

# Departmental Academic Plan

## Department of Environmental Toxicology

2009 – 2014

### I. Introduction

The Department of Environmental Toxicology, initially organized in 1962 as an organized research unit within the CA&ES, is the oldest and best-known of its type in the world. It is considered by many to be at the forefront of the field, and it is no coincidence that its faculty members consistently attract the largest extramural support funding per FTE on campus. Since its inception, it has also contributed extensively to the missions of the California Agricultural Experiment Station and Cooperative Extension. Historically, the department has focused its research efforts on deriving a better understanding of the fate, toxic mechanisms, and detrimental impacts of hazardous materials and agrochemicals, particularly pesticides, in the environment – with an emphasis on determining the methods and conditions for their safe and effective use.

For over four decades, the Department of Environmental Toxicology has also played a pivotal leading role in preparing new professionals to address the myriad of environmental problems revolving around toxic chemicals. UCD graduates have truly had global impact, and in the future it is anticipated that demands for professionals trained in environmental toxicology will significantly increase with the continued expansion of the “Green Revolution.”

### II. Academic Mission

The Department of Environmental Toxicology represents a modern and dynamic research, teaching and service program. Our work is cross-disciplinary in nature, cutting across all three divisions within the CA&ES – Environmental, Human, and Agricultural Sciences. Our faculty members are well established and recognized both nationally and internationally, as they not only address state and local concerns but also important national and international issues, such as safe agrochemical use in third-world countries and the impacts of pollution in the Pacific Rim Region. As leaders in the field, they also provide service and guidance to numerous federal and state agencies, industry, and agricultural commodity groups.

The mission of the Department of Environmental Toxicology is multifaceted:

- To generate basic knowledge regarding the fate of toxic chemicals in the environment and how they impact living systems.
- To apply basic knowledge toward a rational understanding of risk associated with chemical exposure.
- To provide cutting-edge undergraduate and graduate education to meet the demand for trained environmental professionals in academia, government and private industry.

- To provide advice to governmental agencies and agricultural stakeholders on the management of pesticides and other potentially hazardous materials.

### III. Departmental Profile

#### ***Faculty:***

Currently, the Department of Environmental Toxicology consists of 10 Senate faculty members (7.80 FTE), including three joint appointments and one WOS courtesy appointment, one CE specialist (0.60 FTE) and a one-quarter-per-year Unit 18 lecturer (0.13 FTE). There are also five emeriti, six adjunct faculty members (who contribute to both the departmental research and teaching missions), and seven professional research scientists (Addendum 1). Prior to the 1991 VERIP, the department consisted of a significantly larger Senate faculty (11.07 FTE), as well as two CE specialists (2.0 FTE).

In 2004, the CA&ES set a new Senate faculty target for the department of 8.80 FTE. However, the recruitment of a new chemist (Wood) was offset by the passing of one of our colleagues (Charles). Thus, the department still remains at 7.80 FTE. While a nutritional toxicologist (0.40 I&R FTE) is currently under recruitment for joint appointment with the Department of Nutrition, by 2008 at least three Senate faculty members (2.80 FTE), the WOS courtesy member, the CE specialist (0.60 FTE), and one adjunct member will be age 63 or beyond.

Our departmental policy has been to provide an equivalent appointment to every faculty member (with the expectation that they are similarly contributing to research, teaching and service activities). Currently, our 7.80 FTE are divided as 3.71 I&R and 4.09 AES, providing each member with a ratio of 0.48 I&R – 0.52 AES. With appointment of the 0.40 I&R FTE nutritional toxicologist, our 8.20 FTE would thus result in a division of 4.11 I&R and 4.09 AES, providing a new ratio (following reallocation) for each member of 0.50 I&R – 0.50 AES.

#### ***Current Programmatic Specializations:***

Environmental Toxicology is concerned with the chemistry and biology of toxic substances in the environment. Chemical exposures are studied through chemical principles applied to environmental processes. Toxicological risk is evaluated through understanding of biological mechanisms. Agriculturally important pesticides and chemical pollutants are emphasized.

The current programmatic specializations are quite broad considering the relatively small number of faculty. However, the Department of Environmental Toxicology has developed an international reputation for being at the leading edge in all of the areas below:

- Molecular and cellular toxicology – effects of toxicants on gene expression, metabolism, cell growth and differentiation, signal transduction pathways, and gamete fertilization and development (Cherr, Denison, Matsumura, Miller, Oteiza, Rice, Wood).

- Analytical and environmental chemistry – chromatographic and mass spectrometric methods for analysis, emphasizing pesticide residues and other environmental pollutants, biologically active compounds in foods, and the environmental fate and metabolism of toxic chemicals (Shibamoto, Tjeerdema).
- Systems toxicology – reproductive and developmental toxicology, dermal toxicology, and neurotoxicology (Cherr, Miller, Rice, Wilson).
- Ecotoxicology – aquatic toxicology, avian toxicology, and wildlife toxicology (Cherr, Tjeerdema, Wilson).

### ***Program Ranking and Impact***

Although no specific program rankings are currently available, the excellence of our program is clearly demonstrated by our consistently high level of extramural research support (see below) and the numerous graduates that contribute to the field at both the national and international levels. In addition, since 1999 departmental faculty members have received numerous awards (Addendum 2), served as editors or members of editorial boards for many scientific journals (Addendum 3), and participated in numerous activities both on and off campus (Addendum 4).

A strength of our program has been its unique breadth – providing highly diverse training that is considered the model for the field. Another measure of our success has been the presence of the Center for Environmental Health Sciences (CEHS), one of 10 nationally-recognized centers funded by NIEHS, the NIEHS Training Grant in Environmental Toxicology, the longest continuously-funded program of its type in the nation, the USDA-funded Western Region IR-4 Program, which is responsible for supporting the registration of new, lower-risk pesticides for the specialty crop industry, and the USDA-funded Western Integrated Pest Management Center which advises the US EPA and USDA on pesticide regulatory issues.

As a result of our reputation, the Department of Environmental Toxicology was selected to host the UC Toxic Substances Research & Teaching Program, a Multi-Campus Research Unit (MRU) which coordinates and funds toxicological research and training programs throughout the UC System. Our faculty members also participate in other large multidisciplinary units and grant programs, such as the UC Davis Cancer Center and Superfund Program. In addition, the UC Office of Pesticide Information and Coordination is housed in the department, providing guidance to UC researchers and ANR on pesticide research regulatory issues.

## **IV. Departmental Research Programs**

### ***Current Research Programs***

The overall goal of the Department of Environmental Toxicology is to derive a better understanding of the fate, toxic mechanisms, and detrimental impacts of hazardous materials and agrochemicals, particularly pesticides, in the environment – with an emphasis on determining the methods and conditions for their safe and effective use.

Therefore, our research programs are uniquely focused on both the beneficial uses of agrochemicals and other agents and their adverse impacts on both the environment and human health, with the objective of providing guidance on how to maximize benefits while minimizing costs (Addendum 5).

### ***Beneficiaries of Departmental Activities***

Both our basic and AES mission-oriented research activities provide guidance on the toxic actions, management and/or use of toxic agents to federal and state agencies, agricultural commodity groups, and industry (Addenda 8 and 9). These beneficiaries also contribute a significant amount of funding toward our research (see below), and it is this extramural support, and the tremendous success of our faculty and researchers in attracting it, that helps to make our research program successful and productive.

### ***Extramural Grants and Contracts***

Total extramural research support coming to the Department of Environmental Toxicology currently exceeds \$35 million. In 2006-07 (the most recent year for which information is available), departmental extramural direct-cost expenditures totaled \$7,102,372, or some \$807,088/Senate Faculty FTE – *by far the highest ratio at UC Davis*. Derived primarily from NIH, USDA and state agency sources, this level of funding has increased every year since 1998-99, when the expenditure total was just over \$4 million.

### ***Departmental Research Agenda***

Our stakeholders shape our departmental research activities in a number of ways (Addenda 8 and 9). For instance, the director of the USDA-funded Western Region IR-4 Laboratory, which is housed in our department, regularly receives input on research needs as related to pesticide use with high-value specialty crops. In addition, our department is the home of the USDA-funded Western Integrated Pest Management Center, and the director is also the assistant to the director of the UC Statewide Integrated Pest Management Center. Both directors disseminate information on research needs regarding pesticide use in agriculture to our faculty.

Our faculty members also typically serve on committees at both the federal and state levels (Addendum 2) to provide input on policy matters and research needs. A number of our faculty members also regularly attend and present their research results at meetings of the commodity boards (Addenda 8 and 9). Such meetings facilitate the exchange of research ideas with stakeholders. Finally, our faculty members regularly interact and collaborate with CE specialists, both within and outside of our department, who are instrumental in providing input on current agricultural problems.

## **V. Departmental Teaching Programs**

### ***Undergraduate Program***

To our knowledge, the undergraduate major in environmental toxicology at UC Davis (developed in the late 1960s) is *the first of its type in the world*. Since 2001, our

declared majors have increased by over 100% – from 36 to some 73 – and the number continues to grow each week. There has also been a noticeable increased interest in our minor program.

The student-to-faculty ratio (SFR) for the Department of Environmental Toxicology has increased from 15.52 in 1999-2000 to 23.38 in 2006-07 (the most recent year for which numbers are available). In addition, enrollments in most of our courses have increased by 50% in just the past year. For instance, in 2007 enrollment in ETX 10 (Introduction to Environmental Toxicology) was approximately 180 students – up from 99 students in 2005 and representing an 80% increase in only two years.

We expect that the number of students in our major, as well as the total student credit hours (SCHs), will continue to increase with current efforts to update our major to better meet new and emerging needs of potential employers in federal and state agencies, private industry, and the health care professions. For instance, since 1999 we have updated our core courses through their renumbering and the addition of discussion sections (Addenda 6 and 7). In addition, we have appointed five new highly-qualified adjunct faculty members, as well as a number of lecturers, to assist in the expansion of our course offerings. New courses developed since 1999 include:

- ETX 20, Introduction to Forensic Science (4)
- ETX 30, Chemical Drug Use and Abuse (3)
- ETX 104, Environmental and Nutritional Factors in Cellular Regulation and Nutritional Toxicants (4)
- ETX 110, Toxic Tragedies (2)
- ETX 111, Introduction to Mass Spectrometry (3)
- ETX 120, Perspectives in Aquatic Toxicology (4)
- ETX 127, Environmental Stress and Development in Marine Organisms (10)
- ETX 130, Industrial Toxicology (3)

The undergraduate program also includes the following outreach activities:

- The Undergraduate Summer Research Program for underrepresented groups recruited nationwide (funded by NIEHS).
- The STEER grant for exceptional students (also funded by NIEHS) – scheduled to commence in the summer of 2008.
- Undergraduate research internship exchanges for students in Hong Kong via new Agreement of Cooperation developed with City University, Hong Kong.
- Undergraduate research internships for students from Novosibirsk State University, Siberia (funded by the Superfund Basic Science Program).
- Individual undergraduate research internships for national or international students (also funded by the Superfund Program).
- The department offers a six-week course (ETX/NUT127) at Bodega Marine Laboratory each summer.

In the summer of 2007 the total number of undergraduates participating in the above internship programs was 11; for 2008 the projected number is 19 students.

### ***Graduate Programs***

Environmental Toxicology is the administrative home for three graduate programs: 1) the Pharmacology & Toxicology Graduate Group (comprised of 53 students and 73 faculty located in 31 departments), 2) the Agricultural & Environmental Chemistry Graduate Group (52 students and 51 faculty from 13 departments), and 3) the Forensic Science Masters Program (70 students and 17 faculty from 14 departments). The large number of graduate students reflects the excellent reputation of the faculty and the high level of extramural support available to support students and their research within these programs.

With the appointment of five new adjunct faculty members to assist with teaching, our faculty members are now able to offer a number of new graduate-level courses, including:

- ETX 230, Experimental Approaches in Coastal Toxicology (3)
- ETX 260, Immunotoxicology (3)
- ETX 270, Toxicology of Pesticides (3)
- ETX 278, Molecular Techniques (3)
- ETX 280, Forensic DNA Analysis (3)

In addition, the courses below that had not been taught since the VERIPs of the early 1990s are again regularly offered, and have proven very popular with students (particularly those in the Agricultural & Environmental Chemistry, Forensic Sciences, and Pharmacology & Toxicology Graduate Programs):

- ETX 203, Environmental Toxicants (4)
- ETX 220, Analysis of Toxicants (3)
- ETX 220L, Analysis of Toxicants Laboratory (2)
- ETX 228, Gas Chromatography/Mass Spectrometry of Toxic Chemicals (3)
- ETX 234, Neurophysiological Basis of Neurotoxicology (3)

## **VI. Departmental Outreach and Extension Programs**

### ***Extramurally-Funded Programs***

Departmental Outreach and Extension Programs emphasize chemical pesticide residues and biodegradation, residues in livestock, pest management, and regulatory toxicology. Over the years extramurally-funded programs hosted by the Department of Environmental Toxicology have included:

- The UC Toxic Substances Research & Teaching Program – which coordinates and supports toxicological research and training programs system wide.

- The USDA-funded Western Region IR-4 Laboratory – which supports pesticide registration for minor-use crops in the Western Region (Addendum 9).
- The NIEHS-funded Center for Environmental Health Sciences (CEHS) – which supports collaborative toxicological research across campus and communicates important information revolving around toxic chemicals and health to the public.
- The USDA-funded Western Integrated Pest Management Center (formerly the Pesticide Impact Assessment Program, PIAP) – which provides and coordinates funding to identify pest management needs in the Western Region.
- The UC Statewide Integrated Pest Management Center – the assistant to the director operates from our department.
- The Food Animal Residue Avoidance Databank (FARAD) – which has supported the re-analysis of published data via modern pharmacokinetic methods to better characterize the disposition of chemical residues in food animals.
- The Granite Canyon Marine Pollution Studies Laboratory – which conducts applied research to provide state and federal agencies with policy-relevant information on the distribution, trends, magnitude, and causes of aquatic toxicity associated with urban, agricultural, and oil spill-related activities statewide.
- The Toxicology Documentation Center – a centralized source for pesticide and other toxic agent informational resources.

### ***Role of Cooperative Extension***

Historically, the CE specialists in the Department of Environmental Toxicology have provided invaluable – and very visible – guidance to both our agricultural and environmental stakeholders regarding the safe handling and use of pesticides and other toxic agents of importance to the environment. For instance over the years, and in collaboration with their counterparts at other universities (Cornell, Oregon State, Michigan State and Idaho), our specialists have developed (and continue to support) the very successful Extension Toxicology Network (EXTOXNET). Highly regarded both nationally and internationally for its accuracy and accessibility, the website (<http://extoxnet.orst.edu/etn.txt.html>) represents an important venue for the distribution of information on the toxicology and environmental fate of pesticides worldwide. EXTOXNET materials include pesticide information profiles, toxicology information briefs and other materials on toxicology and environmental chemistry, and the number of website hits is well over 100,000 per month.

Our remaining 0.60 FTE CE specialist also continues to publish the Environmental Toxicology Newsletter, which is an important mechanism for keeping CE advisors informed about important issues in the field. It is sent to all CE advisors statewide, as well as other subscribers nationwide. It is also currently cataloged in the National Agricultural Library, and posted on the EXTOXNET website for worldwide dissemination.

Other activities have included maintenance of the Food Animal Residue Avoidance Databank (FARAD), which contains compilations of previously published data that is re-analyzed using modern pharmacokinetic methods to provide new insight on the disposition of chemical residues in food animals. It also serves a role in public education and service by providing information to producers and veterinarians about appropriate withholding times after the drug treatment of food animals.

Within the past decade one of our specialists (Stimmann) retired and, due to budgetary constraints, his position was not returned to our department. In addition, several years ago our remaining specialist (Craigmill) accepted a partial appointment (0.40 FTE) as director of the UC Sierra Foothill Research & Extension Center. Thus, the department currently retains the reduced services of a 0.60 FTE CE specialist who, by the summer of 2008, will be at least age 63. In anticipation of retirement in the very near future, in the summer of 2007 he transferred administration of his extramurally-funded programs to a new principal investigator.

### ***Interface with Programs of Other Departments***

A number of our faculty and programs interface with other departments on campus. For instance, four of our 10 current faculty members hold joint appointments elsewhere: Cherr (Nutrition), Matsumura (Entomology), Oteiza (Nutrition) and Wilson (WOS; Animal Sciences). In addition, and in support of the new Foods for Health Institute, a new faculty member (analytical metabolomicist) is now under recruitment for joint appointment with the Department of Nutrition. With its strong interests in toxicology and exposure assessment, our department is also uniquely poised to support the new School of Public Health.

Our USDA-funded Western Region IR-4 Laboratory provides support to both the Ornamentals Center in the Department of Environmental Horticulture and the Field Research Center in the Department of Vegetable Crops. It also supports field research centers at both the Kearney Research and Extension Center and at UC Riverside.

The department also houses the USDA-funded Western Integrated Pest Management Center (WIPM Center). Established for a three-year funding period in 2000, it has been successfully renewed ever since. The IPM Center provides and coordinates funding to identify pest management needs in the Western Region. The director is also the assistant to the director of the UC Statewide IPM Program, as well as the Director of the UC Office of Pesticide Information and Coordination (OPIC) and the Pesticide Safety and Education Program (PSEP) Coordinator.

### ***Technology Transfer by Faculty Members***

Departmental faculty members utilize a number of venues to communicate important research findings, carry out technology transfer, and provide guidance on the safe handling and use of toxic agents. They are summarized below.

- *Publications, Professional Societies and Websites*

One of the most commonly used methods for technology transfer involves the publication of peer-reviewed research manuscripts, as well as topical reviews and book chapters. Our faculty members also regularly prepare final reports at the conclusion of their research awards, and both attend and make presentations to the annual national and international meetings of a number of professional societies, including the Society of Toxicology, the Society of Environmental Toxicology and Chemistry, the American Chemical Society, etc. Such venues provide for a wide dissemination of AES research results, which enhances their beneficial use. Most of our faculty members also maintain their own research group websites, which also disseminate research information widely.

Of particular note – the Department of Environmental Toxicology hosts the editorial offices of two peer-reviewed international journals: *Pesticide Biochemistry & Physiology* and the *Journal of Agricultural & Food Chemistry*.

- *Agricultural Commodity Organizations*

Another common method for efficient technology transfer is represented by both attendance and the presentation of research results at regular meetings of agricultural commodity boards. Our faculty members regularly participate in the meetings of the California Rice Commission and Rice Research Board – as well as the Almond, Peach, and Prune Boards – to provide the most up-to-date research results and provide guidance on the safe and effective use of pesticides and other agrochemicals.

- *Federal and State Regulatory Agencies*

Departmental faculty members and CE specialists are also regularly sought serve on targeted committees or task forces to assist with chemical issues of concern. In recent years federal agencies have included both the US Environmental Protection Agency and the USDA, while state agencies have included CalEPA, the State Water Resources Control Board, and the Departments of Pesticide Regulation (DPR), Food and Agriculture (DFA), and Fish and Game (DFG). For instance, one of our faculty members has recently provided assistance to the DFG in their efforts to eradicate the exotic northern pike from Lake Davis, and serves on a DFA task force to provide guidance on the use of sex pheromones to control an agricultural pest, the light brown apple moth.

- *Training and Outreach Programs*

The CEHS coordinates faculty members from across campus in support of a number of outreach programs that directly contribute to our departmental mission. For instance, the Rural Health Clinic Outreach Project regularly conducts Pesticide Illnesses and Injuries Workshops for Tribal Health Care and Agricultural Professionals. Historically, participants have included members from thirteen tribal communities in Arizona, California, and Nevada, as well as a variety of agencies, services, and programs working directly with tribes on chemical safety, health, and environmental issues, and have included health care providers from several Indian Health Services' facilities.

The CEHS Environmental Health Education for Farm Workers and Farmers Program has regularly offered courses on: 1) the presence of agricultural chemicals in different phases of farm work, 2) the pathways by which agricultural chemicals enter and affect the body, 3) the recognition of acute and chronic pesticide exposures, and 4) first aid for pesticide illness. Over the years participants have included Mexican, Punjabi, and Hmong farm workers, farmers in San Joaquin, Solano, and Yuba/Sutter counties, and African-Americans residing in agricultural areas.

The CEHS Pesticide Safety Literacy Program produces training programs in English and Spanish on "Child Poison Prevention," which includes information on: 1) poisons, 2) medicines and vitamins, 3) household products, 4) personal care products, plants, and environmental toxins, 5) safe alternatives, 6) poisoning prevention, 7) labels and how to read them, 8) what to do in case of poisoning, and 9) how to use Poison Control Centers.

- *UC Extension*

Finally, some of our faculty members regularly instruct courses through UC Extension in the areas of toxicology, chemical fate in the environment, and hazardous materials management in support of certificate programs in hazardous materials management, occupational health and safety, and biotechnology. In addition to contributing to the training of new hazardous materials managers and chemical safety professionals, such a venue facilitates the dissemination of toxicological information and pertinent research results to professionals from numerous industries throughout California.

## **VII. Future Priorities and Activities**

In general, our goals are to: 1) maintain our current program activities as outlined above, and 2) expand our program activities to include the emerging research areas outlined below, which closely align with the new and emerging areas identified in the new CA&ES Academic and Strategic Plan.

### ***Integrated Analysis of Toxic Responses at the Genomic, Proteomic and Metabolomic Levels***

Over the past several years we have been expanding our efforts toward developing a better understanding of toxic perturbations in target cells or tissues, genes, proteins and/or metabolite expression via DNA microarray, mass spectrometric, and NMR-based approaches. Virtually all of our faculty members contributes to one or more of these areas, including the three new members (Cherr, Tjeerdema, Wood) the department has attracted since 1999. By better defining the biochemical and/or physiological indicators of health, as well as the toxic action mechanisms of pesticides and other environmental toxicants in humans and other species, such an approach can assist in determining characteristic biomarkers of exposure to determine the most sensitive no-response levels, all important contributions to improved chemical regulation.

### ***Environmental and Human Health***

The Department of Environmental Toxicology has a long history of contributing to a better understanding of the potential impacts of toxic chemicals on health, as virtually all our faculty members has an active interest in new and emerging issues revolving around environmental and human health. Maintenance and enhancement of environmental and human health in an era of increasing chemical impacts has been a long-term goal of our faculty. In addition, through the Center for Environmental Health Sciences (CEHS), our department has for many years fostered collaborative efforts in both research and outreach in this area across campus and beyond.

Upon invitation, we are currently developing a new Agreement of Cooperation with City University of Hong Kong to expand our collaborative research, teaching and outreach activities across the Pacific Rim Region. We have recently instituted a summer undergraduate exchange program between our two universities to provide students with the opportunity to contribute to research activities designed to address the emerging pollution problems which threaten the growing populations of our two countries. We also plan to foster the regular exchange of faculty members so they may offer courses of interest to the two campuses. By increasing technology transfer within the region, it is anticipated that chemical impacts may be managed and ultimately reduced over time.

In the future, the Department of Environmental Toxicology is enthusiastically poised to contribute to the success of the new School of Public Health. As the administrative home of the Pharmacology & Toxicology Graduate Group, our department will continue to serve as a center of health-related research and prepare new professionals at both the undergraduate and graduate levels to enter into careers centered in the environmental and health sciences.

### ***Foods for Health – Food Safety***

Several of our faculty members are currently contributing to the development of the new Foods for Health Institute (Denison, Miller, Oteiza, Shibamoto), and in the long run they plan to affiliate their activities with the new program. In addition, we are currently conducting a search for a new faculty FTE in the area of analytical metabolomics (0.40 Environmental Toxicology – 0.60 Nutrition). The characterization of both diets and nutrients that promote health, as well as those agents in foods that may be detrimental (such as phytotoxins and agents produced through cooking and preparation), represents an important new direction for our department. We enthusiastically plan to nurture the new institute by participating in a broad spectrum of activities, from phytochemical analysis to the elucidation of toxic action mechanisms and health effects. Extensive use of the above mentioned genomic, proteomic, and metabolomic approaches will contribute greatly to a better understanding of health and the influence of diet on it.

### ***Agricultural Sustainability***

Interest in sustainability has significantly increased in recent years. With the growing worldwide demand for increased agricultural productivity, and with dwindling land and other resources to devote to it, the challenge of the future will be to produce more while reducing overall environmental impact. As such, development of better pest control

methods, including more selective pesticides as well as alternative techniques (e.g. pheromones, etc.), will prove invaluable. Pest control represents an ongoing struggle, as over time either pest species evolve resistance to control agents, or the environmental impacts of such agents become unacceptable. A number of our faculty have well established programs devoted, at least in part to, to development of a better understanding of pest control agents and methods (Matsumura, Miller, Shibamoto, Tjeerdema, Wilson). In the future, our department plans to expand its current efforts to identify safer, and more effective, pest control agents to assist in making agricultural sustainability a reality.

### ***Global Change, Water and Watersheds***

Global climate change and its impact on water quality will become an increasingly important issue, as effects of global warming take greater hold in this century. Water has always been in limited supply in the arid west and, historically, access has led to numerous conflicts. As populations in the western states continue to grow, impacts on watersheds and water quality will also increase unless conservation-oriented management practices can be identified and implemented to restore and protect them. Our department has a long and rich history of contributions toward the enhancement of water quality, and currently several of our faculty members (Cherr, Tjeerdema) focus their research efforts on aqueous systems. In the future, our department will continue to provide the knowledge and guidance necessary to assist regulatory agencies in managing chemical impacts on these potentially dwindling resources.

## **VIII. Resource Needs to Address the Above Priorities**

### ***Steady-State (no growth) Conditions***

In this scenario, it is assumed that resources to be made available over the next five to six years are only for the purposes of maintaining programs at their current levels. In keeping with future changes in environmental toxicology, we intend to continue to evolve even in a challenging era of limited growth.

- ***Faculty Positions to Maintain Current Activities***

By 2008, at least four Senate faculty members (2.80 FTE plus the WOS courtesy member), the CE specialist (0.60 FTE), and one adjunct member will be age 63 or beyond. Therefore, in order to maintain our current departmental core strengths in an era of increasing undergraduate and graduate enrollments – and to contribute effectively to the new priority areas outlined in Section VII – the department would need to minimally replace the above five members over the next several years. In line with this scenario a nutritional toxicologist (0.40 I&R FTE), with interests in characterizing the influence of nutrition on health via the metabolomics approach, is currently under recruitment with the Department of Nutrition; they would also be affiliated with the new Foods for Health Institute. Other positions of highest priority are below (potential new programmatic affiliation in parentheses).

1. Environmental Chemist (1.0 I&R FTE) – to study chemical mechanisms of environmental fate, reactivity and transport and to sustain our expertise in

chemically-related mechanisms in the environment (*Global Change, Water and Watersheds*).

2. Biological Chemist (1.0 I&R FTE) – to study chemical mechanisms of toxicant-macromolecule interaction and strengthen the interface between chemical and biological expertise in the department (*Genomics, Proteomics and Metabolomics*).
  3. Toxicogeneticist (1.0 I&R FTE) – to develop a program that studies how the genome is involved in responses to environmental stressors and toxicants. This will involve the study of genetics, mRNA expression, cell and tissue-wide protein expression and metabolomics to understand the role of gene-environment interactions in disease (*Genomics, Proteomics and Metabolomics*).
  4. CE Specialist in Risk and Regulatory Issues (1.0 FTE with partial I&R FTE support) – a critical need for outreach to stakeholders and public communication (*Agricultural Sustainability; Environmental and Human Health*).
  5. Molecular ecotoxicologist (1.0 I&R FTE) – to use modern molecular techniques to better understand mechanisms of adverse effects and risks posed by toxicants to ecosystems (*Genomics, Proteomics and Metabolomics; Environmental and Human Health*).
- *Maintenance of Undergraduate and Graduate Curricula*

Our core courses represent the truly novel training aspect for our students, making them uniquely qualified for the many career opportunities awaiting them upon graduation. However, support for our courses requires a significant input of resources, particularly for the core teaching laboratories (ETX 102B, 103B and 111), which have both equipment maintenance and consumable supply needs totaling about \$25,000 per year. In addition, while the CA&ES IER/IUC Program has assisted with the replacement of some of the instrumentation in recent years, it is reasonable to anticipate that instrument turnover should be on the order of every five years. Therefore, over the next 5-6 years it is anticipated that most of the current major instruments (gas and liquid chromatographs and mass spectrometers) will need to be replaced, at a total cost of approximately \$500,000.

In addition the cost of general supplies, teaching assistant support will remain a priority for the enhancement of the educational experience for our students as well as for important safety needs in the laboratory courses.

- *Maintenance of Graduate Education*

Our department fully participates in graduate education, offering a variety of important courses in support of our three graduate programs. Of particular importance are our advanced laboratory courses (ETX 220L and 228). Their

needs to a great extent are concurrent to those of the undergraduate laboratories, and thus are covered by the instrument, supply and TA needs described above. It should be noted that these courses provide important core training to students in a number of graduate programs, including Agricultural & Environmental Chemistry, Civil & Environmental Engineering, Forensic Sciences, and Pharmacology & Toxicology.

- *Resource Needs and Challenges*

With anticipated retirements, research and office space could be reconfigured to meet recruitment needs. The greatest need would be in start-up funding (typically \$500,000/FTE or more) to ensure the availability of adequate resources and equipment for new faculty to be successful, as well as the funding for equipment maintenance, supplies and staff support needed to maintain our high-quality laboratory courses.

Maintaining the staff personnel required to administer our undergraduate and graduate programs is crucial in light of our growing enrollments, the increasing number of courses and adjunct appointments administered by the department, and the increased workload delegated to departments for administration of graduate programs. Even under no-growth conditions, our programs continue to evolve and grow. If we fall below current staffing levels for student services and academic personnel support, all programs within the department will be adversely affected.

### ***Conditions of Modest Growth***

In this scenario, it is assumed that resources to be made available over the next five to six years are for the purposes of both maintaining program strengths and facilitating growth of modest proportions (a total of 5-7%). In addition to the resources identified in the above no-growth scenario, the needs below would provide the department with the ability to meet modest growth projections (potential new programmatic affiliation in parentheses).

- *Faculty Positions to Enhance Current Activities*

1. Food Chemist/Toxicologist (1.0 I&R FTE) – to utilize advanced analytical approaches to characterize the chemistry and toxic actions of hazardous agents either found naturally in foods or produced through processing and cooking (*Foods for Health*).
2. Nanotoxicologist (1.0 I&R FTE) – to integrate toxicological assessment into the interdisciplinary field of nanotechnology. Nanomaterials are used in a plethora of products from sunscreens to microelectronics yet despite their increasingly widespread use understanding of how they interact with biological systems and the environment is limited. This position would complement the expertise currently available on campus thorough the NEAT Initiative (*Nanomaterials in the Environment, Agriculture and Technology*)

- Enhancement of Undergraduate and Graduate Curricula

In addition to the above maintenance needs, with rapidly growing interest in the “Green Revolution,” current enrollment growth could easily double the present number of undergraduate majors, producing the need for 100% more space to accommodate an increased number, as well as size, of laboratory sections. This would also double the funds needed for equipment, TAs, staff support and supplies, and increase the maintenance costs for laboratory instrumentation.

- Enhancement of Graduate Education

Enrollments in the three graduate programs are likely to increase as well, but may be more modest due to limitations in research space, faculty, and support funding. However, with modest growth in faculty the need would arise for additional research space to house their developing programs. In Meyer Hall, this would necessitate expansion of the Department of Environmental Toxicology to completely cover the fourth floor.

- Resource Needs and Challenges

With modest growth, new laboratory space for research and teaching, as well as office space, would be required to meet the needs of additional faculty members and a larger student population. As above, the greatest need would be the availability of start-up funding for new faculty. Additional resources would also need to be available for our laboratory courses (see above). A significant challenge would be in supplying the additional research space for new faculty, as it would require the realignment of space on the fourth floor of Meyer Hall that is currently assigned to either the Departments of Nutrition or Animal Sciences.

## **IX. Conclusions**

The Department of Environmental Toxicology, begun in 1962 as the Agricultural Toxicology & Residue Research Laboratory (an ORU), is the first of its type in the world, and it can be said that the field of environmental toxicology began at UC Davis. Since then, the department has played a major role in the development of the field, and has produced many key professionals in academia, government and private industry. With the emerging challenges and consequences of toxic chemicals and pollution on a global scale, demand for advanced research information and new professionals will only increase. Therefore, just as the department was poised to lead the way during the environmental movement of the 1960s, it continues to be at the forefront of the field – it is ideally positioned to provide leadership in this new century.