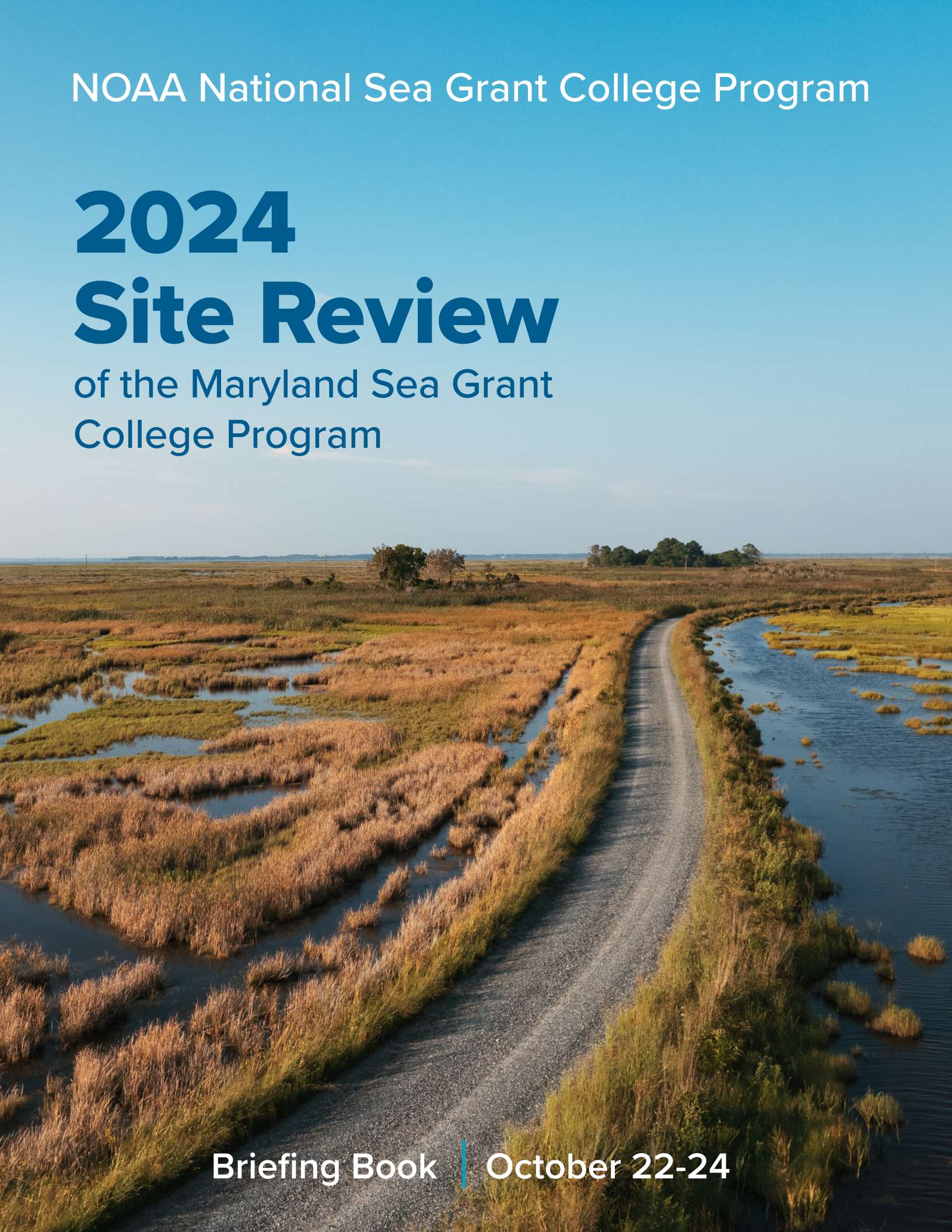
NOAA National Sea Grant College Program

2024 Site Review

of the Maryland Sea Grant College Program



Briefing Book | October 22-24

PROGRAM MANAGEMENT AND ORGANIZATION

Maryland Sea Grant College Program

Since its founding in 1977, Maryland Sea Grant (MDSG) has effectively and responsibly administered the public funds and programs entrusted to our care, while working collaboratively with partners to meet constituent needs. MDSG-supported research, education, and outreach efforts provide state leaders and residents with the science-based information and analyses they need to make decisions toward a more sustainable and resilient future for Maryland's coastal natural resources and economy. Through this approach, coupled with strong program management and organization, we have achieved state and regional recognition as an intellectual and practical leader in marine science, education, and advisory services.

Our work focuses on the continuing efforts to restore and preserve the Chesapeake and coastal bays and their watersheds. Maryland has 3,190 miles of coastline and more than 70% of the state's population resides within the coastal zone. Marylanders have always relied on close cultural and economic connections to our coasts. Maryland makes up 5,904,400 acres (14%) of the Chesapeake Bay watershed, the largest estuary in the United States. MDSG exists within a complex network of organizations devoted to protecting the Bay. There are a variety of challenges involved in restoring watersheds as large and diverse as the Chesapeake and Maryland's coastal bays. Reliable science is necessary to drive effective management of these environmentally and economically important natural resources. Our work remains as critical now as it was a decade ago.

Major policy decisions drive MDSG's activities. New shellfish leasing laws for aquaculture (2009) transformed the industry. The Chesapeake Bay Total Maximum Daily Load (TMDL) regulations (2010) set mandatory limits on nutrient and sediment inputs to improve Bay water quality to meet Bay restoration goals. Several key legislative actions set the state on a path of climate mitigation and adaptation, including the Maryland Commission on Climate Change (executive order 2007; codified 2015), Living Shorelines Protection Act (2005), Greenhouse Gas Reduction Act (reauthorized 2016), and the Sea Level Rise Inundation and Coastal Flooding Act (2018). MDSG's university base and its determination to deliver credible research findings and translate them into action through education and outreach are key contributions to regional and state efforts.

Unprecedented during the 2018–2023 MDSG review cycle was the extreme disruption caused by the COVID-19 pandemic. On March 13, 2020, the MDSG office closed and did not fully return to a post-pandemic workflow until January 2023. The outstanding outcomes highlighted in this briefing book took place amid the challenges faced worldwide during this tumultuous time.

University Program Setting and Governance Structure

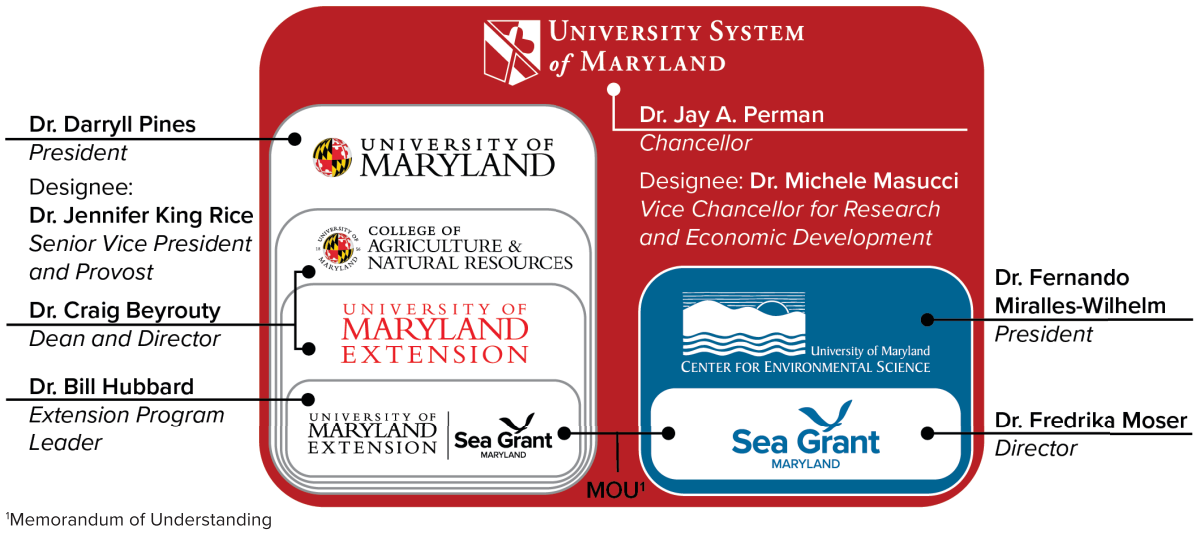
MDSG's institutional setting is consistent with our University System of Maryland (USM) program standing and mission to serve all of Maryland. A governance board oversees MDSG and MDSG Extension (MDSGE) programming. It consists of the USM chancellor, who represents the broad interests of the state; University of Maryland Center for Environmental Science (UMCES) president, who represents the institution with legislative responsibility for environmental science; and University of Maryland, College Park (UMCP) president, who represents Maryland's land-grant institution. MDSGE resides in UMCP's College of Agriculture and Natural Resources (AGNR), University of Maryland Extension (UME). The MDSGE program leader reports to the UME associate dean. Guidance for and approval of programmatic decisions are coordinated jointly by the MDSG director, the MDSGE program leader, and the AGNR dean. UMCES is MDSG's administrative home, overseeing finances, personnel, and grants administration. MDSG's director reports to the UMCES president and serves on the university's executive and administrative councils (Fig. 1).

This organizational structure fully supports MDSG's partnerships across USM, the state, and the National Oceanic and Atmospheric Administration (NOAA) National Sea Grant Office (NSGO). MDSG, UMCES, and UME operate under an agreement codified in our Memorandum of Understanding, signed July 2013 and renegotiated in 2024.

Management Team: Composition and Responsibilities

MDSG meets our mission to support research, education, and public outreach under the guidance of a highly qualified leadership team. The team's management structure is based on communication, transparency, and collaboration.

Figure 1. MDSG Institutional Governance



[1]Memorandum of Understanding

The senior staff meets twice monthly and interacts at least weekly to discuss critical administrative strategies and planning, program evaluation, budgets, research and extension integration, and staff professional development. All members of the leadership team are involved in their respective national Sea Grant networks and activities. MDSG staff (including fellows and interns) meets weekly to discuss updates and opportunities. MDSGE faculty interact regularly with MDSG staff.

Our leadership team, and each member's respective responsibilities, follow:

Fredrika Moser, PhD, *Director*
Provides overall leadership, staff management, coordination, and direction-setting for MDSG. Moser leads the program's interactions with governing boards; UMCP; UME; state, regional, and federal partners; and Congress.

Michael Allen, PhD, *Associate Director for Research and Administration*
Oversees the program's research portfolio, budgets and grants management, and compliance with federal and state regulations. This work includes managing requests for proposals and overseeing our extensive undergraduate and graduate fellowship programs. He coordinates with the USM's administration, including UME and UMCES Administrative Council.

J. Adam Frederick, MS, *Assistant Director for Education*
Manages MDSG's K-12 and free-choice learning programs and oversaw the National Marine Educators Association (NMEA) office when it was located at MDSG. He coordinates with education leaders in the Sea Grant network, higher education, state and local government, schools, and free-choice learning venues.

William Hubbard, PhD, *Assistant Director/Program Leader for Environment, Natural Resources, and Sea Grant*
Oversees personnel and program priorities for MDSGE faculty experts in areas including watershed restoration, climate, fisheries, aquaculture, and seafood safety. He also supervises two administrative assistants, a business manager, and a program specialist.

Annalise Kenney, MA, *Assistant Director for Communications*
Leads MDSG communications team of a graphic designer, two science writers, and fellows/interns. Together, they produce our magazine, reports and other publications, blogs, videos, and social media, while coordinating with local, regional, and national communication networks.

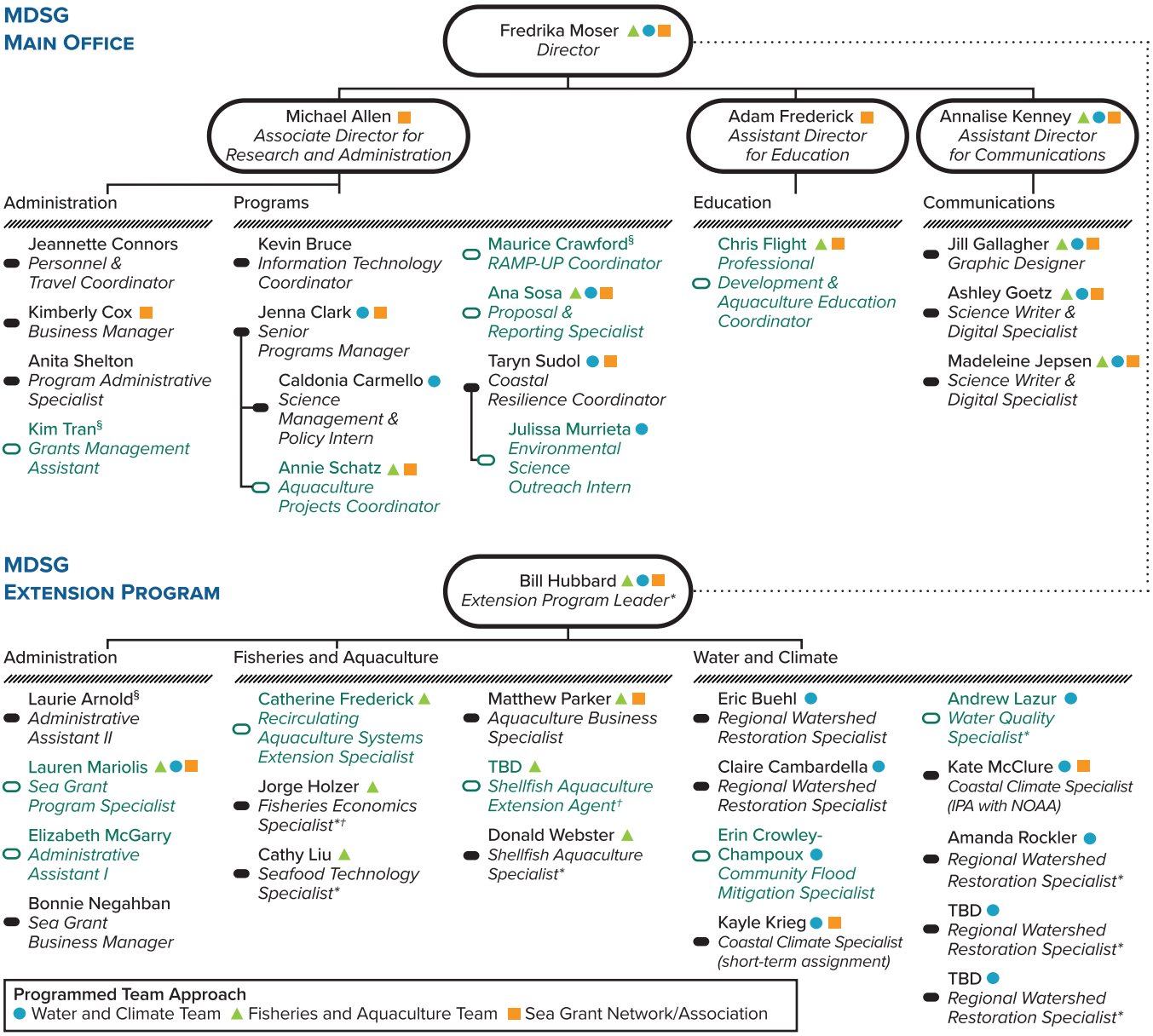
MDSG and Extension Staff Structure

MDSG uses state funding, NOAA core omnibus funding, and grants to employ 18 full-time staff members (Fig. 2) who provide programmatic and administrative support. Part-time staff and graduate and undergraduate students also assist the program.

UME uses state funding, NOAA core omnibus funding, and state and federal grants to support the MDSGE program leader, 15 faculty positions, and four staff positions (Fig. 2). Extension personnel are located statewide at AGNR's research and education centers.

External grants and the expansion of climate resiliency, aquaculture, and marine debris funding from the National Sea Grant Office (NSGO) supported MDSG staffing growth in the last six years. Our Chesapeake Bay Sentinel Site Cooperative (CBSSC) coordinator, originally funded by NOAA National Ocean Service (NOS), became an

Figure 2. Maryland Sea Grant Organizational Chart, September 2024



* Tenure-track position; † Collaborator from partner department or institution § Part-time
Green text indicates new position since 2018.

MDSG coastal resilience coordinator supported by external grants and NOAA Sea Grant climate resiliency funds, expanding our work in climate adaptation and marsh dynamics. Our climate team works with local organizations and governments to plan and implement stormwater management and coastal resilience projects.

With NOAA Sea Grant aquaculture funding, MDSG expanded research, engagement, and administrative support in aquaculture programming. Two partially NOAA-funded oyster aquaculture outreach specialists located at Morgan State University (MSU) and UMCES Horn Point Laboratory joined MDSGE's two existing oyster aquaculture and business specialists. Aquaculture funds also support a recirculating aquaculture systems extension specialist, an aquaculture education coordinator, an aquaculture projects coordinator, and a proposal and reporting specialist. NOAA funds, when available, support a coordinator to assist the MDSGE leader with Sea Grant activities.

Marine debris funding supports a part-time MDSG person to work on marine debris education with youth groups from underserved communities, as well as undergraduates at Hampton University, VA, and University of Maryland Eastern Shore. Both institutions are Historically Black Colleges and Universities (HBCU).

Programmed Team Approach

Extension Integration

The MDSGE program leader attends MDSG staff and leadership team meetings and is a member of the UME administrative team. MDSGE faculty members prepare annual Individual Extension Plans for long-term planning in coordination with MDSG's program planning. MDSG provides communications and reporting support to MDSGE. MDSG works with MDSGE to prepare grant proposals and develop creative programs integrating research and extension. MDSGE staff and faculty also interact with members of our advisory boards, review panels, and researchers. MDSG and MDSGE staff and leadership meet virtually monthly.

MDSG's association with UME also allows MDSG to leverage UME's extensive network of specialists in the related program areas of agriculture and natural resources, family and consumer sciences, and 4-H, which strengthens MDSG and other UME programs.

Institutional Council and Advisory Boards

To maximize MDSG's effectiveness serving Marylanders, external boards provide guidance on program activities. Beyond the University System of Maryland Governance Board, three advisory groups inform MDSG programming:

1) The **Institutional Council (IC)** consists of eight members from key institutions performing research, education, and outreach activities in marine and coastal science in Maryland (Table 1). The IC meets when issues pertinent to accountability, mission development, and priorities from the perspective of Maryland's academic and research institutions arise. The IC met in 2024 to discuss cross-institution efforts to advance climate resiliency and climate literacy.

2) The **External Advisory Board (EAB)** represents a diverse group of stakeholders, including industry, government, and nongovernment institutions, with marine-related interests. The EAB provides guidance in response to concerns of stakeholders and realistic assessments of regional and state needs. MDSG believes managed turnover in the EAB is desirable and recognizes the value of both new membership and long-term contributors (Table 2). MDSG meets biannually with the EAB and communicates via email, phone, and in-person. The last meeting was in June 2024 with the next in December 2024.

3) The **Academic Advisory Committee (AAC)** comprises scientists from Maryland's research, nongovernment, and government institutions who provide input on the research program (Table 3). They advise on programmatic issues, the integration of research and extension, the request for proposal process, and graduate student support and fellowships. AAC members help to evaluate the scientific merit and relevance of preproposals and fellowship proposals. Committee members are selected based on their scientific credentials, expertise, and knowledge. MDSG encourages turnover to foster new ideas, while maintaining essential institutional knowledge and continuity. During 2018–2023, 22 people participated on the AAC. MDSG meets with the AAC biennially and consults with the group virtually on research and programmatic planning.

In 2023, participants collaborated to develop a Maryland-based environmental design program to address climate resilience and adaptation for our coastal communities.

TABLE 1: Institutional Council Members (2018–2024)

Michele Masucci, PhD
Vice Chancellor for Research and Economic Development, University System of Maryland

Fernando Miralles-Wilhelm, PhD
President, University of Maryland Center for Environmental Science

Jennifer King Rice, PhD
Senior Vice President and Provost, University of Maryland College Park

Craig Beyrouty, PhD
Dean, College of Agriculture and Natural Resources, University of Maryland College Park

Moses Kairo, PhD
Dean, School of Agricultural and Natural Sciences, University of Maryland Eastern Shore

Scott Knoche, PhD
Director, Patuxent Environmental & Aquatic Research Laboratory, Morgan State University

Anson Hines, PhD
Director, Smithsonian Environmental Research Center

Anand Gnanadesikan, PhD
Chair, Department of Earth and Planetary Sciences, Johns Hopkins University

Fredrika Moser, PhD
Director, Maryland Sea Grant College

TABLE 2. External Advisory Board (2018–2024)

David Blazer
Maryland Port Administration

Mark Bryer
The Nature Conservancy

Scott Budden
Orchard Point Oyster Company

Allison Colden, PhD*
Chesapeake Bay Foundation

Jana Davis, PhD*
Chesapeake Bay Trust

Erik Fisher
Chesapeake Bay Foundation

Martin Gary
Potomac River Fisheries Commission

Anna Killius*
Chesapeake Bay Commission

William Matuszeski*
US Environmental Protection Agency, Chesapeake Bay Program (retired)

Thomas Miller, PhD*
UMCES, Chesapeake Biological Laboratory

Beth McGee, PhD
Chesapeake Bay Foundation

Jaelon Moaney*
Washington College

Adam Ortiz
Prince Georges County Dept. of the Environment

Eric Schwaab
National Fish and Wildlife Foundation

Ruby Stemmle*
ecoLatinos

Ann Swanson
Chesapeake Bay Commission

Jabari Walker*
Bowie State University

Dave Wilson*
Conservation Community Consulting, LLC; US Wind Inc.

*Current

TABLE 3. Academic Advisory Committee (2017–2022)

American University[§]

Chesapeake Bay Foundation[†]

Chesapeake Research Consortium, Inc.[†]

Hood College[†]

Johns Hopkins University, Whiting School of Engineering[§]

Jug Bay Wetlands Sanctuary[*†§]

Maryland Department of Natural Resources[†]

National Estuarine Research Reserve, NOAA/NOS Office for Coastal Management[*†]

NOAA/NOS/NCCOS Cooperative Oxford Laboratory[†]

Towson University, Department of Biological Sciences[*†]

U.S. Environmental Protection Agency, Chesapeake Bay Program[§]

U.S. Geological Survey, Chesapeake Bay Program Office[*†]

U.S. Naval Academy, Oceanography Department[†§]

University of the District of Columbia, Water Resources Research Institute, College of Agriculture, Urban Sustainability and Environmental Sciences[†§]

University of Maryland, Eastern Shore, NOAA Living Marine Resources Cooperative Science Center[*§]

University of Maryland Center for Environmental Science, Appalachian Laboratory[*†]

University of Maryland Center for Environmental Science, Horn Point Laboratory[*]

University of Maryland Center for Environmental Science, Institute of Marine & Environmental Technology[*†]

University of Maryland, College Park, Earth System Science Interdisciplinary Center[*]

Washington College[†]

*2017; [†]2019; [§]2021

Strategic Planning

MDSG builds capacity to make sound decisions, address critical issues, and implement adaptive management across four focus areas. We support relevant, high-quality, multidisciplinary research, education, and extension efforts to meet our goals and objectives. We seek to build inclusive, diverse, and equitable management and programming. We use a detailed implementation plan to track our activities, measure success, and inform future strategic planning. This approach guides us to meet our mission to support sustainable and economically resilient coasts and watersheds in Maryland and beyond.

In 2017, NOAA approved the MDSG 2018–2021 strategic plan. This robust plan was constituent-driven and included surveys of federal, state, county, and local governments; nonprofit organizations; industry; academia; and educational institutions. MDSG held strategic planning meetings with its advisory boards and workshops with staff and MDSGE faculty. With COVID-19 disruptions, Sea Grant programs updated their existing strategic plans with a 2022–2023 addendum. MDSG followed a similar constituent driven process (virtually) for this update. Changes to the plan are described in the 2018–2023 Strategic Plan Addendum section. MDSG activities are described in more detail in the *Engagement* and *Collaborative Networks* sections in this report.

Request for Proposals (RFP)

MDSG leads several grant competitions to advance scientific knowledge of the Chesapeake Bay and cultivate the next generation of marine and coastal scientists. MDSG seeks actionable science research proposals that align with the strategic research priorities in our focus areas and address cross-cutting priorities, including climate resilience and diversity, equity, and inclusion. From 2018–2023, MDSG conducted omnibus research competitions (2018–2020, 2020–2022, and 2022–2024) and numerous graduate research and post-graduate fellowship competitions. MDSG emphasizes reaching all appropriate Maryland institutions with its RFPs (PIER report p. 3–5).

MDSG's success in supporting relevant and innovative research projects and fellowships stems from three fundamental strengths: (1) close adherence to the goals of the strategic plan to guide RFP priorities and project selection; (2) a robust, web-based proposal and fellowship management system; and (3) a highly competent administration and research team. MDSG outlines its review and selection criteria in RFPs and is guided by the NSGO National Competition Policy. MDSG widely distributes RFP announcements through an extensive email list (via Mailchimp), webinars, social media, direct conversations,

and the website. Mailing lists are frequently updated and include representatives from all Maryland research universities with programs that relate directly to our mission.

MDSG reviews proposals based on a project's technical feasibility, its support of MDSG RFP priorities, and its potential impact on science and society. The process follows strict conflict-of-interest policies and provides anti-bias resources for panelists and reviewers. We use the eSeaGrant platform to manage our proposal, review, and reporting processes. This robust review process is applied across competitive funding opportunities, and MDSG posts all funded projects and researchers on our website. MDSG documents the process and selections in a letter of intent to the NSGO.

Review Process

Preproposals. MDSG sends each preproposal to multiple subject matter experts outside Maryland, Virginia, and Washington, DC, to receive at least three written scientific reviews. Two independent panels review proposals: (1) MDSGE faculty, who evaluate each project's outreach potential, and (2) MDSG AAC members, who assess proposals for technical soundness and relevance to the RFP's strategic priorities. The EAB reviews abstracts for constituent impact. These reviews help determine which preproposals are recommended for development into a full proposal.

Information on proposal funding success rate for MDSG omnibus competitions and summary data on new investigators is in Table 4.

Full Proposals. Full proposals follow a similar review process as preproposals. Researchers from outside the region convene for the final technical review panel (Table 5); these experts use protocols consistent with those set forth by the National Science Foundation and NSGO's Competition Policy. Panelists rank proposals within given topical areas and provide written and oral rationales for their decisions. MDSG's NSGO program manager is invited to attend both panel reviews. The final decision is based on technical ranking, funding availability, relevance, and the balance of research projects across strategic plan focus areas. The director and associate director for research and administration develop the final portfolio of projects, which the NSGO approves. Applicants who submitted preproposals, full proposals, and fellowship applications receive blinded external peer reviews and outreach and technical panel comments.

Research Fellowships. Applications generally follow the full proposal process and align with NSGO's National Competition Policy, though review criteria are specific to the competition. Expert technical peer reviewers evaluate the technical feasibility and potential impact. A panel of faculty and professionals evaluates the applications and peer reviews to make funding recommendations to the program. MDSG ran three graduate fellowship competitions and four graduate research support grant competitions in 2018–2023.

TABLE 4. Number of proposals, institutions, and new investigators funded

Indicators	2018–2020	2020–2022	2022–2024
Preproposals # of institutions	**34** 23	**51** 23	**30** 22
Full proposals # of institutions	**13** 11	**17** 15	**16** 17
Proposals funded # of institutions *# of new PIs (includes co-PIs)**	**8** 7 *16*	**8** 10 *14*	**8** 11 *17*

*PI new to MDSG or not funded for two omnibus cycles.

TABLE 5. External Technical Review Panelists

2018–2020 Omnibus Technical Review Panel Members

Louisiana State University, *Wetland and aquatic biogeochemistry*
University of Connecticut, *Nutrient and sediment cycling*
University of North Carolina at Chapel Hill, *Estuarine ecology/ Fisheries population dynamics*
University of South Florida, *Trophodynamics/ Fish population ecology*

2020–2022 Omnibus Technical Review Panel Members

Bald Head Island Conservancy, *Shellfish and estuarine ecology*
University of Maine, *Fish ecology/Population dynamics*
US Environmental Protection Agency, *Coastal ecology/ Nutrient cycling*
University of Central Florida, *Marine Ecology/Marine conservation/ Coastal restoration*
Washington State University, *Biogeochemistry/Microbial ecology*

2022–2024 Omnibus Technical Review Panel Members

Delaware Department of Natural Resources and Environmental Control, *Chemical oceanography/Ecosystem services*
Northeastern University, *Microbial ecology/Nutrient cycling*
University of Florida, *Phycology/Algal toxicity and diversity*
University of New England, *Fisheries/Aquaculture/ Marine conservation*

Program Development Funds

MDSG uses program development funds to catalyze new research, complete projects, support graduate research, and support meetings and outreach efforts (Table 6). While small, these funds are extremely useful in engaging diverse research, outreach, and education communities in Maryland and beyond. These funds also give MDSG access to new stakeholders in academic, government, and nongovernment organizations (NGOs). MDSG augments omni-

bus funding with state appropriations to further advance program development. The review process varies from an MDSG internal review panel (meeting and engagement) to external peer reviews (research).

Reporting

Each research project must submit annual and final reports summarizing progress relative to a proposal's objectives, as well as Sea Grant performance measures and metrics, data management, presentations, publications, and overall impact beyond academia. Following review by the director or associate director, project accomplishments are summarized for NSGO PIER reporting and communication efforts. PIER report (p. 3–6.) lists many of the NOAA-funded projects.

Support

MDSG Grant Support

Strong financial and grant administration linked to an effective strategic plan is fundamental to running a highly successful Sea Grant program. MDSG received consistent core program support from NOAA and from NSGO competitions and special competitions (Table 7; PIER report p. 7). Omnibus support for the research program includes research grants to PIs and research fellowships (R/E-1, R/E-24, R/E-26). These competitive funds made up 48% of MDSG's total core annual funding, reflecting the priority MDSG places on these programs (PIER report p. 10–11).

MDSG competes for external grants and contracts to support projects consistent with our mission and goals. Major grantors have included the Chesapeake Bay Trust (CBT), European Union ERASMUS program (EU), National Marine Educators Association (NMEA), National Marine Sanctuaries Foundation (NMSF), National Science Foundation (NSF), NOAA, US Department of the Interior (DOI), US Department of Agriculture (USDA), and various Maryland state agencies. During 2018–2023, MDSG received approximately $7.5 million (leveraged managed, less state funds, for both MDSG and MDSGE) in external grants and contracts beyond NSGO (Table 8). MDSG regularly oversees about 100 projects and subawards across our NSGO and external grants portfolio.

TABLE 6. Examples of institutions supported by program development funds (2018–2023)

- Atlantic Estuarine Research Society
- Black in Marine Science
- Friends of Jefferson Patterson Park and Museum
- Coastal & Estuarine Research Federation (CERF)
- ecoLogix
- George Mason University
- Mid-Atlantic Marine Education Association (MAMEA)
- Morgan State University
- National Marine Educators Association
- National Shellfisheries Association
- Society for the Advancement of Chicanos and Native Americans in Science
- Smithsonian Environmental Research Center (SERC)
- St. Mary's College of Maryland
- University of Maryland, College Park
- University of Maryland Eastern Shore
- University of Maryland Center for Environmental Science, Appalachian Laboratory
- University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory
- University of Maryland Center for Environmental Science, Horn Point Laboratory

TABLE 7. Distribution of all funds supporting Maryland Sea Grant efforts, 2018–2023

	Annual period February 1–January 31						
	2018	**2019**	**2020**	**2021**	**2022**	**2023**	**Total**
MDSG Core NOAA Funding[a]	1,614,898	1,614,898	1,614,898	1,614,898	1,719,354	1,719,354	9,898,300
% of total year	32%	28%	24%	25%	28%	24%	
MDSG State Funding[b]	1,144,212	1,182,553	1,186,784	1,202,923	1,318,405	1,443,518	7,478,395
Extension State Funding	857,702	856,994	850,343	850,343	841,801	1,261,881	5,519,064
% of total year	40%	36%	31%	31%	35%	38%	
MDSG Other Funding[c]	1,176,104	1,429,404	1,909,281	1,873,541	1,695,962	1,542,993	9,627,285
Extension Other Funding	226,498	582,728	1,031,085	1,028,928	641,463	1,127,401	4,638,103
% of total year	28%	36%	45%	44%	38%	38%	
Total MDSG & MDSG Extension	**5,019,414**	**5,666,577**	**6,592,391**	**6,570,633**	**6,216,985**	**7,095,147**	**37,161,147**

[a]MDSG Core NOAA Funding Year is Feb. 1–Jan. 31
[b]State Funding is July–June that overlaps the NOAA year
[c]Start and end dates vary; includes non-core NOAA funding

TABLE 8. National Sea Grant competitive awards and selected external awards, 2018–2023.

Funding Years	Source	Total Award	Principal Investigator(s)	Project Title
SEA GRANT COMPETITIVE AWARDS				
2017–2019	NOAA/NSGO	$149,067	Lazur/Parker	NOAA Aquaculture: Controlling Fouling and Pests Associated with Water Column Oyster Aquaculture
2017, 2021	NOAA/NSGO	$266,283	Moser/Miller/ Wilberg	NMFS/Sea Grant Population and Ecosystem Dynamics Graduate Fellowships (2 fellows)
2018–2022	NOAA/NSGO	$736,454	Wong/Frederick	Production of reproductively sterile Atlantic salmon to maximize cost-effective and environmentally-responsible US aquaculture
2018–2023	NOAA/NSGO	$1,604,400	Moser	Knauss Fellowships (25 fellows)
2019–2021	NOAA/NSGLC	$30,000	Moser	Phase 1/Phase 2: Building legal research, education, and outreach capacity to support stakeholder needs in Maryland (2 grants)
2019–2025	NOAA/NSGO	$1,623,464	Moser/Zohar	Aquaculture Hub: Building capacity of land-based Atlantic salmon aquaculture in the US (2 grants)
2020–2024	NOAA/NSGO	$126,612	Parker	Developing A Web Based Business Planning Tool for Increased Shellfish Aquaculture Success & Profitability
2020–2023	NOAA/NSGO	$9,995	Parker	Sea Grant Workshop: Seed to Shuck 2020: Mid-Atlantic Oyster Aquaculture Forum
2021–2025	NOAA/NSGO	$598,951	Moser	Maryland Sea Grant SG-NCCOS National Aquaculture Extension Coordinator
2021–2023	NOAA/NSGO pass through	$42,000	Parker	Economic Status and Contribution of US Aquaculture: Analyzing Viability Structures, Economic Impact, and Management Measures for Future Success
2022–2023	NOAA/NSGO	$15,000	Frederick	Establishing Environmental Literacy in Preservice Teacher Education through University and Sea Grant Collaborations
2022–2025	NOAA/NSGO	$249,748	Plough/Gray/ Hood	Stress-priming of early-stage eastern oysters to increase stress tolerance and consistency of aquaculture production in the face of climate variability
2023–2025	NOAA/NSGO	$254,305	Moser/Crawford	Raising Awareness of Marine Pollution in Underserved Populations (RAMP-UP)
2023–2025	NOAA/NSGO	$749,211	Hubbard	Operationalizing Flood Inundation Mapping (FIM) in Maryland Through a Social Science Approach
SELECTED EXTERNAL AWARDS				
2017–2019	NSF	$433,859	Moser	IUSE-IMPACT: Pathways TO RENEW: Tropical Oceanography Research Experiences for the Next-Generation Workforce
2018–2023	DOI/USFWS	$236,000	Allen	Support for the Mid-Atlantic Panel on Aquatic Invasive Species
2018–2023	NSF	$1,086,465	Allen	REU Site: Undergraduate Research Experiences in Estuarine Processes
2018–2023	NSF	$81,070	Frederick	CNH-L: Stormwater management across urban ecosystems: Diagnostic tools and community engagement for ecological restoration, equitable community development and revitalization
2018–2023	NMEA	$170,081	Frederick	Administrative Support for NMEA
2019–2020	NMSF	$61,375	Frederick	Aquaculture in Action Workshop
2019–2020	NSF	$50,583	Moser/Sudol	CoPe Conference: Evaluating Land Use Tradeoffs Due to Sea Level Rise in the Chesapeake Bay
2019–2024	NSF	$2,453,821	Harris/Moser/ Allen	NSF INCLUDES: SEAS Islands Alliance
2020–2025	USDA	$1,294,984	Parker/Liu/ Webster	AFRI: Transforming shellfish farming with smart technology and management practices for sustainable production
2021–2023	Various	$230,000	Moser	State Science Policy Fellowship Support (6 fellows, various agencies)
2021–2026	USDA	$1,438,860	Moser/Hubbard	AFRI: Sustainable Aquaculture Systems Supporting Atlantic Salmon
2023–2024	CBT	$9,000	Sudol	Tidal Wetland Strategic Plan
2023–2024	MDNR	$18,164	Sudol	Outreach and Engagement Co-lead

Additional non-competitive Sea Grant awards available upon request.
All external leveraged funds awards sorted by agency are available in the PIER report appendix C. b

State and Matching Funds

Though the budget climate for higher education is challenging, funding for MDSG from the state is strong. From 2018–2023, MDSG's annual state appropriation through UMCES grew by 26% to $1.443 million. These funds primarily support core personnel salaries and facilities.

MDSG consistently meets its 50% match requirement (PIER report p. 7). MDSG uses diverse sources to meet its 50% matching fund requirement on NSGO funds. UMCES and UME allow MDSG to forego collecting indirect costs on the administrative, communications, extension, education, and program development portions of its omnibus award. Research projects must provide a 50% match on direct and indirect costs. During 2018–2023, UMCES and MDSG continued to waive subcontracting fees on core MDSG research awards to other institutions.

MDSG generates value for the investment made in our program by working with communities to learn, listen, and work together to meet their needs. We stay abreast of relevant and pressing environmental issues to remain responsive to Marylanders.

Pictured, clockwise: MDSGE staff organized a discussion about flooding with the Jonestown, MD, community (photo: C. Decker), held a rain barrel workshop, and was part of the Montgomery County, MD, GreenFest planning team.

ENGAGEMENT

Relevance

Seeking to best serve our constituents, we measure our relevance in many ways, including the distribution of resources. We engage in working groups, community and government roundtables, one-on-one meetings, and partnerships (PIER report p. 12, p. 25–37). Our expertise and awareness of state priorities enable us to provide and expand capacity where needed. Today, leaders and communities are paying more attention to how climate change has altered the region's ecosystems. With that in mind, MDSG focused 2018–2023 activities on coupling human responses to climate change with the restoration and sustainability of our waterways. MDSG partners include decision makers at all levels of local, state, and federal government; nonprofit organizations; wastewater treatment industry; realtors; faith-based communities; community organizations; students and teachers; landscapers; commercial watermen; aquaculturists; and seafood processors. MDSG has long been active in diversifying the geosciences workforce. Our work with underserved communities, long neglected by environmental policy and funding efforts, has intensified.

MDSG is a bridge builder and neutral broker between the knowledge base of our academic partners and our broad user communities. We provide an impartial forum for public discussion, understanding, and consensus-building about coastal and watershed issues, and we have synthesized scientific findings to inform such discussions. MDSG's constituents see us as a reliable source of information. There is high demand for MDSG to participate in activities across the state, region, and nation. Our strategic plan guides our investment of resources and staff time.

Extension Engagement Services and Training

MDSGE programming puts scientific knowledge into practical application, leading to restored and sustainable bays and watersheds. Outreach and training activities span water, climate, aquaculture, and fisheries issues. We integrate extension, education, and communication to provide services meeting the needs of our Maryland constituents. MDSG-supported meetings, trainings, and seminars engage business and industry, scientists, educational institutions, and government agencies to solve problems and enact solutions. MDSG is a trusted source for information on many coastal issues. Some examples follow and are in the *Performance* section.

Aquaculture Industry Expansion. MDSGE specialists are integral to developing new state policies, regulatory changes, critical support programs, and funding opportunities to help the aquaculture industry grow. They advance shellfish aquaculture by providing watermen and other entrepreneurs with business advice, access to financing, and training on critical skills needed for profitable production. A land-based aquaculture team connects researchers, communicators, educators, extension, and global industry to train a new workforce and improve production techniques.

Seafood Safety and Processing. MDSGE's seafood specialist helps Maryland's seafood industry improve production and the safety and reliability of products through Hazard Analysis and Critical Control Point (HACCP) training programs. These programs educate seafood industry personnel about safe handling and processing of blue crabs and oysters to prevent food-borne illnesses. MDSGE's innovative programming successfully partners industry and academia.

Watershed Restoration Specialists. MDSGE faculty and partners help coastal communities manage stormwater runoff, mitigate flooding, and improve septic systems to reduce the input of nutrients and sediment into the Chesapeake and coastal bays. These efforts improve Bay health and help municipalities meet US Environmental Protection Agency (EPA) mandated TMDL requirements.. MDSGE provides guidance and training to local governments, nongovernment organizations, faith-based communities, riverkeepers, underserved communities in Baltimore and on Maryland's Eastern Shore, and many others to help them secure resources and implement best management practices. Watershed Stewards Academies, through the design and development of an award-winning curriculum, teach residents to understand and communicate stormwater remediation best practices in their neighborhoods and communities.

Coastal Climate Change. The coastal community team works collaboratively with researchers, communities, NGOs, businesses, and state and local governments to design, coordinate, and implement climate resilience activities. Efforts focus on identifying local needs and establishing partnerships among academics and communities to help residents address erosion, flooding, and other coastal risks.

Education and Training

MDSG takes a multilevel approach to education by supporting workforce development in environmental, estuarine, coastal, and marine sciences and by providing Marylanders with access to learning opportunities.

Pre-College

MDSG designs innovative and comprehensive programs to reach students across the geographic and social spectrum, from rural to urban, in schools from Baltimore to Barcelona (PIER report p. 12). We developed a teacher professional development model for project-based environmental science education. Informed by our university setting and success in the classroom, the model's excellence stems from a diversity of partners, including state and federal agencies, academia, nonprofits, and school administrations.

Partners for MDSG's Aquaculture in Action (AinA) program include the Institute of Marine and Environmental Technology (IMET), the Maryland Department of Natural Resources (DNR), and teachers and administrators in public and private schools. MDSG's Biofilms and Biodiversity environmental science program expands beyond Maryland to a sister effort, called The VIRTUE Project, coordinated with the University of Gothenburg in Sweden. It trains students and teachers through in-person and online learning to analyze aquatic biodiversity, microplastics, and local water quality in Sweden, Germany, Spain, and Baltimore. These two programs address instructional strategies, environmental literacy standards, and the cross-cutting themes represented in the Next Generation Science Standards. Partnerships with the Maryland Science Center and the National Aquarium led to other successful education programs for lifelong learners.

For the last decade (2014–2023), MDSG served as the headquarters for the National Marine Educators Association (NMEA), elevating MDSG's national recognition as a leader in marine science education. Outcomes include helping NMEA save money, increase and retain membership, improve efficiencies with technology, and strategically plan for the future of the organization.

Higher Education: Learning, Training, Partnerships, and Outreach

Since 1977, MDSG has supported hundreds of undergraduate, graduate, and postgraduate students at institutions across Maryland and outside the state, in scientific fields relevant to our mission (Fig. 3; PIER report p. 12).

Undergraduate Students

MDSG is committed to providing undergraduate students with opportunities for marine science research and preparation for science careers. We participate in four undergraduate internship programs, each with a slightly different focus: (1) NSF-funded Research Experiences for Undergraduates Program in Estuarine Science (REU) in Maryland; (2) NSF-funded SEAS Islands Alliance in Puerto Rico, Guam, and the US Virgin Islands; (3) University

of Maryland Gemstone Honors Program; and (4) NSGO's Community Engaged Internship Program (read more about these programs in the *Performance* section).

Graduate Fellows

MDSG's core graduate fellowship programs, Maryland Sea Grant Research Fellowship (E-1) and Competitive Graduate Research Fellowship (E-24, E-26), support competitively selected graduate students to work with established marine scientists in the design and conduct of university-based research, as well as in outreach in academic and nonacademic venues. Students work on projects associated with MDSG's omnibus-funded research grants (E-1) or a student-proposed project (E-24, E-26). Other competitive fellowships MDSG manages are Coastal Management and Digital Coast Fellowships, Knauss Marine Policy Fellowships, and Population and Ecosystem Dynamics and Marine Resource Economics Fellowships. All fellowships offer opportunities for professional development, including communication training and editing support for posts to our student blog, *Fellowship Experiences*.

Postgraduate Fellows

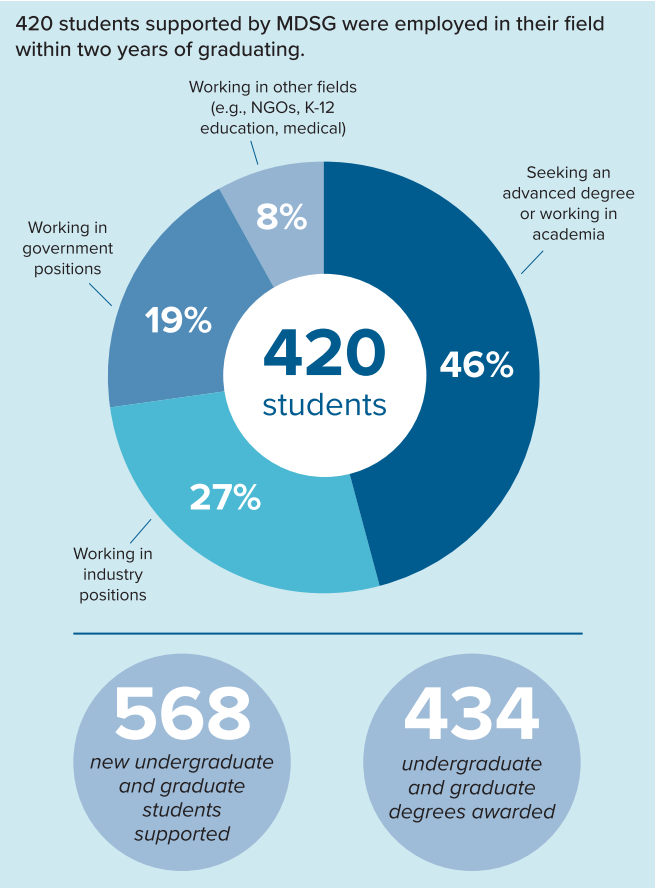
Responding to a training gap in marine science policy education, MDSG expanded training opportunities to include post-baccalaureate interns and post-advanced degree fellows in several new programs: (1) Science Management and Policy Interns assist MDSG leadership, communications, and program staff; (2) Maryland Law and Policy fellows explore legal issues around pressing science policy questions in the region, including climate change and aquaculture; and (3) State Science Policy Fellows join state agencies to work on high-level coastal sustainability and management issues. These fellowships allow recent graduates to work at the marine science and policy interface. Key local partners include the University of Maryland Agriculture Law Education Initiative, DNR, Maryland Department of the Environment, and UMCES.

Communications and Information Dissemination

MDSG's communications team delivers well-researched scientific information that is accessible to audiences with varying levels of expertise, including nonscientists. Communications products provide information about science and policy in the Chesapeake and coastal bays to audiences who use it for policy, research, education, outreach, and more. Many MDSG products inform our partners and constituents about our program results.

MDSG's magazine, *Chesapeake Quarterly*, uses longform, narrative-driven science writing by staff writers to communicate scientific concepts to a wide audience. This free

Figure 3. MDSG-supported students, 2018–2023



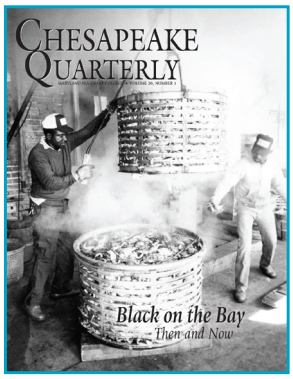
magazine is delivered to more than 4,160 print and 1,200 digital subscribers from varied backgrounds, including local, state, and federal officials, scientists, educators, students, and people interested in Maryland's waterways. In 2020, the magazine transitioned to a primarily digital format with articles published on the ArcGIS StoryMaps platform. The online format allows for the inclusion of high-quality photos, videos, and data visualizations to augment interest and understanding.

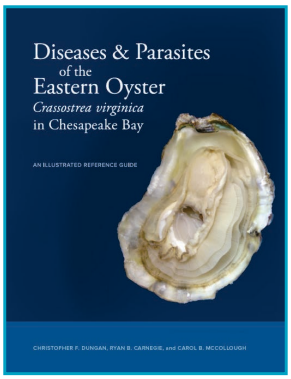
MDSG's expertise in translating scientific information to print and digital media has led to projects that range from attention-grabbing videos to full-length books. MDSG publishes videos about its work on the MDSG YouTube channel, including a seven-part, in-depth series in 2023 about oyster aquaculture. On a day-to-day basis, MDSG's active social media presence includes frequent postings of science-based content on Facebook, Twitter/X, YouTube, LinkedIn, and Instagram, to connect with general audiences as well as regional and national partners in coastal science. The communications team plans, manages, and implements frequent content updates to MDSG's website. MDSG publishes articles to two blogs, *Fellowship Experiences* and *On the Bay*, which respectively provide information directly from MDSG fellows about their careers in

science and feature news about research and collaboration supported by MDSG.

To highlight and support MDSG's programmed team approach to engage constituents, the communications team writes, edits, and designs reports and other organizational publications, including annual reports to NOAA, biennial reports highlighting major accomplishments, workshop reports, and the 2024–2027 Strategic Plan. Communications supports research and outreach activities by creating websites and infographics. The team provides science communication workshops to early-career researchers and students. They also host interns through the Community Engaged Internship Program, growing the next generation of science communicators.

HIGHLIGHTED PUBLICATIONS





Two standout publications from this reporting period: Black on the Bay: Then and Now *issue of* Chesapeake Quarterly magazine (2021) *and* Diseases of the Eastern Oyster, Crassostrea virginica, in Chesapeake Bay *illustrated reference guide (2020).*

COLLABORATIVE NETWORK ACTIVITIES

Relationships

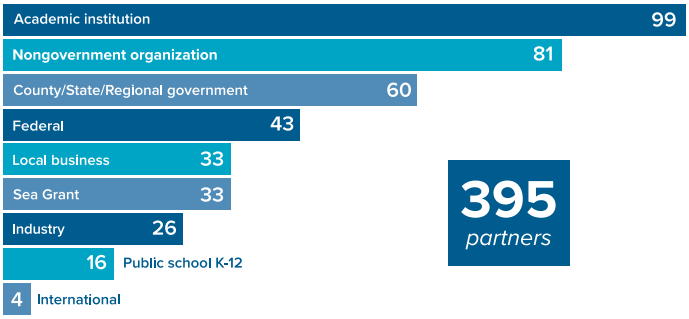
MDSG values relationships across the program, through funded research efforts, coordinated planning, and constituent engagement and collaborations. MDSG's grant activities emphasize the importance of being geographically and institutionally diverse. Many MDSG relationships have been sustained over several years—in some cases, for decades—helping to build trust and capacity. Guided by MDSG's strategic plan and the importance of maintaining highly relevant programming, a deep talent pool, and broad constituent reach, MDSG seeks collaborations with other Sea Grant programs, NOAA, and other agencies. Local and state constituents, the academic community, and NGOs account for many of MDSG's 2018–2023 partners (Fig. 4; PIER report p. 13, 25–35). These collaborations seek to empower our constituents, catalyze new focus area programming, and leverage funding and personnel to serve a broad spectrum of constituents. Importantly, MDSG has become more intentional about inviting communities and organizations traditionally left out of the environmental conversation, including work with underserved urban and rural constituents.

MDSG engages and integrates across federal, state, and academic boundaries, through working groups (e.g., EPA Chesapeake Bay Program, Maryland Climate Change Commission, Maryland Environmental Literacy Advisory Network, Baltimore Urban Waters), advisory committees, workshops, symposia, and roundtable discussions. Regional partnerships, especially with Sea Grant and NOAA programs in the Mid-Atlantic, are critical for reaching wider audiences. MDSG engaged with more than 350 partners in 2018–2023 (PIER report p. 13, p. 25–35).

MDSG establishes relationships at local, national, and international scales, including collaborations in US territories in the Caribbean and South Pacific, as well as the EU. Through these connections, MDSG both leads and assists others in developing research, training, and management competence. Building

Figure 4. Partners

Maryland Sea Grant worked with 395 partners from a diversity of programs.



up our partners' capacity is foundational to MDSG's core values. Critical support from managed and influenced funds (over $38 million in leveraged) empowers MDSG's collaborative networks (PIER report p. 13).

The national Sea Grant (SG) network fundamentally strengthens all Sea Grant programs by being an outstanding think tank and an invaluable source of information, collaboration, and capacity-building. MDSG staff are active in many SG network activities and committees, and Director Moser served as president of the Sea Grant Association (SGA) from 2019–2020, deepening engagement with the network, NOAA, and Congress. MDSG maintains close contact with NSGO and our program manager (Rebecca Briggs, 2016–2020; Lacy Alison 2020–present), ensuring knowledge of both internal and external network activities.

Sea Grant Collaborations

Mid-Atlantic Sea Grant Programs. MDSG works closely on various activities with the Mid-Atlantic Sea Grant programs, including monthly calls, team meetings at SGA, and a biennial regional meeting. Delaware, North Carolina, Pennsylvania, and Virginia Sea Grant are longstanding and highly valued collaborators on regional issues.

Regional Projects. Through education, aquaculture, special journal editions, and marine science workforce diversity projects, MDSG partnered on grants with over 70% of all Sea Grant programs. These include a multitude of cooperative programming with island territories and states (Guam, Puerto Rico, and Hawai'i) and across the US from Alaska to California, Maine to Florida, and the Gulf of Mexico.

SG Network Activities. In addition to MDSG representation on SG network committees and in Mid-Atlantic Sea Grant regional activities (MDSG hosted the 2022 regional meeting), MDSG partners with SG communities of practice (e.g., climate, DEIJA, water resources, coastal inundation) and collaborates directly with counterparts in other programs (e.g., education, seafood safety, aquaculture, communications, workforce development, research).

MDSGE staff members presents at Mid-Atlantic Sea Grant Meeting.

NOAA Program Collaborations

Chesapeake Bay Sentinel Site Cooperative (CBSSC). MDSG's coastal resilience coordinator engages state and federal governments, academia, industry, and NGO scientists and decision makers to share data and synthesize findings to improve spatial and temporal understanding of ecological change and rates of sea level rise. CBSSC leads workshops, conferences, and trainings.

Advancing Regional Aquaculture. NOAA supports MDSG and MDSGE aquaculture projects on topics including market research, business plans, recirculating aquaculture systems for Atlantic salmon, an oyster aquaculture research and demonstration farm, and local and offshore aquaculture siting tools (with National Centers for Coastal Ocean Science [NCCOS]).

Watershed Restoration. MDSG partners with NOAA, MDSGE programs, and others in an innovative, interagency effort to assist local governments with coordination and resources for advancing watershed implementation projects. These efforts include collaboration between MDSG, CBT, and DNR's Chesapeake and Coastal Service, which is funded through NOAA's Office for Coastal Management.

Climate Change Programming. MDSG leverages staff and funding in innovative ways to provide critical support to Maryland counties at risk from nuisance flooding and erosion. A strong partnership with DNR accesses funds from NOAA to advance multiple climate resiliency efforts, including flood visualization, marsh migration, education, and research. Leveraged funds support a variety of collaborations to advance community engagement.

Building Legal Capacity. With initial support from NSGO and the National Sea Grant Law Center, MDSG led a coastal law and policy roundtable (2019) with regional constituents and others. This led MDSG to initiate a law and policy education model that culminated in a newly established MDSG Law and Policy Fellowship program supported by NSGO funds.

Other Collaborations

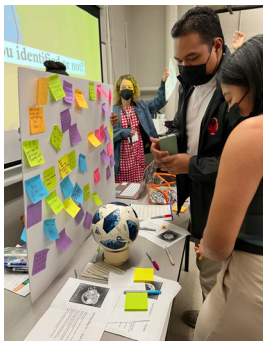
Climate Roundtable. For over a decade, MDSG has guided an interdisciplinary discussion on climate resiliency where collaborators brainstormed innovative approaches to coastal community adaptation to climate change. This led to collaborations across and beyond Maryland institutions, including an HBCU, on research projects, identification of priorities and gaps in climate resilience needs, and a workshop on holistic approaches to designing resilience projects with coastal communities.

Invasive Species. Since 2002, MDSG has served on the Mid-Atlantic Panel on Aquatic Invasive Species (MAPAIS)

executive committee and for 11 years managed the panel's distribution of approximately $500,000 in grant funds to researchers and organizations involved in regional invasive species research and outreach. Outcomes include managing more than 30 MAPAIS grants that helped states create management plans, supported education programming, and funded research projects on early detection and spread of invasive species. Educators and managers have used MAPAIS products, such as the *Mid-Atlantic Field Guide to Aquatic Invasive Species* and K-12 educational resources.

External Grants, Aquaculture and Education. MDSG is a co-PI on two $10 million USDA grants and one $10 million NSF grant. The USDA grants support work to advance land-based recirculating aquaculture systems for Atlantic salmon and new technologies to improve on-bottom oyster aquaculture production. The NSF grant supports efforts to diversify the geosciences workforce through education programming with institutions in Puerto Rico, US Virgin Islands, and Guam.

Special Journal Issues. MDSG's associate director served as a guest editor for the SG network's special issue of *Oceanography* magazine with colleagues across the network. MDSG collaborated on multiple articles in the volume. The MDSG coastal resilience coordinator co-edited a special issue of the journal *Wetlands* and wrote the introductory article. This issue was an outcome of the MDSG/VASG-led 2019 Chesapeake Bay Marsh Summit.




Pictured, left to right: MDSGE's Seed to $$$ Workshop (2023); SEAS Island Alliance students at workshop in Puerto Rico in 2022; Chesapeake Bay Landscape Professional Certification Program Morgan State Crews Course participants visit a green roof.

PERFORMANCE

MDSG works to address Maryland's marine, coastal, and watershed environmental challenges and improves the health and prosperity of its residents. Our strategic plan's goals and objectives drive the activities we pursue in each focus area.

The success of MDSG's program and its impacts reflect our management and organization, constituent engagement, collaborative working style, strong leadership, and productivity (Table 9). MDSG's status as an intellectual and practical leader is demonstrated by our grant funding success, leadership roles within and beyond Maryland, and the impact of our programming on policy, people, and the environment as highlighted below in our focus areas and in the PIER report (Impacts and Accomplishments, National Performance Measures and Metrics). Though many activities span multiple topical and programmatic objectives, for simplicity, we have organized projects by the national focus areas. *Note: Impacts in each focus area have a parenthetical reference to the PIER report page number of the full impact statement.*

COVID-19

From March 2020 through December 2022, MDSG staff primarily worked remotely. Amid global turmoil and necessary personal adjustments for team members, MDSG continued to succeed. We pivoted to support and serve our stakeholders through this crisis. MDSGE and partners created a new market and consumer education products to help keep the oyster industry viable. MDSG's virtual workshops, focus groups, and professional development opportunities ensured key constituents were able to make evidence-based decisions, research and community collaboratives continued to grow, and MDSG-supported students were prepared for careers in their field.

Table 9. MDSG Staff and Extension Faculty Professional Service (2018–2024)

This list includes service to external organizations (outside MDSG, UMCES, and, in the case of MDSGE, UMD). Many of our staff serve MDSG, UMCES, and UMD on hiring panels, university and organizational committees, and other internal service. Staff are also active in many Sea Grant Association and network activities and committees, as noted in Fig. 2.

MICHAEL ALLEN

Associate Director for Research and Administration

Co-chair, Coastal Estuarine Research Federation (CERF) Mentoring and First-timers Comm.
Editor, *Oceanography* Sea Grant (SG) Special Issue
Fiscal Officer, MAPAIS
Vice-chair, Mid-Atlantic Panel on Aquatic Invasive Species (MAPAIS)
Member, CERF Mentorship Program

NICOLE BASSENBACK

Former Extension Program Assistant

Board, Friends of St. Clements Bay
Member, MD Stream Restoration Assn.

KELSEY BROOKS

Former Regional Watershed Restoration Specialist

Member:
- Loch Raven South Small Watershed Action Plan Steering Committee (SC)
- Watershed Assistance Collaborative

ERIC BUEHL

Regional Watershed Restoration Specialist

Advisory member, Mid Shore Board of Realtors Clean Water Comm.
Co-coordinator (acting), Baltimore Urban Waters Partnership (BUWP)
Member:
- Caroline Co. Hazard Mitigation Plan Update Comm.
- Cecil Co. Watershed Implementation Plan Advisory Comm. (AC)
- Envision the Choptank Work Group (WG) SC
- Talbot Co. Green Infrastructure Plan Comm.
- Watershed Assistance Collaborative

CLAIRE CAMBARDELLA

Regional Watershed Restoration Specialist

Co-ambassador, BUWP

JENNA CLARK

Senior Programs Manager

Member, CERF Design Competition Planning Comm.

JENNIFER DINDINGER

Former Regional Watershed Restoration Specialist

Northeast Representative-elect, Assn. of Natural Resource Extension Professionals Finance Comm., Policies and Procedures Review Comm., and Strategic Planning Comm.
Member:
- Chesapeake Bay Program's (CBP) Stewardship Goal Implementation Team (GIT) Subcommittee
- CBP Climate Resiliency WG
- MD Dept. of the Envt. Stakeholder Consultation Group for Advancing Stormwater Resiliency in MD

ADAM FREDERICK

Assistant Director for Education

Co-founder, MD Envtl. Literacy Advisory Network (MELAN); co-chair, MELAN's Higher Ed. WG
Coordinator, Natl. Marine Educators Assn. (NMEA) Natl. Office
Member:
- NMEA Ocean Decade WG
- South Carolina SG Biodiscovery Resources Advisory Group

WILLIAM HUBBARD

Extension Assistant Director & Sea Grant Program Leader

Board Member:
- MD Dept. of Planning/Patuxent River Commission
- Southeastern Coastal Center for Agricultural Health and Safety

Liaison, Natl. SG Extension Assembly-EDEN
Panel Leader/Manager:
- USDA Natl. Institute of Food and Agriculture (NIFA) Climate Hub-Extension Special Grants Program Competitive Grants Review
- USDA NIFA Renewable Resources Extension Act Focus Funds Competitive Grants Program & Review

Member, UMCES Horn Point Hatchery Advisory Council

JORGE HOLZER

Fisheries Economics Specialist

Vice-chair, Atlantic States Marine Fisheries Commission (ASMFC) Comm. on Economics, Social Sciences
Member:
- ASMFC Striped Bass Plan Review Team
- CBP Invasive Catfish WG; Sustainable Fisheries GIT
- MD Dept. of Natural Resources Chesapeake & Coastal Service's Working Waterfronts AC
- Intl. Council for the Exploration of the Sea (ICES) WG on Economics; Subgroup on Trade-offs for Fishery Mgmt.; WG on Recreational Fisheries Surveys
- Mid-Atlantic Fishery Mgmt. Council's Scientific and Statistical Comm. and Socioeconomic WG
- Editorial Council, Journal of Environmental Economics and Mgmt.

ANDY LAZUR

Water Quality Extension Specialist

Development Committee Chair, LEAD 21 Alumni Assn. Board
Education Comm. Chair, Board Member; MD Onsite Wastewater Professionals Assn.
Vice Chair, Natl. Onsite Wastewater Recycling Assn.
Member, US Environmental Protection Agency Decentralized Wastewater Workforce Development SC

CHENGCHU (CATHY) LIU

Seafood Technology Specialist

Board Director, American Chinese Food Society, Institute of Food Technologists MD Section
Fellow, Intl. Academy of Food Science and Technology (IAFoST)
Member:
- Natl. Seafood HACCP Alliance SC
- Intl. Assn. of Food Protection Seafood Safety and Quality Professional Development SC
- Alliance UNESCO Intergovernmental Oceanographic Commission Western Pacific: Project on Toxic Marine Organisms and Their Toxins SC

KATE MCCLURE

Coastal Climate Specialist

Co-coordinator, SG Climate Network
SC Member, Delmarva Alliance of Adaptation Professionals
Member:
- CBP Climate Resiliency WG
- MD State Agency Saltwater Intrusion WG
- MD Nuisance Flood Plan WG

FREDRIKA MOSER

Director

President, Sea Grant Assn. (SGA)
President-elect, SGA
Past president, SGA
Chair:
- SGA Executive Comm.; Nominating Comm.

Member:
- CERF Ambassador Program
- CBP Climate Resiliency WG
- Chesapeake Bay Sentinel Site Cooperative (CBSSC) Mgmt. Comm.
- MD Commission on Climate Change Adaptation & Resiliency WG
- Morgan State PEARL Review Panel
- University System of Maryland Presidential Search Committee

MATTHEW PARKER

Aquaculture Business Specialist

Chair:
- US Aquaculture Assn. Finance Comm., Strategic Planning Comm., Election Comm., Subcommittee on Continuing Education Workshops
- US Aquaculture Society Professional Awards Comm., Elections Comm., Society Policies & Procedures Comm., Past Presidents Comm.
- World Aquaculture Society (WAS) Communications Comm., Finance Comm.

Interim Extension Director, Prince George's Co.
President-elect; Past President; Treasurer, US Aquaculture Society
President, US Aquaculture Assn.
Secretary/Treasurer, US Aquaculture Assn.
Member:
- CBP Partnership Water Quality and Habitat GIT Oyster Best Mgmt. Practice Expert Panel
- MD Agricultural and Resource-Based Industry Development Corp. Shellfish Loan Review Comm.
- Natl. SG Law Center AC
- Natl. SG Office Representative
- Natl. Aquaculture Extension SC

AMANDA ROCKLER

Watershed Restoration Specialist

Co-ambassador, BUWP
Co-lead and founding partner, Baltimore Regional Green Environmental Equity Network
Board member:
- Chesapeake Conservation Climate Corps
- Chesapeake Conservation Landscaping Council

Member:
- Chesapeake Bay Landscape Professional Certification AC
- CBP Stewardship WG
- Climate Wise Academy SC
- Montgomery Co. Water Quality Advisory Council
- Montgomery Parks and Recreation Natural Resources Monitoring Team
- Natl. Fish and Wildlife Foundation's Small Watershed Grants Program Evaluation Team
- Natl. Urban Waters Partnership
- Water Environment Federation Stormwater Comm.

ANNIE SCHATZ

Aquaculture Projects Coordinator

SC Member, SG Aquaculture Roadmap

JACQUELINE TAKACS

Former Regional Watershed Restoration Specialist

Treasurer:
- Mid-Atlantic Marine Education Assn. (MAMEA)
- NMEA

Member:
- US Aquaculture Society Education Comm.
- Watershed Assistance Collaborative

Panelist, ADVANCING Professional Track Faculty Program, UMD Office of Faculty Affairs

LISA TOSSEY

Former Assistant Director for Communications

Board of Directors, NMEA
Member, MAMEA President's Chain

DON WEBSTER

Regional Extension Specialist

Board of Directors:
- Chesapeake Agriculture Innovation Center
- Farmer Veteran Coalition, MD Ch.
- Maryland Agriculture Council

Member:
- Atlantic Corporation Natl. Farm Raised Seafood Development AC
- Chesapeake Bay Foundation Chesapeake Oyster Alliance
- MD Aquaculture Coord. Council
- Northeastern Regional Aquaculture Center Technical AC
- Talbot County Weed Control Commission

BRITTANY WOLFE-BRYANT

Former Regional Extensi-n Specialist

Proxy member, Maryland Oyster Advisory Commission

Healthy Coastal Ecosystems

From 2018–2023, MDSG investigated coastal and ecosystem processes in marine, estuarine, and freshwater areas through groundbreaking applied research projects and robust education and outreach. Research on contaminant sources and sinks, nutrient and sediment dynamics, ground and surface water quality, bay grasses, wetland ecosystems, invasive species, and tools to track fish species advanced our understanding and management of coastal ecosystems.

Contaminant Fate and Transport

Since the industrial revolution, humans have introduced chemical waste to waterways. Understanding contaminant fate and transport is essential for reaching clean water goals.

MDSG supported early investigations of contaminants of emerging concern (CECs) in Maryland's Chesapeake Bay waters. Scientists found that common products and pharmaceuticals, like sunscreen and antibiotics, are widespread in water, sediment, and oyster tissues (p. 83–84). In a separate study, using advanced mass spectrometry analysis, researchers identified hundreds of new chemical tracers to identify septic system effluent in waterways. Advanced tracking refines understanding of inputs to the Bay from this poorly quantified non-point source (p. 81–82).

Another research effort found road salt application can increase salinity in freshwater systems and produce "chemical cocktails" harmful to wildlife, the environment, and human health. It demonstrates the need to consider salt pollution in runoff when developing best management practices for winter roadways (p. 87–88).

Outcomes: Research findings informed the EPA about the presence and distribution of CECs. Results from the septic system effluent study, presented to the Maryland General Assembly, influenced state and county decisions on septic system regulation and best technologies for nitrogen removal. EPA also worked with MDSG-funded researchers to develop a factsheet on freshwater salinization syndrome (FSS), now posted on the EPA website. This research, shared with about 1,000 practitioners and scientists at a 2022 workshop, led to a frequently cited report on FSS management questions.

Nutrient Dynamics and Water Quality

As communities strive to meet EPA Total Maximum Daily Load (TMDL) mandates to reduce nutrient and sediment inputs to the Chesapeake and coastal bays, MDSG has supported actionable science to improve understanding of water quality dynamics around the region.

Rising sea levels, salinity, and low oxygen trigger complex chemical processes, potentially exacerbating ammonium and phosphate pollution from coastal farmland to adjacent marshes. Researchers found salt marshes on farmland had higher ammonium and phosphate concentrations than other coastal areas. Phosphate concentrations were above pollution thresholds in nearly every area tested. Results show the need for new strategies to reduce legacy farm nutrient loads and adapt to saltwater intrusion in rural farmlands (p. 79). A different study found a common farm field drainage system for nutrient reduction did not increase greenhouse gas emissions as hypothesized, easing concerns about its use (p. 85).

A unique, whole-ecosystem study of aeration in a highly polluted Chesapeake Bay tributary yielded new data to inform discussions of whether aeration should be scaled up to improve Bay water quality. Finding aerators can improve oxygen far beyond their location prompted decision makers in Maryland and Finland to consider applying this research to management of other impaired waterways (p. 80–81).

New data demonstrated the importance of winter phytoplankton dynamics on Bay water quality, showing that winter microbial community growth is remarkably high and dominated by slow-growing diatoms, not the expected dinoflagellates. Scientists believe these organisms significantly contribute to the Bay's seasonal hypoxia as they decompose (p. 86–87). Another phytoplankton study on the Anacostia River by Gallaudet students advanced understanding of water quality response to stormwater management (p. 79–80).

Outcomes: Results, shared with farmers and state and federal agencies, informed a new legislatively mandated Saltwater Intrusion Plan. Anne Arundel County committed $1 million to replace a stream aeration system and implement additional watershed restoration strategies. Findings from septic system tracking provided key insights for county and state decisions on regulating nitrogen inputs. Discovery of winter phytoplankton composition led to NSF funding to develop an autonomous coastal observatory to track Bay mixotrophy community composition and metabolic activity. Community scientists learned how to monitor water quality in Washington, DC, rivers and DC officials planned for new water quality research with Gallaudet University.

Bay Grasses

Submerged aquatic vegetation (SAV) is a key restoration metric for the Chesapeake Bay. MDSG-supported researchers investigated the role of the Susquehanna Flats—a bed of SAV in the upper Bay—in capturing small, nitrogen-enriched particles from the river. The beds captured particles at a faster rate than the water channels, and large grass beds held the most sediment (p. 121). In the same region, MDSG-funded researchers investigating

mat-forming cyanobacteria *Lyngbya* (spp.) in SAV beds detected the presence of a toxin responsible for paralytic shellfish poisoning, prompting additional genetic mapping to determine the *Lyngbya* species (p. 123).

Outcomes: Transformative research on SAV advanced the understanding of carbon and nitrogen deposition in tidal estuarine grass beds to help refine Bay models. Analysis identified benthic algal mats in the Susquehanna Flats as *Microseira (Lyngbya) wollei* (reclassified genus) prompting EPA, DNR, and others to work on a monitoring plan.

Marshes and Sea Level Rise

As sea level rates in the region rise at about twice the national average, policy makers see new urgency in understanding marsh ecosystems and their potential to sequester carbon, affect nutrient cycling, and mitigate effects of storm surge and flooding.

While investigating how barrier island migration affects carbon storage in saltwater marshes in the Mid-Atlantic region, researchers discovered back-barrier marshes help slow barrier island migration, while the highest rates of carbon loss occur on the ocean side from erosion of exposed peat (p. 81).

The Chesapeake Bay Sentinel Site Cooperative (CBSSC) is a critical hub for marsh ecologists and coastal managers to collaborate on research, education, and engagement around marsh health and resiliency during climate change, including synthesis of wetland elevation data through a linked network of Bay stations (p. 88). Ongoing MDSG-funded research measuring the effectiveness of living shorelines to minimize effects of climate change on erosion and Bay habitat complements CBSSC efforts.

Outcomes: Researchers secured a new National Fish and Wildlife Foundation (NFWF) grant to fund a marsh restoration plan to slow migration and create habitat in the Virginia islands' back-barrier marshes, while local officials in Chincoteague, VA, said project workshops helped community members better understand barrier island dynamics. More than 400 people participated in CBSSC's events, including a Marsh Resilience Summit (p. 122) and workshop series on coastal farming challenges and vertical land motion (p. 104, 121). These workshops influenced land management plans and laid the groundwork for the Chesapeake Bay Wetlands Strategic Plan. Members of the CBSSC produced a video on monitoring marshes (viewed more than 1,000 times), developed a conceptual model of marsh dynamics, installed marsh and flood monitoring instruments, and created an interactive map to measure change in wetland sediments.

HEALTHY COASTAL ECOSYSTEMS
Key Impacts 2018–2023

- Researchers from Gallaudet University, a private university for deaf and hard of hearing students, studied the impact of major stormwater infrastructure improvements in Washington, DC.
- For 11 years, MDSG has advanced collaborative invasive species research, education, and outreach through the Mid-Atlantic Panel on Aquatic Invasive Species.
- Research informed the replacement of a $1 million stream aeration system and spurred Anne Arundel County officials to implement more restoration activities in the watershed.
- EPA recognized the need for road salt management after new research demonstrated harm from this pollution source.
- Research advanced understanding of ecosystem interactions among sediments, nutrients, submerged aquatic vegetation (SAV) and hydrodynamics to improve management.

Invasive Species

Funded researchers investigated the effectiveness of native tidal wetland plants in restoration after removal of the invasive *Phragmites*, finding transplanted natives allowed sites to recover after three years. (p. 38, 89–90).

Outcomes: MDSGE created briefs and ran a workshop where researchers presented management tools to replace *Phragmites* with native plants, providing actionable information for homeowners, community associations, and managers. Based on the workshop, owners at one site continue to monitor and remove invasive *Phragmites*.

Novel Tools for Monitoring Bay Fishes

Tracking fish and estimating population presence is critical for fisheries management. MDSG-funded researchers explored several potentially powerful, noninvasive, and affordable monitoring tools to improve fisheries management. They developed quantitative PCR assays to track American and hickory shad (p. 86), while another study used environmental DNA (eDNA) metabarcoding to gather data on the biodiversity of vertebrates in the Chesapeake Bay (p. 120–121).

Outcomes: Researchers made significant progress in developing tools to better assess populations of shad, making it easier to gather needed data about these important Bay fish. eDNA metabarcoding identified 45 aquatic vertebrate species in the Bay, including top predators such as sharks and dolphins, as well as key recreational fish species. Results were shared with community members and a youth summer camp program.

Sustainable Fisheries and Aquaculture

MDSG continues its longstanding focus on achieving sustainable harvests for the Chesapeake's traditional fisheries and supporting the rapidly expanding aquaculture industry. Watermen and aquaculture producers provide healthy seafood for Maryland, are part of a rich culture, and create thousands of jobs in related seafood businesses. MDSG directed major research and extension efforts, including informing ecosystem-based fisheries management, expanding oyster aquaculture, supporting land-based recirculating aquaculture systems, and ensuring safe seafood production. Importantly, as reported by DNR, the dockside value of blue crabs and eastern oysters in 2022 alone was more than $55 million.

Advancing the Aquaculture Industry

Shellfish aquaculture offers expanded employment opportunities and an alternate income source for traditional wild oyster harvesters. With oyster aquaculture, Maryland seeks to improve estuarine water quality, promote biodiversity, produce sustainable food, and provide jobs.

Extension specialists managed a university demonstration oyster farm to train growers on remote setting of larval oysters, new methods of oyster cage aquaculture, and research-based ways to reduce biofouling (p. 90–91, 98–99).

During the COVID-19 pandemic, MDSGE sought innovative ways to help oyster farmers contend with sales losses and layoffs, including helping growers market shellfish (p. 91–92) and building consumer confidence in buying and preparing seafood.

Outcomes: During the pandemic, MDSGE helped 21 oyster growers avoid layoffs by creating a new market to purchase large aquaculture oysters for reef restoration. To increase online direct-to-consumer oyster sales, MDSGE created a Shuck at Home video series to help home cooks safely shuck and cook oysters. Ten growers learned how to reduce cage biofouling and others benefited from a supporting MDSGE guidance document (p. 47).

Advancing Sustainable Aquaculture

MDSG funded a strong research portfolio of complementary oyster aquaculture projects. In addition, two workshops convened researchers, regulators, extension specialists, and members of the aquaculture industry to foster collaboration and advance cross-disciplinary research.

One researcher investigated how water currents affect benthic organisms under oyster cages and discovered that oyster biodeposits strongly influence nutrients and oxygen conditions nearby (p. 125–126). Other scientists studied effects of on-bottom oyster cages on nutrient cycling and SAV. They created an online tool for oyster growers to predict nitrogen removal potential based on their oyster farm's characteristics (p. 126–127).

MDSG-funded researchers at Morgan State University (MSU) developed Maryland's first native low-salinity oyster lines and successfully established multiple oyster broodstock lines for aquaculture, resulting in hardier oysters for Maryland waters (p. 96–97).

Soft-shell clam production is a promising area for industry expansion, allowing growers to diversify their portfolio and increase their farm's viability and resilience. MDSG-supported scientists bred soft-shell clams (*Mya arenaria*) and developed six aquaculture grow-out methods (p. 126).

Outcomes: State agencies committed $3 million to upgrade and permanently staff MSU's research hatchery to expand its work and support for the oyster industry. Other research helped advance state agencies' and oyster growers' permitting discussions on nutrient/oyster dynamics and compatibility issues with co-location of SAV and oyster cage aquaculture. MSU researchers produced about 46,000 soft-shell clam seeds and found high survival rates across all six grow-out methods, although growth rates varied. The research resulted in a provisional patent.

Land-based Finfish Aquaculture

MDSG led and expanded a $1 million NSGO-funded project, Recirculating Aquaculture for Salmon Network (RAS–N), to build capacity for the rapidly expanding US land–based production of Atlantic salmon (p. 95–96).

The Sustainable Aquaculture Systems Supporting Atlantic Salmon (SAS²) project, funded by a $10 million USDA grant, expands the initial RAS-N project in research, work-

$22 million

in NOAA and USDA grants secured by scientists, extension, and education programs, along with industry partners, to advance regional aquaculture.

force development, and community engagement. MDSG and MDSGE led new communication, outreach, and education activities, including helping plan and host a 2023 conference for technology transfer and networking for 110 consortium members, and developing land–based aquaculture programs for Maryland high schools and regional 4-H programs. SAS[2] supports a full time MDSGE coordinator position.

Advancing Aquaculture Tools

Oyster growers and an MDSGE specialist co-developed a shellfish aquaculture business planning tool. The online tool provides customized income projections for individual businesses. The tool is also included in a NOAA-hosted aquaculture planning tool online repository. Since 2011, MDSGE's aquaculture business specialist has helped commercial watermen and other applicants prepare business plans to apply for financing, which is important as traditional loans are often unavailable (p. 94).

Outcomes: The aquaculture business tool was accessed over 290 times in 2022–2023, including international users. Between 2018 and 2023, MDSGE's aquaculture business specialist worked with MARBIDCO, a state-chartered, quasi-public economic development organization, to secure about $2.5 million in loan commitments for oyster farmers and complete loan applications for oyster aquaculture development assistance.

MDSG, NSGO, and NOAA's National Centers for Coastal Ocean Science (NCCOS) hosted three of six nationwide workshops showcasing and receiving input on several tools for aquaculture siting to advance sustainable development. More than 160 participants attended, allowing tool developers to connect with user groups (p. 127–128).

MDSG collaborated with researchers to write, design, and publish an illustrated book to advance understanding of eastern oyster diseases and illness. This is a first-of-its-kind resource for the Chesapeake Bay region (p. 92–93).

Outcomes: NCCOS workshops resulted in improvement and broader distribution of aquaculture siting tools, as well as use of MDSGE's aquaculture business tool. Participants say they benefited from hearing perspectives of coastal-ocean user groups who are not usually in these conversations. Scientists, students, and aquaculturists use the oyster reference book to identify diseases so as to prevent them from being introduced into other waters.

Seafood Safety and the Blue Crab Industry

To help Maryland's blue crab industry compete with cheaper imported crabmeat, MDSGE's seafood technology specialist worked with 12 local businesses in the Maryland Crabmeat Quality Assurance Program. Participating businesses agree to undergo food safety inspections beyond state and federal requirements, which earns them use of a special logo marketed by the State's Office of Seafood Marketing. The specialist conducts routine trainings in Hazard Analysis and Critical Control Points (HACCP) to keep the industry compliant with food safety procedures (p. 101).

To extend the shelf life of fresh domestic blue crab meat, Maryland seafood processors and an MDSGE specialist used competitive NOAA funding to develop an economically important processing protocol for a new hydrostatic pressure processing (HPP) technology (p. 94–95).

SUSTAINABLE FISHERIES AND AQUACULTURE
Key Impacts 2018–2023

- Researchers developed the first low-salinity oyster broodstock line specific to Maryland waters. It is currently being tested by growers.
- 25 submerged land leaseholders in Maryland learned to successfully set 320 million larvae and operate remote setting systems, yielding 96 million spat planted on Maryland leases in 2021.
- The Atlantic States Marine Fisheries Commission incorporated researchers' model to direct ecological reference points in the Atlantic menhaden stock assessment process, and plan to include new striped bass research findings in their next striped bass stock assessment.
- Extension services helped create two new businesses and supported 38 aquaculture jobs; Assistance to MARBIDCO helped secure a total of $2.5 million in loans for 33 oyster farmers.
- A workshop for scientists and aquaculture industry experts identified joint projects to advance the industry and led to new federal and state grants.
- Guidance provided to crab industry representatives on seafood safety and microbiological analysis was valued at $2.2 million.
- Extension trained 298 individuals in seafood safety Hazard Analysis and Critical Control Points (HACCP) valued at $4.8 million.
- During the pandemic, extension specialists and partners supported the oyster industry by creating a new market for larger oysters, with an economic benefit of nearly $800,000.
- Research led to the first map of the blue crab genome.

Outcomes: Since 2018, MDSGE trained 298 professionals in HACCP standards, resulting in $4.8 million economic impact. Research found HPP reduces bacterial growth and can triple the shelf life of fresh blue crab meat without compromising taste or texture. Economic analysis showed HPP could reduce processor, food service, and retail losses by 5–11%.

Ecosystem-based Fisheries Management

MDSG's work plays an important role in finfish harvest management. As the conversation shifted toward ecosystem-based fisheries management (EBFM), MDSG funded science to advance EBFM and to broadly inform fishery decisions. Important commercial management decisions in state and federal fisheries regulatory bodies benefit from our research and expert advice (p. 97).

One of the first studies to look at multiple harvest control rules for various fishes helped inform menhaden management. MDSG-funded researchers combined data about menhaden and striped bass in a simulation model to show how combinations of different harvest control rules for each fish would influence the fish populations (p. 97–98).

Outcomes: Fisheries researchers were invited to incorporate the simulation tool in the 2025 striped bass stock assessment process conducted by the Atlantic States Marine Fisheries Commission (ASMFC).

MDSGE's fisheries resource economist provides expertise and analysis to fisheries managers. He advises on economic impacts and economic fisheries policy for the ASMFC, and the Mid-Atlantic and the New England Fishery Management Councils (p. 98–99).

Outcomes: The fisheries economist made significant contributions to management decisions affecting state, national, and international fishing regulations and quotas for commercial fish harvests. Examples include developing a bioeconomic model for managing recreational fisheries, recently implemented by the Northeast Fisheries Science Center and adopted by the Mid-Atlantic Fishery Management Council for summer flounder, black sea bass, and scup. The fisheries economist also studied the feasibility of reinstating the Research Set-Aside program (auctioning off quota) to generate resources for fisheries management research.

High-quality science for forage fisheries supports a holistic understanding of the ecosystem. MDSG supported a first-of-its-kind study of mysids in the Chesapeake. Understanding mysids distribution, behavior, and abundance provides critical baseline data to improve the accuracy and effectiveness of ecosystem-based models (p. 129).

Using genomic metabarcoding, MDSG researchers can more precisely identify Bay zooplankton species and the contents of larval fish guts, to better understand key relationships among fish recruitment and zooplankton type, abundance, and diversity (p. 124).

Outcomes: Researchers shared baseline data on mysids with regional fisheries management groups to improve ecosystem-based models for resource management in the Chesapeake Bay. Researchers reported metabarcoding can help them more quickly and precisely identify zooplankton species in the Bay. Findings were shared with DNR and NOAA scientists.

RESEARCH PUBLICATIONS

MDSG supported research that led to 145 scholarly publications. High-impact journals in which these publications appeared included:

Estuaries and Coasts
G3: Genes, Genomes, Genetics
Journal of Environmental Management
Limnology and Oceanography
Marine Ecology Progress Series
Nature Climate Change
PLOS One
Reviews in Aquaculture
The ISME Journal: Multidisciplinary Journal of Microbial Ecology

Resilient Communities and Economies

Maryland's coastal communities are central to the state's culture, history, and economy. As commercial fishing and agricultural practices change, recent policy decisions and management actions are creating different economic opportunities. The emerging need to adapt to climate change and meet nutrient and sediment pollution limits will present are helping communities and local governments. MDSG is well-positioned to provide solutions to those challenges. Working with government and nonprofit partners and scientific researchers, we can help Maryland's coastal businesses grow sustainably, train new leaders to reduce stormwater pollution, and understand and mitigate risks from climate change.

Supporting Coastal Communities

As sea level rise threatens coastal communities and planning efforts are underway, MDSG helps connect communities to the tools and research they need. We also serve as a conduit for stakeholder feedback, ultimately increasing resilience.

Research and engagement address flooding and marsh encroachment on Maryland's Eastern Shore. Several MDSG-supported teams of anthropologists, scientists, planners, and residents discussed solutions for the region (p. 131). Discussions inspired a series of MDSG-supported short films, including a collaborative learning film about community engagement; a video produced with Morgan State University students highlighting a historic community's struggle with climate change and the loss of their church and cemetery (p. 109); and an ethnographic documentary of Smith Island, MD, which provided new insight into a community facing climate change through the personal storytelling of residents (p. 130–131).

Researchers used literature reviews and surveys of stakeholders to develop a science-based framework for measuring resilience. The resilience indicators were later integrated into the National Institute of Standards and Technology's Community Resilience Program (p. 132–133).

MDSG conducted NSF-funded coastal farmers focus groups to understand how sea level rise is affecting farmers' priorities and future land use under saltier and wetter conditions. MDSG connected farmers with wetland ecologists and elevated to policy makers the challenge sea level rise poses for economically important farmlands (p. 104–105).

Outcomes: One affected Eastern Shore county revitalized its drainage ditch maintenance and constructed a living shoreline to help slow coastal erosion, addressing a specific need of the local communities. Based on coastal farming focus groups, the US Department of Agriculture National Resource Conservation Service in Virginia included more salt-tolerant species in the seed mix for its Conservation Reserve Program.

RESILIENT COMMUNITIES AND ECONOMIES
Key Impacts 2018–2023

- Watershed Stewards Academies expanded to six counties; graduated 171 stewards; built 27,775 square feet of best management practices, treated 98,690 square feet of impervious surfaces; educated 10,221 people; and engaged 2,267 volunteers.
- Extension specialists helped secure almost $5 million in watershed restoration grants, resulting in an estimated reduction of 616.1 tons of total suspended solids.
- The Landscape Certification Program trained 300 professionals and certified 134 professionals, whose efforts reduced nitrogen, phosphorus, and sediment inputs to the Chesapeake Bay.
- MDSG convened 74 scientists, engineers, landscape architects, architects, and community liaisons to generate ideas for projects to advance climate resilience in Maryland's built environment.
- Over 400 participants attended CBSSC events, resulting in new partnerships, policy formation, research proposals, and land management adaptations.

Participants in the Large-Scale Marsh Persistence and Restoration in the Chesapeake Bay workshop developed 11 large-scale marsh restoration project ideas, many with a focus on environmental justice. This workshop helped the Chesapeake Bay Program Goal Implementation Team select two sites for new marsh restoration projects (p. 108).

Helping Communities Protect Watersheds

Effective management of stormwater runoff is critical to meet the Chesapeake Bay watershed's clean water goals. MDSGE works with partners to address this challenge and help communities meet their mandated TMDLs.

Watershed Stewards Academies (WSA) are train-the-trainer programs teaching volunteers how to lead efforts to restore streams, install stormwater best management practices (BMPs) such as rain gardens and plant buffers, and secure grant funding for additional projects. MDSGE partnered with local groups to build six WSAs in five counties and the DC metropolitan area. Hundreds of volunteers have been educated about pollution issues and management practices related to stormwater (p. 101–102). During COVID-19, a watershed specialist started an online WSA with high

participation. MDSGE also secured new county funding, split between two counties in Southern Maryland, to hire a watershed specialist to work full-time on water-quality projects, including WSA programming (Fig. 2; p. 102).

The Chesapeake Bay Landscape Professional Certification Program (CBLP) is an MDSGE collaboration with regional partners to train individuals and companies in conservation landscaping design and installation and maintenance of stormwater management systems. Efforts to reach underserved communities include providing training and materials in Spanish to reach Hispanic owners and workers in the landscaping industry (p. 103–104).

Outcomes: Since 2018, WSAs graduated 171 stewards, built 27,775 square feet of BMPs that treat 98,690 square feet of impervious surfaces, educated 10,221 residents, engaged 2,267 volunteers, and installed 543 rain barrels. CBLP trained more than 1,300 professionals and certified more than 1,200 professionals, whose efforts reduced nitrogen, phosphorus, and sediment inputs to the Bay.

MDSGE protected coastal water quality through education programs about maintaining septic systems or upgrading to more efficient systems to prevent nitrogen and other pollutants from entering the Bay. More than 40 webinars and workshops taught constituents about septic system upkeep and best available technology to use in coastal areas affected by sea level rise (p. 105–106). In a different project, MDSGE used social marketing strategies to understand residents' resistance to restoration projects and develop alternative approaches to improve buy-in. This work helped community leaders in Cambridge, MD, optimize projects to meet residents' needs while achieving the city's water quality goals.

Outcomes: After septic system workshops, a third of respondents in a post-participation survey pumped their tank (a best practice that represents a newly recognized nitrogen credit of 0.4 pounds per household in the state's Watershed Implementation Plan). Counties reported 51 applications to the state's grant program to help septic system owners upgrade older, failing systems with best available technology. The social marketing survey data helped secure an initial $85,000 NFWF grant for phase one of the 10-year plan. This community initiative installed 20 rain gardens and conservation landscaping projects on residential properties and received further NFWF funding. Social marketing successfully built a foundation for further work in Cambridge, leading to funding for a living shoreline project.

Climate Research and Technical Assistance Inform Management Decisions in Maryland

MDSG's climate resilience team works with state and local government to improve resiliency planning and adaptation, helping communities prepare for climate change (p. 106).

Providing clear, science-backed information about sea level rise is a necessary public service—but decision makers must be able to translate it to their projects. Since 2018, MDSGE has partnered with Maryland's CoastSmart Communities Initiative to help draft statewide sea level rise projections and lead efforts to guide and train groups to use these projections in planning and executing projects. In 2022, MDSGE staff co-led training on sea level rise guidance for 117 staff from state agencies, local government, and partner organizations. In 2023, the projections were updated by an UMCES-led science panel, which included MDSGE. The guidance was highly praised by a co-chair of the Sea Level Rise Grand Challenge Committee of the World Climate Research Programme, who pressed for other states to adopt this approach (p. 107). MDSG also prepared a Climate Change Vulnerability Assessment of the Maryland Coastal Bays Program Comprehensive Conservation & Management Plan.

Outcomes: Materials from the sea level rise guidance are used to guide development of coastal resilience projects and make funding decisions. The guidance contributed directly to three local flood and hazard mitigation plans, and video tutorials on its use were viewed more than 2,600 times.

TABLE 10. Workshops, 2018-2023

Workshop	Attendees
2018 MDSG Aquaculture Researcher Roundtable	70
2019 Marsh Resilience Summit	230
2019-2020 Vertical Land Motion in the Chesapeake Bay and Coastal Farming Challenges Series (Virtual)	83 and 35
2019 Maryland Coastal Law and Policy Roundtable	50
2022 Large-Scale Marsh Persistence and Restoration in the Chesapeake Bay	99
2023 Seed to $$$: MidAtlantic Aquaculture Forum	42
2023 Built Environment Design for Climate Resilient Coastal Communities Roundtable	68

Effective Environmental Science Education

Maryland is a coastal state, yet millions of its residents live without easy access to a shoreline. MDSG has developed programs and public outreach materials to educate Marylanders about marine science and policy in their own backyard. These include high school student and teacher trainings, undergraduate and graduate student support and fellowships, articles in our award-winning magazine, fact sheets for Congress, blog and social media posts, and publications. Our diverse activities focus on building a science-literate population and training the next generation.

Expanding Access to Project-Based Science

Since 1995, MDSG's assistant director for education has run a highly successful, pre-college educational program called Aquaculture in Action (AinA). Designing and constructing aquaculture facilities in schools, it integrates project-based learning, chemistry, physics, biology, and mathematics to solve practical problems while rearing fish from larvae to adults. Project-based learning is highly engaging and can improve student outcomes and retain teachers. New instructional strategies for AinA curriculum include a water monitoring system using affordable but professional-grade sensors, microcomputers, and open-source software, along with a user-friendly guide for teachers. MDSG created and conducted workshops for teachers to master these technologies and use them in the classroom (p. 110–111, 113, 134).

Students gain research skills by measuring biodiversity through the Biofilms and Biodiversity (Baltimore) and VIRTUE (EU) projects. Students study racks of small aluminum disks placed in Maryland and international waters, respectively. These disks attract organisms, which students identify in the classroom. They also learn about the global threat of microplastics, which are often found within biofilms. The projects advance the idea that life abounds even in waters with poor water quality (p. 113, 114).

Another example of project-based learning focuses on Maryland's native spotted salamander. MDSG developed a protocol to enable hundreds of Maryland high school students to conduct hands-on, scientific studies of the salamanders and their unique algal symbiosis. Students rear salamander larvae in specialized aquaculture containers, and later return the larvae to vernal pools (state permit protocols granted by DNR). NSF-funded researchers at the Smithsonian's National Zoo and Conservation Biology Institute and George Washington University employed the students' help to rear larvae (p. 110).

ENVIRONMENTAL SCIENCE EDUCATION
Key Impacts 2018–2023

- 568 undergraduate and graduate students supported
- 49 master's and 64 doctoral degrees awarded; 420 students employed in their field within two years of graduating; about 90% of post-graduate fellows stayed in the region after their fellowship
- Aquaculture in Action project-based learning educated 2,000 students who raised and released over 2,500 native fish.
- *Chesapeake Quarterly* magazine: 4,160 print subscribers and more than 1,200 digital subscribers
- YouTube: surpassed half a million views on MDSG's top 5 videos

A new MDSG project, Raising Awareness of Marine Pollution in Underserved Populations (RAMP-UP), enhances community literacy among underserved youth about marine debris and plastic pollution.

Outcomes: Since 2018, 22 Maryland schools have AinA programs—with 14 microcomputing systems—educating 2,000 students who raised and released over 2,500 native fish. More than 1,200 Maryland high school students have had hands-on science lessons through MDSG's Biofilms and Biodiversity project. About 150 educators took part in related professional development. Working with international partners, the project also expanded to students in Sweden, Germany, Spain, and Norway and was supported by an EU grant. The project was also incorporated into a National Aquarium Model Urban Wetland program. Over the past six years, 600 science students have hatched, fed, measured, and studied salamander larvae. In its pilot year, the RAMP-UP program's informal education marine debris activities reached more than 50 students.

Supporting Undergraduate Education

The NSF Research Experiences for Undergraduates (REU) program began in 1989 with 10 students. Since then, the program has expanded student training and professional development, broadened student diversity, and grown the mentorship network across the university. It serves up to 15 upper-division STEM students per summer at two UMCES Chesapeake Bay laboratories. In response to the COVID-19 pandemic, the program pivoted to a virtual format to provide research and professional opportunities that allowed interns to safely conduct mentored research projects. MDSG incorporated best practices from the virtual environment into hybrid research and professional development programs since 2022 (p. 139–140).

MDSG collaborates with partners at UMCES, Universidad Interamericana de Puerto Rico, University of Guam, and University of the Virgin Islands to broaden access to marine and geoscience education and career opportunities for underrepresented and underserved island students through the NSF INCLUDES SEAS Islands Alliance. Through a five-year collaborative grant (2019–2025), the program provides mentorship, communications skills, research experiences, conference opportunities, exposure to graduate school, and workforce placements (p. 119, 140).

UMD's Gemstone Honors Program is a multidisciplinary four-year research program for undergraduate students of all majors. Research teams work on topics of interest to them, including projects relevant to MDSG's mission. Since 2008, MDSG has provided about $100,000 for Gemstone research projects on the Chesapeake Bay watershed (p. 118).

MDSG helped initiate a new interdisciplinary coursework for an advanced landscape architecture course at Morgan State University. The course connects environmental scientists to faculty who collectively advise on a student-driven design project tackling climate change and sea level rise (p. 135–136).

MDSG has participated in the Community Engaged Internship (CEI) program since 2019, mentoring students in science communication and extension (p. 137–138).

Outcomes: Since 2018, 86 students from diverse backgrounds and geographies participated in MDSG's 12-week REU program. Students led 52 scientific presentations at conferences and symposia and co-authored more than 14 peer-reviewed publications. They also participated in professional development opportunities, including customized communications training. More than 290 students from Puerto Rico, Guam, and the US Virgin Islands have participated in the SEAS Islands Alliance. MDSG's communications team mentored five SEAS interns and held science communication workshops for more than 50 students. SEAS evaluations suggest 89% of respondents are still engaged in STEM pathways and 83% are still involved in marine science (n=109). Gemstone Program funds have supported a diverse group of more than 235 students over the last 12 years. Of those students, 176 earned their degrees and 141 attained a job within two years of graduating. The CERF design studio course at MSU culminated in a final student presentation to advisors and members of the MSU community. Their work focused on reframing the challenge of climate change as a community-level opportunity for innovation and inclusion. They created designs and envisioned what a resilient, sustainable coastal community might look like in 100 years. Three CEIs worked on science communication projects, including classroom lesson materials, magazine articles, and videos. One former CEI is now a UME videographer.

PERFORMANCE MEASURE

574 Sea Grant-facilitated professional development activities

24K Individuals engaged in informal education programs

Supporting Graduate and Postgraduate Research and Fellowships

MDSG leads several graduate research competitions to support students conducting applied coastal, estuarine, or social science research relevant to the state. MDSG also offers science management, policy, and law opportunities to provide professional training on marine science policy issues. As part of these experiences, students receive mentorship in science writing, professional development training, and outreach opportunities on MDSG projects (p. 115–116).

Outcomes: MDSG supported 23 research fellows and 15 research grantees on topics including nutrient cycling and methane production, microplastics and biofilms, oyster genetics, eDNA, living shorelines, wetland ecology, and climate resilience. MDSG supported 25 Knauss Fellows, and seven State Science Policy Fellows who have gone on to careers with state and federal agencies, private consulting, and academia. MDSG has also supported two Science Management and Policy interns, two Spanish/English bilingual Environmental Science Outreach Interns, three Law and Policy fellows, and four in-office graduate assistants. MDSG fellows write blog posts describing their scientific and professional growth. Since 2018, MDSG edited and published 60-plus student blog posts and highlighted fellows' contributions in impact statements about their projects.

Communications Products for Public Education

MDSG's award-winning magazine, *Chesapeake Quarterly*, and blogs have covered issues pertinent to Chesapeake region science and policy, including marsh science, algal blooms, microplastics, invasive species, oyster aquaculture, and examining equity around the Bay. MDSG's communications team hosted interns and led science communication workshops with the intent of providing key experience to early-career scientists and science communicators. (p. 116, 119–120, 134, 136–137).

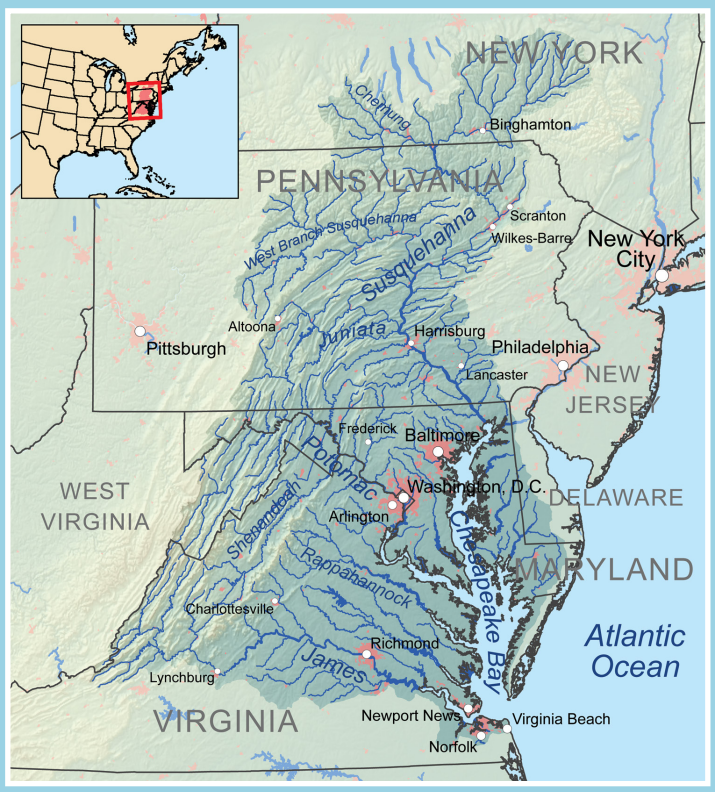
Outcomes: Digital issues of *Chesapeake Quarterly* have received more than 115,000 views within the 2018–2023 period. One standout issue, "Black on the Bay: Then and Now" (2021) examined the integral contributions of Black Marylanders to Chesapeake Bay industries and cultural touchstones of seafood, sailing, aquaculture, and more and received an Apex Award for publication excellence. A 2022 article about the environmental impact of single-use plastic boat wraps was republished in *SAIL* magazine, a national publication. From 2018–2023, MDSG science writers also published 57 articles to the *On the Bay* blog about Chesapeake Bay research and projects. In addition to the main MDSG website, MDSG and MDSGE managed websites for SEAS Island Alliance, Centro Tortuga, SAS², CBSSC, MAPAIS, and the Smart Sustainable Shellfish Aquaculture Management project.

An MDSG community engaged intern at work in the field in 2021.

Program Advancements since Previous Site Review

Maryland Sea Grant received no recommendations and five suggestions from the 2018 Site Review Team. Below are the panel's suggestions and MDSG's responses.

1	**Suggestion**	Fill Assistant Director of Communications position as soon as possible.
	Response	The Assistant Director position was filled by Lisa Tossey (2019–2022) and Annalise Kenney since 2023.
2	**Suggestion**	Increase MDSGE capacity by developing an aquaculture extension position for Southern Maryland and an additional coastal climate change position.
	Response	MDSG partnered with the UME and MSU to create a three-year position 30% extension appointment to support aquaculture in Southern Maryland. State funding constraints have delayed permanently filling this role, but we gained valuable insights into its scope and needs for oyster aquaculture assistance. Separately, MDSG is expanding its coastal climate change capacity using external funding sources, NOAA core funds, and creative job reclassification.
3	**Suggestion**	Develop leadership and coordination capabilities within the SG extension structure.
	Response	MDSGE has increased efforts to empower faculty to expand leadership and coordination in state and regional programming. Examples include: • Expanding watershed work to Pennsylvania Sea Grant, which hired two specialists to replicate MDSGE's work • Chairing and participating in the MD Aquaculture Coordinating Council • Serving as President of the US Aquaculture Society (2019–2020) • Leading key working groups to address climate and flooding issues, such as the Baltimore Urban Waters Program, Eastern Shore Climate Adaptation Partnership, Sea Grant Climate Group, and the Sea Level Rise Projections Guidance Document • Chairing the MDSGE Diversity, Equity, and Inclusion Committee
4	**Suggestion**	Expand the ability to attract and support students and faculty from underrepresented groups.
	Response	MDSG has collaborated with MSU (an HBCU) on architecture, multimedia, shellfish aquaculture, and extension programs. We also participated in a $10 million NSF grant to increase diversity in marine science within US island territories and developed marine debris modules for UMES and Hampton University undergraduates. Our Aquaculture in Action program reaches Baltimore schools, and we engage students of color through informal environmental science education.
5	**Suggestion**	Explore ways to serve as a bridge between national programs and continue to support programmatic coordinators.
	Response	The MDSG director served as Sea Grant Association President (2017–2022), advancing discussions on ethics, diversity, and inclusion across Sea Grant and NOAA. External funding, including two $10 million USDA grants, a ~$700,000 grant, and additional NSGO funds, has supported program coordinators in climate and aquaculture, connecting national programs with regional and local needs and partially supporting four MDSG/MDSGE coordinators.



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