

Trends in Marine Science Degrees and Future Workforce Pathways to Increase Underrepresented Minority Participation

Matt Gilligan

May 2015

Without direct and targeted effort, we risk losing 1) the contributions of a large and growing segments of the U.S. population to remain globally competitive and 2) new perspectives from diverse demographic backgrounds in the future marine science workforce. And besides, persistent and profound underrepresentation just looks bad.

- 2014 COL OSER meeting presentations
- LSAMP/NAML lab connections
- Increasing UM workforce pipeline/pathways/supply chain (REU programs-→ Grad. programs)

Trends in Marine Science Degree Completions

Matt Lettrich

September 2014

Purpose

To identify trends in degree completions in marine science and related disciplines using the Department of Education's IPEDS* data.

- Matt did this work while at NSF
- Poster at 2014 NMEA meeting
- Presented it at the 2014 OSER meeting in Savannah
- Now at NOAA and met recently with NOAA Education Office to discuss continuing and also working with OL to ground-truth their survey data

“Core” Marine Disciplines

CIP Title (CIP-6 Code)

Ocean Engineering (14.2401)

Marine Biology and Biological Oceanography (26.1302)

Marine Sciences (30.3201)

Oceanography, Chemical and Physical (40.0607)

“Related” Marine Disciplines

CIP Title (CIP-6 Code)

Aquaculture (01.0303)

Fishing and Fisheries Sciences and Management (03.0301)

Wildlife, Fish and Wildlands Science and Management (03.0601)

Water, Wetlands, and Marine Resources Management (03.0205)

Ecology (26.1301)

Aquatic Biology/Limnology (26.1304)

Hydrology and Water Resources Science (40.0605)

Geophysics and Seismology (40.0603)

Marine Science/Merchant Marine Officer (49.0309)

Operational Oceanography (29.0306)

Maritime Studies (30.2901)

Geological and Earth Sciences/Geosciences, Other (40.0699)

“Core” CIP Title	Definition
Ocean Engineering	A program that prepares individuals to apply mathematical and scientific principles to the design, development and operational evaluation of systems to monitor, control, manipulate and operate within coastal or ocean environments, such as underwater platforms, flood control systems, dikes, hydroelectric power systems, tide and current control and warning systems, and communications equipment; the planning and design of total systems for working and functioning in water or underwater environments; and the analysis of related engineering problems such as the action of water properties and behavior on physical systems and people, tidal forces, current movements, and wave motion.
Marine Biology and Biological Oceanography	A program that focuses on the scientific study of the ecology and behavior of microbes, plants, and animals inhabiting oceans, coastal waters, and saltwater wetlands and their interactions with the physical environment. Includes instruction in chemical, physical, and geological oceanography; molecular, cellular, and biochemical studies; marine microbiology; marine botany; ichthyology; mammalogy; marine population dynamics and biodiversity; reproductive biology; studies of specific species, phyla, habitats, and ecosystems; marine paleoecology and paleontology; and applications to fields such as fisheries science and biotechnology.
Marine Sciences	A program that focuses on the study of biology, chemistry, geology and physics applied to marine, estuarine and coastal environments. Includes instruction in marine biogeochemistry, atmosphere and ocean dynamics, coastal ecology, coastal ocean processes, microbial ecology, marine ecosystem modeling, and polar microbiology.
Oceanography, Chemical and Physical	A program that focuses on the scientific study of the chemical components, mechanisms, structure, and movement of ocean waters and their interaction with terrestrial and atmospheric phenomena. Includes instruction in material inputs and outputs, chemical and biochemical transformations in marine systems, equilibria studies, inorganic and organic ocean chemistry, oceanographic processes, sediment transport, zone processes, circulation, mixing, tidal movements, wave properties, and seawater properties.

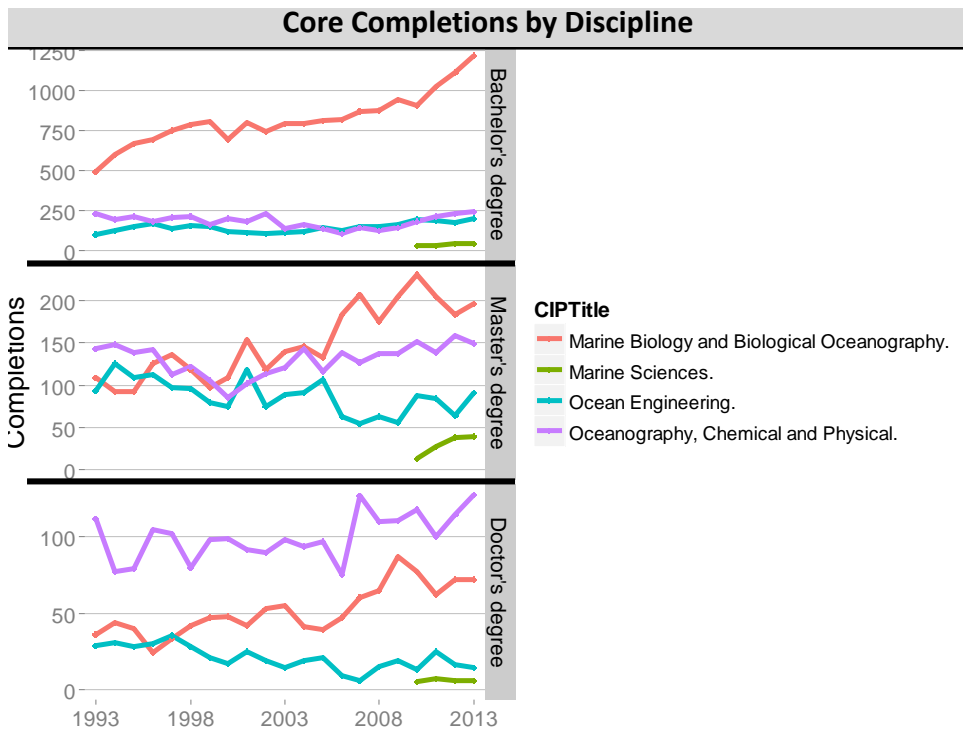
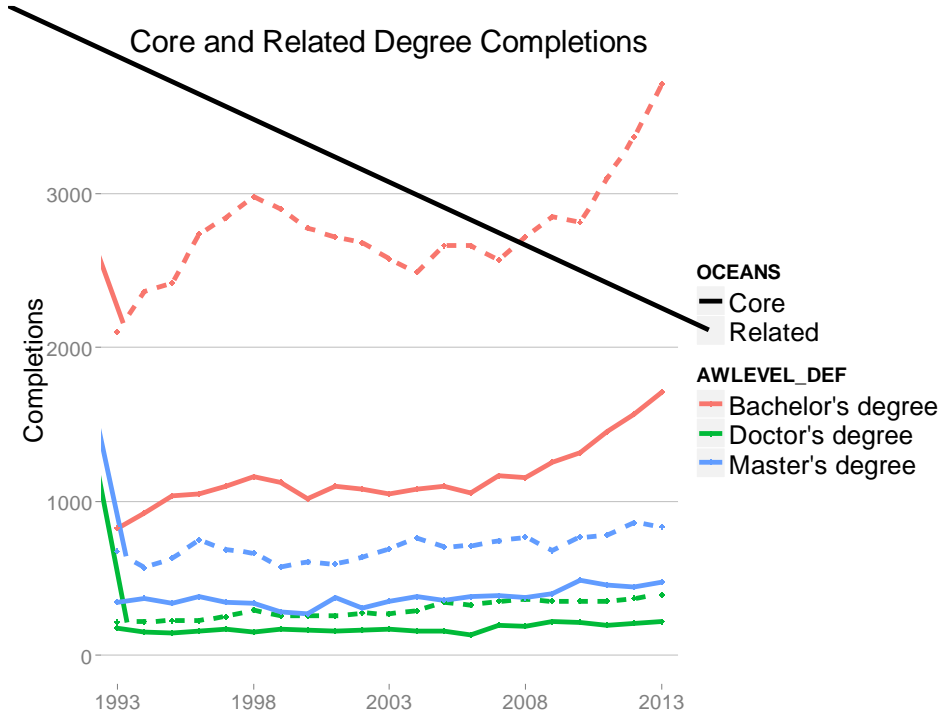
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"Related" CIP Title	Definition
Aquaculture	A program that prepares individuals to select, culture, propagate, harvest, and market domesticated fish, shellfish, and marine plants, both freshwater and saltwater. Includes instruction in the basic principles of aquatic and marine biology; health and nutrition of aquatic and marine life; design and operation of fish farms, breeding facilities, culture beds, and related enterprises; and related issues of safety, applicable regulations, logistics, and supply.
Fishing and Fisheries Sciences and Management	A program that focuses on the scientific study of the husbandry and production of non-domesticated fish and shellfish populations for recreational and commercial purposes and the management of fishing and marine/aquatic product processing to ensure adequate conservation and efficient utilization. Includes instruction in the principles of marine/aquatic biology, freshwater and saltwater ecosystems, water resources, fishing production operations and management, fishing policy and regulation, and the management of recreational and commercial fishing activities.
Wildlife, Fish and Wildlands Science and Management	A program that prepares individuals to conserve and manage wilderness areas and the flora, marine and aquatic life therein, and manage wildlife reservations and zoological/aquarium facilities for recreational, commercial, and ecological purposes. Includes instruction in wildlife biology, marine/aquatic biology, environmental science, freshwater and saltwater ecosystems, natural resources management and policy, outdoor recreation and parks management, the design and operation of natural and artificial wildlife habitats, applicable law and regulations, and related administrative and communications skills.
Water, Wetlands, and Marine Resources Management	A program that prepares individuals to apply the principles of marine/aquatic biology, oceanography, natural resource economics, and natural resources management to the development, conservation, and management of freshwater and saltwater environments. Includes instruction in subjects such as wetlands, riverine, lacustrine, coastal, and oceanic water resources; water conservation and use; flood control; pollution control; water supply logistics; wastewater management; aquatic and marine ecology; aquatic and marine life conservation; and the economic and recreational uses of water resources.
Ecology	A program that focuses on the scientific study of the relationships and interactions of small-scale biological systems, such as organisms, to each other, to complex and whole systems, and to the physical and other non-biological aspects of their environments. Includes instruction in biogeochemistry; landscape and/or marine/aquatic dynamics; decomposition; global and regional elemental budgets; biotic and abiotic regulation of nutrient cycles; ecophysiology; ecosystem resilience, disturbance, and succession; community and habitat dynamics; organismal interactions (co-evolution, competition, predation); paleoecology; and evolutionary ecology.
Aquatic Biology/Limnology	A program that focuses on the scientific study of the ecology and behavior of microbes, plants, and animals inhabiting inland fresh waters such as lakes, ponds, rivers, creeks, estuaries, and wetlands. Includes instruction in geology and hydrology; aquatic ecosystems; microbiology, mycology; botany; ichthyology; mammalogy; population biology and biodiversity; studies of specific species, phyla, and habitats; and applications to fields such as natural resources conservation, fisheries science, and biotechnology.
Hydrology and Water Resources Science	A program that focuses on the scientific study of the occurrence, circulation, distribution, chemical and physical properties, and environmental interaction of surface and subsurface waters, including groundwater. Includes instruction in geophysics, thermodynamics, fluid mechanics, chemical physics, geomorphology, mathematical modeling, hydrologic analysis, continental water processes, global water balance, and environmental science.
Geophysics and Seismology	A program that focuses on the scientific study of the physics of solids and its application to the study of the earth and other planets. Includes instruction in gravimetric, seismology, earthquake forecasting, magnetometry, electrical properties of solid bodies, plate tectonics, active deformation, thermodynamics, remote sensing, geodesy, and laboratory simulations of geological processes.
Marine Science/Merchant Marine Officer	A program that prepares individuals to serve as captains, executive officers, engineers and ranking mates on commercially licensed inland, coastal and ocean-going vessels. Includes instruction in maritime traditions and law, maritime policy, economics and management of commercial marine operations, basic naval architecture and engineering, shipboard power systems engineering, crew supervision, and administrative procedures.
Operational Oceanography	A program that focuses on the study of physical oceanography as applied to the naval tactical and strategic environment and the support of military operations. Includes instruction in atmospheric thermodynamics and radiation propagation, air-ocean fluid dynamics, ocean waves, nearshore environments and processes, ocean acoustics, ocean analysis, tactical oceanography, prediction, and related quantitative and experimental methods.
Maritime Studies	A program that focuses on the history, science, policy issues, and literature of the ocean. Includes instruction in maritime history, maritime law, maritime literature, oceanography, maritime security, and maritime politics.
Geological and Earth Sciences/Geosciences, Other	Any instructional program in geological and related sciences not listed above.

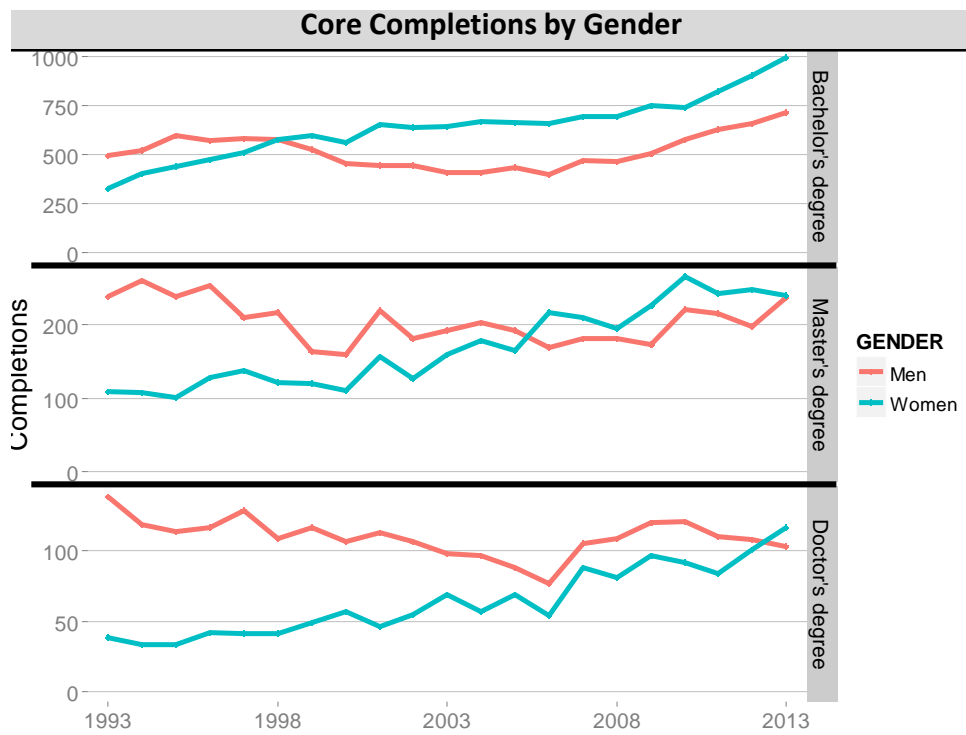
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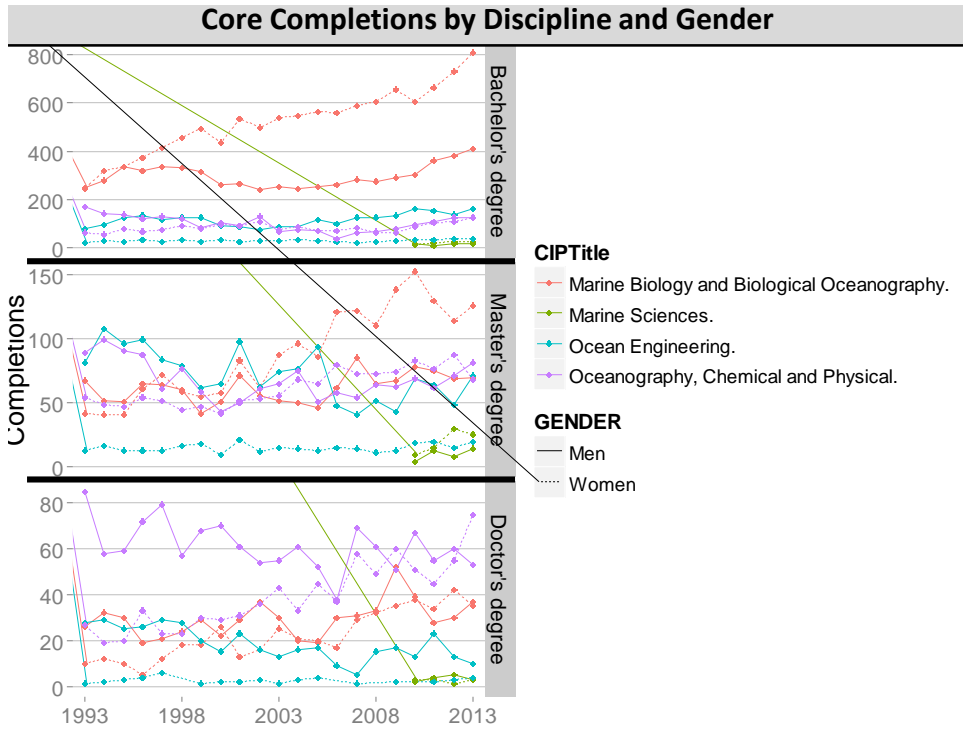
About the Data

- Freely Available from Dept. of Education
- Collected every year
- Completions between July 1-June 30
- Reported by all institutions receiving federal \$
- Does not include concentrations or tracks

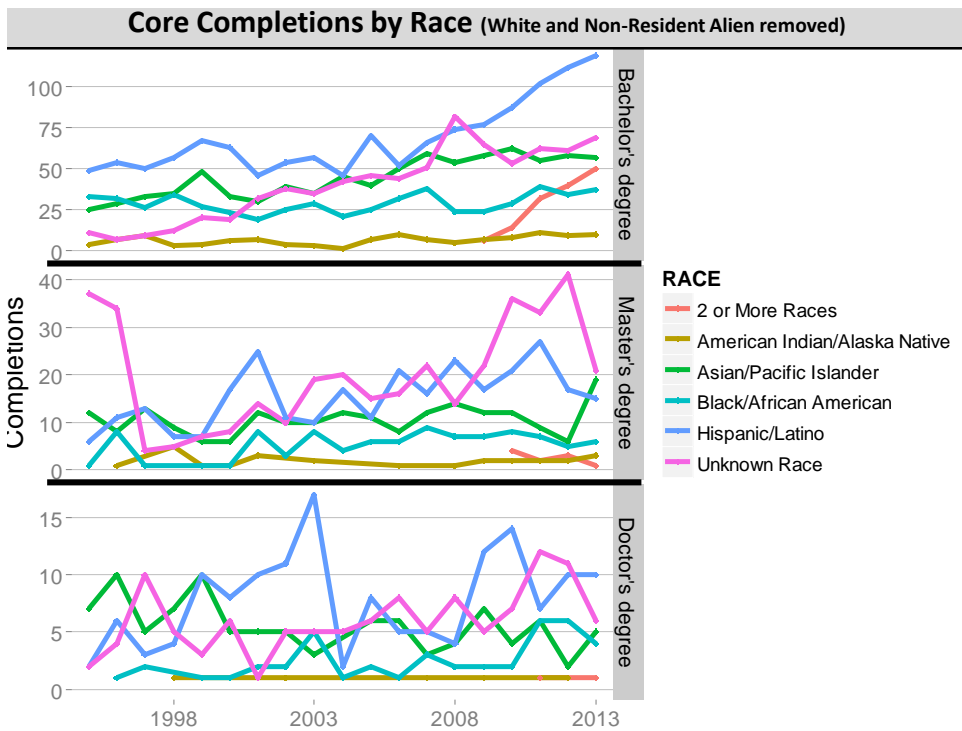
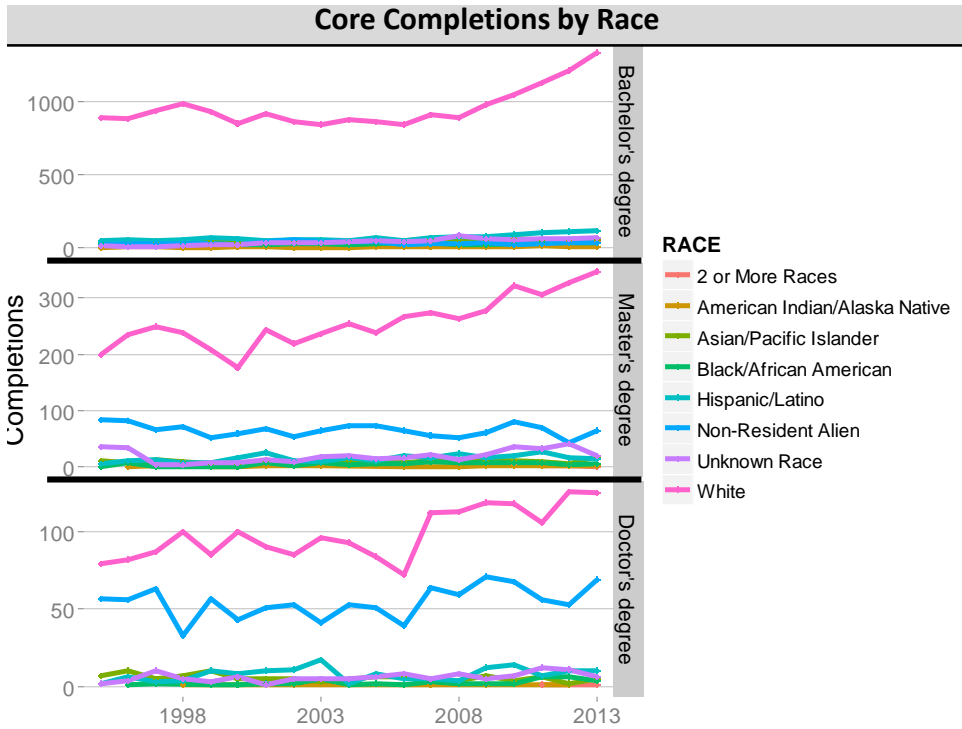


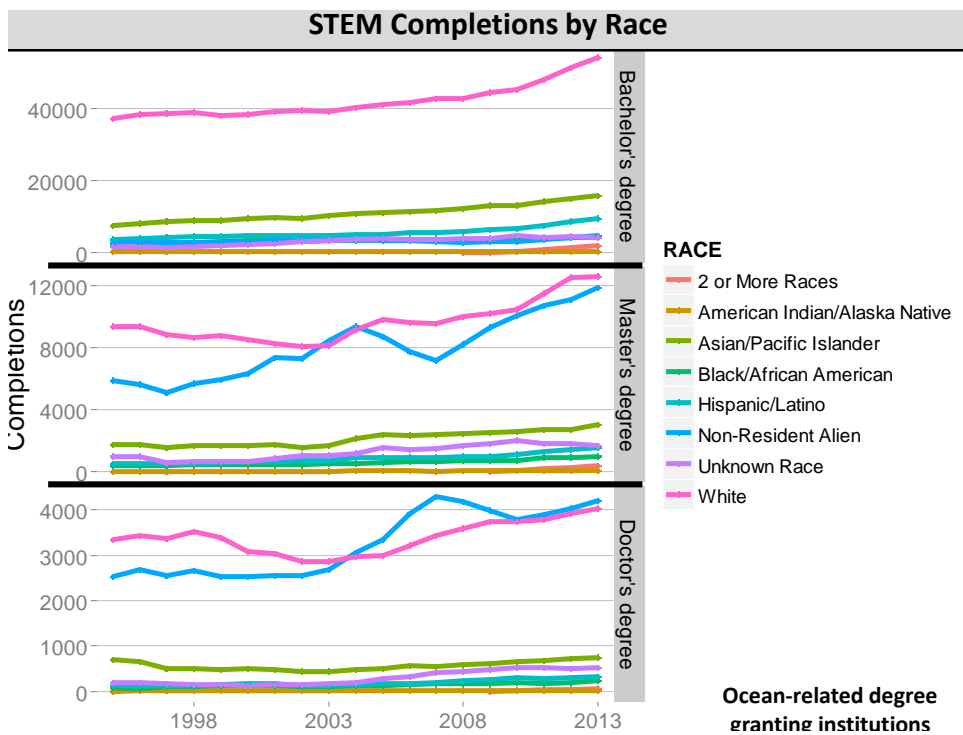
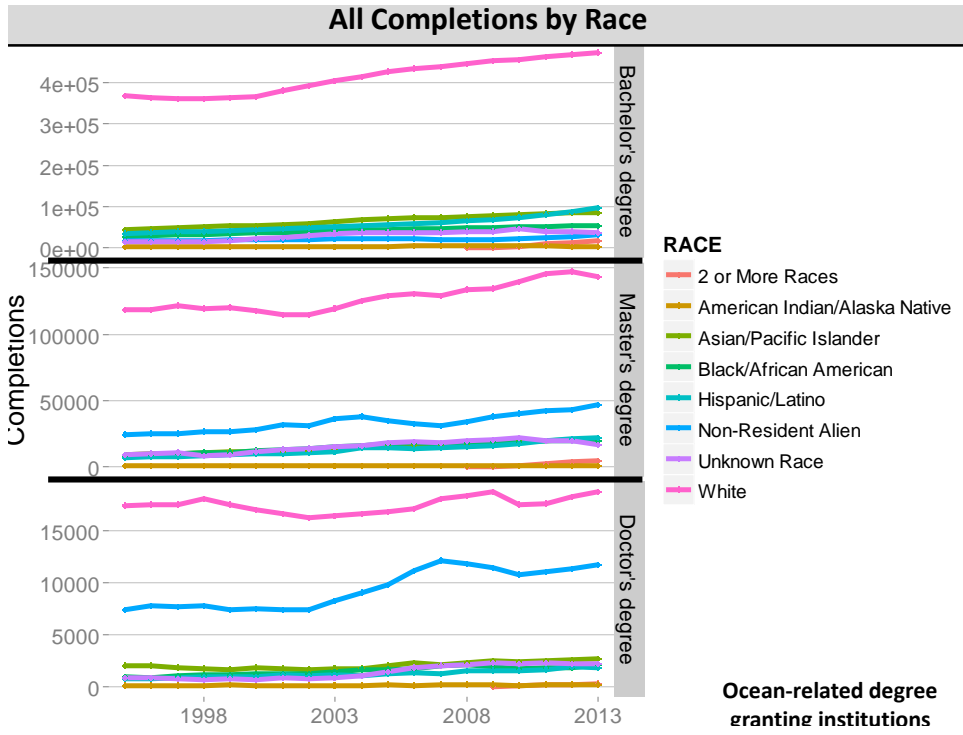
Trends By Gender

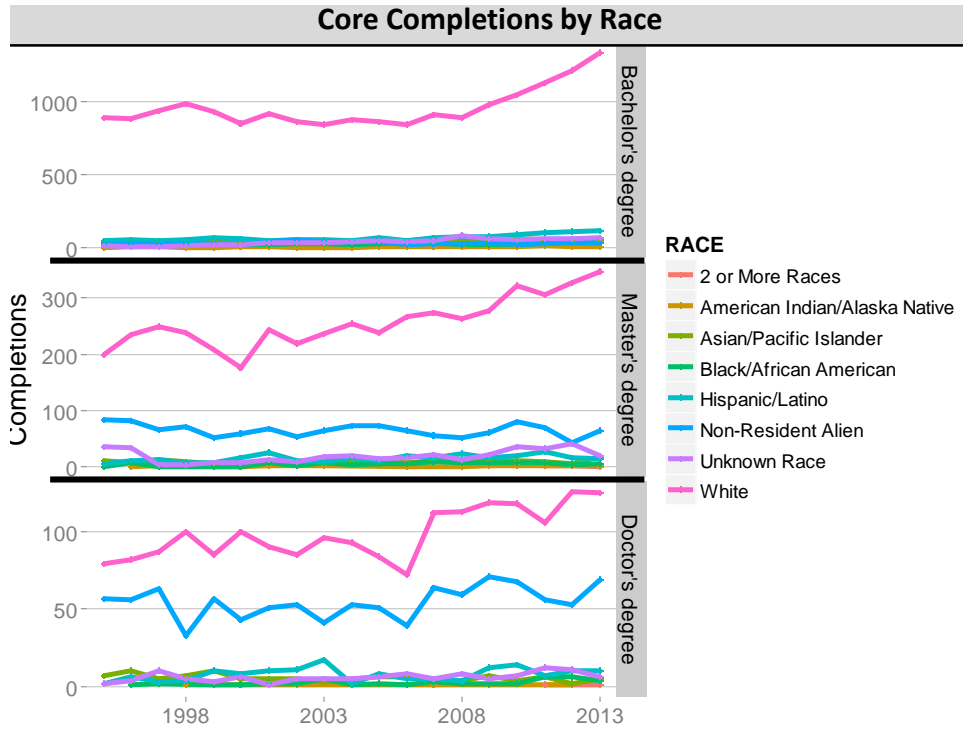




Trends By Race

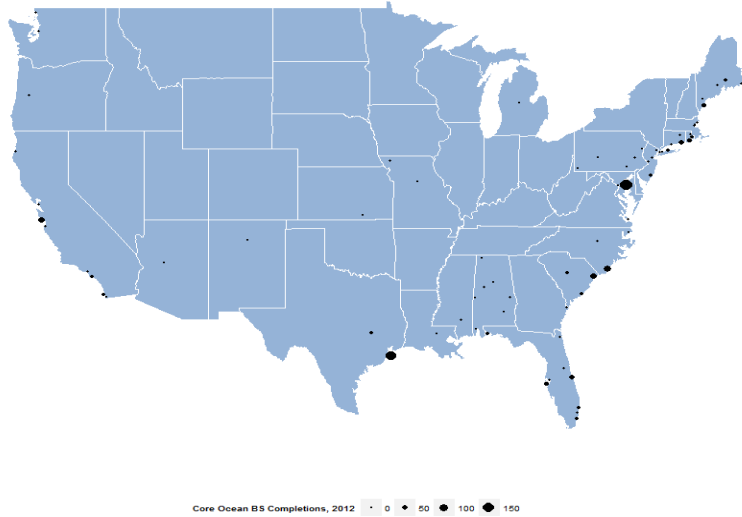




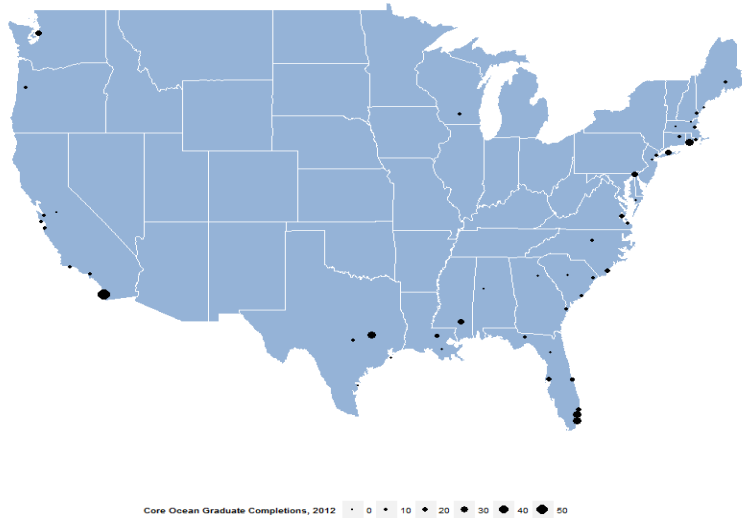


Geographic Distribution

Undergraduate Completions Geographic Distribution, 2012



Graduate Completions Geographic Distribution, 2012



Top Bachelor's

Row Labels	Marine Biology and Biological Oceanography
Texas A & M University-Galveston	1540
University of North Carolina Wilmington	1458
University of California-Santa Cruz	1261
Coastal Carolina University	1190
Eckerd College	874
The Richard Stockton College of New Jersey	693
University of South Carolina-Columbia	673
University of Miami	653
Florida Institute of Technology	580
College of Charleston	541
Roger Williams University	499
University of Hawaii at Hilo	456
University of Rhode Island	407
California State University-Long Beach	374
The University of West Florida	373
University of New England	369
Hawaii Pacific University	347
The University of Tampa	310
Western Washington University	252
University of San Diego	248
University of California-Los Angeles	247
University of Puerto Rico-Humacao	237
Auburn University	197
Boston University	186
Stony Brook University	182
Jacksonville University	173
East Stroudsburg University of Pennsylvania	167
Savannah State University	158
Fairleigh Dickinson University-Metropolitan Campus	155
Hampton University	141

Row Labels	Ocean Engineering
United States Naval Academy	1064
Texas A & M University-College Station	550
Florida Atlantic University	439
Florida Institute of Technology	358
Texas A & M University-Galveston	308
University of Rhode Island	271
Massachusetts Institute of Technology	67

Row Labels	Oceanography, Chemical and Physical
United States Naval Academy	1415
United States Coast Guard Academy	654
University of Washington-Seattle Campus	422
University of Miami	222
Humboldt State University	170
Florida Institute of Technology	162
Kutztown University of Pennsylvania	138
Rider University	118
North Carolina State University at Raleigh	102
The University of Tampa	76
University of California-Berkeley	49
Millersville University of Pennsylvania	44
University of Michigan-Ann Arbor	40
Texas A & M University-Galveston	32
University of San Diego	29
Elizabeth City State University	26
Louisiana State University and Agricultural & Mechanical College	26
University of Maine	25
Hawaii Pacific University	24
University of Southern Mississippi	23
The University of West Florida	21
Nova Southeastern University	20
Central Michigan University	14
Massachusetts Institute of Technology	9
Lamar University	8
University of North Carolina Wilmington	4

Top Master's

Row Labels	Marine Biology and Biological Oceanography
Nova Southeastern University	366
Stony Brook University	319
College of William and Mary	307
College of Charleston	242
University of North Carolina Wilmington	196
University of Maryland-College Park	181
Florida Institute of Technology	156
University of California-San Diego	152
University of Puerto Rico-Mayaguez	139
University of Maryland Eastern Shore	93
University of South Carolina-Columbia	92
University of Southern Mississippi	70
University of Alaska Fairbanks	65
University of Miami	63
University of Delaware	60
Northeastern University	57
Coastal Carolina University	57
Nicholls State University	55
University of San Diego	54
Savannah State University	48
California State University-Monterey Bay	43
San Jose State University	39
University of Georgia	37
University of Maine	35
University of California-Santa Barbara	29
Texas State University	24
Hawaii Pacific University	20
San Francisco State University	17
The University of Alabama	16
University of California-Santa Cruz	15

Row Labels	Ocean Engineering
Massachusetts Institute of Technology	493
Florida Atlantic University	312
Texas A & M University-College Station	237
University of Florida	179
Florida Institute of Technology	125
University of Rhode Island	113
Stevens Institute of Technology	113
University of Hawaii at Manoa	92
University of New Hampshire-Main Campus	64
University of California-Berkeley	38
Oregon State University	26
University of Delaware	24
University of Connecticut	11
George Washington University	3
Louisiana State University and Agricultural & Mechanical College	1
University of Miami	1
University of Southern California	1

Row Labels	Oceanography, Chemical and Physical
University of Washington-Seattle Campus	247
University of Southern Mississippi	214
University of South Florida-Main Campus	208
Naval Postgraduate School	184
University of Rhode Island	181
Texas A & M University-College Station	179
University of Hawaii at Manoa	163
University of California-San Diego	160
Louisiana State University and Agricultural & Mechanical College	139
Old Dominion University	132
Florida Institute of Technology	131
Oregon State University	116
University of North Carolina Wilmington	116
Florida State University	105
University of Connecticut	88
University of Maine	52
University of Alaska Fairbanks	49
Rutgers University-New Brunswick	42
University of Miami	42
University of North Carolina at Chapel Hill	39
Massachusetts Institute of Technology	35
University of Wisconsin-Madison	32
University of California-Santa Cruz	19
Stony Brook University	19
University of Michigan-Ann Arbor	16
Western Connecticut State University	14
Nova Southeastern University	5
University of San Diego	4

Top Doctor's

Marine Biology and Biological Oceanography.		Ocean Engineering.		Oceanography, Chemical and Physical.	
Row Labels		Row Labels		Row Labels	
College of William and Mary	209	Massachusetts Institute of Technology	144	University of California-San Diego	298
University of Maryland-College Park	137	University of Florida	69	University of Rhode Island	185
University of California-San Diego	133	Texas A & M University-College Station	69	University of Washington-Seattle Campus	162
University of Miami	118	Florida Atlantic University	47	Texas A & M University-College Station	153
University of Puerto Rico-Mayaguez	81	University of Hawaii at Manoa	30	University of South Florida-Main Campus	151
Stony Brook University	75	Stevens Institute of Technology	30	Louisiana State University and Agricultural & Mechanical College	133
University of Delaware	59	University of Rhode Island	21	Oregon State University	104
University of South Carolina-Columbia	48	Florida Institute of Technology	10	Massachusetts Institute of Technology	100
University of California-Santa Barbara	46	University of Delaware	5	Stony Brook University	96
University of Georgia	45	University of California-Berkeley	5	Florida State University	93
University of Maryland Eastern Shore	31	University of New Hampshire-Main Campus	3	University of Hawaii at Manoa	88
University of Southern Mississippi	26	George Washington University	1	Old Dominion University	81
University of Maryland-Baltimore County	16			University of California-Santa Cruz	50
University of North Carolina-Wilmington	16			University of Connecticut	42
University of Alaska Fairbanks	14			University of Delaware	42
University of Maine	11			University of North Carolina at Chapel Hill	41
University of Maryland-Baltimore	8			Rutgers University-New Brunswick	41
Duke University	5			University of Wisconsin-Madison	40
University of Massachusetts-Dartmouth	3			University of Miami	39
Texas A & M University-Corpus Christi	2			University of Alaska Fairbanks	36
Texas A & M University-Galveston	2			University of Maine	32
Texas A & M University-College Station	1			University of Southern Mississippi	26
				Florida Institute of Technology	25
				University of Michigan-Ann Arbor	22
				Nova Southeastern University	18
				Naval Postgraduate School	8
				University of Southern California	1

Demographics of Ocean Science Graduate Programs Some Long Term Perspectives

Russell McDuff
Board Chair, OceanGate Foundation
Professor Emeritus, UW School of Oceanography

37 Years of Data

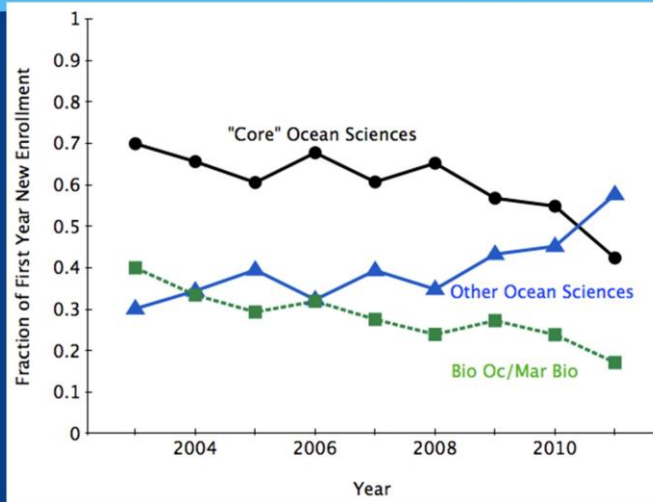
- * First Data Gathering In 1978 Dating to 1975
- * Over The Years Many Thanks to Charley Hollister, Arthur Nowell, Jake Pierson, John Farrington, Mel Briscoe; Henry Hope, Sue Cook, Allison Miller, Amanda Holloway
- * JOI -> 1994, CORE 1995-2007, COL 2007-
- * Alas: Preservations, Scope and Format Inconsistent

Data Fidelity and Consistency

Some (and Perhaps Substantial) Limitations

- * Changing mix of responding institutions from year to year
- * Internal consistency of data provided
- * Continuity of record as survey instrument changes
- * Heterogeneous set of institutions
- * Ever changing institutional representatives

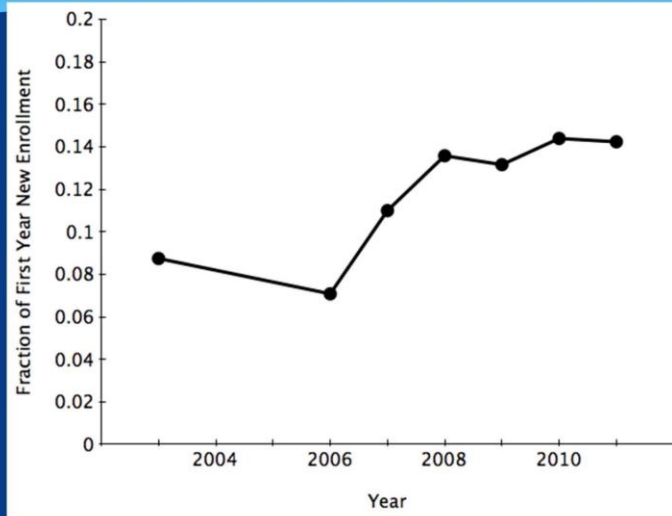
Disciplinary Expertise: New Enrollment



Program Population: Ethnicity

Ethnicity	Fraction of Graduate Students
Caucasian	88
Hispanic	4
Asian American	5
Native American	1
African American	2

Ethnicity: New Enrollment



Savannah State University

B.S. Marine Science Degree

Approved 1979

Marine Biology (1985-1998)

Marine Sciences (1999-present)

M.S. Marine Science Degree

Approved 2001

A.S. Aquarium Science Degree

Approved 2010



SSU Marine Science degrees

B.S. ~9/yr recently

M.S. ~5/yr (same as UGA M.S./Ph.D)

28th in the nation B.S.

20th in nation for M.S. (Lettrich, IPEDS data)

Degrees earned by African-Americans in the Ocean Sciences from 2002-12:

47% of the M.S.

89% of the B.S. (NSF data, 2014)

Keys to Success

- Institutional culture of nurturing and retention (small schools, community colleges, MSIs) vs sink or swim.
skills/financial/family/social situations
- Undergraduates must be engaged quickly and experience the sciences fully, inspiring confidence to pursue advanced degrees and careers.

SSU's Bridge to Research Model for REU

(Early engagement 1994-2008, 2009-)

Last 6 years: 92% retention of UMs (African-American 58%; Hispanic, 6%; Asian/Nat.Am./Alaskan, 7%), first-generation (33% since 2013), community-college (7% since 2013), and young (Freshmen, 30%; Sophomore 49%) SSU REU participants in the STEM pipeline.

Repeated surveys of students during the first 6 years identified significant improvement ($p < 0.05$) in students' conceptualization of scientific research; written and oral communication skills; and career-related skills (improve 2-5 years after their initial REU).

Evolution of the NSF REU Program and Opportunities

- Early formal research skills development bridging to more traditional REU.
- Screening in by excluding those w/previous exp. First should be best possible.
- Feeder for more traditional (no-repeat waiver).
- Recruitment networks = LSAMP

The Louis Stokes Alliances for Minority Participation Program (NSF)

- Becoming a Scientist or Engineer: Your Pathway to the Future with LSAMP
https://www.youtube.com/watch?v=Li90yoX_dGA rt 5
- LSAMP: Aiming High and Making a Difference
- <https://www.youtube.com/watch?v=53y7QJoH7Co> rt 30

LSAMP

- Congressional Commission to NSF late 1980s
- Name changed to LSAMP in 1999 upon the retirement of Congressman Stokes
- Goals: Increasing number of UMs earning STEM degrees and entering graduate programs.
- 400k UM participants since early 1990s
- Currently there are 39 multi-institution alliances w/30K graduates per year

COSEE-TEK – LSAMP COLLABORATION: THE OCEAN SCIENCE AND TECHNOLOGY CHALLENGE – DEVELOPING 21ST CENTURY SKILLS

Babb, I. G.; Payne, D. L.; Erickson, J.; McKee, M. P.; Joy, K.; Hamilton, J.; Jewell, M.; University of Connecticut

The Center for Ocean Sciences Education Excellence – Technology and Engineering for Knowledge (COSEE-TEK) and the Louis Stokes Alliance for Minority Participation (LSAMP) Northeast Alliance have been collaborating for the past three years to engage underrepresented minority undergraduate students in STEM.

Involved teams of students from each of the Northeast Alliance schools working with COSEE-TEK mentors to design, build, and field test an autonomous sensor or sampling device. The OSTC culminated with a two-day workshop at UConn Avery Point that provided the teams time to finalize and test their technologies on the water from the RV Connecticut. Students also explored Long Island Sound from the Project Oceanology vessel the Envirolab.

COSEE-TEK – LSAMP COLLABORATION: THE OCEAN SCIENCE AND TECHNOLOGY CHALLENGE – DEVELOPING 21ST CENTURY SKILLS

Babb, I. G.; Payne, D. L.; Erickson, J.; McKee, M. P.; Joy, K.; Hamilton, J.; Jewell, M.; University of Connecticut

Results of 2 Years of Pre/Post Evaluation

In 2013, students recognized the value of inquiry, working as a team and hands-on experiences. In 2014 with all five universities in the NE Alliance represented the responses to questions related to skills was not as pronounced. However, there was significant uptick in the number of students considering a career in ocean science or engineering. The OSTC provides an evolving model to both build skills and affect thinking about careers in the ocean sciences and engineering.

IBP/OSREU/LSAMP Pilot Project

- NAML origin: Art Hicks at 2007 NAML meeting
- Pre-proposals (Matt) Sep. meetings w/Art @Lisa Rom and IBP staff → formal proposal.
- 1 yr., \$30k award to IBP (MG PI DS Co-) to increase applications from UMs to OS REUs (~30)
- Presentation at LSAMP PI/PDs meeting in D.C.
- Funding to attend 5 LSAMP meetings.

IBP/OSREU/LSAMP Pilot Project

- Priority LSAMPs and contact list from Art
- Responses/meetings scheduled
- Objectives at meetings
 - Visibility of OSREUs in presentations, panels, exhibit tables, advertisement in conference program.
 - Hub for marine labs, REU program, grad program reps to participate/network.
- Share opportunity to participate at LSAMPs that IBP project cannot attend

IBP/OSREU/LSAMP Pilot Project

- Evaluation
 - Data collection through REU PIs/PDs (counting control and exp. UM applications)
- Expansion and Continuation
 - not from OCE/ED w/o results (over a year off)
- Continuity, longevity and depth strategies
 - Not a drive-by, please

Discussion