Agriculture. Universities from 12 western states participate in WRAC's research and extension activities. All research projects are required to address regional issues and to involve teams of investigators from more than one university. The WRAC Administrative Office is located in the School of Aquatic and Fishery Sciences.

9. Cooperative Education and Research Program: **CERP** is a cooperative agreement between SAFS and the Northwest Fisheries Science Center (NOAA, NMFS). It involves cooperative use of personnel and facilities for education and research. Recent program activities include continuing education classes and joint research projects that support the Northwest Center's responsibilities under the U.S. Endangered Species Act, the Fisheries Conservation

and Management Act, and the Marine Mammal Protection Act. CERP sponsors internships for undergraduate and graduate students in underrepresented groups.

10. Northwest Regional Fish Collection: The SAFS Fish Collection is a fully computerized, well-documented, archival research collection of freshwater and marine fishes of Washington State, the Pacific Northwest, and the Pacific Rim, existing to serve the research and educational needs of students and professionals by providing on-site study facilities; a comprehensive library of books, journals, and reprints; loans and gifts of ichthyological materials; identification services; and an active program of public outreach. Ranked 20th among 118 North American ichthyological resource centers, our current holdings include 5,950,762 specimens, in 91,323 computer-cataloged lots. A dedicated website (www.uwfishcollection.org) provides full searchable online access to the catalog, connected to Species Analyst and FishNet, the latter a cutting edge biodiversity network of some 24 ichthyological collections.

11. Aquatic Ecological Research in Alaska (Alaska Salmon Program; ASP): This six-week long course in the Alaskan outback provides a small group of undergraduate students hands-on training in theories and techniques of aquatic ecology research. Students participate in lectures and conduct field studies to gain practical experience in designing and conducting research projects. The program benefits from active faculty and graduate student research during the course that enables undergraduates to better appreciate the processes that underlie the scientific method of inquiry (see Appendix C.7).

12. Friday Harbor Laboratories: SAFS faculty regularly teach "immersion" courses through the lab, located in the San Juan Islands. Financial support enables students to spend an entire quarter focusing on classroom field studies to address important aquatic science issues, including conservation and disease**.**

13. Alaska Fisheries Science Center (AFSC) Internships: This NOAA Fisheries program funds SAFS undergraduates to participate in summer-long internships working on AFSC research projects in field and lab settings. Students are paired with project mentors and given opportunities to gain practical research experience. The School provides stipends and AFSC travel and other logistical support (see Appendix C.8).

C. Outreach at Aquatic & Fishery Sciences

SAFS faculty, staff, and students participate in diverse outreach and service activities. In addition to opportunities that support college student experiential learning, we provide many programs for K-12 students, professionals interested in aquatic science issues, and the general public. In addition to an extensive and frequently updated School website, a newsletter is mailed widely to alumni, students, and many other constituents (Appendix D.6).

1. Salmon in the Classroom (SIC): This joint SAFS/Seattle Public Utilities K-12 program emphasizes water quality and conservation issues relating to salmon and our changing environment. By rearing salmon in the classroom—from eggs to juveniles—students learn about Pacific salmon and trout life cycles.

2. Fish Hatchery Tours: Through the SIC program, thousands of school children have participated in these tours, where they observe adult salmon returning to the hatchery pond to spawn. *Tours are also open to the public.*

3. University of Washington Fish Collection: The UWFC hosts tours for groups ranging from K-12 students to senior citizens. K-12 groups learn about the importance and uses of the UWFC; they also observe and handle interesting fishes from around the world and discuss the evolutionary adaptive significance of fish morphology.

4. Big Beef Creek: The Big Beef Creek Field Station is located on Hood Canal, and provides site-based

teaching and research in fisheries and many other fields, including opportunities for high-school students to study salmon conservation.

5. Bevan Series on Sustainable Fisheries: This annual seminar series examines the ramifications of our past, present, and future use of marine resources. Speakers from academia, agencies, and non-governmental organizations tackle sustainability from diverse disciplines such as ecology, fisheries management, conservation biology, law, and anthropology.

6. Coastal Observation and Seabird Survey Team (COASST). COASST promotes "citizen science" by organizing volunteers to monitor seabirds on the Oregon and Washington coast. COASST members collect information for long-term baseline data on seabird beaching, and they provide an active voice in coastal marine conservation.

7. NatureMapping: This program coordinates a national network that links agencies, academics, and land planners with local communities. Volunteers, especially school children, observe, inventory, and monitor their natural resources to help keep common animals common.

8. American Fisheries Society, Student Chapter: This all-student volunteer organization offers UW students opportunities to interact with professionals, researchers, and other students working in aquatic-related fields, and is committed to furthering the health of aquatic ecosystems through outreach activities, education, and research.

9. UW Speakers Bureau: The UW Speakers Bureau promotes community access to the broad range of information and knowledge at the University. Through the Bureau, speakers, including members of SAFS, help improve citizen's understanding of the complex scientific issues facing the State.

III. The Faculty

Faculty in the School of Aquatic and Fishery Sciences come from diverse educational backgrounds (Table 3.1), are among the best in the world as leaders in the primary fields that define our School:

- Evolution, Ecology, and Behavior;
- Genetics, Physiology, Diseases within aquaculture sciences
- Management, Conservation, and Restoration
- Quantitative Science, Stock assessment, Modeling

The success of faculty in developing and meeting career goals that contribute to a dynamic, healthy department are evidenced in three areas of recurring review typical across the University of Washington: teaching, research, and service. The Faculty provide Annual Activity Reports (AAR; see Appendix G.1) that serve as means to evaluate contributions to the School overall, provide basis for anticipating new directions in teaching and research, and to affect changes as needed in response to opportunities or in addressing instances of lower than expected performance. These annual reports are effectively summarized in the short Faculty CVs included in Appendix G.2, which are typical of sustained professional achievement by individual faculty throughout their careers. SAFS Faculty enjoys national and international stature reflective of strong individual reputations and enduring, collective commitment to the School that consistently directs the group to maintain high standards in teaching, research and service.

In addition to our active faculty, two other important groups of faculty support the educational mission and greatly augment our research program: 1) adjunct faculty from the UW campus and, 2) several dozen affiliate faculty from other universities, state and federal research management agencies, and sectors of industry (Appendix D. 2). This latter group provides valuable support to the School, most often in graduate thesis programs in the forms of research supervision, facilities and logistics, and direct financial support.

A. Teaching

SAFS Faculty are some of the very best in this University as evidenced in student evaluations, awards for teaching, and efforts to broaden teaching beyond the department in order to expand student enrollment and participation in allied programs:

1. **Student Evaluations**: SAFS faculty are consistently given very high student evaluations for formal courses at all levels, particularly in two important categories: overall quality of the course, and instructor's effectiveness in teaching. On a 5-point scale across all School courses taught the last five AYs, SAFS is routinely ranked above 4.0 (>4 = "very good"), higher than other units in the College and other departments in the University (Fig. 3.1; Appendix C.3). Teaching effectiveness of SAFS faculty and quality of courses were scored at about 4.1 compared to the UW average of 3.9 in the 2001-02 AY.

TABLE 3.1—List of present, active faculty, degrees and institutions, and areas of major research interests.

Faculty	Degree	Year	Interests
James J. Anderson	PhD	1977, Oceanography, Univ. Washington	Biomathematics, Ecology, Fisheries, Oceanography, Toxicology, Fish Protection at Power Plants, Decision Processes, Ecosystem Modeling, Animal Behavior
	BS	1969, Oceanography, Univ. Washington	
David A. Armstrong	PhD	1978, Ecology, U.C. Davis	Crustacean Ecology, Fisheries Population Dynamics
	MS	1974, Fisheries, Oregon State Univ.	
	BS	1970, Biology, U.C. Irvine	
David A. Beauchamp	PhD	1987, Fisheries, Univ. Washington	Aquatic Community Ecology, Food Web Modeling, Native-Nonnative Interactions, Behavior, Population Assessment, Bioenergetics Modeling, Hydroacoustics
	MS	1982, Fisheries, Univ. Washington	
	BS	1980, Fisheries, Univ. Washington	
Loveday L. Conquest	PhD	1975, Biostatistics, Univ. Washington	Statistical Methods, Habitat/Watershed Assessment, Environmental Pollution Monitoring
	MS	1972, Statistics, Stanford Univ.	
	BA	1970, Mathematics, Pomona College	
Walton W. Dickhoff	PhD	1976, Physiology, U.C. Berkeley	Endocrinology; Fish Hormones, Growth and Reproduction
	AB	1970, Biological Sciences, U.C. Berkeley	
Robert E. Francis	PhD	1970, Biomathematics, Univ. Washington	Fisheries Management, Marine Ecosystem Dynamics, Fisheries Oceanography, Climate Change
	MS	1966, Biomathematics, Univ. Washington	
	BA	1964, Mathematics, U.C. Santa Barbara	
Carolyn S. Friedman	PhD	1990, Comparative Pathology, U.C. Santa Barbara	Health Management and Culture of Marine Invertebrates
	BA	1983, Aquatic Biology, U.C. Santa Barbara	
Vincent F. Gallucci	PhD	1971, Statistics and Biomathematics, North Carolina State Univ.	Stock Assessment, Sharks, Artisanal Fisheries, Fisheries Management
	MS	1966, Biophysics, SUNY, Buffalo	
	BS	1963, Physics, SUNY, Stony Brook	
Christian E. Grue	PhD	1977, Wildlife & Fisheries Science, Texas A&M	Wildlife Toxicology, Wildlife Science
	MS	1977, Biology, Northern Arizona Univ.	
	BA	1972, Zoology, U.C. Santa Barbara	
Donald R. Gunderson	PhD	1975, Univ. Washington	Marine Fisheries, Stock Assessment and Recruitment Processes
	MS	1966, Montana State Univ.	
	BS	1963, Montana State Univ.	
Lorenz Hauser	PhD	1996, Univ. Wales, UK	Population Genetics, Molecular Ecology, Evolutionary Biology
	MS	1990, Fisheries Biology and Management, Univ. College of North Wales, UK	
	MS	1989, Zoology, Univ. Vienna, Austria	
Russell P. Herwig	PhD	1989, Fisheries, Univ. Washington	Environmental/Applied/Molecular Aquatic Microbiology, Aquatic Nuisance Species, Seafood Safety, Bioremediation
	MA	1978, Marine Sciences, Coll. William & Mary	
	BS	1974, Biology, Muhlenberg College	
Ray Hilborn	PhD	1974, Zoology, Univ. British Columbia	Stock Assessment, Population Dynamics, Fisheries Policy
	BA	1969, Biology, Grinnell College	
John K. Horne	PhD	1995, Fisheries Ecology, Memorial Univ. Newfoundland	Scale-Dependent Processes Influencing Aquatic Organism Distributions, Predator–Prey Interactions, Acoustics and Aquatic Ecology and Resource Management
	MS	1988, Fisheries Ecology, Dalhousie Univ.	
	BS	1985, Marine Biology, Dalhousie Univ.	
James R. Karr	PhD	1970, Zoology, Univ. Illinois, Urbana	Stream Ecology & Watershed Management, Tropical Forest Ecology, Conservation Biology, Public Policy
	MS	1967, Zoology, Univ. Illinois, Urbana	
	BS	1965, Fish & Wildlife Biology, Iowa State Univ.	
Robert J. Naiman	PhD	1974, Zoology, Arizona State Univ.	River Ecology
	MA	1971, Zoology, U.C. Los Angeles	
	BS	1969, Zoology, Cal. State Polytechnic Univ.	

TABLE 3.1—continued.

Faculty	Degree	Year	Interests
Kerry Naish	PhD	1993, Marine & Fisheries Genetics, Univ. Wales	Quantitative Genetics, Molecular Genetics, Genome Mapping, Conservation, Endangered Species Act, Aquaculture, Salmonids, Shellfish
	MS	1989, Ichthyology and Fisheries Science, Rhodes Univ., South Africa	
	BS	1987, Ichthyology and Fisheries Science, Rhodes Univ., South Africa	
	BS	1986, Zoology, Univ. Cape Town, South Africa	
Julia K. Parrish	PhD	1988, Zoology, Duke Univ.	Animal Aggregation, Seabirds, Marine Conservation
	BS	1982, Biochemistry/Biophysics, Carnegie-Mellon Univ.	
Theodore W. Pietsch	PhD	1973, Biology, USC Los Angeles	Systematic Ichthyology, Distribution and Zoogeography, Behavior, Functional Morphology, Biotic Survey and Inventory, History of Science
	MS	1969, Biology, USC Los Angeles	
	BA	1967, Zoology, Univ. Michigan	
Andre E. Punt	PhD	1991, Applied Mathematics, Univ. Cape Town	Biomathematics, Multispecies Modeling, Population Dynamics, Stock Assessment
	MS	1988, Applied Mathematics, Univ. Cape Town	
	BS	1986, Computer Science, Univ. Cape Town	
	BS	1985, Applied Mathematics and Computer Science, Univ. Cape Town	
Thomas P. Quinn	PhD	1981, Fisheries, Univ. Washington	Fish Behavior, Ecology and Evolution
	MS	1978, Fisheries, Univ. Washington	
	BA	1976, Biology, Swarthmore College	
Charles A. Simenstad	MS	1971, Fisheries, Univ. Washington	Estuarine/Coastal Ecology, Food Web Structure, Juvenile Salmon Ecology
	BS	1969, Fisheries, Univ. Washington	
John R. Skalski	PhD	1985, Biometry, Cornell Univ.	Population Estimation, Environmental Sampling, Effects Assessment
	MS	1978, Biometry, Cornell Univ.	
	MS	1976, Wildlife Science, Oregon State Univ.	
	BS	1974, Wildlife Management/Biology, Univ. Wisconsin	
Gordon L. Swartzman	PhD	1969, Industrial Engineering, Univ. Michigan	Ecosystem Dynamics, Spatial Statistics, Fisheries Acoustics, Predator–Prey Dynamics
	MSEE	1965, Electrical Engineering, Univ. Michigan	
	BSEE	1964, Electrical Engineering, The Cooper Union	
Glenn R. VanBlaricom	PhD	1978, Oceanography, Scripps Inst. of Oceanography, U.C. San Diego	Aquatic and Marine Wildlife, Community Ecology, Ecological Consequences of Oil Spills in Marine Environments
	BS	1972, Oceanography and Zoology, Univ. Washington	
Robert C. Wissmar	PhD	1972, Zoology, Univ. Idaho	Freshwater Ecosystems, Fish Ecology, Trophic Dynamics
	MS	1968, Zoology, Univ. Idaho	
	BS	1965, Zoology, Univ. Utah	

2. **Graduate Student Exit Survey** (poll administered by the Graduate School): Those students completing advanced degrees (M.S. and Ph.D.) give high ratings to the School. Across all-important categories including departmental academic standards, supervision and career mentoring, quality of the faculty, and overall quality of the program, SAFS is ranked higher than other University departments in general, and ahead of other units in COFS (Appendix A.2). There has been great improvement in an historic context. The School was ranked well below the University between 1982-1989 (data shown in the last 10-year self-study, Appendix E1 of that 1991 report). Data on Faculty teaching evaluations given in the 1996 interim self-study report showed the School was ranked almost equal to the broader University and other COFS units. In other ways that reflect the quality of their graduate education, SAFS graduates have a high rate of publishing in the

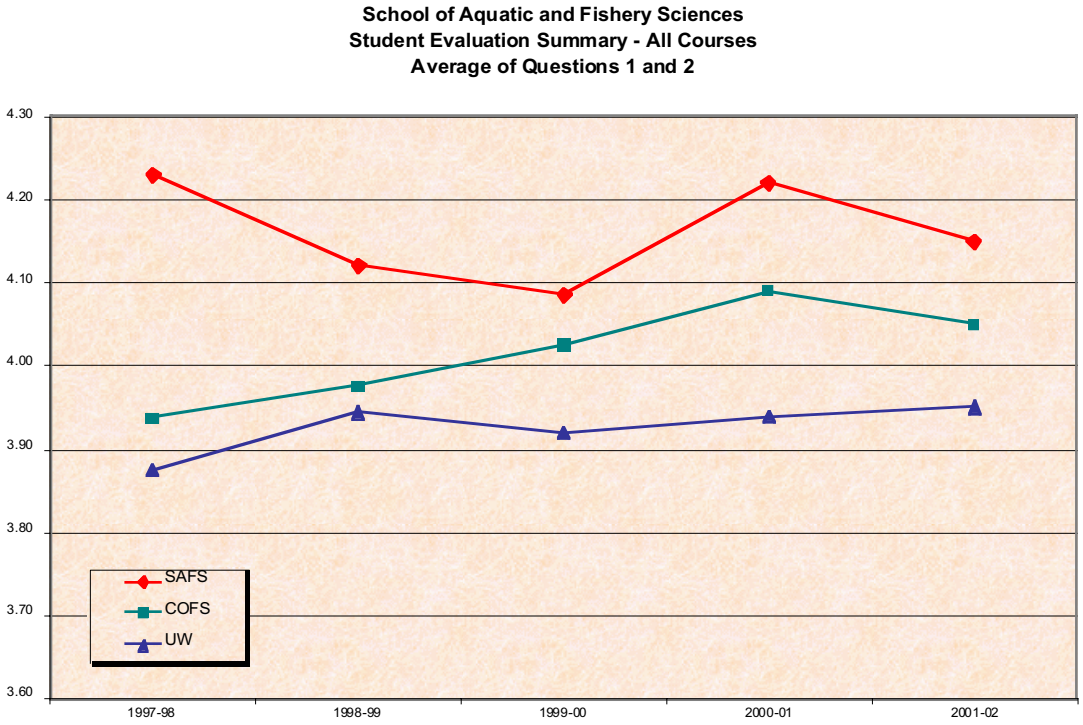

FIGURE 3.1—Student course evaluation scores from the UW Instructional Assessment Center. Questions 1 and 2 are "course as a whole" and "instructor's effectiveness," respectively, and average values for all courses taught are presented.

peer-reviewed literature of our fields, and acquire teaching experience during their student careers. Approximately 35% of M.S. and 85% of Ph.D. students have published by graduation (Appendix A.2; see Section V for other information on peer-review publications by students).

3. **Distinguished Teachers**: Three SAFS faculty (Conquest, Pietsch, and Quinn) are recipients of the University's Distinguished Teaching Award. The College of Ocean and Fishery Sciences' Distinguished Teaching Award has been given for Undergraduate education to four present SAFS faculty (Conquest, Herwig, Pietsch, and Quinn; and four others now retired or departed), and for Graduate education to three faculty (Conquest, Francis, and Pietsch; and two others now departed).

A.1 Teaching: Changes and Improvements

Since the mid-1990s and as underscored in our 2000 Strategic Plan, the Faculty has worked to significantly increase quality of instruction and enrollment in courses within the SAFS undergraduate major, and to expand SAFS instruction on behalf of several other closely related UW academic programs. This has been approached in several ways:

Revision and expansion of lower division undergraduate courses: Enrollment in and quality of instruction of ***FISH 101*** declined significantly to 1998-99. The course was not given for almost 2 academic years as we shifted other parts of the curriculum to provide a faculty time to restructure the course,. The "new" course is case-study driven based on readings, discussions and critical thinking around important issues in aquatic conservation. The course is now taught by Bob Francis, a well-known full professor who is highly regarded as a teacher. Marine Biology is a new series in its second year, spearheaded by a group of newer faculty from all three academic units in COFS. The only course opened to general enrollment (**FISH 250;** also with one honors section) is taught by Julia

Parrish in fall and already has about 140 students enrolled. This course features hands-on lab and experiential field trips. An honors section continues in both winter and spring quarters taught by faculty from Oceanography and Marine Affairs.

Participation in Freshman Seminar series as a means to expose incoming undergraduates to the provocative issues representative of courses and faculty interests within SAFS.

Improvement of Student Services by hiring highly dedicated, professional people to work in advising majors, and promoting the School's curriculum and career opportunities across campus. As noted previously, majors have doubled to about 100 since 1998 (see Section V.A), which has increased enrollment in many courses across the curriculum. Important aspects of this Office are to work with faculty as interface between student interests, advising tied to requirements of the major, and expansion across the network of other science department advisors to increase enrollment overall. Head of Student Services is a member of the Curriculum Committee and advises regarding enrollment trends, faculty schedules and those of other courses in ways to reduce conflicts to provide maximum enrollment opportunity.

Reach a broader undergraduate science audience:

- SAFS faculty are assigned to teach in other programs now including PoE (Karr and formerly Parrish), Biology (Naish and Hauser), CQS (a long-standing historic role; Conquest, Skalski, Gallucci, Francis, Hilborn, Punt, and salary provided for some lecturers as needed), Friday Harbor Labs Apprenticeship courses (Gunderson, Kocan, Miller). Over the last four academic years, from 1998 to 2002, the fraction of SAFS teaching outside the department based on SCH has varied from about 25 to 40% (Table 3.2), and we expect the amount will remain high as two SAFS faculty begin instruction in the Biology curriculum this year.
- We have established a more interdisciplinary seminar series of high caliber, the ***Bevan Series***, to attract student interest in aquatic conservation, sustainable fisheries, and the mix of sci-

TABLE 3.2—Trends in faculty teaching load based on student credit hours (SCH) across different course levels. Note that a significant portion of SAFS teaching is provided to other campus units (termed "outside SAFS SCH"), and most of SAFS formal teaching occurs at the undergraduate level (only about 8-13% in recent years is taught at the 500-level).

	1998–99	1999–00	2000–01	2001–02
Undergraduate				
SAFS 100-400 SCH	3,800	2,563	2,509	4,763
Outside SAFS SCH	1,706	1,489	1,989	1,569
Total UG SCH	**5,506**	**4,052**	**4,498**	**6,332**
Percent outside SAFS courses	31.0%	36.7%	44.2%	24.8%
Graduate				
500 level	559	444	667	534
600-800 thesis	1,775	1,751	1,819	2,157
Total Graduate	**2,334**	**2,195**	**2,486**	**2,691**
Percent SCH at 100-500 level	77.4%	72.0%	74.0%	76.1%
500 level percentage of 100-500	9.2%	9.9%	12.9%	7.8%
Thesis percentage of total	22.6%	28.0%	26.0%	23.9%
Total enrollment	**1,870**	**1,452**	**1,804**	**1,999**
Total SCH	**7,840**	**6,247**	**6,984**	**9,023**

ence and societal issues that drive policy. Now in its 3rd year, the winter quarter Bevan Series is the most popular seminar series ever offered by the School and includes both an undergraduate and graduate course section).

- The School has participated in creation of a ***COFS Honors Program*** to attract top students as majors into SAFS courses (we already have new majors drawn from this group).

Expand undergraduate experiential research opportunity: Highlighted throughout this report are examples of success in this endeavor: new programs initially supported by Tools for Transformation, the Honors Program, significant provision of SAFS endowment funds for undergraduate research, and much increased faculty participation to lead and direct undergraduate work. In recent data provided by the Office of Undergraduate Education on undergraduate research and service, SAFS (15 full FTEs) ranks very high among the science departments in number of undergraduate research quarters, 89 in the 2001-02 AY, compared, for instance, to the new Biology program (about 45 faculty FTEs combined from Zoology and Botany) where undergraduate research was about 180 quarters. A growing number of courses in SAFS are directly geared to undergraduate research and include:

- A 400-level ecotoxicology course taught by Chris Grue, who uses issues of concern to the State of Washington in aquatic toxicology as means to expose students to the scientific method. They define a research issue, conduct experiments, analyze data, and write a peer-reviewed manuscript intended for publication.
- A summer field course at the SAFS Alaska Camps brings a small group of undergraduate students into research questions in salmon biology, management, and aquatic processes mentored by Tom Quinn and Ray Hilborn from SAFS, and Daniel Schindler from Biology.

A.2 Teaching Load and Equitability

Goal: Increase Student Credit Hours (SCH) taught by faculty. As noted below, there has been a significant decline in the number of School faculty members that has affected entire disciplines formally taught, and caused some reduction in course offerings across other disciplines. This was done in order to increase enrollments in ways that make better use of salaried faculty time (reflecting criteria that apply to different categories of instruction), and assignment of other resources such as TAs and upgrades of teaching facilities and equipment.

Since 1995, 21 courses formally within the Institute of Food Science and technology (IFST) and 5 closely linked within the School have been dropped. The Curriculum Committee is presently studying status of more than 15 courses still listed, but that have not been taught for a number of years. Given the shift in faculty assignments to other higher priority topics, these 15 courses will likely be dropped formally from our course offerings. Six additional upper division courses have been dormant, but are under review as important instructional themes that may be taught as additional new faculty are hired. Over that same period, SAFS has added 6 formal lecture/lab courses for which we are directly responsible in areas such as marine biology, watershed ecology and restoration, biomonitoring, sustainable human ecosystems, and aquatic diseases. Five courses at the 400-level have been added to provide both more intense linkage of students to reading and discussion drawn from the seminar series, and designated experiential instruction/research for undergraduates at the Alaska Field Camps, Friday Harbor Labs, and expanded "capstone" research requirement of the majors. A series of 500-level graduate courses have been added to provide scheduling and enrollment flexibility across a rotation of subject areas covered by the faculty in 2-credit, intense seminars. To further ensure that enrollment is maximized

to the extent possible within constraints of TAs, lab bench space, etc., many courses have been switched to alternate year schedules (e.g. the 550 quantitative series and some 400-level specialty courses). A list of courses with notation about status as "active" or "dormant" is given in Appendix C. 10.

As a result of these changes in content and quality of the curriculum and efforts to teach more effectively within and outside the School, the Faculty now teach more total credits per academic year, and a account for a higher ratio of ***SCH/faculty*** than in the past (Table 3.2; Figs. 3.2-3). In 1998-99 there were about 18 faculty FTEs teaching 7,800 SCH/AY; in 2001-02, 15 FTEs taught 9,000 SCH. While the increase in absolute SCH is about 15% (Table 3.2), the per capita increase is 30% (Fig. 3.3). Most of the per capita increase in teaching credit hours has occurred in the SAFS 100-400 level courses (25%) and graduate thesis supervision at the 700-800 level (26%; Fig. 3.4; Table 3.2). In the last three AYs, most dramatic increases in course enrollment and SCH has occurred in FISH 101 (about 300%), 200-level courses (notably FISH 250; about 160%), and at the 300-level (growing popularity of some of the core and flagship courses such as FISH 311 and 312).

Over a longer historic period, total SCH/Faculty FTE/AY have been about 400, with the notable increase in 2001-02 (Fig. 3.2). But in one important respect this is not a good portrayal of most individual faculty's contribution since the data include FISH 101. This high enrollment service course was historically taught by a single salaried lecturer or WOT faculty. Since the SCH previously contributed by FISH 101 were a very large fraction of the School's total based on a single person, we also compute annual faculty per capita SCH without this single course, and the trend in greater individual teaching effort is evident (Fig. 3.3). ***Individual faculty teaching effort measured by this metric has increased form about 200 SCH/AY in the late 1980s, to about 250 in the mid-1990s, and now to over 400/AY; we expect per capita SCH will trend further upward.*** This 100% increase in the last 10 years repre-

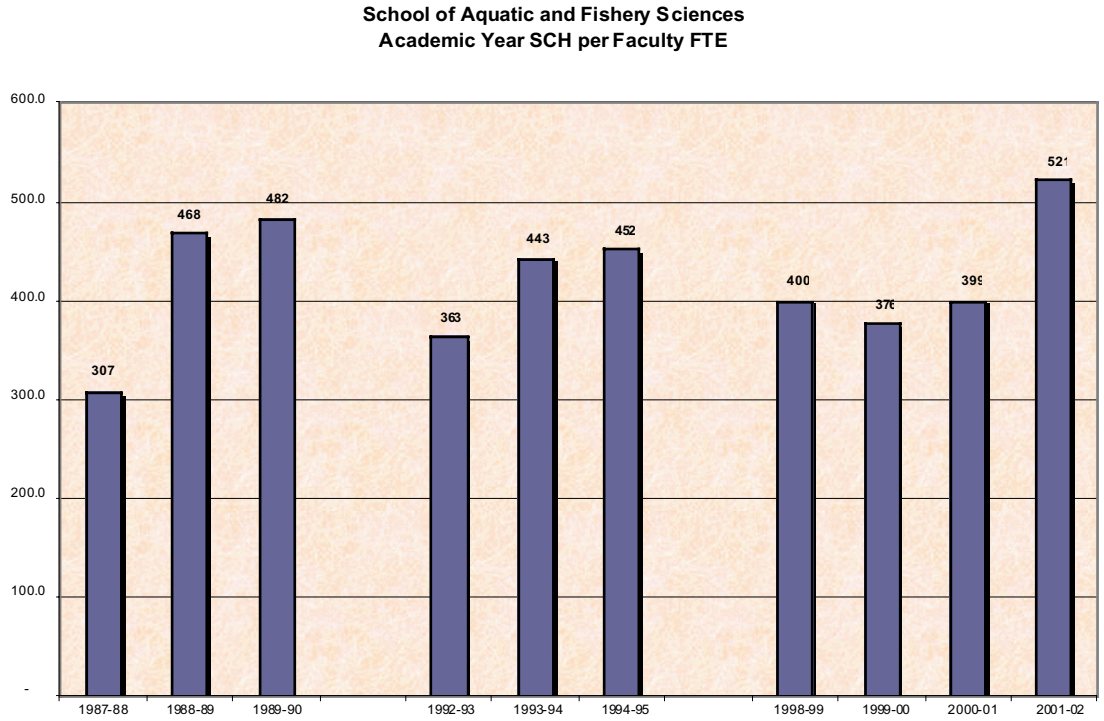

FIGURE 3.2—Trend in SCH per faculty FTE per academic year (AY). Notice the substantial increase in 2001-02 AY as new, higher enrollment courses were added to the curriculum.

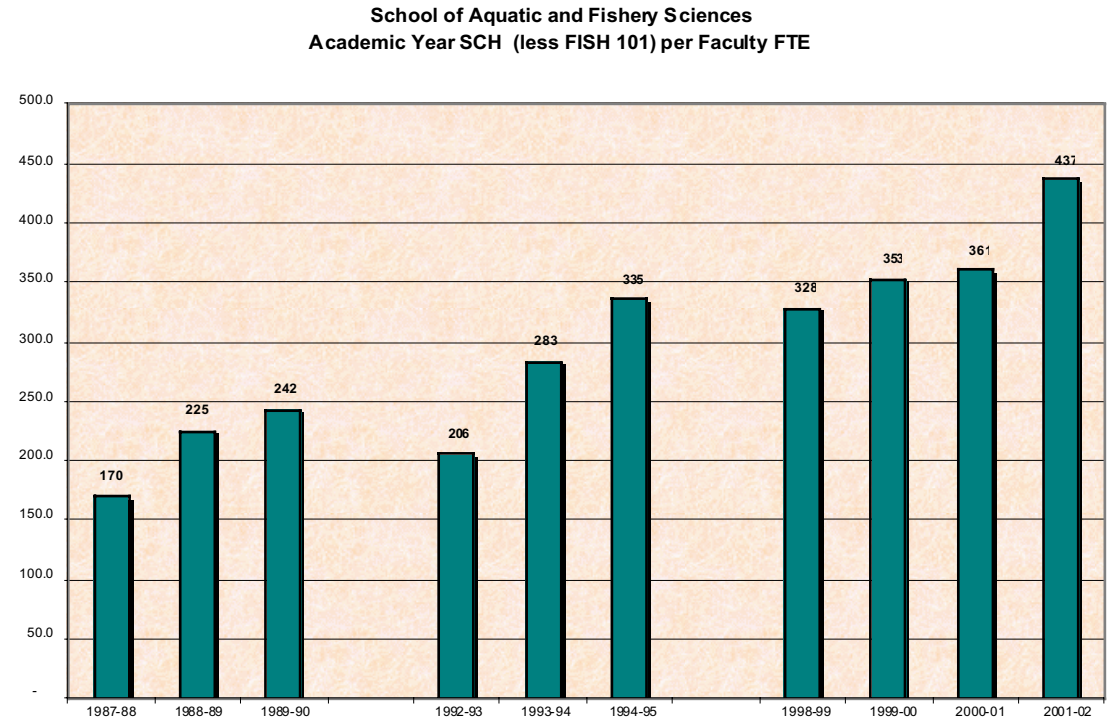

FIGURE 3.3—Trend in SAFS SCH/faculty FTE/AY (as in Figure 3.2), less a high-enrollment service course (FISH 101). As noted in the text, this course has been taught by a single person and historically accounted for a significant fraction of the School's SCH. Inclusion of these SCH's tends to mask the relative loads carried by the rest of the teaching faculty. Based on this correction, individual faculty teaching measured by SCH has doubled since the late 1980s.

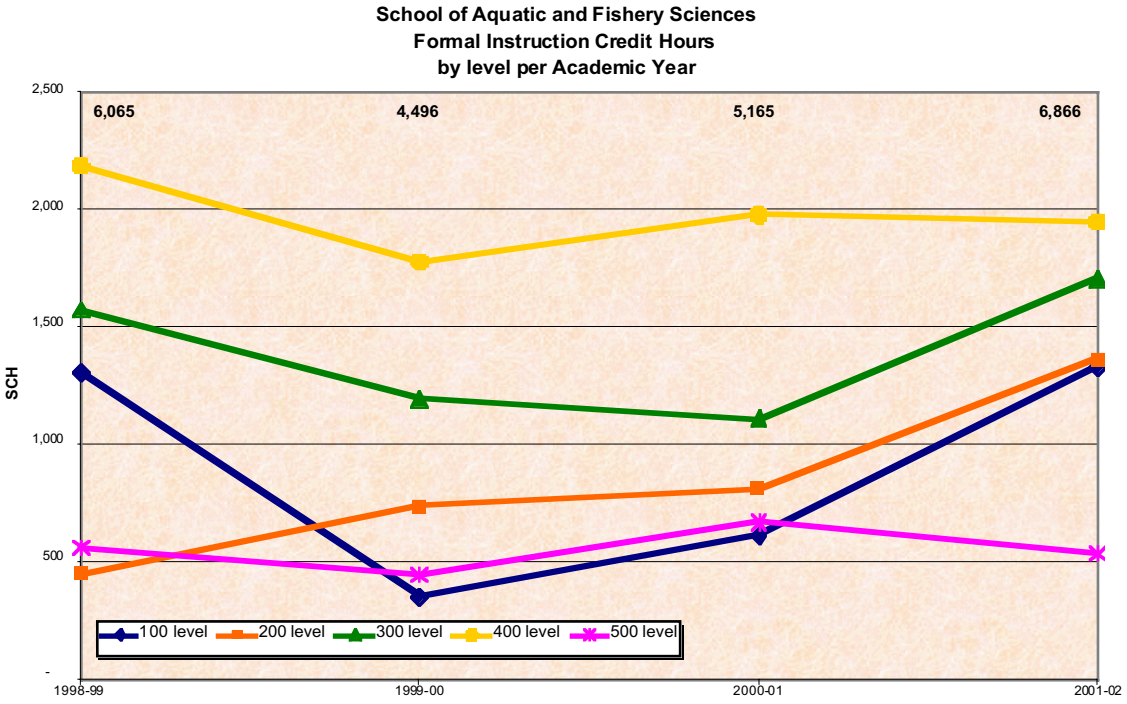

FIGURE 3.4—Total SAFS SCH per academic year by course level. Most dramatic increases in recent time have occurred in the 100, 200, and 300-level courses through a combination of new courses (e.g. FISH 250, Marine Biology) and growing enrollment in core and flagship courses such as FISH 311 and 312 (fish biology and ecology) that draw enrollments from other departments.

sents strategic planning to increase course enrollment in a way that provides some balance between high enrollment instruction on the one hand, and lower enrollment intense experiential instruction and student research on the other.

Teaching Equitability: SAFS continues to address the issue of equitability in teaching load across the faculty, which is difficult to assess since it can be viewed in different ways based on metrics used. SCH are one means commonly used by the University to compare departments and programs, yet there is risk in overweighting sheer quantity of enrollment and credits while losing sight of effort and quality otherwise. SAFS is proud to offer very high-quality instruction including substantial experiential research opportunity, and repeated attention to skill sets reinforced across our core and flagship courses (see Section V). Such attention given individuals within the major is possible in numerous courses where enrollment is between 15-40 undergraduates, and less so if we were a department with a larger "service" course mission. In terms of SCH, SAFS faculty compare very favorably to other units in COFS, to other science departments on campus, and to peer academic departments in other universities. Based on our detailed peer survey conducted this year, SAFS faculty teach about 2.5x more SCH /AY than teaching faculty in other aquatic science, natural resource, and oceanographic departments elsewhere (Table 1.1).

There is certainly great difference across individual faculty in relative teaching measured by SCH (Fig. 3.5), but we see no overt evidence of imbalance based on rank or gender. In the case of several very new faculty, the data of teaching load has not been developed, but assignments across the AY are in accord with standards of annual teaching credit hours required (9-12), a mix of relatively high and lower enrollment courses, and

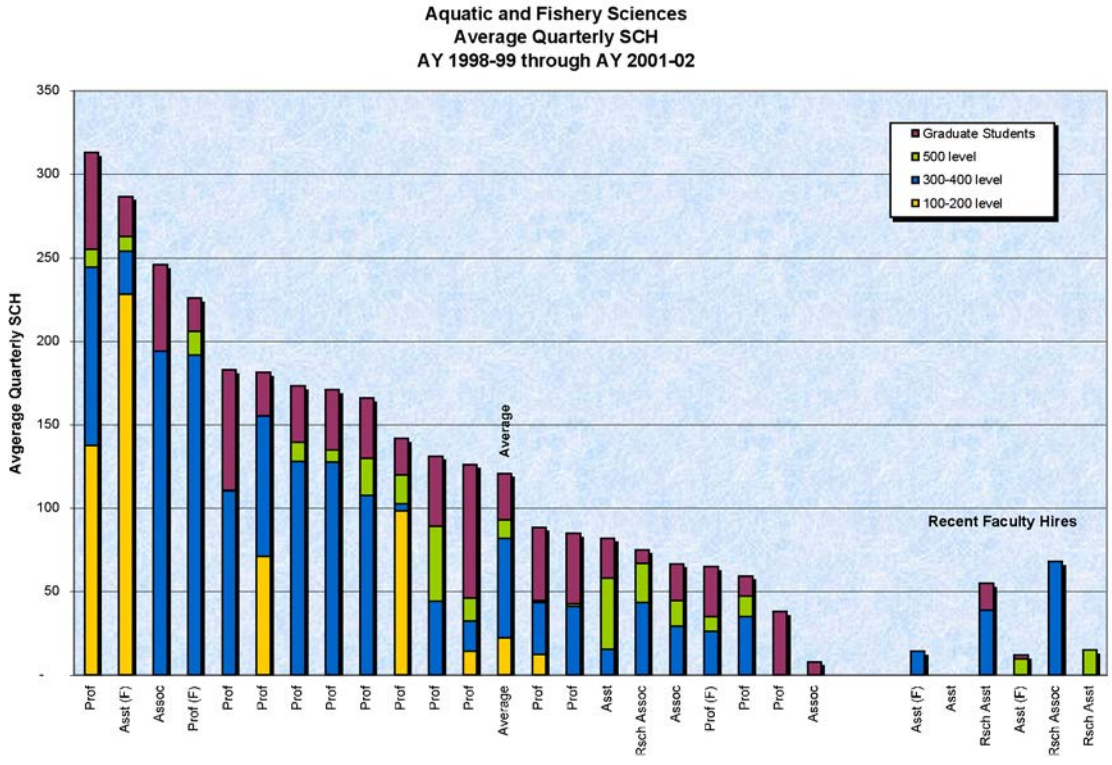

FIGURE 3.5—Average individual faculty teaching loads based on SCH/quarter by course level over the past 4 academic years. "Graduate students" are thesis credits (700 and 800-level combined). Faculty rank is given as full professor (Prof), associate (Assoc) or assistant (Asst) in the tenure-track ranks and the research (Rsch) faculty ranks. Female faculty are indicated as (F). "Recent" faculty were hired in the last two academic years.

upper division graduate instruction. All other faculty are full and associate professors, and most of the active faculty are near or above the group average (5 faculty below the average are retired emeritus, research, or Coop faculty whose courses tend to be lower enrollment).

A.3 Graduate Student Supervision

For over 80 years, thesis research supervision of graduate students has been a central element of our academic program as an ongoing contribution to educate scientists employed at universities, federal and state resource/management agencies, non-governmental organizations, and within the business sector of several broad fields (see Sections V. B, C). SAFS faculty carry a heavy supervisor load that averages about 5 active graduate students each (Fig. 3.6; at present about equally split between M.S. and Ph.D. students). Faculty commitment to the Graduate Program is reflected both in its size and per capita load, but also in the substantial financial obligation required since a majority of SAFS graduate support comes from external G&Cs awarded to faculty PIs. Over the last several years, each faculty has graduated about one student per AY (either M.S. or Ph.D.), who have generally published in peer-reviewed literature prior to completion and have participated in some form of instructional training, and virtually all are employed in their preferred fields as further indication of high faculty standards given graduate student mentorship (see details in Sections V.B, C).

A.4 Reduction in Number of Faculty, but New Focus and Commitment

Over the last decade, there has been substantial change in faculty composition and disciplinary focus that has shifted programmatic emphases across the School. SAFS faculty count can be portrayed in two ways: 1) those faculty most directly tied to the teaching program based on State salary support who are, for the most part, regular 9 month FTE teaching faculty and; 2) total faculty who contribute to research and graduate student supervision, including those sup-

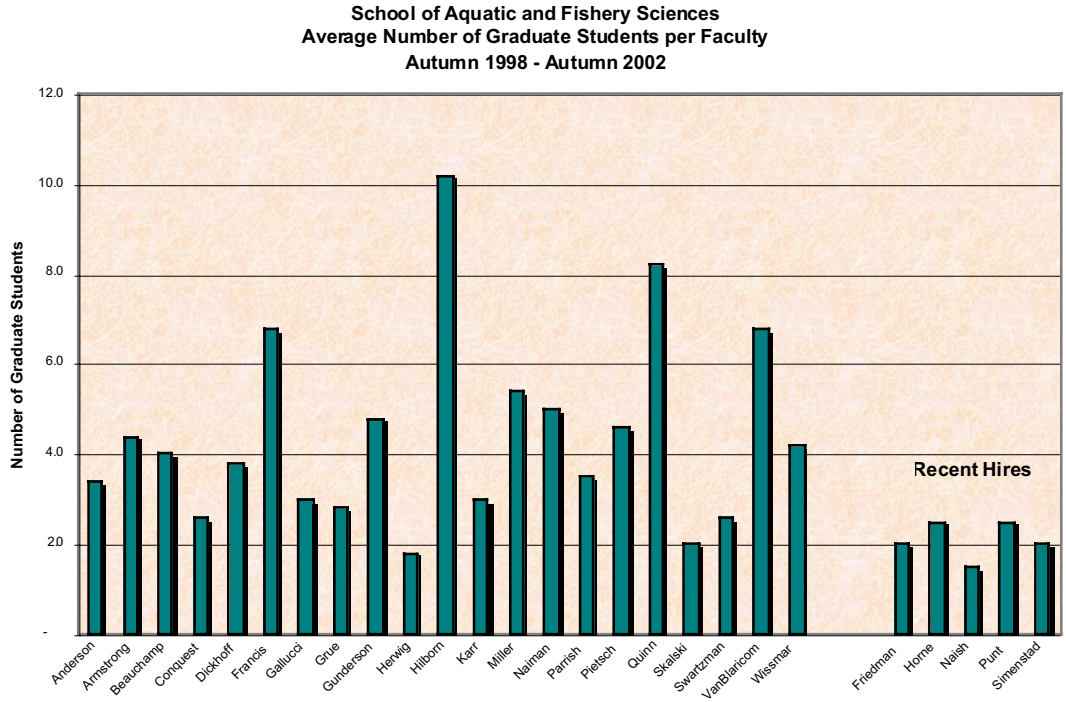

FIGURE 3.6—Number of active graduate students/faculty averaged across the last five Autumn Quarters. M.S. and Ph.D. students are combined (see Figure 5.2 for relative proportions in the program overall).

ported largely on external grant and contract funds; typically "research" and "WOT" (without tenure by virtue of funding) faculty. Within COFS, WOT faculty receive 2 months salary/AY from School funds and in return, are expected to participate in the formal instruction program. SAFS is also the home of one of the national Cooperative Fish and Wildlife Research Units ("Coop") funded by the U.S. Geological Survey. Three of our faculty are fully salaried by this arrangement, teach one course/AY, and carry very large graduate student supervisory research loads.

With this general distinction in mind between State-supported teaching faculty and total faculty who contribute to the research mission, the trend in faculty number has been significantly down since 1995 (Fig. 3.7). Total faculty count and State faculty FTE equivalents were essentially constant between 1991-95 at about 36 and 25, respectively. But beginning at the end of the 1995-96 AY and through the 2000-01 AY the ***School lost 10, 9 month FTE faculty*** (Chew, Foote, Hershberger, Landolt, Mathews, Pikitch, Pigott, Rasco, Stickney, Taub) before we began to rehire (see details of faculty departure and hire in Appendix D.3; and faculty lists from the previous academic reviews in 1991 and 1996, Appendix D.4). In the last two years, we have lost additional tenure-track faculty (Bentzen, Dong, Miller), but have added four new faculty in this group (Friedman, Hauser, Naish, Parrish; and a tenure-track search is presently underway for a 5th person). In addition, several research and WOT faculty departed in that same interval, but the School has recruited new faculty in these groups (Beauchamp, Horne, Punt, Simenstad). At present, the School has a total of **26** active faculty who contribute to research and graduate student supervision overall, and about **15** regular State FTE teaching faculty (Fig. 3.7). Women now comprise about 27% of the teaching faculty (4/15; 6/25 in 1995) including three of the last four tenure-track hires.

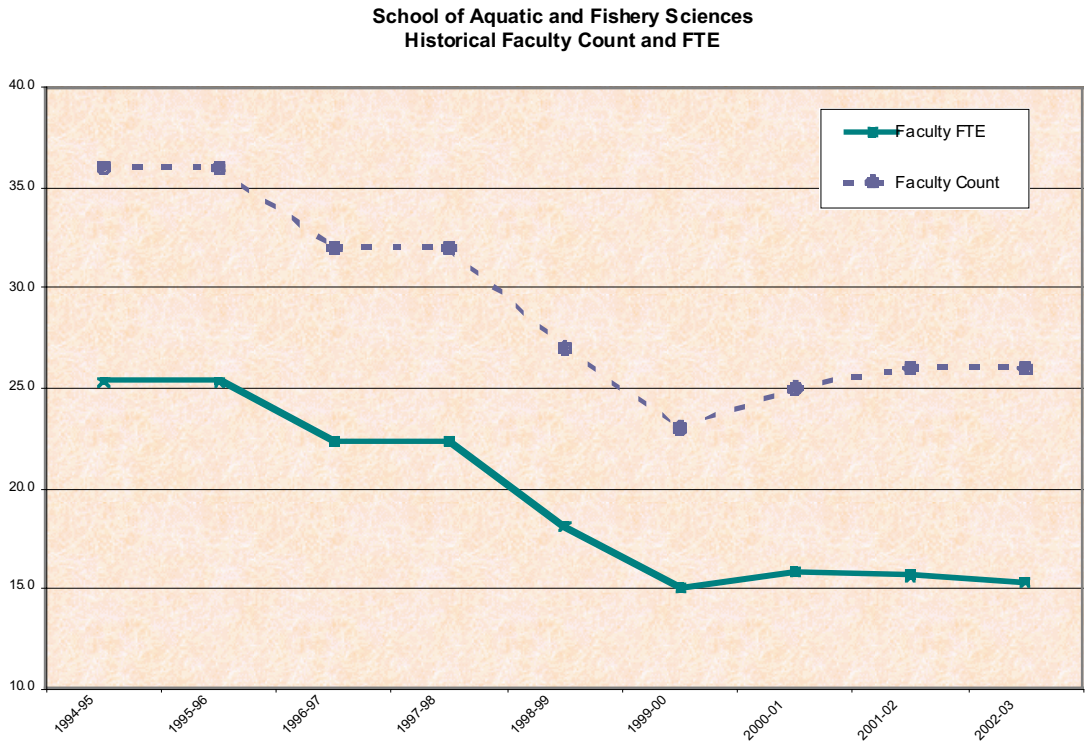

FIGURE 3.7—Trend in historical count of full 9-month State-funded tenure-track faculty FTEs (basis of the formal teaching program), and total active faculty PIs (basis of G&C funding and graduate student research supervision). Note the loss of about ten, 9-month equivalent teaching faculty since 1995.

Obviously, a 40% net reduction in State FTE teaching faculty has had dramatic effect on the curriculum and research focus within the School. Most conspicuous is eventual departure of all faculty who had formally comprised the Institute of Food Science and Engineering (IFST). Over the last 10 years the B.S. in Food Science was eliminated because undergraduate majors had dwindled to an extreme extent, and there is effectively no graduate program nor plans to rehire faculty in this subject area. During the strategic planning process in 1999, five general subject areas were considered as both the principle categories within the teaching curriculum and as representative of faculty research:

- Evolution, Ecology, and Behavior
- Genetics and Physiology
- Management, Conservation, and Restoration
- Aquaculture, Utilization, and Pathology
- Quantitative Science

The BS curriculum as now structured (see Section V.A) recognizes three "focus" areas (Appendix C.1) to direct student interests:

- Aquatic Ecology
- Conservation and Management
- Aquatic Biology and Culture

Other than departure of faculty from the IFST, those aspects of SAFS' teaching and research emphasis most affected by the loss of 10 FTE faculty are disciplines and subjects within: 1) aquacultural sciences, 2) quantitative topics and skill sets that have so long been a strong aspect of the School's reputation and, 3) 500-level formal graduate instruction (at present, only about 10% of total annual SCH come from formal graduate instruction; Table 3.2).

Pressures and Impediments

At the present low level of teaching faculty, the School has little flexibility to expand programs that might attract more majors in popular fields such as marine biology including marine mammals, provide the scope and depth of quantitative instruction that students seek as essential for many jobs in the field, or participate further in teaching needs of other programs where we contribute at present (Biology, PoE, CQS, FHL research apprenticeships).

B. Research

B.1 Funding

Success of Faculty in obtaining competitive grants has long provided the majority of funds for School activities, primarily the entire research program including significant support for graduate student training. About ***75% of the annual budget*** overall (including those funds returned from indirect costs) is derived from grants and contracts (G&C; see Section I, Fig. 1.2). Since the mid-1990s, annual G&C expenditures have been about $7M and in the 2001-02 FY were $7.8M. Adjusted for inflation, there is a pattern of some decline in total SAFS G&C awards from '96-97 as faculty departed, and of late an increase as new programs emerge (Fig. 3.8). The benefit to our academic program is enormous since most G&C funds (>60% in FY 2001-02) are expended in salaries of post-docs, graduate students, faculty, professional research staff, and hourly undergraduate students (Fig. 3.9) who provide the intellectual and logistical base of experiential opportunities closely linked to our curriculum.

The annual level of SAFS G&C awards is high in comparison to other UW departments of comparable or much larger faculty size (Table 3.3). Based on data from the Office of Research (provided in reports of awards and expenditures), SAFS accounted for about $7.9M of direct G&C expenditures in the 2001-02 FY). The entire College of Forest Resources (>40 FTE) expended $8.2M in the same fiscal year, Zoology and Botany combined (now Biology; >35 FTE) about $7.3M, and Oceanography about $11.3M (Table 3.3). The SAFS value, however, is understated since all re-

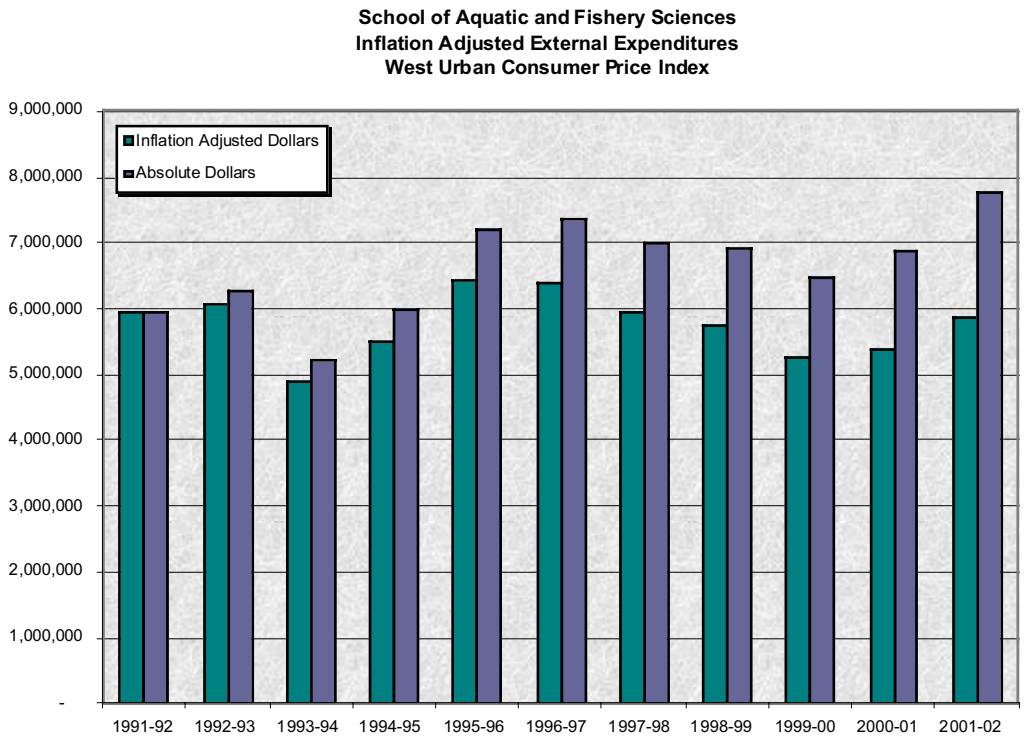

FIGURE 3.8—Trend in total SAFS annual G&C research expenditures since time of last review. Total dollars are corrected by a "western urban" CPI. Note increase in recent years as new faculty programs have begun under the new hires within tenure and research faculty ranks. Indirect costs are not included, but see Fig. 1.3 for those values and comparison with the State budget.

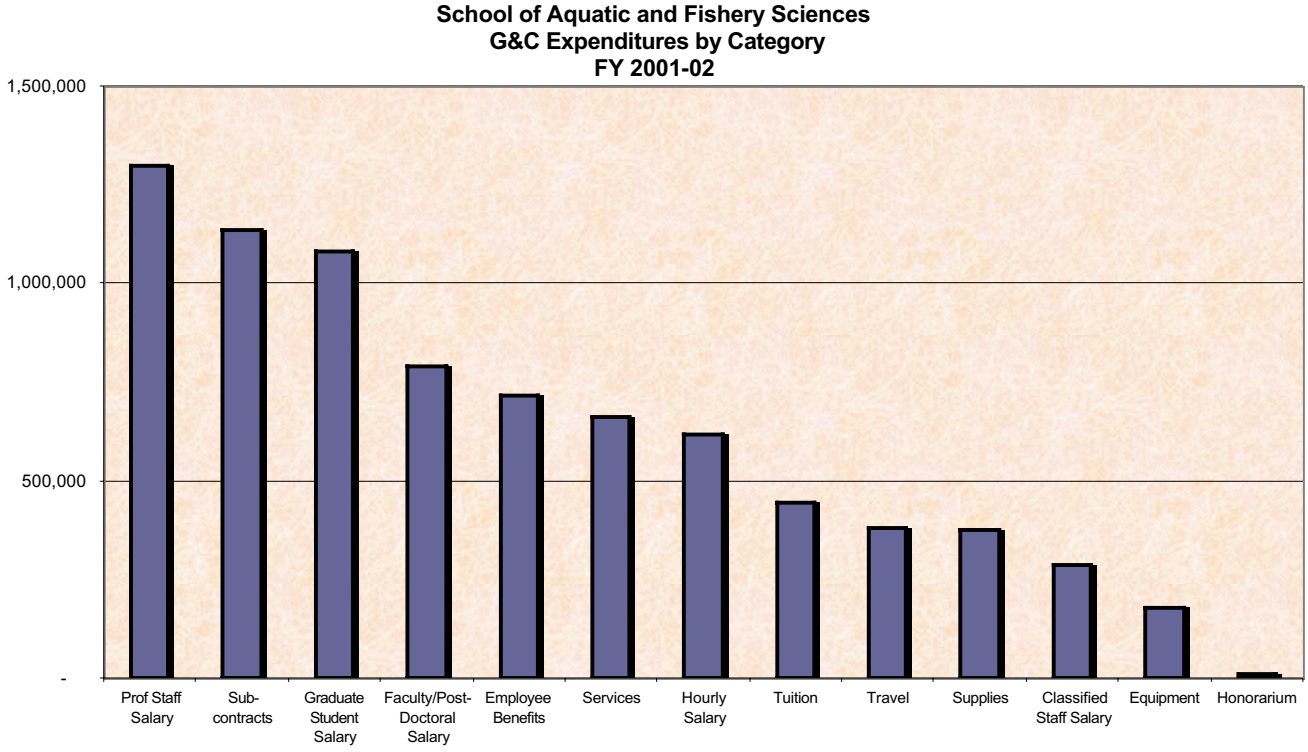

FIGURE 3.9—Representative G&C expenditures by category for FY 2001–02. Over 60% of the direct dollars are spent in salaries of technical staff, post-docs, graduate students, and hourly UG students.

TABLE 3.3—Comparison of SAFS G&C expenditures for the last two fiscal years with similar UW science departments. Not included in the SAFS data are G&C awards to our faculty through JISAO (Joint Institute for study of the Atmosphere and Ocean) that totaled $1M of direct costs for FY01-02. Note that some of the other departments have much higher faculty FTE counts.

Department	2000–01	2001–02
SAFS	6,900,000	7,900,000
Atmospheric Sciences	5,800,000	5,100,000
Botany	1,900,000	2,100, 000
Forestry	7,500,000	8,200,000
Oceanography	13,100,000	11,400,000
Zoology	5,000,000	5,200,000

search dollars to our faculty through JISAO (Joint Institute for study of the Atmosphere and Ocean) are not reported for the School, and in FY 2001-02 this totaled about $1M.

The School is made substantially richer as an academic environment by on-going research and discovery supported from faculty G&C awards. ***Virtually every faculty research program benefits the teaching mission of the School.*** Most conspicuously are the numerous graduate students who are supported, but opportunities for undergraduate education are now commonly nested in over-arching research programs such as the Alaska Salmon Program, the Fish Collection tied to biodiversity expeditions, the Columbia Basin River program, the many projects supported through the Coop, and long-term integrated research such as PNCERS and the WET TEAM. In all of these examples and numerous other faculty research programs, teaching is directly supported by strong inclusion of undergraduates in the topics under study, and though the plethora of actual experiences and lessons carried in the data and analyses, then brought to their classes by active faculty who are both researchers and teachers.

There is an important trend in funding over the past 9 years in which the per capita awards to PIs are getting larger (Fig. 3.10). Since 1993-94, inflation-adjusted annual G&C expenditures have increased about 60% from $140,000 to $220,000 per faculty PI (indirect costs excluded in Fig. 3.10; note that in Table 1.1, data on per capita faculty G&C expenditures compared to peers ***include*** indirect costs). This trend of larger annual G&C awards to faculty indicates two positive attributes: 1) fewer small awards that often require inordinate time of both PIs and administrative staff, and; 2) more longer-term, interdisciplinary programs at higher funding levels. The later trend is particularly significant since it greatly enhances the research base behind hypothesis-driven research and experimentation by including scientists and students from other fields. Those collaborators from SAFS (faculty, staff and students) experience broader integration of data and analytical approach brought from other scientific disciplines. While many of the SAFS research questions asked within the framework of G&C funding are directed toward biotic topics (species, communities, organismal ecology), they must be studied in the context of oceanographic, watershed, and atmospheric forcing, use tools from computer science to remote sensing, and be interpreted in light of societal policies, values, and economics. This combines to provide students deeper learning and training in the science of their future careers and its applications to human issues.

B.2 Publications

The Faculty and graduate students (see Sections V. B, C) within SAFS have a strong publication record as further evidence of research achievement. ***About 80 peer-reviewed journal papers have been published annually since 1995 at a per capita average between 2.5-3 /faculty/year*** (Fig. 3.11), in about 24 primary journals that

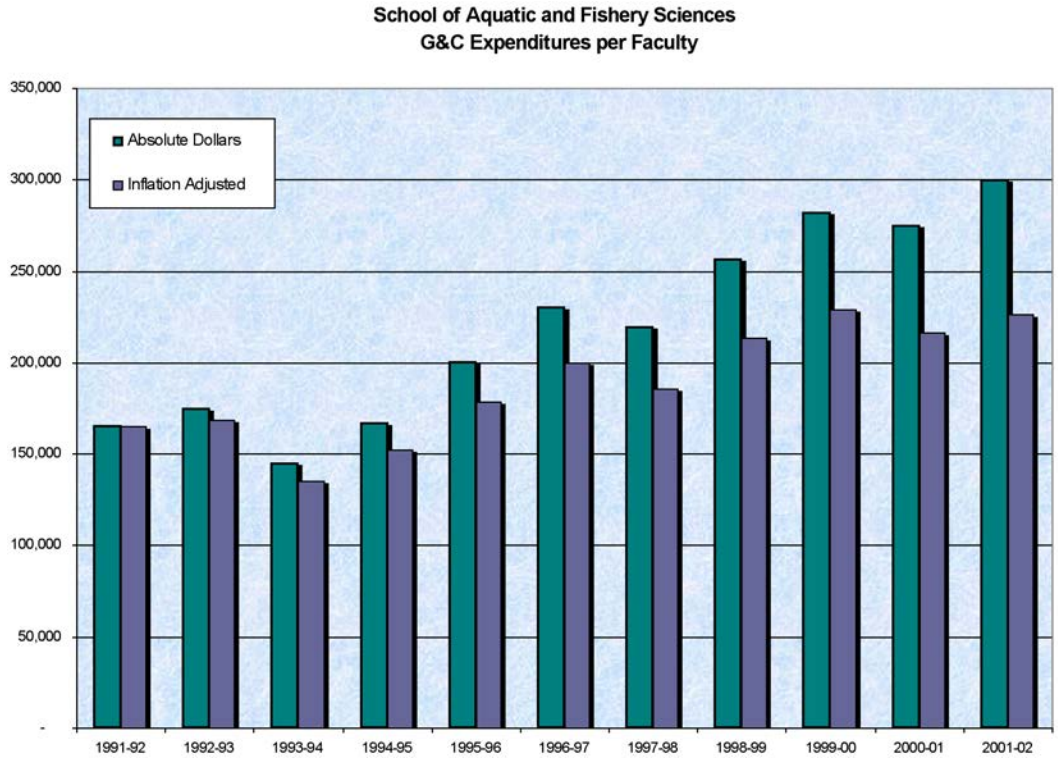

FIGURE 3.10—Trend in annual G&C expenditures per faculty member. This per capita value is based on the full faculty count (effectively PIs) shown in Fig. 3.7, and is adjusted for inflation by the same index. Note the increase of about 60% in annual G&C awards per faculty since the early 1990s.

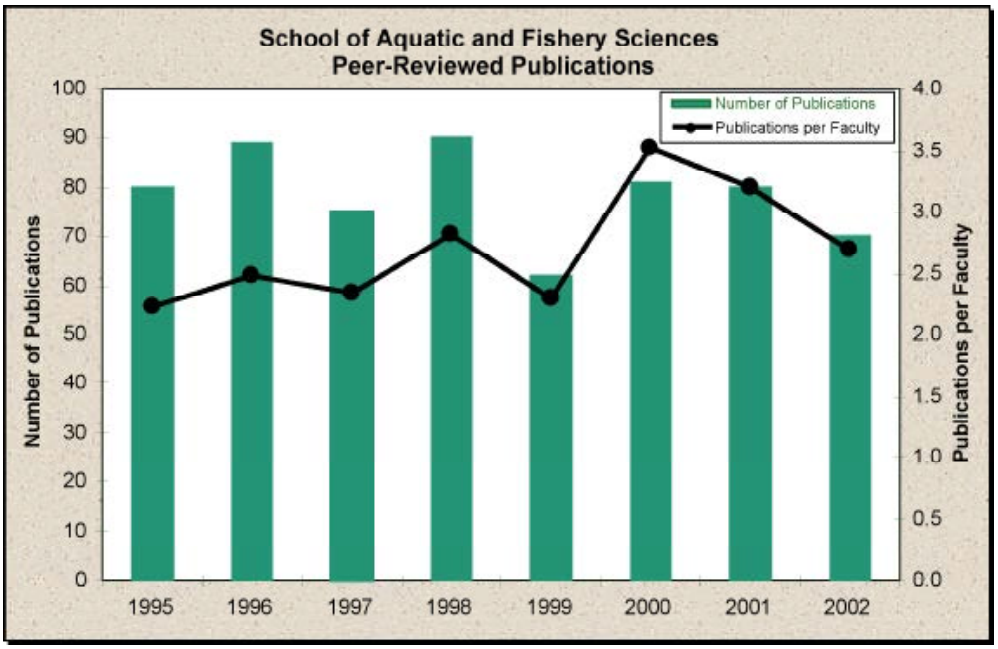

FIGURE 3.11—Trend in published peer-reviewed journal papers since 1995. Shown are total annual numbers for SAFS, and number per faculty based on the total count in Fig. 3.7 lagged one year back from year of publication. Not included are book chapters or papers in symposia proceedings.

indicate subject areas and diversity typical of the School (Fig. 3.12). Beyond the actual count of published papers, there are many co-authors that expand faculty and student participation in the peer-review process that we value highly (Fig. 3.13). This venue is an extremely important means to convey scientific research findings and to influence thought in and direction of our fields.

B.3 Awards and Invited Seminars

Some SAFS faculty are Fellows in prestigious societies including AAAS, Cal Academy of Sciences, American Statistical Union, Linnean Society of London. They receive invitations to give major seminars at universities world-wide, and present addresses and plenary talks at dozens of national and international meetings of scientific societies and organizations (Appendix D.5). Within the College of Ocean and Fishery Sciences, 6 SAFS faculty have received the Outstanding Research Award (Anderson, Armstrong, Francis, Hilborn, Quinn, Taub). Other faculty have been recognized by awards for distinguished service and excellence in science by organizations including the American Fisheries Society, CASE Circle of Excellence, American Statistical Association, NOAA Year-of-the-Ocean Environmental Hero, Society for Marine Mammalogy, U.S. Dept. Interior, USGS, and others listed in Appendix D.5.

C. Service

Important aspects of our professional contributions and measures of influence are manifested in the broad range of service provided annually by the Faculty. By virtue of strong professional reputations, SAFS faculty are called into service repeatedly in a number of ways that benefit science and policy. Examples of the pervasive service roles are listed in Appendix D.5 and include: 1) membership in over fifty important working committees including panels of the Federal government such as EPA, National Academy of Science panels on coastal eutrophication, global change, status of fish stocks, the National Research Council, National Science Foundation, National Marine Fishery Service technical teams on various issues, the President's

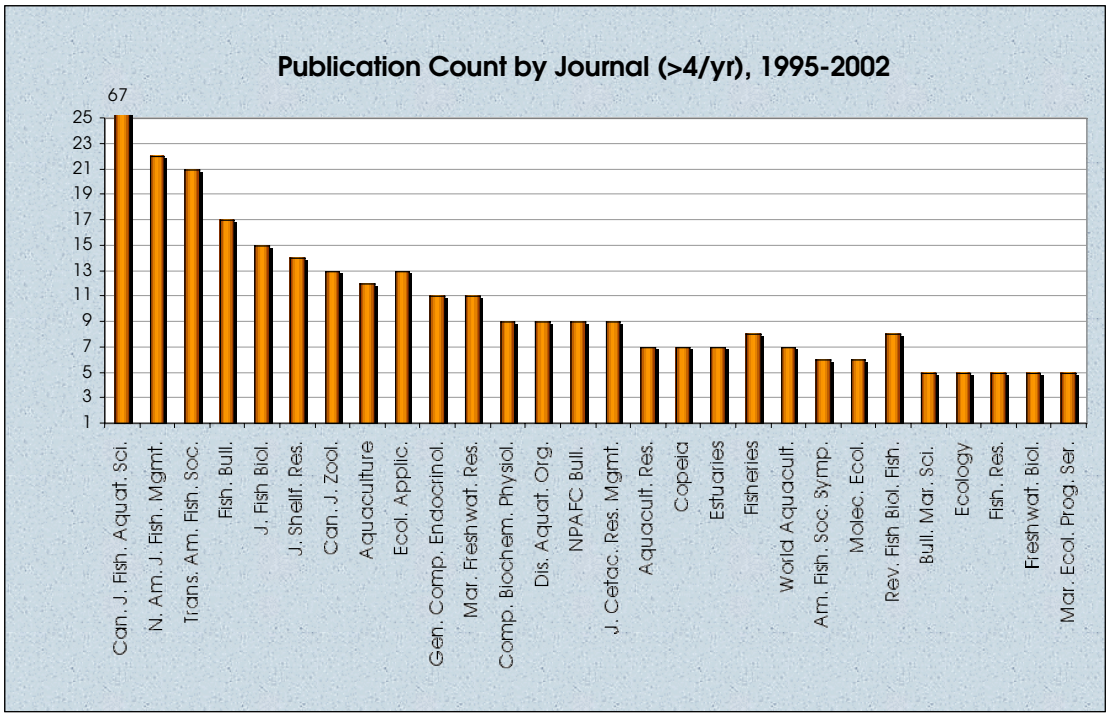

FIGURE 3.12—Most prevalent journals in which SAFS literature is published since 1995. Shown are those in which five or more articles appeared; 1-4 papers have been published in several dozen more.

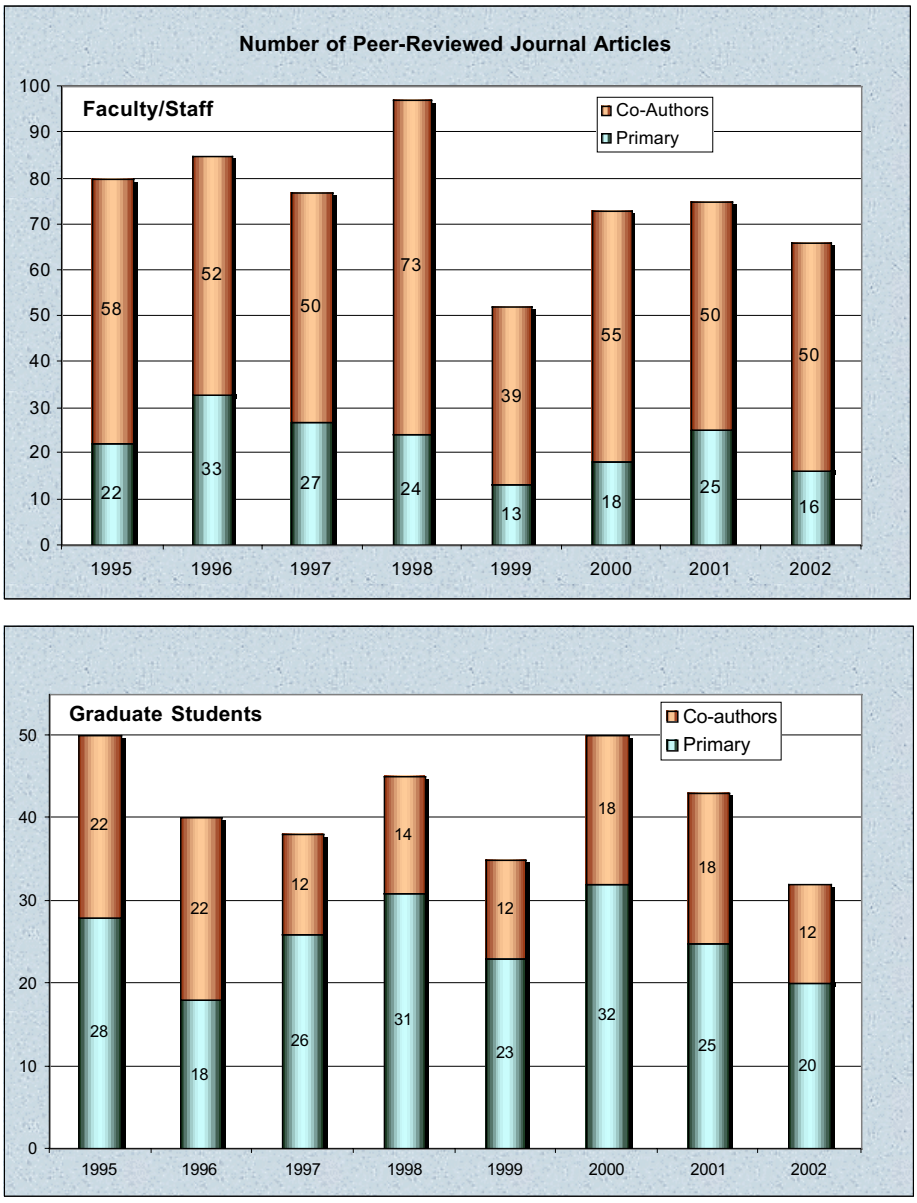

FIGURE 3.13—Number of SAFS faculty and graduates students who appear as primary (1st) or co-author on the annual journal articles published from the School (see Fig. 3.11 for annual totals). Note that in some years, graduate students are primary authors on more papers than are faculty, which reflects strong departmental ethic that encourages student publication as integral to education and professional development.

Commission on Ocean Policy; 2) a number of international councils and federations and; 3) service to dozens of regional and local entities tied to questions of habitat, resources, conservation, policy, and recovery; and work to sponsor major sessions for professional societies and to serve in elected posts (Appendix D.5).

SAFS faculty have served in the last 10 years as editors and associate editors of over 20 peer-reviewed journals where much of the School's literature is published (Appendix D.5; Fig. 3.12). Collectively, the SAFS Faculty each year provide well over a 100 reviews of manuscripts for dozens of journals, and evaluate numerous competitive proposals for organizations like Sea Grant, NSF, EPA, and several other agencies within NOAA; all indicative of the intellectual breadth in our department.

IV. Diversity

The School of Aquatic and Fishery Sciences is a natural resources program focusing on environmental sciences, the management of aquatic resources, and conservation biology. SAFS is well known locally, nationally, and internationally and has strong ties with local tribes, governmental agencies, industry, and nonprofit organizations. These relationships facilitate opportunities for underrepresented groups such as American Indians, Hispanics, African-Americans, and students with disabilities. SAFS is strongly committed to increasing diversity in both the undergraduate and graduate programs and has embarked on the following efforts.

A. Current Diversity Efforts

1. *Cooperative Bachelor's/Master's Degree Program in Fisheries Science between the Forest Resources Program at Tuskegee University and the School of Aquatic and Fishery Sciences at the University of Washington.*

A memorandum of agreement was signed in autumn 1997 that initiated a cooperative program between the undergraduate program in Forest Resources at Tuskegee University and the undergraduate and graduate programs in SAFS at the UW. This is a 3 + 3 program in which students attend Tuskegee University for three years, then transfer to the UW School of Aquatic and Fishery Sciences to complete their Bachelor of Science degree. At that time, if admissible, students enroll in a two-year MS degree program. Students therefore earn a B.S. and M.S. degree in Fisheries within a six-year period.

This program gives African-American students interested in natural resources the opportunity to attend a predominantly black institution for their first three years of college and then obtain training in aquatic and fishery sciences at UW to complete their B.S. degree. Qualified students can then continue in our program for an M.S. degree. SAFS is excited about this chance to increase opportunities for African-American students in our program. A recent success story is that of Johnny Grady, Jr., who came to SAFS from Tuskegee University in autumn 1998. Johnny completed his M.S. degree from SAFS in autumn 2001 and is now enrolled in the Ph.D. program in the College of Forest Resources (Johnny is supported by the NSF-funded IGERT grant in Urban Ecology). Johnny continues to stay in touch with SAFS through the Center for Water and Watershed Studies activities. SAFS is proud to have played a part in Johnny's continuing success.

2. *Articulation Agreements between Peninsula College, Grays Harbor College, and the School of Aquatic and Fishery Sciences at the University of Washington.*

These agreements provide efficient and continuous curricula for students transferring from either Peninsula College or Grays Harbor Community College to the UW's School of Aquatic and Fishery Sciences. American Indian students from the Olympic Peninsula can benefit from these programs, although further recruitment efforts must take place directly with local tribes, or through a program like STEP (see #3 below). Lin Murdock of SAFS Student Services works

closely with Peninsula College and Grays Harbor College advisors to ease the transfer process between these two institutions and the UW. Ms. Murdock formerly worked in the Office of Minority Affairs and makes use of these close connections in SAFS outreach efforts and support of ongoing students.

3. *Strong Participation with UW Science & Tribes Educational Partnerships (STEP) Program (http://depts.washington.edu/stepcofs)*

SAFS faculty, staff, and students work closely with the UW Science & Tribes Educational Partnerships (STEP) program to introduce Native American students to field and laboratory research experiences and to succeed in university studies while reinforcing cultural ties to their tribes. STEP helps prepare Native American students for academic and professional success in the natural resource sciences. A key component of STEP is the annual Summer Institute, which provides a research environment for STEP students to immerse themselves in research projects and hone both laboratory and field research skills. SAFS faculty and graduate students (teaching assistants) participate regularly in the Summer Institutes. SAFS facilities such as Big Beef Creek, Manchester Research Lab (NMFS), SAFS wet labs, and the SAFS Computing Lab are used for research experiments and subsequent data analysis by STEP participants.

4. *High Seas Salmon Program Support for Students from Underrepresented Groups*

SAFS High Seas Salmon Research Program research staff have been able to work with three Native American undergraduates, recruited through the STEP program. The students analyzed chinook salmon data from the Bering Sea groundfish trawl fisheries. One of these, Elaine Espirito (Yakama Tribe), has become a SAFS major. The High Seas Program also financially supports and mentors Jamal Moss, an African-American Ph.D. student. Jamal is a Mary Gates Scholar but also has additional research expenses to which the High Seas Program contributes.

5. *Recruitment and Support through Washington Cooperative Fish and Wildlife Research Unit*

The Washington Cooperative Fish and Wildlife Research Unit (the Coop) helps arrange undergraduate or graduate student funding through a Cooperative Education Agreement with a federal agency (e.g., the U.S. Fish and Wildlife Service). The agency would then provide full support for the student as long as the student serves an internship with the agency during the final year of the degree program. The Coop has a demonstrated record of recruiting minority students to the SAFS Graduate Program through this agreement. The most recent example is Tony Orr, an African-American Ph.D. student. He is investigating the foraging ecology of juvenile California and Steller sea lions and is being funded through the National Marine Fisheries Service.

B. Future Plans for Increasing Diversity in SAFS

1. Recruitment of students who may participate in the new partnership agreements. SAFS will continue to maintain contact with administrators and faculty at the partner colleges and universities to actively recruit qualified students to participate in the partnership agreements. SAFS will request funds from the UW Office of Minority Affairs to support visits from groups of prospective students.
2. Continued communication with faculty and administrators from local and Olympic Peninsula high schools, community colleges, and ONRC to develop instructional support, including distance learning, to reach underrepresented populations in the state of Washington. Periodic evaluation of recruitment efforts and achievement of educational goals will continue.

Through collaborative efforts with the Office of Minority Affairs, the Office of Educational Partnerships, the Graduate School, ONRC, the tribes, governmental agencies, non-profit environmental organizations, and

community colleges in the state of Washington, SAFS is committed to actively recruiting undergraduate and graduate students from underrepresented groups.

C. Nurturing an Atmosphere of Inclusiveness

SAFS takes great care to create an atmosphere of inclusiveness for all our students, and in particular those from underrepresented groups. For graduate students, each student is matched to his/her thesis advisor the spring before entering the UW. SAFS new graduate students go through carefully planned orientation activities before classes being in the fall. Each student is placed in a group of offices with students of similar research interests, and who are being advised by a certain research group of major professors. The Associate Director meets with every new student upon arrival and "keeps tabs" on students with the help of the Student Services Office (SSO). The SSO staff work hard to see that SAFS remains an inviting and congenial place for students, especially those from underrepresented groups. SAFS takes special care to include students in departmental activities, and to welcome and counsel students who may find graduate school an unfamiliar place. SAFS policy is, "our door is always open"; students know this and respond accordingly.

FINS is an association for SAFS graduate students. In addition to sponsoring scientific workshops and encouraging student participation in scientific conferences, FINS sponsors many social activities throughout the year, such as the weekly post-seminar "TGIT" reception, movies, hikes, bowling, folk dancing, etc. A "SAFS Social" e-mail list is also maintained; this results in the side benefit that many SAFS students end up in shared housing with their colleagues. Because each student "lives" in grouped offices with students of similar research interests, it is difficult to avoid being included in research-related or purely social activities ("They drag me away from my desk and insist that I go to TGIT to socialize!—but I know it's good for me.")

Regarding undergraduate students, the local student chapter of the American Fisheries Society makes special efforts to reach out to undergraduates. Also, SAFS undergrads are specifically invited to attend departmental seminars (including faculty search seminars) and the receptions afterwards. Mindful that undergraduates do not have offices, SAFS created a student lounge and other "hang-out" places in the building, all of which have become high use facilities. Undergrads have access to the SAFS Computer Lab, FISH 207. They are invited to all SAFS socials, including the September picnic, the Spring picnic, and the Holiday Party. They are encouraged to attend the SAFS Graduate Student Symposium. They are also encouraged to be Freshman Interest Group (FIG) "peer leaders" and UW Orientation Team leaders. All students and a wider audience are kept informed through periodic "newsletters about the School (Appendix D.6).

D. Nurturing Academic Success

Especially with undergrads, it is not uncommon for students to be admitted to the UW with some deficiencies around study skills, time management, and so on. Lin Murdock of SAFS Student Services reaches out to students, especially those from underrepresented groups, to ensure they are aware of the campus academic resources available to them. These include the OMA's Instructional Center, the UW Counseling Center's "Study Smarter" workshops, and the Disabled Student Services. In addition, Ms. Murdock will place students from underrepresented groups with various SAFS faculty so that students may benefit from laboratory experience and being part of a research team.

V. Degree Program

A. Undergraduate Bachelors Degree

Greatest Faculty attention over the past 5 years has been given to every aspect of the Undergraduate Program. In keeping with University emphasis on quality of undergraduate education that emerged in the mid-1990s, SAFS has responded to improve the education of our majors in two ways: 1) address relevance, content, and quality of the curriculum that has now resulted in significant increase in declared majors since 1998 and; 2) expanded opportunity for experiential learning and participation in research based on the scientific method as formally required for the degree, and provided in greatly increased use of facilities and provision of funding support.

1. Structure and Intent of the Degree

The four-year B.S. degree in SAFS is intended to provide education and training that make a person competitive for admission to U.S. and international graduate programs, or "work-ready" based on broad knowledge of central disciplines in aquatic and fishery sciences, analytical training, critical thinking, and oral/written communication. Graduating seniors now participate in a quarterly School capstone symposium, and increasing numbers give research presentations at the annual University Research Symposium (6 people in spring '02). Students are required to take an extensive number of courses outside the School to acquire knowledge and proficiency in writing, and quantitative/symbolic reasoning in math and statistics, chemistry, physics, biology, ecology, and a breadth of electives, prior to focus on core and specialty courses within the SAFS major (Appendix C.1). Primary features of SAFS' course requirements and tracks implemented in recent years include:

- Reduced number of "core" credits to allow more flexibility in specialty interests.
- Ability to select across three "focus" areas rooted in "flagship" courses that encapsulate the broad fields of "aquatic ecology", "conservation and management", and "aquatic biology and culture" (Appendix C.1).
- Reinforcement of "skill sets" across these and upper division courses in analytical, quantitative, written, and oral capability (Appendix C.4).
- Completion of an expanded "capstone" experience tied to the scientific method and intended as training in formulation of questions/hypotheses, collection and analyses of data, and written/oral communication of findings and interpretations (Appendix C.5).
- Creation of an Honors Program within the College (Appendix C.6) that both draws in some new majors who will complete a four year University Honors program, and allows SAFS majors to achieve College honors distinction.

2. Resources and Unique Features

SAFS is able to offer undergraduate majors and

others taking our courses very high quality instruction based on several attributes of our School:

- Courses of reasonable enrollment (typically 15-40 depending on topic and format; lecture, lab, field) that enable good access to and feedback from faculty and TAs. Questions and help about lecture content, problem sets, lab exercises, field-data reports, and writing assignments receive close attention
- Good teaching laboratory facilities for computer, bench-top analytical exercises, and experiments typical of many courses, and including an on-campus salmon research station recently modified for better course instruction and experimentation, an updated molecular ecology program in conjunction with Oceanography, and a world-class fish collection
- Field trips and other off-campus destinations including the Friday Harbor Lab, vessel trips within Puget Sound, the educational opportunities at field camps of the Alaska Salmon Program (Appendix C.7), participation in numerous faculty research field programs tied to capstone projects and sometimes funded by the School such as the Alaska Fisheries Science Center/NMFS-SAFS Internship Program (Appendix C.7)
- Strong educational and research ties to other UW academic departments (PoE, Biology, Marine Affairs, Oceanography, FHL, CQS, Forest Resources) that are incorporated into many aspects of our curriculum in order to broaden the interdisciplinary base of instruction in aquatic sciences and application to societal issues.
- Ongoing attention to use of School resources to best provide much-needed TA support for courses, and upgrades of instructional facilities and equipment (e.g. computers, scopes, live-animal facilities, teaching laboratories, molecular ecology labs)
- Increase in use of SAFS endowment funds (planned growth to $50K/year) to support undergraduate activity in capstone research programs, travel and participation in scientific meetings (Appendix C.8)
- Genuine Faculty commitment to meet the high standards of instruction and training stated in our 2000 strategic plan and imbedded in the revised curriculum, and to provide opportunity for experiential participation; evidence of student approval is seen in consistently high ratings and evaluations of course quality and effectiveness of faculty instruction (See Section IIA)

3. Success of the Program and Our Students

- **Trends in declared majors**: There have been two periods of serious decline in the last 12 years: around 1991 and again in 1998. Based on the efforts described above to improve all aspects of the Bachelors program, majors have doubled in five years to about 100 (see Fig. 5.1). Our near-term goal is to build majors to about 120 people based on present number of teaching faculty (See Section A2). We see opportunity to expand the program further, but that would require new Faculty FTEs to do so.
- **Tools Support**: SAFS was awarded two UW Tools for Transformation grants to implement the Alaska Field Program during the summer quarter (Aquatic Ecological Research in Alaska; Appendix C.7) beginning in 1999, and the Marine Biology series in 2001. Both are highly successful venues for intense research at remote field sites, and high enrollment capacity to serve wide interest in marine sciences (140+ students), respectively. The Marine Biology series is also supported by the UW Honors Program to provide a 3-quarter sequence in the natural sciences on campus.

- Given quality of courses in SAFS and across the College, plus strong teamwork by faculty in all units, SAFS joined to form a College Honors Program in summer 2002. Of 21 undergraduate presently enrolled in the Honors Program, 16 are declared majors in SAFS
- SAFS majors generally maintain high GPAs that helps to increase competitive standing in application to graduate school. In Fall 2002, 19 majors were named to the UW Quarterly High Scholarship List (>3.5 for minimum 12 graded credits)
- SAFS graduates from our B.S. program give high scores for the quality of their education. As evaluated on a 5 point scale in the Academic Profile for 2000-01, SAFS was rated 4.2 (Fig. 3.1; Appendix C.3)

B. The Graduate Program

The School has a world-renowned reputation for superior graduate-level education and research training in aquatic sciences. About 150 applications are received annually for 15-25 admission slots, depending on level of forward funding from year to year. The School recruits and students seek the program through several means: 1) we have far more applicants than openings each year based in large measure on the reputation of the Faculty as outstanding scientists in their respective fields, a strong publication record across the unit, and depth of teaching in core areas of our major; 2) information provided on websites; 3) personal contacts at scientific meetings where our faculty and graduate students are major participants; 4) professional interactions that often inspire those already in careers to return for advanced training (many gradu-

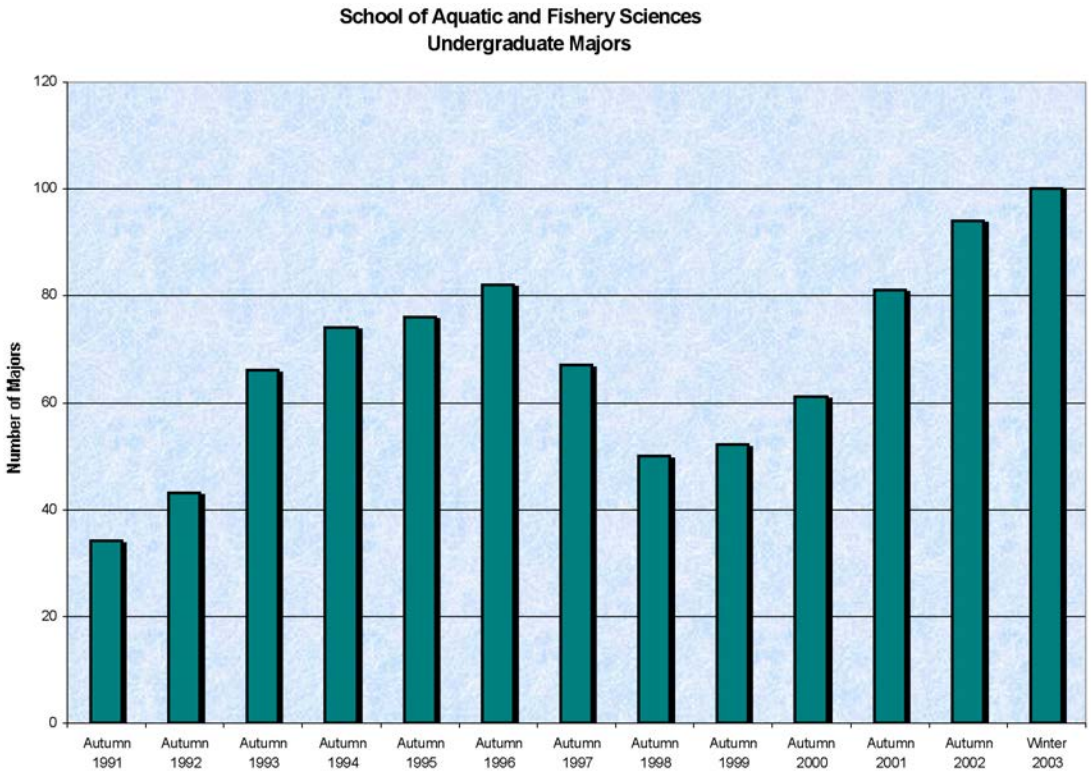

FIGURE 5.1—Trend in declared UG majors in SAFS since 1991. Low enrollments in 1991 led, in part, to a negative 10-year review at that time. On the basis of the decline beginning in the mid-1990s, faculty worked as detailed in this report to make the curricula more relevant, resulting in a substantial increase of SAFS declared majors.

ate students complete our program from active positions at agencies like NMFS and Washington State WDFW). Added to these attributes and avenues of information, are extensive modern and/or unique resources such as labs, computing infrastructure, general equipment, boats, field sites, and a strong external base of research funding (Section III; Fig. 3.9).

Size of the Program

Total annual graduate student enrollment has been about 120-130 for the past 10 years (Fig. 5.2). Historically, there have been more in the M.S. (about 60% of total), but recent efforts to recruit more into the Ph.D. program, and more common use the "by-pass" option (see Appendix C.2) has resulted in nearly equal numbers for both programs in the 2002-03 academic year (Fig. 5.3). Across the faculty in their role as major professor and supervisor of thesis research, this number of active students equates to about 4-5 per faculty per year (see Section III; Fig. 3.6). As noted in Section IIIA.2, a majority of the active graduate students in any faculty's program are supported by external G&C awards to that faculty.

Standards for Admission

These are set in accord with minimal thresholds stipulated by the Graduate School regarding GPA (3.0) and GRE scores (we encourage a minimum of at least 500 in each of the verbal, quantitative and analytical sections), and TOEFL (237, if required). In fact, entering SAFS graduate students have much higher average scores than those required. Over the last 10 AYs, average verbal, quantitative, and analytical GRE scores of entering students have been about 570, 680, and 650, respectively (Fig. 5.4). In order to attract the very best applicants to the program, the School has more aggressively recruited top-ranked people, in part, by use of larger fellowship awards. Those eligible for such support are in a "Tier 1" category. The three-year average scores for those accepted at this level are, in same

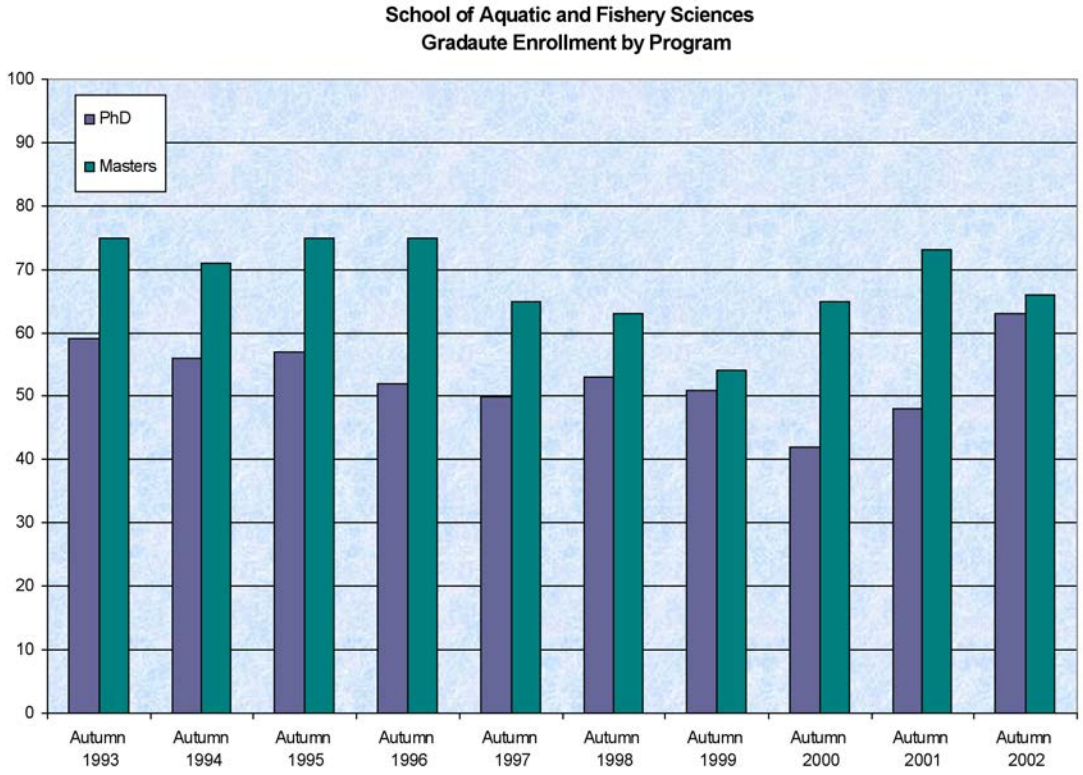

FIGURE 5.2—Trend in active graduate student enrollment by degree program. Note the relative increase in Ph.D. majors compared with the historically higher M.S. program.

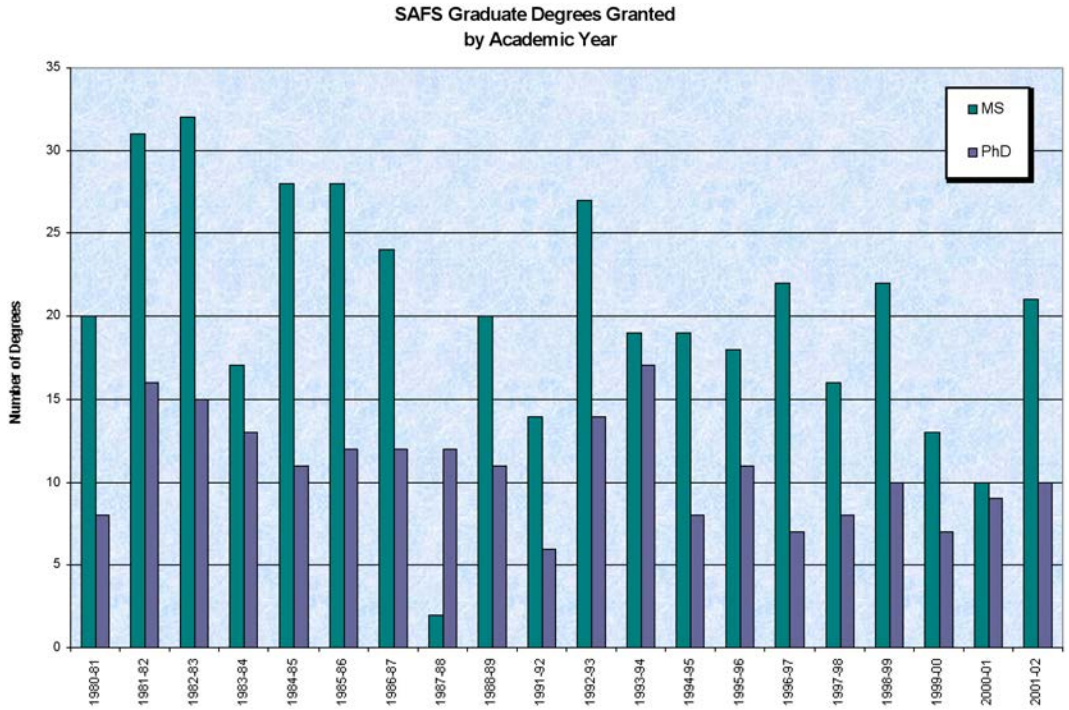

FIGURE 5.3—Number of M.S. and Ph.D. degrees awarded annually since 1981. There have been about 15–20 M.S. and 10 Ph.D. degrees awarded/AY since 1991. Since 1995, based on total faculty count, this equates to about one graduate student/faculty/AY finishing their program (see faculty count in Fig. 3.7).

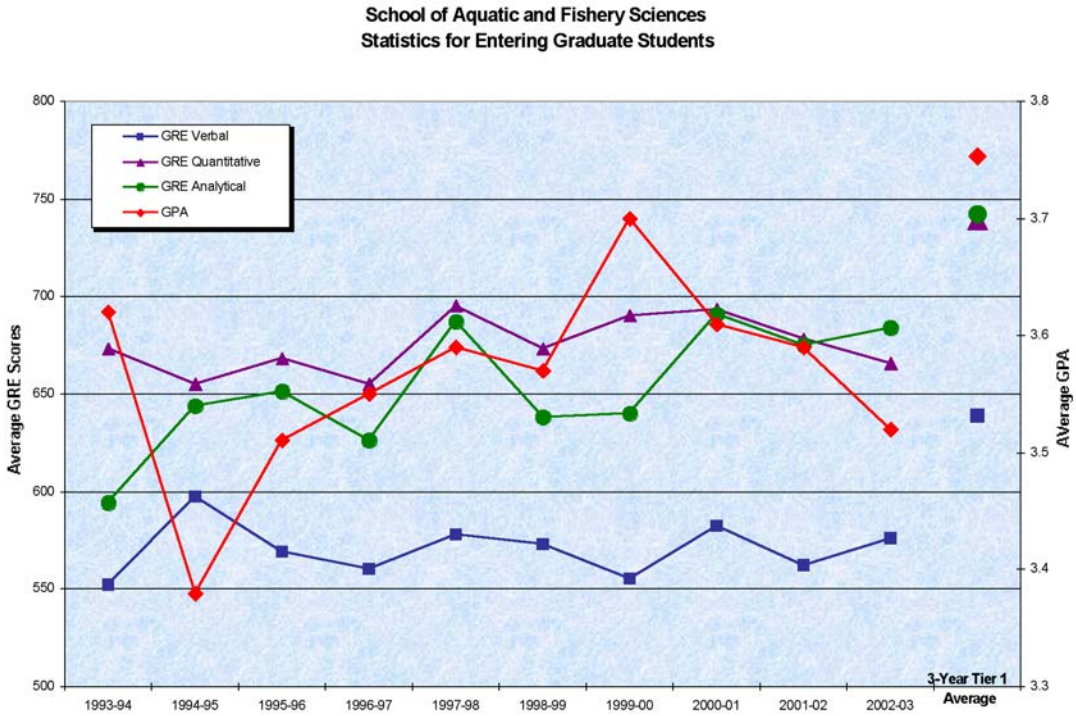

FIGURE 5.4—Quality of SAFS entering graduate students based on GRE scores and GPA. The UW Graduate School's minimum requirements are a 3.0 GPA and a strong recommendation that GRE scores exceed 500 in each category. In addition to the overall averages for an entering year-class, scores are also noted for a top-ranked "Tier 1" group that is eligible for School endowment support.

sequence, 640, 740, and 740, respectively. Compared to the Graduate School threshold, GPA of an entering SAFS cohort has been about 3.6 in recent years and near 3.8 among Tier 1 people (Fig. 5.4).

Mentorship

The School gives high priority to mentorship of graduate students in a number of ways that supports them intellectually during this phase of their careers and, we hope, makes their experience with us satisfying and fulfilling. Support for these advanced students comes in a number of ways:

Procedural: In the case of both degrees, the student is supervised directly by a faculty member serving as major professor, and a thesis supervisory committee. It is the responsibility of all three parties to meet milestones stated in the Graduate Student Guide, and reinforced by the Student Services Office (SSO) that link important tasks to a timeline that begins upon admission. The milestone-timeline oversight is to ensure: a) formation of a committee to review intended course work, b) set subject areas and dates for written and oral exams in the case of PhD students, c) provide a draft thesis proposal and d) submit a formal version after committee review to the SSO, complete course work, etc. (Appendix C.2 and Timelines).

Financial: The School believes that the best graduate education is one based on departmental financial support that allows the person to focus on course and research tasks as much as possible. Several actions and funding sources ensure a stable financial base for most students:

- Beginning in 1999, we formalized acceptance procedures that require a signed guarantee from the Faculty of one full year entering support, or waiver if the person has alternative support (e.g. ongoing State and Federal agency positions and income).
- We changed the duration of fellowship recruitment awards provided from SAFS endowments to top-ranked applicants from numerous, 9 month commitments (too many were then without funds by the end of that period), to fewer two year commitments. This greater underpinning enables Faculty to find longer-term support to cover PhD careers.
- As noted in Section IIB.1, the Faculty have a strong record of external G&C funding, that includes substantial support for graduate research assistantships. Approximately 22% ($1.6M) of recent annual G&C expenditures goes to RAs and tuition (Fig. 3.9).
- Continuing graduate students may apply in any quarter for travel funds to give research papers at scientific meetings, and in spring quarter for annual awards from the endowment pool to receive support for additional stipends (1-2 quarters) and/or research funds ($2,000-4,000; Appendix A.3; application form).

Intellectual

Graduate students are highly valued members of the School's teaching and research mission since many have opportunity to teach at some time during their career (Fig. 5.5), and both graduate degrees require a research-based thesis that results in high instance of publishing in peer-reviewed journals during their career (see Section III; Fig. 3.13). The School strives to be intellectually stimulating in a number of ways that foster a sense of academic community:

- **Graduate student organizations** like FINS and the SAFS chapter of the American Fishery Society play significant roles in helping to organize the weekly seminar series including selection of some speakers and arrangement of logistics. In the case of the Bevan Series, graduate students may take course credit in a venue that puts the weekly well-known speaker in the

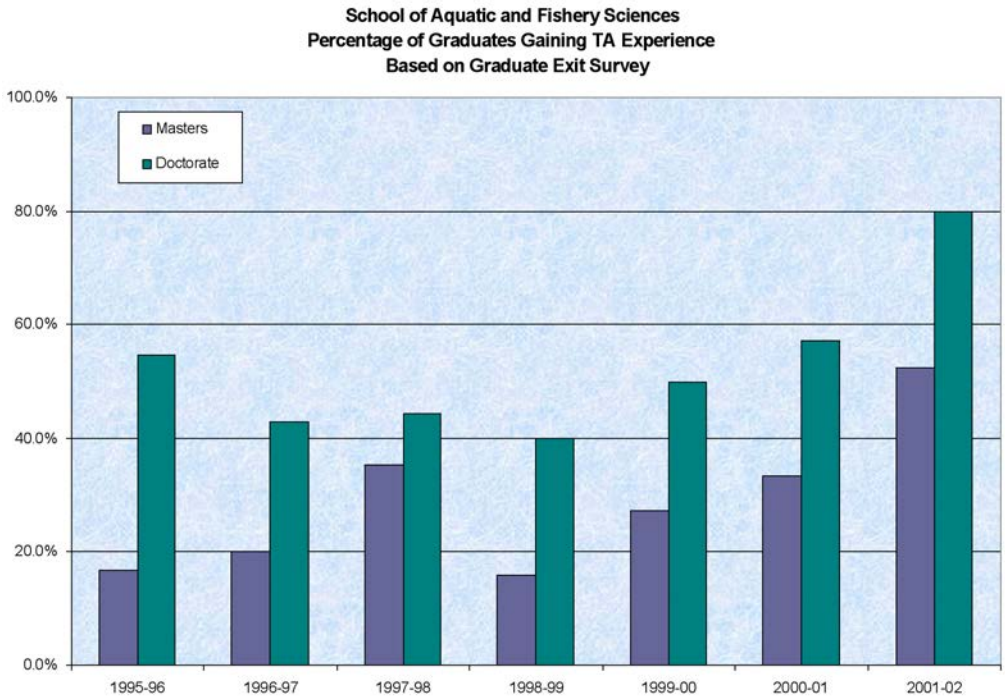

FIGURE 5.5—Percentage of students in the SAFS M.S. and Ph.D. programs who gain teaching experience during their graduate careers, based on exit surveys provided by the Graduate School. Note the substantial increase since the late 1990s as the School worked to re-structure the curriculum in a way that provided more TA support to classes.

class with students in an interview-discussion format. This is a very popular method of joining famous scientists with students in a venue they shape to a large extent.

- **Graduate students serve on search committees** during the selection and hiring process of new faculty (now underway in the School for a marine fish ecologist). They are very active and vocal in this process and give valuable opinions through the committee student representative, and participate during the site-visits of candidates (special interview times, lunch with the person).
- **Grad representatives serve on our Curriculum Committee** (CC) and are important in discussions and decisions about strengths, weaknesses, and directions relative to the curriculum. At this point in time, they are concerned that too much faculty teaching has been directed toward the undergraduate program, and the curriculum does not provide enough in certain fields they believe are essential in their training. Review of the Graduate curriculum, motivated by the students, is now major focus of the CC.
- **We encourage student grass-roots action** within the School when they see opportunity to help in training of important skills. Particularly in the area of quantitative training, students are increasingly providing workshops and special tutorials for their group and some faculty. This winter quarter 2003, a month-long workshop on S-Plus language has been given (mentored by a faculty but essentially arranged and taught by a student), a Visual Basic workshop is underway, and more advanced versions will be given next fall quarter by students.
- **Publications in the peer-reviewed journal literature**. In our fields, it is essential to publish research findings as means to advance the scientific base of information, and to influence direction of thinking. The Faculty believe it is

important that this experience be gained by as many students as possible, especially those in the doctoral program. Since 1995, about 70 graduate students have been senior or co-authors on journal articles published from the School annually (see Section III; Fig. 3.13; note that this is count of people, not individual papers that might include more than one student among authors of each paper). Evidence of the importance placed on this training in writing and the review process can be seen in number of senior authors who are students or faculty. In many years since 1995, graduate students are lead authors on more or nearly equivalent numbers of papers as compared to faculty (Fig. 3.13).

Efforts to Decrease Time to Degree for Graduate Students

Over the last three years, we have implemented a number of steps to assist us in reducing the time it takes our graduate students to complete either an M.S. or a PhD degree. We now have the ability to track degree milestones on the graduate student database, and so provide updated lists of graduate students' progress in the milestone timeline for each major professor on a regular basis. Further motivation for students to stay on track is ineligibility for departmental endowment funding awards if he/she is too far delinquent and non-responsive to alerts given by the SSO and the major professor. Additionally, we take into account degree milestones when selecting students for TA positions (knowing that TA positions are often time-consuming and can hinder a student from making degree progress).

This year, for the first time, these reports helped us to identify students who are seriously behind in their milestones. In consultation with the major professors, decisions are made regarding whether or not it is appropriate to put such students on probation. Additionally, our most evident problems with time to degree tend to be students who are taking multiple years of "on leave" status (which is not backed out of the data contained in Departmental Academic Profile reports, and so exaggerates the actual average years to degree). In this respect, we have increased our vigilance in approving additional quarters of leave in cases when the person has already been given extensive leave time previously. Also, when a student has reached his or her degree time limit, we have strongly encouraged faculty to require a "Graduation Plan" for the student before allowing the student to continue.

A. Master of Science Degree

This program is intended to provide education and training beyond the B.S. for those people who seek experience and skills in research-based inquiry. Students must take a minimum of 45 credits, at least 27 must be taken in formal courses and, of these, 18 must be graded. Details of requirements, committee structure, and milestone timeline are given in Appendix C.2. A masters degree is required before admission to the Ph.D. program, and many incoming students plan to eventually complete the latter. This stanza, however, provides the faculty supervisor opportunity to access in the M.S. program the students capabilities in ways indicative of Ph.D.-level scholarship, and the student is provided with critical training for careers that benefit from a terminal masters' education if that is their choice.

Measures of Success

In several important measures indicated above, the School and its M.S. students achieve high success within this degree track:

- Graduate School Exit Surveys over the last several years indicate high satisfaction with the M.S. program. Academic standards and overall quality of the program are ranked about 4.1 (5 is highest score), much better than in the most of the 1990s (Fig. 3.11; Appendix A.2).

- An increasing number of students in this program gain some teaching experience as TAs in courses; from < 20% of those graduating in the 1998-99 AY to >50% in 2001-02. We consider this an important aspect of education if it is possible for students to participate during the shorter period of an M.S. program.
- Time to degree is reasonable for a research-thesis requirement and takes about 3 years among those graduating since 1996 (Fig. 5.6).
- As noted, the majority of those in the M.S. program are supported by the School and, to a lesser extent, other funds or ongoing agency salary, so that relatively little debt is incurred.
- Most graduates report that they find employment in their chosen profession. Exit surveys indicate that 90-100% secure positions in their first choice (Appendix A.2).
- Publishing in the peer-reviewed literature is stressed in both degree programs, and about 25-30% of M.S. graduates have such authorship, compared to a COFS level of 11-23%, and the University at only 7%.

Placement and Careers

Most of those people who complete the SAFS M.S. go into four major areas (Fig. 5.7; Appendix E): 1) ongoing graduate students in PhD programs (13%); 2) staff scientists in universities including SAFS/UW (12%); 3) staff scientists/fisheries biologists at the National Marine Fisheries Service (19% as NWFSC and AFSC combined) and; 4) business, mostly environmental consulting firms and within the aquaculture industries (20%).

B. Doctor of Philosophy Degree

This degree track represents a very important element of the School, both with respect to its teaching/training mission, and also the stature and success of its research mission. Doctoral students over the course of their professional development, expand faculty research programs by taking leads in pursuing questions

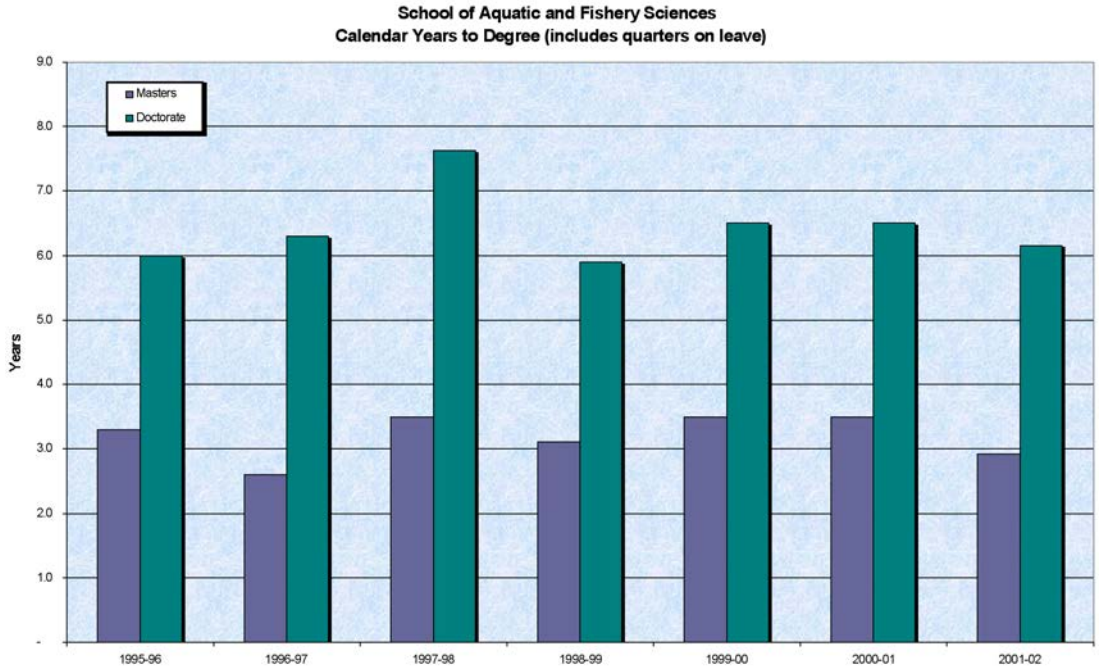

FIGURE 5.6—Time to degree in the SAFS M.S. and Ph.D. programs since 1995. Data are from the Departmental Academic Profiles (Appendix B.1). The data are not corrected for "leave" time that is relatively common during Ph.D. careers in particular.

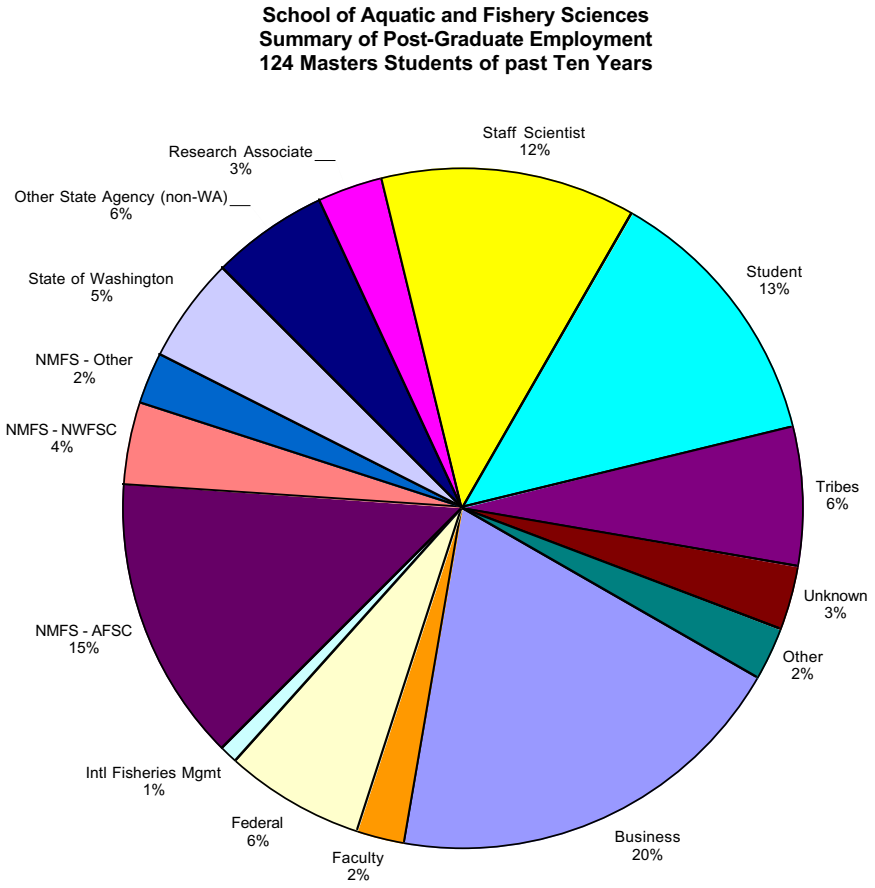

FIGURE 5.7—Placement data on over 120 SAFS M.S. graduates over the last 10 years. The majority of our graduates enter other graduate programs, the business sectors in environmental consulting and aquaculture, Federal and State resource agencies, or research branches within universities.

asked in funded research, and often expanding them in new directions. In general terms, the degree requires 90 graduate-level course and dissertation credits based on nature of the thesis, interests of the student, and assessment of strengths and needs by the supervisory committee (Appendix C.2). The milestone timeline steers the person through stanzas to form a committee, submit a draft dissertation proposal and final version based on comments, prepare for and take a qualifying exam, a general exam that reflects the dissertation topic to some extent, and the final exam at completion of the dissertation.

Measures of Success

This degree program has long been successful in training top scientists and educators for numerous agencies, non-governmental organizations, universities, and businesses across the U.S., and around the world. Evidence of success includes:

- Graduate School Exit surveys indicate that our students were somewhat less satisfied with the SAFS program through much of the 1990s, compared with COFS and the University (respective average scores for overall quality of the programs on a 5 point scale about 3.7, 4.0, and 4.1 (Appendix A.2). In most recent data, SAFS is ranked at about 4.0 by the doctoral graduates.
- An increasing number of SAFS Ph.D. students gain teaching experience, which has increased from 40% in 1998 to 80% in 2001 (Fig. 5.5).
- Time to degree has taken about 6 years for cohorts graduating since 1995 (Fig. 5.6). Since Uni-

versity data are not corrected for leave time over an individual's graduate career, we are not sure how much actual "active" time is required as better measure of investment of time and need for funding. More commonly during a longer doctoral degree, people take some leave for various personal and professional reasons.

- As in the case of M.S. students, those in the doctoral program receive a majority of support directly from SAFS, which implies a substantial investment of faculty time to write grant proposals for such funding.
- The number who secure a job upon graduation is comparable to COFS and the UW as a whole at about at about 70-80% across years of the exit surveys (Appendix A.2), virtually all find a job in their area/career-track of first choice.
- Many Ph.D. graduates have published at least one paper in peer-reviewed literature by the time of graduation. Since the early 1990s, 70-100% of respondents in different years have published (Appendix A.2).

Placement and Careers

SAFS graduates of the doctoral program often enter scientific tracks in several State and Federal resource management agencies, and reach senior positions of leadership. Many remain in the northeastern Pacific to help in research, management, and formulation of policy so critical to many of the regions economic sectors (Fig. 5.8). Most common professional categories include: 1) the National Marine Fisheries Service, both the NWFSC and the AFSC branches in Seattle, Kodiak and Newport (24%); 2) state resource-management

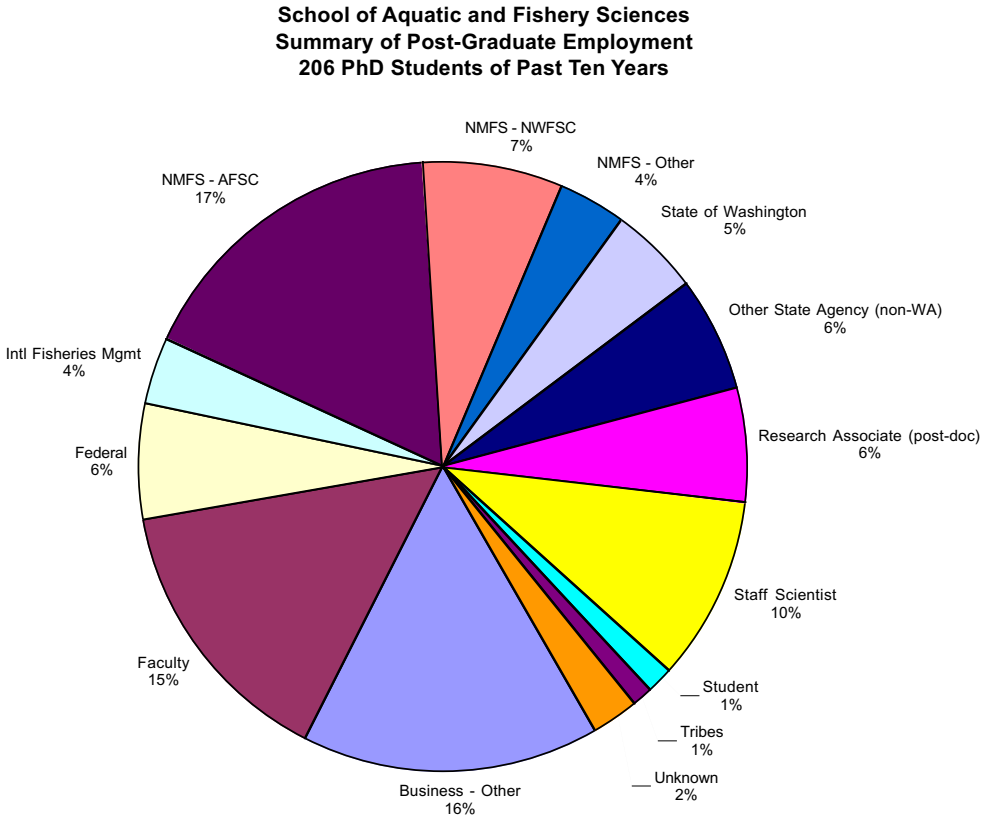

FIGURE 5.8—Placement data on over 200 SAFS Ph.D. graduates in the last 10 years. Most follow careers in science and resource management in the Pacific Northwest within NMFS, state agencies, and business sectors. A significant fraction become tenure-track faculty in other universities in the U.S. and other countries.

agencies in Washington and neighboring states (11%); 3) staff scientists and post-docs in non-governmental agencies and universities (16%; excludes faculty appointments); 4) business as team leaders in environmental consulting and aquaculture (16%) and; 5) faculty at major universities in the U.S. and other countries (15). This last group is particularly important since it represents the most direct ongoing academic influence the School affects through those now in tenure-track positions at U. Maine (2 people), U. New Hampshire, U. Wisconsin, McGill, National U. Taiwan, Catholic U. Chile, U. Mar del Plate Argentina, Umea U. Sweden, and U. Barcelona.

Graduate students from both the M.S. and Ph.D. programs are world-renowned as scientists, resource managers, and policy advisors in the U.S. and other countries. The School Continues to view our Graduate Program as a major contribution provided to the State and across the Pacific Northwest in ways that benefit the citizens through education of many who eventually work in the industries, agencies, and governments of this region.

VI. The Future

If we step back and consider from where the School came in disciplinary focus 50 years ago compared to now, it is not hard to imagine a further blend of fields within aquatic and fishery sciences that continues to cross the boundaries of academic units in ways consistent with an educational mission to foster the "citizen-scientist." Both as practitioners in professional careers and as well-informed voters, our students' education will enable them to be more facile and intuitive in integrating "hard" science, resource extraction and conservation with societal needs, values, policies, and world uncertainties. In various ways, we can imagine other fields that compliment SAFS (and vice versa) being integrated into more formal academic structures…but that is, perhaps, far away in time.

Since the last academic review a decade ago, The School has achieved successes in several major areas detailed in this report; particularly in the teaching program and in the content and scope of our research mission. Yet we have made such progress against a backdrop of diminished State resources, most notably the effective loss of 10, 9-month FTE faculty. The Faculty enthusiastically believe there is more that we can contribute to the overall educational missions of the University, but at present capacity we are fairly limited in what that greater contribution might be without additional resources. In the Executive Summary, we noted among SAFS' roles that of "interface" between some strong science departments like Biology, Oceanography, and Natural Sciences. In many respects, we can also include elements of social sciences and policy found in other departments like Marine Affairs.

Predicated on resources and our own ingenuity to re-arrange and re-prioritize, the School believes that future roles and expansion might include:

- Increased teaching in quantitative sciences and methods linked to resource assessment, population dynamics, statistical treatment of data, handling and analyses of extremely large data sets, and growing needs to incorporate remote data to understand physical forcing that drives and shapes aquatic and terrestrial communities. We are at limits of faculty who can teach either in service courses within CQS, for instance, or provide new, advanced training very much sought by our graduate students
- There is clearly great UG interest in fields like Marine Biology. SAFS and a few faculty in other departments have worked hard to produce the fledgling program started two years ago, and there is conviction that a meaningful degree program is possible. The resources of faculty, graduate student TAs, and dedicated infrastructure are not now sufficient to expand the formal teaching or experiential dimension that would be needed
- The School will continue to increase its commitment to provide UG majors access to support and facilities for research experience, and

continue working to transform lab courses for more routine experimental, question-based exercises. We find it difficult presently to increase TAs (now only about 5% of the State budget) and ensure an over-arching laboratory support base provided by a lab coordinator. We feel our ability to effectively establish and maintain such laboratory learning will depend on more teaching resources than now in hand.

- Aquaculture industries in the Pacific Northwest and elsewhere around the world are based on a strong SAFS history of research and development. That dimension of our program has been attenuated in the last 7 years, yet the need remains to teach and research in the primary scientific disciplines that benefit those industries, and other aspects of aquatic sciences dependent on organismal biology and physiology. At the same time, we have not filled directorship of the Western Regional Aquaculture Center that underscores importance of the field in our program. We have as goal to recruit a scientist of stature to serve both as director of WRAC, and as teacher/mentor in the UG and graduate curriculum.

In science domains that embody present SAFS interests to some degree, but might be strategically expanded in the future, we believe our department must be alert to the importance of:

- Longer-term perspectives in studies and monitoring to strengthen predictive capability. In the instance of the very long Bristol Bay sockeye salmon data set (over 50 years), we find increasing relevance of that historic backdrop to questions of climate, and atmospheric-marine coupling that affect populations, and the trend on salmon abundance as it affects productivity in terrestrial systems (marine derived nutrients)
- Metrics of "early" warning tied to climate forcing that can be incorporated into predictive models and management strategies.
- Need to measure and analyze at large scales of time and space.
- Modified educational tact to better integrate "ecological health" with fields like medicine, engineering, economic, etc.
- An expanded role to inform and influence policy makers at a legislative level.
- Education and training of a more facile scientist-professional who can react to future priorities and emerging issues in ways not constrained by prescribed approaches and models used in times past.
- Freshwater as a world resource of increasingly limited capacity, and ever greater geopolitical consequence. While our faculty engage in research and dialogue tied to science and policy related to freshwater systems in a regional context, it is clear that there is contribution to be made in science linked to management and policy that could contribute to broader world themes.

This final list, in many ways, relates to our Graduate Program and how we move forward in efforts to strengthen this immensely important aspect of our mission. As noted within the report, so much focus has been directed to the UG curriculum and means to provide experiential opportunities, that there is perhaps now some imbalance that should motivate the Faculty to closely analyze the Graduate Program. We are convinced that the School's ability to recruit and retain the very best faculty is dependent, in part, on the quality of the Graduate Program that contributes to the research mission in so many ways. Several bullets above are particularly relevant to new emphases and directions we will study as criteria in planning new faculty hires in the future that make stronger advanced education and research opportunities in critical, emerging fields in aquatic and fishery sciences.