

Chapter 22

Federal Research and Development in Massachusetts

- Approximately \$3.6 billion of federal R&D funds are spent each year in Massachusetts.
- Massachusetts ranks 6th among the 50 states, District of Columbia, and Puerto Rico in terms of the amount of federal R&D dollars received annually.
- Approximately 22 percent of all federal funds spent in Massachusetts 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.

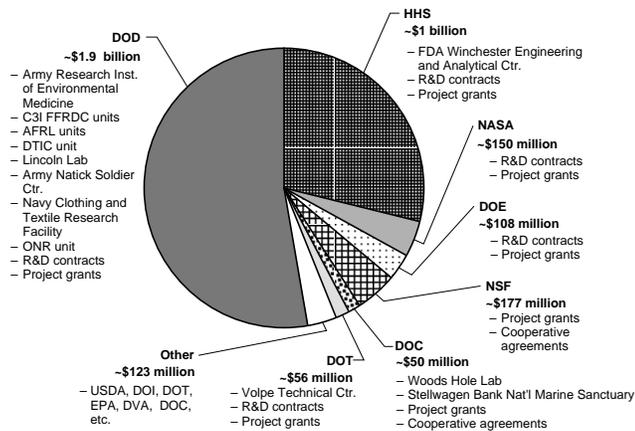


Figure 22.1 – Sources of Federal R&D Dollars Spent in Massachusetts (Total Federal R&D ~\$3.6 billion)

BACKGROUND

In recent years, the federal government has spent in the neighborhood of \$3.6 billion annually in Massachusetts on research and development (R&D) activities. On average, federal R&D dollars account for approximately 22 percent of all federal funds spent in Massachusetts 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 Massachusetts. Foremost among these agencies is the Department of Defense (DOD), which accounts for 53 percent of all federal R&D dollars spent in the state. The Department of Health and Human Services (HHS) accounts for 29 percent of the federal R&D dollars spent in Massachusetts, while the National Science Foundation (NSF) and the National Aeronautics and Space Administration (NASA) account for an additional 5 and 4 percent, respectively. The remaining federal R&D dollars come collectively from the Departments of Agriculture (USDA), Commerce (DOC), Energy (DOE), Interior (DOI), and Transportation (DOT) and several other federal agencies.²²

All federal R&D dollars spent in Massachusetts 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 Massachusetts.

FEDERAL R&D UNITS IN MASSACHUSETTS

Amherst, Massachusetts, is home to DOI's Massachusetts Cooperative Fish and Wildlife Research Units and a unit of USDA's Northeastern Research Station.

²² For a complete agency-by-agency breakdown of these R&D dollars, see Appendix C.

- The Massachusetts Cooperative Fish and Wildlife Research Unit is part of DOI's U.S. Geological Survey (USGS). It is on the Amherst campus of the University of Massachusetts. It conducts research on fishery ecology, wildlife populations, and natural resources. Specific research activities of this unit include evaluating wildlife population models and researching anadromous fish ecology. This federal R&D unit annually receives approximately \$200,000 of federal R&D funds and has about three FTEs.
- The R&D Work Site is a unit of the Northeastern Research Station inside USDA's Forest Service. It conducts research on the ecological factors affecting U.S. forests. Specific research activities of this unit have focused on the relationship between small-mammal communities in forests and breeding bird communities in forests. This federal R&D unit annually receives approximately \$1.1 million of federal R&D funds and has about five employees.

Bedford, Massachusetts, is home to DOD's Command, Control, Communications, and Intelligence Federally Funded Research and Development Center (FFRDC) and a Department of Veterans Affairs (DVA) R&D unit.

- The Command, Control, Communications, and Intelligence FFRDC is sponsored by the Office of the Secretary of Defense and operated by the MITRE Corporation. It conducts R&D on command, control, communications, and intelligence systems for DOD and the intelligence community. The center has three divisions, the Center for Air Force Integrated Intelligence Systems, the Center for Integrated Intelligence Systems, and the C3 Center. This latter division is in McLean, Virginia. The first division provides the Air Force, most especially the Electronic Systems Center, with comprehensive command and control knowledge, expertise, and experience. The R&D activities of the second division focus on developing concepts for intelligence activities, enhancing architectures for information man-

agement, and engineering intelligence systems. The combined divisions of this federally owned and contractor-operated facility annually receive about \$180 million of federal R&D funds and employ approximately 1,450 people.

- While the principal focus of the Edith Nourse Rogers Memorial Veterans Hospital, the VA Medical Center in Bedford, 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 85 projects with total funding of approximately \$4 million. These R&D activities focus on a wide range of topics, including chronic disease epidemiology, cardiovascular disease, cancer, pulmonary disease, mental health, hematology, gastrointestinal disease, hypertension, diabetes, and genetics.

Boston, Massachusetts, is home to a part of DOD's Air Force Research Laboratory Space Vehicles Directorate, a part of Air Force Research Laboratory Sensors Directorate, a unit of the Office of Naval Research, and a regional office of the Defense Technical Information Center; USDA's Human Nutrition Research Center on Aging; DOI's North Atlantic Field Station; and a DVA R&D unit.

- The Space Vehicles Directorate at Hanscom Air Force Base is a unit of DOD's Air Force Research Laboratory. It is headquartered in Albuquerque, New Mexico. This unit conducts R&D on exploiting and controlling space. This federal unit annually receives approximately \$27 million of federal R&D funds, only about 11 percent of which is spent on in-house R&D activities, and has about 239 civilian personnel, only a portion of whom are involved in R&D activities.
- The Sensors Directorate Electromagnetics Technology Division at Hanscom Air Force Base is a unit of DOD's Air Force Research Laboratory. The directorate is headquartered in Dayton, Ohio, with another site in Rome, New York. This division conducts R&D to meet Air Force needs for air, space, and command and control applications in electromagnetics, related elec-

tronic and electro-optics, and information security technologies. In addition, it conducts R&D on the entire electromagnetic spectrum from deep ultraviolet to microwaves to address the growing needs of warfighters for cost-effective performance options. This federal unit annually receives approximately \$9 million of federal R&D funds, only about 28 percent of which is spent on in-house R&D activities, and has about 108 civilian personnel, only a portion of whom are 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 at 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 \$792,000 of federal R&D funds to support the in-house management activities of about 17 FTEs.
- The Northeastern Regional Office of the Defense Technical Information Center (DTIC) contributes to the 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 \$150,000 of federal R&D funds and employs about two people, only one of whom is involved in R&D activities.
- The Human Nutrition Research Center on Aging (HNRC) is a unit of USDA's Agricultural Research Service (ARS). It conducts research on the influence of nutrition on the aging process. Specific research activities of this center include studies of the influences of nutrition on tissue loss, the role of nutrition in the

genesis of chronic degenerative conditions, and the nutritional requirements necessary to maintain optimal well-being of an older person. This federal R&D unit receives approximately \$15.1 million of federal R&D funds and has about 14 FTEs.

- The North Atlantic Field Station is a unit of the Patuxent Wildlife Research Center inside DOI's USGS. It conducts research on and surveys of the Massachusetts shoreline. Specific research activities of this unit include obtaining field data required to develop and implement a numerical model of circulation within the Nauset estuary and Cape Cod National Seashore and studying the flushing rate of Town Cove to assess the limits on groundwater-delivered nutrients and their affects on the estuary. This federal R&D unit receives approximately \$92,000 in federal R&D funds and has one FTE.
- While the principal focus of the Boston 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 273 projects with total funding of approximately \$9.7 million. These R&D activities focus on a wide range of topics, including behavioral toxicology, cancer epidemiology, behavioral psychopathology, and immunotoxicology. One particularly noteworthy research project of the center focused on the neurological function in veterans suffering from environmental exposures.

Brockton, Massachusetts, is home to a DVA R&D unit.

- While the principal focus of the Brockton 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 236 projects with total funding of approximately \$4.4 million. These R&D activities focus on a wide range of topics, including understanding the pathophysiology, clinical characteristics, and treatment of schizophrenia.

Cambridge, Massachusetts, is home to DOT's John A. Volpe National Transportation Systems Center and the Smithsonian Institution's Astrophysical Observatory.

- The John A. Volpe National Transportation Systems Center is a unit of DOT's Research and Special Programs Administration. It conducts research on accident prevention, acoustics measurement, GPS applications, and surveillance and sensors technology. Specific R&D activities of the center include assessing the use of GPS for highway vehicles; evaluating GPS outage reporting systems for civilian and military aviators; developing and improving various types of meteorological sensors for airport applications; and developing sensors for the detection, tracking, and characterization of aircraft wake turbulence. The Volpe Center is not directly funded under the federal budget. Instead, the center relies totally on fee-for-service payments to support its operations. Nevertheless, over two-thirds of the center's R&D activities are funded by DOT and other federal agencies.
- The Astrophysical Observatory, part of the Smithsonian Institution, conducts research in astronomy, astrophysics, and Earth and space sciences in close coordination with the observatory at Harvard. This research, while interrelated and complementary, is organized according to the following divisions: atomic and molecular physics, high-energy astrophysics, optical and infrared astronomy, planetary sciences, radio and geoastronomy, solar and stellar physics, and theoretical astrophysics. Observational data are gathered by instruments aboard rockets, balloons, and spacecraft, as well as by ground-based telescopes at the Fred Lawrence Whipple Observatory in Arizona and the Oak Ridge Observatory in Massachusetts, and by a millimeter-wave radio telescope in Cambridge. The observatory annually receives approximately \$16.5 million of federal R&D funds and has about 141 FTEs, an estimated two-thirds of whom are involved in R&D activities. A substantial portion of these funds is spent on the maintenance and operation of R&D equipment and facilities.

Lexington, Massachusetts, is home to DOD's Lincoln Laboratory.

- Lincoln Laboratory is an FFRDC sponsored by the Air Force and operated by the Massachusetts Institute of Technology. It conducts R&D on communications, space surveillance, missile defense, tactical surveillance systems, air traffic control, and air defense. This federally owned and contractor-operated unit annually receives approximately \$370 million of federal R&D funds and has about 2,500 civilian personnel.

Natick, Massachusetts, is home to DOD's Navy Clothing and Textile Research Facility, Army Research Institute of Environmental Medicine, and Natick Soldier Center.

- The Navy Clothing and Textile Research Facility is a unit of DOD. It is the primary developer of uniforms and protective clothing ensembles worn by Navy sailors. The R&D activities of the facility focus on the design, improvement, and assessment of protective garments and equipment, including ballistic helmets and vests, firefighting ensembles, life vests, environmental and steam protective clothing, chemical agent protection ensembles, and protective handwear and footwear. This federal facility annually receives about \$1.7 million of federal R&D funds, approximately \$1.5 million of which are spent on in-house activities, and has about 36 civilian personnel, only a portion of whom are directly involved in R&D activities.
- The Army Research Institute of Environmental Medicine is a unit of DOD. It conducts R&D in environmental and occupational medicine. More specifically, research is conducted in biochemistry, biophysics and biomedicine, thermal medicine, and environmental health research. This federal unit annually receives about \$10 million of federal R&D funding, approximately \$7 million of which is spent on in-house activities, and has about 79 civilian personnel.
- The Natick Soldier Center, formerly known as the Natick Research, Development, and Engineering Center, is a unit of DOD. It conducts R&D for the Army on the technologies required by

the soldier and soldier support systems, particularly soldier survivability, sustainability, mobility, and quality of life in the field. The R&D activities of the center touch on biotechnology, anthropometry, biomechanics, consumer research, textiles, fibers and materials, food science, aerodynamics, and modeling and simulation. This federal unit annually receives about \$89 million of federal R&D funds, approximately \$25 million of which is spent on in-house activities, and has about 450 civilian personnel, only a portion of whom are directly involved in R&D activities.

Northborough, Massachusetts, is home to DOI's Massachusetts District Office of Water Resources.

- The Massachusetts 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, in combination with the Rhode Island District Office, annually receives approximately \$1.4 million in federal R&D funds.

Scituate, Massachusetts, is home to DOC's Stellwagen Bank National Marine Sactuary.

- The Stellwagen Bank National Marine Sanctuary is a unit of DOC's National Oceanic and Atmospheric Administration (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 how variations in the underwater landscape affect the distribution and abundance of fishes and related species and determining why endangered North Atlantic right whales spend time in Cape Cod Bay and the southern section of Stellwagen Bank during late winter and early spring. This federal unit annually receives approximately \$50,000 of federal R&D funds and has one FTE.

Turners Falls, Massachusetts, is home to DOI's Silvio O. Conte Anadromous Fish Research Laboratory.

- The Silvio O. Conte Anadromous Fish Research Laboratory is a unit of DOI's USGS. It conducts both basic and applied research relative to biological and management concerns regarding anadromous fish populations and their associated ecosystems. Specific research activities of this unit include restoring and enhancing anadromous fishes and discovering the environmental and resource consequences resulting from dams or altered ecosystems. This federal R&D unit annual receives approximately \$1.4 million of federal R&D funds and has about 18 FTEs.

Winchester, Massachusetts, is home to HHS's Winchester Engineering and Analytical Center.

- The Winchester Engineering and Analytical Center is a unit of HHS's Food and Drug Administration. The center conducts research on medical devices, radiation-emitting products (e.g., microwaves), and radioactive drugs to determine their effect on health. This federal unit annually receives approximately \$3.4 million of federal R&D funds and has about 37 FTEs directly involved in R&D activities.

Woods Hole, Massachusetts, is home to DOC's Woods Hole Laboratory and DOI's Woods Hole Geology Field Center.

- The Woods Hole Laboratory is the headquarters of the Northeast Fisheries Science Center inside DOC's NOAA. The overall center monitors and analyzes fishery resources and their effects on the ecosystem. The specific research conducted at Woods Hole focuses on the collection and analysis of data on fishery resources and the status and dynamics of their habitat, the ecological processes that control resource productivity, and the performance of the fisheries. This federal unit annually receives approximately \$9.2 million of federal R&D funds and has about 115 FTEs, only a portion of whom are involved in R&D activities.
- Woods Hole Geology Field Center is a unit of DOI's USGS. It conducts research on the submerged regions of the U.S. Exclusive Economic Zone and the Great Lakes, focusing on the coastal areas. Specific research activities of this center include seafloor mapping of Massachusetts Bay; geologically interpreting the seafloor near Falkner Island, Connecticut; and conducting environmental research on contaminants and red tides. This federal R&D unit, which is affiliated with the Geologic Eastern Regional office in Reston, Virginia, annually receives approximately \$9.6 million of federal R&D funds and has about 70 employees.

FEDERAL R&D GRANTS TO MASSACHUSETTS ENTITIES

Every major institution of higher education in Massachusetts 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 Harvard University, Massachusetts Institute of Technology (MIT), Boston University, the University of Massachusetts (U of Mass), Tufts University, Brandeis University,

Northeastern University, and Boston College (BC). The table below shows the total number of R&D grants that were active in FY 1998, highlighting those made by HHS, NSF, DOD, and NASA 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 Harvard are \$6 million from DOE and \$4 million from the EPA. The grants in this same category going to MIT include \$9 million from DOE and \$2 million each from DOC and EPA. The comparable grants going to Boston U include \$3 million from DOE and \$1 million from the Department of Education. The grants going to U of Mass include \$4 million from USDA, \$3 million from DOE, and \$1 million from the Department of Education.

Table 22.1 – Sources of Federal R&D Grants to Higher Education in Massachusetts

Institution	HHS		NSF		DOD		NASA		Other Agencies		Total	
	Amount	#	Amount	#	Amount	#	Amount	#	Amount	#	Amount	#
Harvard	\$191M	715	\$19M	240	\$11M	44	\$5M	76	\$10M	54	\$236M	1,129
MIT	\$63M	246	\$30M	395	\$34M	154	\$11M	228	\$15M	87	\$152M	1,110
Boston Univ	\$87M	331	\$13M	180	\$8M	38	\$4M	67	\$5M	32	\$117M	648
U of Mass	\$60M	317	\$15M	238	\$5M	42	\$2M	34	\$8M	209	\$90M	840
Tufts	\$37M	176	\$2M	55	\$1M	4	<\$1M	8	\$2M	22	\$43M	265
Brandeis	\$18M	114	\$3M	49	<\$1M	3	<\$1M	8	\$1M	6	\$23M	180
Northeastern	\$5M	36	\$5M	87	\$4M	11	<\$1M	4	\$1M	12	\$15M	150
BC	\$4M	27	\$3M	34	<\$1M	4	<\$1M	7	<\$1M	9	\$8M	81
Other	\$10M	86	\$7M	145	\$1M	6	\$1M	20	\$1M	22	\$20M	279
Total	\$476M	2,048	\$97M	1,423	\$63M	306	\$23M	452	\$44M	453	\$703M	4,682

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 School of Medicine at Harvard University.

Several other nonacademic institutions in Massachusetts also receive a significant amount of federal R&D grants each year. Foremost among these institutions that received R&D grants in FY 1998 are Massachusetts General Hospital in Boston (\$136 million), Brigham & Women's Hospital in Brookline (\$133 million), Dana-Farber Cancer Institute in Boston (\$64 million), Beth Israel Hospital in Boston (\$63 million), and Children's Hospital in Boston (\$50 million). Worthy of note as well, the Woods Hole Oceanographic Institute received over \$21 million of R&D grants from NSF alone in FY 1998.

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 the 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 Massachusetts received 627 SBIR awards totaling \$160 million. Examples include an \$800,000 award from HHS to Innovative Training Systems, Inc., in Newton for development of an addiction-severity assessment tool and a \$700,000 award from DOE to Physical Sciences, Inc., in Andover for work on control of mercury emissions from fossil fuel-fired power plants.

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 Massachusetts are ones valued at more than \$2.2 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 Massachusetts every year to foster research in water and water-related problems.

OTHER FEDERAL R&D ACTIVITIES IN MASSACHUSETTS

Several entities located in Massachusetts also receive notable sums in the form of contracts or cooperative agreements from federal agencies for specific R&D efforts. By far the majority of these funds go to the Raytheon Company, which in FY 1998 received close to \$180 million in contracts from DOD for R&D work on such programs as the National Missile Defense Ground-Based Radar, Joint Precision Strike Demonstration, and RIM-7P Sea Sparrow Missile Systems. In addition, Range Systems Engineering Company (\$113 million), Tasc, Inc. (\$63 million), the Institute for Defense and Disarmament Studies (\$50 million), and Abt Associates (\$39 million) received very large R&D contracts from federal agencies in FY 1998. Note that these amounts are in addition to any federal R&D grants also received by these companies. For example, Abt Associates received close to \$25 million in R&D grants from HHS in FY 1998. Also worthy of particular note are the more than \$20 million in contracts awarded each year by NASA to the Smithsonian Institution, another federal R&D agency, for R&D at the Chandra X-Ray Observatory, formerly the Advanced X-Ray Astrophysics Facility, in Cambridge, Massachusetts. MIT, Boston University, and the University of Massachusetts also received contracts from various federal agencies to conduct R&D for the federal government that totaled several million dollars for each university. 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 \$97 million of federal R&D dollars in the form of cooperative agreements was also received in FY 1998 by entities located in Massachusetts. By far the largest of these cooperative agreements (\$28 million) came from DOE to support the Laboratory for Nuclear Science at MIT. Another of these cooperative agreements (\$100,000) came from DOC to the Woods Hole Oceanographic Institution to operate the Cooperative Institute of Climate and Ocean Research (CICOR). Other federal agencies awarding cooperative agreements to Massachusetts-based entities include NSF, DOD, and DOC. Among these latter cooperative agreements are awards supporting three of NSF's Materials Research Science and Engineering Centers—the Cen-

ter for Polymer Science and Engineering at the University of Massachusetts at Amherst, the Center for Materials Science and Engineering at MIT, and the Materials Research Center at Harvard.

