

Chapter 5

Federal Research and Development in California

- Approximately \$14.4 billion of federal R&D funds are spent each year in California.
- California ranks 1st among the 50 states, District of Columbia, and Puerto Rico in terms of the amount of federal R&D dollars received annually.
- Approximately 19 percent of all federal funds spent in California each year on matters other than the direct support of individuals (i.e., such entitlements as retirement, disability, and housing assistance) is spent on R&D.

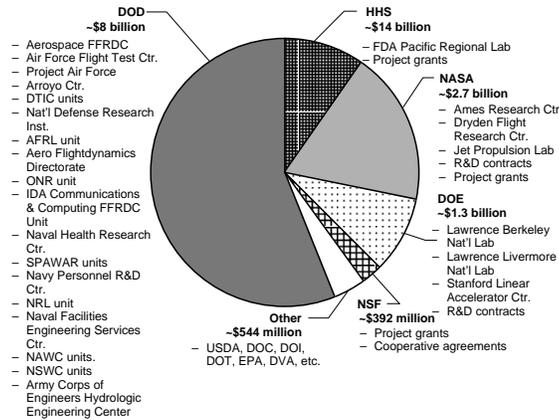


Figure 5.1 – Sources of Federal R&D Dollars Spent in California (Total Federal R&D ~\$14.4 billion)

BACKGROUND

In recent years, the federal government has spent in the neighborhood of \$14.4 billion annually in California on research and development (R&D) activities. On average, federal R&D dollars account for approximately 19 percent of all federal funds spent in California each year on matters other than the direct support of individuals (i.e., such entitlements as retirement, disability, and housing assistance).

Most major federal agencies that currently support federal R&D efforts provide funding for R&D activities in California. Foremost among these agencies is the Department of Defense (DOD), which accounts for 56 percent of all federal R&D dollars spent in the state. The National Aeronautics and Space Administration (NASA) accounts for an additional 19 percent of the federal R&D dollars spent in California, while the Department of Health and Human Services (HHS), the Department of Energy (DOE), and the National Science Foundation (NSF) account for 10, 9, and 3 percent, respectively. The remaining federal R&D dollars come collectively from the Departments of Commerce (DOC), Agriculture (USDA), Transportation (DOT), Veterans Affairs (DVA), and Interior (DOI) and from several other federal agencies.⁵

All federal R&D dollars spent in California either cover the costs of operating federal R&D units in the state, including paying the salaries of federal R&D personnel working at these units, or are awarded as grants, contracts, or cooperative agreements to entities in the state. The following is an overview of what becomes of these federal R&D dollars once they arrive in California.

FEDERAL R&D UNITS IN CALIFORNIA

Albany, California, is home to USDA's Western Regional Research Center, Plant Genome Expression Center, and Pacific Southwest Research Station.

⁵ For a complete agency-by-agency breakdown of these R&D dollars, see Appendix C.

- The Western Regional Research Center is a unit of USDA's Agricultural Research Service (ARS). It consists of five research divisions focusing on cereal product utilization, crop improvement and utilization, plant protection, food safety and health, and process chemistry and engineering. Specific research activities include the use of image analysis to detect the structure of food; developing biotechnological approaches to improve postharvest properties; and researching the adhesion of pathogens to surfaces of poultry, fruits, and vegetables. This federal R&D unit, in combination with the Plant Genome Expression Center described immediately below, annually receives approximately \$22 million of federal R&D funds and has about 208 FTEs.
- The Plant Gene Expression Center is a unit of USDA's ARS that conducts research on high-throughput sequencing of plant genomic DNA to identify genes of rice, corn, soybeans, and other plants. Its research is conducted in collaboration with Stanford University and the University of Pennsylvania. The funding and staffing figures for this laboratory are included in those for the Western Regional Research Center described immediately above.
- The Pacific Southwest Research Station, headquartered in Albany, is a unit of USDA's Forest Service. It conducts research on conifer genomics, variation, and evolutionary relationships and genetic conservation disease resistance. Specific activities of this research station include the development of integrated resource assessments and mitigation measures for changes in ecosystem structure, function, distribution, and long-term productivity, and investigation of the ecological roles and impacts of insects in Western forests. This federal R&D unit annually receives approximately \$4 million of federal R&D funds and has about 72 employees.

Arcata, California, is home to DOI's California Cooperative Fishery Unit and USDA's Redwood Sciences Laboratory.

- The California Cooperative Fishery Unit is part of DOI's U.S. Geological Survey (USGS). It is on the campus of Humboldt State University. It conducts research on California fish and aquatic resource problems, as well as ecosystem functions, to determine life history attributes of threatened and endangered species. Specific research activities of this unit include studying habitats supporting coastal salmonids, including streams, estuarine, and near-shore marine habitats. This federal R&D annually receives approximately \$90,000 of federal R&D funds and has one FTE.
- The Redwood Sciences Laboratory is a unit of the Pacific Southwest Research Station inside USDA's Forest Service. This laboratory, which is on the campus of Humboldt State University, conducts research on timber management, wildlife interactions, and management effects on hillslope processes, fisheries, and stream environment. Specific research activities of this laboratory include studies on forest management interactions for a variety of wildlife species in the Pacific Northwest, including the northern and California spotted owls, marbled murrelets, pine marten, Pacific fisher, and Pacific salmon. This federal R&D unit annually receives approximately \$2.3 million of federal R&D funds and has about 56 employees.

Berkeley, California, is home to DOE's Lawrence Berkeley National Laboratory.

- The Lawrence Berkeley National Laboratory is a federally funded research and development center (FFRDC) sponsored by the DOE and operated by the University of California at Berkeley. Its research focuses on advanced materials development, chemical reaction dynamics, building energy efficiency, electromechanical energy storage, heavy-ion fusion accelerator development, environmental science, Earth science, and the human genome. It also has a Low-Background Facility located in the powerhouse of the Oroville dam, a California Department of Water Resources facility. This site is specially configured for low-background gamma-ray spectroscopy and is used for sen-

sitive neutron counting. This federally owned and contractor-operated R&D laboratory annually receives approximately \$266 million of core funding, virtually all of which is spent on specific R&D projects, and has about 3,800 employees. A portion of the laboratory's funds is spent on the maintenance and operation of R&D equipment and facilities.

Camarillo, California, is home to DOI's Pacific Outer Continental Shelf Regional Office.

- The Pacific Outer Continental Shelf Regional Office is a unit of DOI's Minerals Management Service (MMS). It conducts environmental studies on the effects of offshore mineral development from the California-Mexico border to the Washington-Canada border, focusing primarily on southern California. Specific research areas include physical oceanography, marine mammals, seabirds, and ecosystems. This federal unit annually receives approximately \$3 million of federal R&D funds and has about 100 employees, only eight of whom are directly involved in R&D activities.

China Lake, California, is home to a unit of DOD's Naval Air Warfare Center Weapons Division.

- The Naval Air Warfare Center Weapons Division is a unit of DOD. It is headquartered at the Naval Weapons Center in China Lake, with additional sites at the Pacific Missile Test Center at Point Mugu, California, and the Naval Ordnance Missile Test Station at White Sands Missile Range in New Mexico. The China Lake portion of the center develops weapons by conducting basic and applied research on hardware fabrication prototyping. Major weapons programs at China Lake include the Sidewinder, Sparrow, and Phoenix air-to-air missiles programs. The three parts of the center annually receive a total of approximately \$545 million of R&D funds, about \$363 million of which are spent in-house. China Lake has a staff of approximately 3,100 civilians, only a portion of whom are directly involved in R&D activities.

Corona, California, is home to DOD's Naval Surface Warfare Center Corona Division.

- The Naval Surface Warfare Center Corona Division, also known as the Naval Warfare Assessment Station at Corona, is a unit of DOD. The command conducts R&D on emerging Navy and joint warfare systems. The station focuses on making independent assessments of major weapons and combat systems for the Navy. The specific R&D activities of this unit focus on conducting capability assessments of surface warfare systems, including air defense, strike weapons, and theater ballistic missile defense. This unit also conducts R&D on test instrumentation, data collection, data distribution, and data archive technology to support test assessments. This federal unit annually receives approximately \$9.8 million of federal R&D funds for in-house activities and has about 723 civilian personnel, only a small portion of whom are actively involved in R&D activities.

Davis, California, is home to DOD's Hydrologic Engineering Center and USDA's ARS Research Facility at the University of California at Davis, Western Human Nutrition Research Center, Institute of Forest Genetics, and Western Center for Urban Forest Research and Education.

- The Hydrologic Engineering Center is a unit of the Water Resources Support Center within DOD's U.S. Army Corps of Engineers. It is headquartered in Alexandria, Virginia. The center conducts research, as well as providing training, planning analysis, and technical assistance, on hydrologic engineering for the Corps. Recent R&D activities include analyzing warehouse data to assess the water balance in the Coralville Reservoir and developing methods and models for urban hydrology. This federal unit annually receives approximately \$1.2 million of federal R&D funds and has about 35 employees.
- The ARS Research Facility at the University of California at Davis is a unit of USDA's ARS. The facility includes divisions focusing on exotic and invasive weed, crops pathology and ge-

netics, and clonal germplasm. One division conducts research on the impacts of tamarisk, or saltcedar, on biodiversity in the New World, biological control of yellow-star thistle, and the behavior and effects of other weed species. Another division conducts research on germplasm characterization, molecular marker maps, seedling vigor, submergence tolerance, and stem rot resistance. Yet another division receives, collects, preserves, evaluates, and distributes the germplasm of fruit and nut crops. This federal R&D unit annually receives approximately \$1.9 million of federal R&D funds and has about 25 FTEs.

- The Western Human Nutrition Research Center is a unit of USDA's ARS. It conducts research into the functional consequences of chronic energy restriction caused by undereating, micronutrient bioavailability, and imbalances stemming from poor food behaviors and/or excessive use of supplements or fortified foods. Specific research activities of this center in the next few years will focus on chronic energy restriction, nutrition, and health in women and the impact of protective factors in foods on physiological function and maintenance of health. This federal R&D unit annually receives approximately \$4.9 million of federal R&D funds and has about 34 FTEs.
- The Institute of Forest Genetics is a unit of the Pacific Southwest Research Station inside USDA's Forest Service. The institute is on the campus of the University of California at Davis and conducts research on genetic diversity, conservation genetics, biotechnology, and disease resistance. Specific research activities include identifying the extent and function of diversity in conifer species, documenting the origin of invasive plant species to aid in their control, discovering the role that genes play in controlling important traits in forest trees, and identifying specific genes in conifers that provide resistant to various virulent pathogens. This federal R&D unit annually receives approximately \$2.1 million of federal R&D funds and has about 30 employees.

- The Western Center for Urban Forest Research and Education is a unit of the Pacific Southwest Research Station inside USDA's Forest Service. This center, which is on the campus of University of California at Davis, conducts research that describes the structure of urban forests and related benefits and costs. Specific research activities include studies of the benefits of tree shade on parking lot microclimate and air quality, strategies for reducing sidewalk-repair costs due to conflicts with roots of street trees, effects of urban forests on stormwater runoff, and application of remote sensing technologies on volunteer-based tree inventory to monitor urban forest health. This federal R&D unit annually receives approximately \$389,000 of federal R&D funds and has about nine employees.

El Segundo, California, is home to DOD's Aerospace FFRDC and a regional office of the Defense Technical Information Center.

- The Aerospace FFRDC is sponsored by the Air Force and operated by the Aerospace Corporation. Its research focuses on the architecture and engineering of space and launch systems that have national security functions. A particular emphasis of Aerospace FFRDC's R&D activities is launch vehicle, satellite, and control systems hardware and software. This federally owned and contractor-operated R&D facility annually receives an average of about \$292 million of core funding and has a staff of approximately 2,600 employees in El Segundo. It has an additional 3,100 employees at other sites in the United States and abroad. A substantial portion of its funds are spent on the maintenance and operation of R&D equipment and facilities.
- The Western Regional Office of the Defense Technical Information Center (DTIC) contributes to R&D efforts by providing access to and facilitating the exchange of scientific and technical information. Specifically, DTIC concentrates on providing information on planned, ongoing, and completed DOD-related R&D to federal agencies and their contractors. This federal unit annually receives approximately \$240,000 of federal R&D funds and employs about three people.

Fresno, California, is home to USDA's Water Management Research Laboratory, Horticultural Crops Research Laboratory, and Fresno Forestry Sciences Laboratory.

- The Water Management Research Laboratory is a unit of USDA's ARS. It conducts research on irrigation and drainage water management practices, with the objective of developing practices and methods that use water efficiently, improve agricultural productivity and sustainability, and reduce negative environmental impacts of irrigated agriculture in semiarid and arid areas. Specific research activities include crop management for the preservation of soil and groundwater quality, irrigation management, and crop rotation as alternatives to methyl bromide. This federal R&D unit, in combination with the Horticultural Crops Research Laboratory described below, annually receives approximately \$7 million of federal R&D funds and has about 79 employees.
- The Horticultural Crops Research Laboratory is also a unit of USDA's ARS. It conducts research on fresh and dried crops, with a particular research focus on postharvest issues, such as methyl bromide alternatives. It consists of three research divisions focusing on crop protection and quarantine insects, the postharvest quality and genetics, and crop pathology and genetics management. One division conducts research on dried fruit and nut entomology, insect detection, and physiology and microbial control of stored products. The research areas of a second division include grape and stonefruit breeding and postharvest decay. The research focus of the third division includes the development of efficient control strategies for citrus viruses through biological, molecular, and recombinant DNA technology. The funding and staffing figures for this federal R&D unit are included with those presented immediately above for the Water Management Research Laboratory.
- The Fresno Forestry Sciences Laboratory is a unit of the Pacific Southwest Research Station inside USDA's Forest Service. It

conducts research on ecosystems in the Sierra Nevada Mountains. Specific research activities of this laboratory include studies to identify and describe linkages between various biological, physical, and human components of forest ecosystems and to evaluate forest management strategies aimed at sustaining plant, animal, and fish communities in the Sierra Nevada. Species of particular concern include the California spotted owl, pine martens, fishers, yellow-legged frogs, and other amphibians associated with riparian, meadow, and high-mountain lake habitats. This federal R&D unit annually receives approximately \$2.3 million of federal R&D funds and has about 17 employees.

La Jolla, California, is home to a unit of DOD's Institute for Defense Analyses Communications and Computing FFRDC and DOC's La Jolla Laboratory.

- The Center for Communications Research is one of three units constituting the Institute for Defense Analyses Communications and Computing FFRDC. This FFRDC, which is nominally headquartered in Alexandria, Virginia, is sponsored by the National Security Agency and operated by the Institute for Defense Analyses (IDA). The Center for Communications Research in La Jolla works closely with its sister unit in Princeton, New Jersey, to conduct mathematical research to support cryptography and cryptanalysis. These two units also conduct R&D on speech and special signals-processing techniques. Together with the Center for Computing Sciences in Bowie, Maryland, the three units of this federally owned and contractor-operated R&D center annually receive approximately \$35 million of core funding, all of which is federal R&D funds, and have about 150 employees. A substantial portion of these funds is spent on the maintenance and operation of R&D equipment and facilities.
- The La Jolla Laboratory is the headquarters unit of the Southwest Fisheries Science Center inside DOC's National Oceanic and Atmospheric Administration (NOAA). The laboratory's

Coastal Fisheries Division conducts research on the biomass of fish and the biological and environmental factors that affect their survival. Its Marine Mammal Division monitors the status of dolphin populations in the eastern tropical Pacific and the coastal marine mammals of California. This division also develops and tests mathematical models to determine how such factors as growth, reproduction, and geographic distribution of marine mammal populations influence population levels. The laboratory's Pelagic Fisheries Resources Division conducts basic fishery analysis and provides management information on tropical and temperate tunas, billfishes, and other large pelagic fishes. Its U.S. Antarctic Marine Living Resources Division gathers biological information to prevent overexploitation of fish and krill and to protect seal, penguin, and pelagic seabird populations off the northernmost tip of the Antarctic Peninsula and South Georgia Island. This federal unit annually receives approximately \$10.3 million of federal R&D funds and has about 97 FTEs, only a portion of whom are involved in R&D activities.

Lancaster, California, is home to NASA's Dryden Flight Research Center and a portion of DOD's Air Force Research Laboratory Propulsion Directorate and its Air Force Flight Test Center.

- The Dryden Flight Research Center is a unit of NASA. It is located at Edwards Air Force Base. The center conducts experimental flight research on integrated flight and propulsion controls; advanced optical sensors and controls; viscous drag reduction; advanced configurations; high-altitude, long-endurance aircraft; remotely piloted vehicle technology; hypersonic vehicles; high-speed civil transportation; advanced rockets; air-breathing propulsion concepts; instrumentation systems; and flight load predictions. This federal facility annually receives a total of approximately \$207 million, at least \$140 million of which directly involves R&D efforts. The center has about 558 FTEs, only a portion of whom are involved in R&D activities. A substantial portion of its funds is spent on the mainte-

nance and operation of R&D equipment and facilities. In a recent year, over \$20 million of R&D contracts were awarded by the center, approximately \$4 million of which were made to entities based in California.

- The Propulsion Directorate at Edwards Air Force Base is a unit of DOD's Air Force Research Laboratory. It is headquartered in Dayton, Ohio, and conducts research on rocket propulsion. Specific R&D projects focus on the high-energy density of matter and space-based interceptors for missile defense. This federal unit annually receives approximately \$49 million of federal R&D funds, only about 22 percent of which is spent on in-house R&D activities, and has about 219 civilian personnel, only a portion of whom are directly involved in R&D activities. A substantial portion of these funds is spent on the maintenance and operation of R&D equipment and facilities.
- The Air Force Flight Test Center at Edwards Air Force Base conducts R&D on manned and unmanned aerospace systems. Specific activities of this center include research, development, test, and evaluation on testing aerospace systems and subsystems, including development testing of aerodynamic decelerators; weapons systems; electronic warfare systems; recovery of research vehicles; operating the USAF Test Pilot School; and developing, operating, and managing the Edwards Flight Test Range. This federal unit annually receives about \$551 million of federal R&D funds, approximately \$266 million of which are spent on in-house activities, and has almost 7,000 personnel, over 3,000 of whom are civilians.

Livermore, California, is home to DOE's Lawrence Livermore National Laboratory.

- The Lawrence Livermore National Laboratory is an FFRDC sponsored by DOE and operated by the University of California. It conducts research in a wide range of areas, including advanced defense technologies, energy, environment, and biosciences, as well as the basic sciences. Its R&D projects include high-energy-density plasmas in connection with space physics

and astrophysics, uranium as an energy resource, the use of cleaner energies as alternative fuels, and microtechnology. This federally owned and contractor-operated laboratory annually receives approximately \$1 billion of core funding and conducts an estimated \$627 million of specific R&D projects. The laboratory has about 9,000 employees. A portion of the laboratory's funds is spent on the maintenance and operation of R&D equipment and facilities. An additional 890 people who work for Sandia National Laboratory in Albuquerque, New Mexico, are also located at this site.

Los Angeles, California, is home to HHS's Pacific Regional Lab-Southwest and a DVA R&D unit.

- The Pacific Regional Laboratory--Southwest is a unit of HHS's Food and Drug Administration. It conducts research on food and cosmetic safety. Specific areas of research activity focus on food and drug chemistry, pesticides, and microbiology. Coupled with this unit is the FDA's San Francisco District Laboratory in Alameda, California, which also conducts a small amount of R&D. Together these federal units annually receive approximately \$325,000 in federal R&D funds and have about four FTEs directly involved in R&D activities.
- While the principal focus of the VA Greater Los Angeles Health-care System facility, the VA Medical Center in West Los Angeles, is providing medical care to veterans, it is also the location of a number of research activities. In a recent year, this federally owned and operated facility was the site of 1,065 projects with total funding of approximately \$6 million. These R&D activities focus on a wide range of topics, including drug therapy, schizophrenia, epilepsy, investigational drugs, functional colonic diseases, Alzheimer's disease, neoplasms, and congestive heart failure.

Menlo Park, California, is home to DOI's Geologic Western Regional Office and its co-located Western Regional Coastal and Marine Geology Center, and Western Mapping Center.

- The Geologic Western Regional Office is a unit inside DOI's USGS. It oversees the R&D activities of Alaska, Hawaii, Washington, Oregon, California, Idaho, Nevada, Utah, and Arizona. These activities include research on geophysics, geochronology, earthquakes, landslide hazards, geochemistry, geologic mapping, climate change, oil and gas assessment, environmental monitoring and remediation, coal resource assessment, paleontology, and ecosystem analysis. Specific research activities in these regions involve using the USGS's four volcano observatories in Alaska, Washington, California, and Hawaii to study hazardous volcanoes and reduce losses; reducing earthquake hazards; and studying the geoenvironmental impacts of mercury and arsenic. One of the centers affiliated with this office is the Western Regional Coastal and Marine Geology Center, which conducts research on environmental quality and preservation, natural hazards and public safety, and natural resources and information technology as it relates to scientific instrumentation and data gathering. Specific research activities of this center include studying the marine sediment on the continental shelf south of Los Angeles to determine contamination amounts from historical sewage effluent discharges, conducting hydrothermal studies of the Gloria Ridge in Oregon, and conducting image mapping of sea floors. This federal R&D unit annually receives approximately \$70.8 million of federal R&D funds, which are dispersed throughout all the states in the western region, as are its employees.
- The Western Mapping Center is a unit of DOI's USGS. It is a production, research, and data management facility for maps and digital cartographic data products. This federal R&D unit annually receives approximately \$690,000 in federal R&D funds and has about 122 FTEs, 16 of whom are directly involved in R&D.

Moffett Field, California, is home to NASA's Ames Research Center and DOD's Aeroflightdynamics Research, Development, and Engineering Center's Applied Technology Directorate.

- The Ames Research Center is a unit of NASA. It conducts research on information technology, airspace operations systems, and astrobiology. Specific research activities focus on the exploration of life in the universe, the role of gravity in living systems, and the study of the Earth's atmosphere and ecosystems. Recent research projects have included the development of the Lunar Prospector spacecraft and a next-generation Internet architecture. This federal facility annually receives a total of approximately \$583 million, at least \$382 million of which directly involves R&D efforts. The center has about 1,478 FTEs, only a portion of whom are involved in R&D activities. A substantial portion of its funds is spent on the maintenance and operation of R&D equipment and facilities. In a recent year, over \$100 million of R&D contracts were awarded by the center, approximately \$67 million of which were made to entities based in California.
- The Aeroflightdynamics Directorate is a unit of DOD's Army Aviation Research, Development, and Engineering Center, headquartered in Huntsville, Alabama. A related directorate is at Fort Eustis, Virginia. It conducts R&D on all aspects of rotorcraft, including helicopters, tiltrotor aircraft, and other advanced rotary-wing aircraft. Specific major R&D activities of this unit include such areas as the aeromechanics, aerodynamics, design layout, structural dynamics, aeroelastic stability, flight controls, rotor loads and vibrations, pilot-vehicle interface, fluid controls, simulation, computational fluid dynamics, crew station design, and acoustics of all rotorcraft. This federal unit annually receives approximately \$22.5 million in federal R&D funds, approximately \$9.3 million of which are spent on in-house activities, and has about 118 civilian personnel, most of whom are directly involved in R&D activities. In October 1999, the Aviation Research, Development, and Engineering Center was provisionally merged with the Missile Research, Development, and Engineering Center, which is also headquartered in Huntsville, Alabama.

Monterey, California, is home to DOD's Naval Research Laboratory Fleet Numerical Meteorology and Oceanography Center and DOC's Monterey Bay National Marine Sanctuary.

- The Fleet Numerical Meteorology and Oceanography Center is a unit of DOD's Naval Research Laboratory headquartered in the District of Columbia. The center conducts R&D on atmospheric forecast systems. The center's research projects include the coupled ocean/atmosphere mesoscale prediction system, the Mediterranean gale force winds expert system, aerosols, and an automated tropical cyclone forecasting system. This federal unit annually receives approximately \$17.5 million of federal R&D funds, only a portion of which are spent on in-house activities, and has about 64 civilian personnel.
- The Monterey Bay National Marine Sanctuary is a unit of DOC's NOAA. Such sanctuaries conduct research on the marine environment to identify areas of special national significance stemming from their resource or human-use values and on the conservation and management of these marine areas, including restoration of damaged ecosystems. Specific R&D activities of this unit include studying human disturbances in kelp forests, assessing coastal erosion, characterizing ocean currents, studying the oceanographic conditions of El Niño, determining why the sanctuary is critical for whales, and assessing the impacts of significant red tide events. This federal unit annually receives approximately \$140,000 of federal R&D funds and has about five FTEs.

Pacific Grove, California, is home to DOC's Pacific Fisheries Environmental Laboratory.

- The Pacific Fisheries Environmental Laboratory is a unit of the Southwest Fisheries Science Center inside DOC's NOAA. It conducts research on the link between the environment and fisheries, physical oceanography, and fisheries climatology. Recent research activities of this laboratory include assessing the trends in species composition and size distribution of fisheries,

examining the large-scale climatic variability and environment relationships in ecosystems, and developing methodologies for analyzing long-term trends and changes in both oceanographic and fisheries time series. This federal unit annually receives approximately \$970,000 of federal R&D funds and has about 10 FTEs, only a portion of whom are involved in R&D activities.

Palo Alto, California, is home to a DVA R&D unit.

- While the principal focus of the VA Palo Alto Health Care System facility, the VA Medical Center in Palo Alto, is providing medical care to veterans, it is also the location of a number of research activities. In a recent year, this federally owned and operated facility was the site of 525 projects with total funding of approximately \$10.9 million. These R&D activities focus on a wide range of topics, including aging, Alzheimer's disease, cancer, spinal cord regeneration, and schizophrenia. The center's Rehabilitation Research and Development Center studies ways technology and engineering can assist the disabled—most specifically, computer-assisted, voice-activated robotic aid for quadriplegics and ultrasonic, head-controlled wheelchairs.

Pasadena, California, is home to NASA's Jet Propulsion Laboratory.

- The Jet Propulsion Laboratory is an FFRDC sponsored by NASA and operated by the California Institute of Technology. The laboratory conducts R&D in planets, Earth sciences, astrophysics, and telecommunications. Recent research activities include the Cassini mission to Saturn, the Microwave Limb Sounder to study the chemistry of Earth's upper atmosphere, the Space Infrared Telescope Facility (SIRTF) to study galaxy formation, and the Deep Space Network to image planets and asteroids. This federally owned and contractor-operated facility annually receives about \$1.1 billion of core funding, all of which is federal R&D funds, and has a workforce of 4,900 employees. A substantial portion of these funds is spent on the maintenance and operation of R&D equipment and facilities.

Port Hueneme, California, is home to DOD's Naval Facilities Engineering Services Center and Naval Surface Warfare Center Port Hueneme Division.

- The Naval Facilities Engineering Services Center is a unit of DOD. It conducts R&D in defense environmental restoration, pollution prevention equipment, and Navy shore facilities improvement. This federal unit annually receives about \$31 million of federal R&D funds, approximately \$21 million of which are spent on in-house activities, and employs about 534 civilians, only a portion of whom are directly involved in R&D activities.
- The Naval Surface Warfare Center Port Hueneme Division is a unit of DOD. It tests and evaluates surface-warfare ship combat systems and subsystems, unique equipment, and related expendable ordnance of the Navy Surface Fleet. It provides system engineering, development, and integration of Navy shipboard offensive and defensive combat weapons systems. The specific R&D activities of this unit focus on testing and evaluating weapon systems, combat systems, operational software, and all aspects of deployed systems. This federal unit annually receives about \$24.8 million of federal R&D funds for in-house activities and has about 2,300 civilian personnel, only a small portion of whom are directly involved in R&D activities.

Point Mugu, California, is home to a unit of DOD's Naval Air Warfare Center Weapon Division.

- The Naval Air Warfare Center Weapon Division is a unit of DOD. The center is headquartered in China Lake, California, with additional units at the Missile Range in White Sands, New Mexico, and Port Mugu. The portion of the center housed in Port Mugu is the Pacific Missile Test Center. Its R&D activities focus on air-to-air and air-to-surface missiles; avionics hardware, software, and total-combat flight programs; and electronic and information warfare. This federal unit employs about 1,940 civilians, only a portion of whom are directly involved in R&D

activities. Its budget is included in that presented above for the center's headquarters in China Lake, California.

Redding, California, is home to USDA's Redding Silviculture Laboratory.

- The Redding Silviculture Laboratory is a unit of the Pacific Southwest Research Station inside USDA's Forest Service. It conducts research on developing concepts, information, and predictive models of the dynamic nature of Western forests and determining the effects of various management strategies on forest productivity, health, and sustainability. Specific research activities of this laboratory include studies to understand how site characteristics, soil factors, and soil processes interact to influence productivity. This federal R&D unit annually receives approximately \$1.9 million of federal R&D funds and has about 28 employees.

Riverside, California, is home to USDA's U.S. Salinity Laboratory, National Clonal Germplasm Repository for Citrus, and Riverside Forest Fire Laboratory.

- The U.S. Salinity Laboratory is a unit of USDA's ARS located on the campus of the University of California at Riverside. It is composed of three research divisions focusing on soil physics and pesticides, plant science, and soil and water chemistry. They conduct basic research on the biology, chemistry, and physics of salt-affected soil-plant-water systems, alternatives to methyl bromide, and virus transport in soil. This federal R&D unit, in combination with the National Clonal Germplasm Repository for Citrus described directly below, annually receives approximately \$4 million of federal R&D funds and has about 51 FTEs.
- The National Clonal Germplasm Repository for Citrus is a unit of USDA's ARS located on the campus of the University of California at Riverside. It is a repository that collects, maintains, evaluates, preserves, and distributes pathogen-free clonal

germplasm of citrus, 32 related Aurantioideae genera, and date palms and related species and maintains an informational file on each accession. Research at this unit is conducted cooperatively with university scientists. Specific research activities of this unit include characterizing and evaluating citrus and date palm germplasm, developing a core subset based on molecular characterization, and studying seasonal variations in CTV titer under field conditions. The funding and staffing for this federal R&D unit are included with those presented for the U.S. Salinity Laboratory described immediately above.

- The Riverside Forest Fire Laboratory is a unit of the Pacific Southwest Research Station inside USDA's Forest Service. It conducts research on fire meteorology, management, and effects; air pollution and global change impacts on Western forest ecosystems; and wildland recreation and urban cultures. Specific research activities of the fire laboratory include the development of improved seasonal weather forecasts for fire management, and the development of knowledge to improve the capability of land managers to measure, model, predict, and mitigate the behavior and effects of prescribed fire, wildfire, and other disturbances on southwestern ecosystems. This federal R&D unit annually receives approximately \$4.4 million of federal R&D funds and has about 60 employees.

Sacramento, California, is home to DOI's Western Ecological Research Center and California District Office of Water Resources.

- The Western Ecological Research Center is a unit of DOI's USGS. It conducts research to address ecological information needs, including such areas as herpetology, conservation biology, wetlands ecology, and ecological restoration. The center has 16 field stations scattered throughout California in Redwood, Dixon, Pacific Coast, Point Reyes, the San Francisco Bay, Golden Gate, Santa Cruz, Yosemite, Kings Canyon, Piedras Blancas, Channel Islands, San Diego, Box Springs, San Simeon, Canyon Crest, Kern, and Davis. Specific research activities of

the center and its field units include studying the anthropogenic degradation of the southern California desert ecosystem, investigating declining species, and studying the ecology of the western pond turtle in the Mojave River. This federal R&D unit annually receives approximately \$3.9 million in federal R&D funds and has about 102 FTEs.

- The California District Office of Water Resources is a unit of DOI's USGS. It oversees the R&D activities of USGS's National Water-Quality Assessment (NAWQA), Ground-Water Resources Assessment, Toxic Substances Hydrology, and Federal State Cooperatives programs. The NAWQA program conducts research on the nation's surface and groundwater resources to better understand the effect of pesticides, erosion, and bacterial contamination on water quality. The Ground-Water Resources Assessment program studies groundwater systems to develop models and simulations to better understand the workings of these systems. The Toxic Substances Hydrology program studies the behavior of toxic substances in hydrologic environments. These research activities investigate subsurface contamination at local releases and aquatic ecosystem contamination on a watershed and regional scale. The Federal State Cooperatives program studies the effects of agricultural chemicals, floods, droughts, and waste disposal on water supply and groundwater quality. This federal unit annually receives approximately \$12.4 million in federal R&D funds.

Salinas, California, is home to USDA's Agricultural Research Station.

- The U.S. Agricultural Research Station is a unit of USDA's ARS. It conducts research on sugarbeets, vegetables, and melons. Specific research activities include breeding and genetics; control of viral, fungal, and bacterial diseases; weed control; and developing alternatives to methyl bromide for soilborne disease control. This federal R&D unit annually receives approximately \$2.6 million of federal R&D funds and has about 34 FTEs.

San Diego, California, is home to DOD's Naval Health Research Center, Space and Naval Warfare Systems Command and San Diego Systems Center, the Navy Personnel Research and Development Center, a unit of the Office of Naval Research, the Defense Technical Information Center's MATRIS Office, and a DVA R&D unit.

- The Naval Health Research Center is a unit of DOD. It conducts R&D on the biomedical and psychological aspects of the Navy and Marine Corps. Research areas include health and physical readiness, alcohol rehabilitation, and understanding the processes that lead to physical and mental performance degradation. Specific R&D projects have focused on the effects of exposure to environmental stressors (e.g., heat, cold, gravitational forces); identifying, developing, and evaluating countermeasures to performance degradation of environmental stressors; and measuring and understanding the physiological effects of protective gear on the individual. This federal unit annually receives about \$15 million of federal R&D funds, approximately \$4.7 million of which are spent on in-house activities, and employs 60 civilians, only a portion of whom are directly involved in R&D activities.
- The Space and Naval Warfare Systems (SPAWAR) Command is a unit of DOD. In addition to its headquarters unit, the command has two field stations that conduct R&D, known as Systems Centers, located in San Diego and Charleston, South Carolina. It conducts R&D on the collection, transmission, processing, display, and management of information essential for naval and warfare operations. Specific research activities of this unit include studies in atmospheric physics, electro-optics, underwater acoustics, engineering psychology, signal propagation and processing, artificial intelligence, material sciences, microelectronics, chemical oceanography, and environmental and biological sciences. This federal unit annually receives about \$445.7 million of federal R&D funds, approximately \$222.8 million of which are spent on in-house activities, and has about 1,085 civilian personnel, only a portion of whom are directly involved in R&D activities.

- The Space and Naval Warfare Systems Center in San Diego is a unit of DOD. It is a part of SPAWAR Command, also located in San Diego, and has an East Coast counterpart unit in Charleston, South Carolina. This center conducts R&D in the areas of command, control, communications, intelligence, surveillance, reconnaissance, and navigation. Specific R&D activities of this unit focus on undersea surveillance, communications networks, data links for information transfer, information assurance, military planning, navigation improvements, targeting threats, marine mammal use for harbor defense, environmental science for base/port environmental assessments, and wireless networks to improve connectivity. This federal unit annually receives about \$224.8 million of federal R&D funds, approximately \$98.5 million of which are for in-house activities, and has about 3,529 civilian personnel, only a portion of whom are directly involved in R&D activities. Virtually all of these R&D funds are provided to the center on a reimbursable basis to cover the costs of work being done for a variety of units throughout DOD and are therefore already reflected in amounts contained elsewhere in this report. A substantial portion of these funds is spent on the maintenance and operation of R&D equipment and facilities.
- The Navy Personnel Research and Development Center (NPRDC) is a unit of DOD. It conducts R&D on manpower and personnel. The center's R&D program encompasses recruiting, selection, and classification; personnel planning and policy analysis; distribution and assignment; knowledge management systems; personnel surveys; and program evaluation. A recent project focused on developing a comprehensive program to improve the Navy's management of its personnel resources. In November 1999, the NPRDC moved to Millington, Tennessee, and became known as the Navy Personnel Research, Studies, and Technology Department, a component of the Navy Personnel Command. This federal unit annually receives about \$8.4 million of federal R&D funds, approximately \$4.6 million of which are spent on in-house activities, and employs about 79

civilians, only a portion of whom are directly involved in R&D activities.

- The R&D Management Command is a unit of the Office of Naval Research (ONR) inside DOD. ONR is headquartered in Arlington, Virginia, and provides R&D managers to oversee the extramural R&D programs of the Navy and Marine Corps performed by universities, nonprofit organizations, or for-profit companies. ONR sponsors extramural R&D programs in information, electronics, and surveillance; ocean, atmosphere, and space; engineering, materials, and physical science; human systems; and naval expeditionary warfare. This federal unit annually receives approximately \$699,000 of federal R&D funds to support the in-house management activities of about 15 FTEs.
- The Manpower and Training Research Information System (MATRIS) Office is the unit of DOD's Defense Technical Information Center (DTIC) that provides information services in the fields of manpower, personnel, training, human factors, biomedicine, human safety, and human survivability to facilitate communications among researchers and prevent duplicative R&D efforts. This federal unit annually receives approximately \$750,000 of federal R&D funds and employs about eight people.
- While the principal focus of the VA San Diego Healthcare System facility, the VA Medical Center in San Diego, is providing medical care to veterans, it is also the location of a number of research activities. In a recent year, this federally owned and operated facility was the site of 839 projects with total funding of approximately \$7.7 million. These R&D activities focus on a wide range of topics, including AIDS, Alzheimer's disease, geropsychiatry, substance abuse, nursing service, diabetes, cardiology, and cardiac surgery.

San Francisco, California, is home to DOC's Gulf of Farallones and Cordell Bank National Marine Sanctuaries and a DVA R&D unit.

- The Gulf of Farallones and Cordell Bank National Marine Sanctuaries are units of the DOC's NOAA. Such sanctuaries conduct research on the marine environment to identify areas of special national significance stemming from their resource or human-use values and on the conservation and management of these marine areas, including restoration of damaged ecosystems. Specific R&D activities of these sanctuaries include the conduct of baseline studies of populations and habitats critical in the region, studying water quality, assessing habitats, and identifying the biological and behavioral characteristics of harbor seals. Other R&D activities include identifying the dynamics of the lush feeding ground for many marine mammals, seabirds, algae, invertebrates, endangered humpback whales, Dall's porpoises, albatross, shearwaters, and other marine species. Together, these federal units annually receive approximately \$144,000 of federal R&D funds and have two FTEs.
- While the principal focus of the San Francisco VA Medical Center is providing medical care to veterans, it is also the location of a number of research activities. In a recent year, this federally owned and operated facility was the site of 485 projects with total funding of approximately \$5.4 million. These R&D activities focus on a wide range of topics, including heart disease, aging, brain, HIV, gene expression, liver diseases, and substance abuse.

San Marino, California, is home to the Smithsonian Institution's West Coast Research Center.

- The West Coast Research Center is one of two regional units of the Smithsonian's Archives of American Art, headquartered in the District of Columbia. It is the only regional center to conduct research on-site, however. The archive conducts research on the visual arts in America, using primary source documentation. The overall archive (i.e., the headquarters and both regional centers) annually receives approximately \$830,000 of federal R&D funds, most of which is spent in the District of Co-

lumbia. The West Coast Research Center has an annual budget of approximately \$100,000 and a staff of one, who generally spends about 10 percent of the time conducting research.

Santa Barbara, California, is home to DOC's Channel Islands National Marine Sanctuary.

- The Channel Islands National Marine Sanctuary is a unit of DOC's NOAA. Such sanctuaries conduct research on the marine environment to identify areas of special national significance stemming from their resource or human-use values and on the conservation and management of these marine areas, including restoration of damaged ecosystems. Specific R&D activities of this unit include studying the sea floor using an underwater remotely operated vehicle; studying whale habitat and prey; studying the Ice Age through the system of stacked delta deposits that fringe the southern margin of the Santa Barbara Channel; and identifying the effects of shore runoff. This federal unit annually receives approximately \$71,000 of federal R&D funds and has one FTE.

Santa Cruz, California, is home to DOC's Tiburon (Santa Cruz) Laboratory.

- The Tiburon (Santa Cruz) Laboratory is a unit of the Southwest Fisheries Science Center inside DOC's NOAA. It studies the causes of variability in the abundance and health of fish populations, analyzes ecological relations in marine communities, and studies the economics of exploiting and protecting natural resources. The groundfish being studied at the laboratory include rockfishes, flatfishes, Pacific whiting, sablefish, and lingcod. The salmon being studied include coho, chinook, and steelhead. This federal unit has annually receives approximately \$2.7 million of federal R&D funds and has about 29 FTEs, only a portion of whom are involved in R&D activities.

Santa Monica, California, is home to DOD's Project AIR FORCE, Arroyo Center, and National Defense Research Institute.

- The Arroyo Center is an FFRDC sponsored by the Army and operated by RAND. The center helps the Army adapt to and stay ahead of changes in the world, define radical and different ways of operating, and maintain objectivity and balance on sensitive topics. It conducts research and analysis on such diverse areas as the connection between the Army's land management and environmental problems and the Army's logistics management system. This federally owned and contractor-operated R&D unit employs approximately 75 people and annually receives about \$18 million of core funding, all of which is federal R&D funds.
- Project AIR FORCE is an FFRDC sponsored by the Air Force and operated by RAND. It provides the Air Force with independent analyses of policy alternatives affecting the development, deployment, combat readiness, and support of current and future aerospace forces. Research activities focus on global engagements; aerospace force development; aircraft survivability; manpower, personnel, and training; resource management; weapons costing; and strategy and doctrine. This federally owned and contractor-operated R&D unit employs approximately 105 people and annually receives about \$23 million of core funding, all of which is federal R&D funds.
- The National Defense Research Institute (NDRI) is an FFRDC sponsored by the Office of the Secretary of Defense, the Joint Staff, and the defense agencies and operated by RAND. It conducts research on acquisition and technology policy, forces and resources policy, and international security and defense policy. Specific research activities of NDRI have focused on warfare in the information age, implications of new technology for national security, how the worldwide military situation is changing and how these changes affect U.S. interests, ways to develop and acquire effective military forces, the enlargement of NATO, U.S. aircraft carrier production, and integrating women into the military. This federally owned and contractor-operated R&D unit employs approximately 78 people and annually receives about \$22 million of core funding, all of which is federal R&D funds.

Shafter, California, is home to USDA's Western Integrated Cropping Systems Research Unit.

- The Western Integrated Cropping Systems Research Unit, also known as the Shafter Research Laboratory, is a unit of USDA's ARS. It conducts research on the development of modern, sustainable systems for the production of cotton and other irrigated crops. Specific research activities include developing the Shafter Airborne Multispectral Remote Sensing System, a system designed to be flown aboard a light aircraft to acquire high-resolution images of the Earth's surface in different wavelengths of light. This federal R&D unit annually receives approximately \$915,000 of federal R&D funds and has about 16 FTEs.

Stanford, California, is home to DOE's Stanford Linear Accelerator Center.

- The Stanford Linear Accelerator Center is an FFRDC sponsored by DOE and operated by Stanford University. This center conducts basic research on the structure of matter at the atomic level, using X rays, and, at much smaller levels, using electron and positron beams. This federally owned and contractor-operated center annually receives approximately \$175 million of core funding and conducts an estimated \$166 million of specific R&D projects. The center has about 1,300 employees. A portion of the center's funds is spent on the maintenance and operation of R&D equipment and facilities.

Fresno, Loma Linda, Long Beach, Pleasant Hill, and Sepulveda, California, are home to VA Medical Centers. While the principal focus of all of these facilities is providing medical care to veterans, each center is also the location of a number of research activities. In a recent year, these federally owned and operated facilities have been the sites of 1,129 R&D projects with total funding of close to \$7 million. These R&D activities focus on a variety of topics, including spinal cord injuries, Alzheimer's disease, osteoporosis, and congestive heart failure.

FEDERAL R&D GRANTS TO CALIFORNIA ENTITIES

Every major institution of higher education in California is the recipient of significant federal R&D dollars each year through grants made by federal agencies to faculty, graduate students, and research centers. The vast majority of the R&D grants are made by HHS, NSF, and DOD to individual faculty members and therefore ultimately inure to the benefit of such institutions as the University of California (U of Calif), Stanford University, the University of Southern California (USC), California Institute of Technology (Caltech), California State University (Cal State), Loma Linda University, and the Charles R. Drew University of Medicine and Science (Drew). The table below shows the number of R&D grants active in FY 1998, highlighting those made by HHS, NSF, and DOD to parties at the various institutions and estimates of the total dollars transferred to them in FY 1998 pursuant to the terms of these grants. Among the grants in the “Other Agencies” category going to the University of California are ones from DOE (\$47 million), NASA (\$35 million), the Environmental Protective Agency (EPA) (\$13 million), USDA (\$12 million), DOC (\$6 million), and the Department of Education (\$6 million). The comparable grants going to Stanford include \$11 million from NASA, \$7 million from DOE, and \$4 million from the Department of Trans-

Table 5.1 – Sources of Federal R&D Grants to Higher Education in California

| Institution | HHS | | NSF | | DOD | | Other Agencies | | Total | |
|--------------|-----------------|--------------|---------------|--------------|---------------|------------|----------------|--------------|-----------------|---------------|
| | Amount | # | Amount | # | Amount | # | Amount | # | Amount | # |
| U of Calif | \$759M | 3,330 | \$163M | 2,270 | \$88M | 458 | \$124M | 2,037 | \$1,134M | 8,095 |
| Stanford | \$175M | 680 | \$23M | 347 | \$26M | 121 | \$24M | 183 | \$249M | 1,331 |
| USC | \$99M | 312 | \$16M | 213 | \$11M | 71 | \$6M | 78 | \$132M | 674 |
| Caltech | \$27M | 151 | \$24M | 230 | \$16M | 73 | \$19M | 155 | \$86M | 609 |
| Cal State | \$23M | 119 | \$11M | 189 | \$3M | 19 | \$11M | 109 | \$48M | 436 |
| Loma Linda | \$4M | 25 | <\$1M | 3 | 0 | 0 | \$3M | 2 | \$7M | 30 |
| Drew | \$6M | 17 | 0 | 0 | <\$1M | 1 | 0 | 0 | \$6M | 18 |
| Other | \$5M | 40 | \$4M | 93 | \$1M | 6 | \$5M | 58 | \$14M | 197 |
| Total | \$1,099M | 4,674 | \$241M | 3,345 | \$145M | 746 | \$191M | 2,622 | \$1,676M | 11,390 |

portation. Most of the dollars in this category going to Caltech came equally from DOE and NASA.

These activities are particularly significant because they fund much of the “basic research” so critical to expanding our knowledge and understanding of fundamental scientific phenomena. In addition, these funds account for a substantial portion of the dollars available each year to various academic departments within these institutions, such as the Scripps Institution of Oceanography Graduate Department at the University of California at San Diego. These higher education institutions in California also received R&D grants in the neighborhood of \$68 million from DOE and \$61 million from NASA in FY 1998.

Several other nonacademic institutions in California also receive a significant amount of federal R&D grants each year. Foremost among the institutions that received R&D grants in FY 1998 are Scripps Research Institute in La Jolla (\$116 million), Science Applications International Corporation (SAIC) in San Diego (\$63 million), Salk Institute for Biological Studies in La Jolla (\$36 million), City of Hope National Medical Center in Duarte (\$22 million), Burnham Institute in La Jolla (\$21 million), Lawrence Berkeley National Laboratory in Berkeley (\$17 million), and RAND in Santa Monica (\$17 million).

Scattered among these grants, as well as among the contracts discussed in the section below, are small business innovative research (SBIR) awards. These are special awards made by SBIR programs supported by the 10 federal agencies with annual budgets for extramural R&D of more than \$100 million. In a recent year, small businesses in California received 852 SBIR awards totaling \$230 million. Examples include a \$500,000 award from the Department of Transportation to Akela, Inc., in Santa Barbara to study the feasibility of using impulse radar to detect and identify detonators and a \$700,000 award from HHS to Metrika Laboratories, Inc., in Mountain View to develop a digital single-use total and HDL cholesterol self-test.

Also included among these grants are formula grants from federal agencies. Formula grants differ from the much more common project grants in that the money transmitted through formula grants is allocated to a state or one of its subdivisions in accordance with a distribution formula prescribed by law or regulation. Among the formula

grants benefiting California are ones valued at more than \$5.7 million from USDA's Cooperative State Research, Education, and Extension Service (CSREES) to State Agricultural Experiment Stations, forestry schools, and veterinary colleges for the support of research in agriculture, forestry, and animal health and disease. Similarly, a modest formula grant goes from DOI's USGS to the Water Resources Research Institute in California every year to foster research into water and water-related problems.

OTHER FEDERAL R&D ACTIVITIES IN CALIFORNIA

Several entities in California also receive notable sums in the form of contracts or cooperative agreements from federal agencies for specific R&D efforts. The majority of these funds go from DOD to Lockheed Martin Corporation, which in FY 1998 received close to \$775 million in contracts for R&D work on such programs as the Theater High-Altitude Air Defense (THAAD) system for the Army and the Space-Based Infrared System for the Air Force. In addition, TRW (\$647 million), Boeing Company (\$565 million), SAIC (\$339 million), and McDonnell Douglas Corporation (\$298 million) received very large R&D contracts from federal agencies in FY 1998. Included among these awards is one for approximately \$17 million for the operation of the Energy Technology Engineering Center (ETEC) for DOE. Note that these amounts are in addition to any federal R&D grants also received by these companies. For example, SAIC received close to \$63 million in R&D grants from HHS in FY 1998. Stanford (\$69 million), the University of California (\$64 million), USC (\$29 million), and Caltech (\$15 million) also received contracts from various federal agencies to conduct R&D for the federal government. Although these amounts are notable, they do not come close to eclipsing the funds that these institutions receive from federal R&D grants.

A total of \$276 million of federal R&D dollars in the form of cooperative agreements was also received in FY 1998 by entities in California. By far the largest of these cooperative agreements (\$34 million in FY 1998) came from NSF to Caltech in Pasadena for operation and supporting R&D of the Laser Interferometer Gravitational-Wave Ob-

servatory (LIGO). Another of these cooperative agreements (\$8 million in FY 1998) came from DOC to the University of California's Scripps Institution of Oceanography to operate the Joint Institute for Marine Observations (JIMO). Other federal agencies awarding cooperative agreements to California-based entities include DOE, DOC, DOD, and NSF. Among these latter cooperative agreements are awards supporting five of NSF's Science Technology Centers—the Center for Engineering Plants for Pathogen Resistance at the University of California at Davis; the Center for Clouds, Chemistry, and Climate at University of California at San Diego; the Southern California Earthquake Center at the University of Southern California (cofunded by DOI's USGS); the Center for Quantized Electronic Structures at the University of California at Santa Barbara; and the Center for Particle Astrophysics at the University of California at Berkeley. In addition, California is home to four of NSF's Materials Research Science and Engineering Centers—the Center for Magnetic Recording Research at the University of California at San Diego; the Materials Research Science and Engineering Center at the University of California at Santa Barbara; the Center for Materials Research at Stanford University; and the Center for Polymer Interfaces and Macromolecular Assemblies jointly supported by Stanford University, IBM-Almaden, and the University of California at Davis.