



Maryland Sea Grant Aquaculture Researcher Roundtable

Adele H. Stamp Student Union
University of Maryland, College Park
January 10th, 2018



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Agenda

- 9:30 – 10:00 am Introductions
- Purpose of the meeting
Fredrika Moser, Maryland Sea Grant
 - Aquaculture – Status and Challenges
Yonathan Zohar, University of Maryland Baltimore County, Institute of Marine and Environmental Technology
- 10:00 – 10:45 am Brief Overview of Roundtable Topics (7 minute talks)
Expanded explanation of the topics are on page 6
- Legal/Marketing
Karl Roscher, Maryland Department of Natural Resources
 - Breeding and Genetics
Louis Plough, University of Maryland Center for Environmental Science, Horn Point Laboratory
 - On-Bottom/Water Column Production
Don Webster, University of Maryland Extension and Maryland Sea Grant Extension Program
 - Business Optimization
Matt Parker, University of Maryland Extension and Maryland Sea Grant Extension Program
- 10:45 – 11:00 am Break
- 11:00 – 11:30 am Brief Overview of Roundtable Topics (*Continued*)
- Diversification
Tuck Hines, Smithsonian Environmental Research Center and Matt Gray, University of Maryland Center for Environmental Science, Horn Point Laboratory
 - Sustainability
Allen Place, University of Maryland Center for Environmental Science, Institute of Marine and Environmental Technology
 - Environmental Threats
Colleen Burge, University of Maryland, Baltimore County, Institute of Marine and Environmental Technology
- 11:30 – 12:00 pm Industry Perspective
James Dale Blackwell, Jr., 38° North Oysters; Scott Budden, Orchard Point Oyster Co.; Ted Cooney, Madhouse Oysters LLC; Stuart Dawson, Mudgies Oyster Farm; Jon Farrington, Johnny Oysterseed, LLC; Donald Marsh, South Point Oyster Farm; Scott M. Robinson Jr, Madhouse Oysters LLC; Johnny Shockley, Hoopers Island Oyster Co.; Eric Wisner, Eric Wisner Oysters, LLC
- 12:00 – 1:00 pm Lunch

- | | |
|----------------|--|
| 1:00 – 1:45 pm | Roundtable Discussion 1 <ul style="list-style-type: none"> • Legal/Marketing • Breeding and Genetics • On-Bottom/Water Column Production • Business Optimization |
| 1:45 – 2:15 pm | Roundtable Group Reports |
| 2:15 – 2:30 pm | Break |
| 2:30 – 3:15 pm | Roundtable Discussion 2 <ul style="list-style-type: none"> • Diversification <ul style="list-style-type: none"> ○ Other shellfish aquaculture ○ Other aquaculture • Sustainability <ul style="list-style-type: none"> ○ Closed system aquaculture ○ Open water aquaculture • Environmental Threats <ul style="list-style-type: none"> ○ Aquaculture effects on the environment ○ Environmental effects on aquaculture production |
| 3:15 – 3:45 pm | Roundtable Group Reports |
| 3:45 – 4:30 pm | Topic Sign-Up Activity, Informal Discussions, and Conclusions |

Meeting Background

The National Sea Grant College Program has a long and successful history of supporting research and extension programs in sustainable fisheries management and production. This includes significant investments in oyster disease research and in aquaculture. Maryland Sea Grant is interested in facilitating the development of innovative and cross-disciplinary research teams to address key aquaculture questions pertinent to advancement of the industry in Maryland, the region, and nationally.

The National Sea Grant Program Aquaculture Initiative Federal Funding Opportunity, as well as other funding opportunities for aquaculture research, are currently open and seeking proposals (Appendix D). This meeting is an opportunity to discuss potential research efforts that could address the aquaculture industry’s needs (both in Maryland and beyond), meet researchers across multiple disciplines, and begin forming collaborations that could evolve into proposals for these, and future, aquaculture competitions.

In November 2017, we convened members of Maryland’s aquaculture industry (primarily oyster farmers) who articulated their priorities for advancing the industry. Two summaries from that meeting are included in this briefing book: Appendix B and C: *Maryland Shellfish Aquaculture Industry Roundtable Summary* and *Shellfish Aquaculture Industry Potential Research Interests*, respectively. Concurrently, we surveyed Maryland scientists to learn about their expertise and interests in aquaculture research. A synthesis of the priorities from researchers (collected by survey before this meeting) and industry is in the section “Roundtable Discussion Topics” of this briefing book. We used this information to help design today’s Maryland Sea Grant Aquaculture Researcher Roundtable meeting.

Meeting Logistics

Name Tags

To further assist with identifying collaborators at today's meeting, we have added symbols to everyone's name tags identifying the sector they work in. These are as follows:

- Extension: Sunburst 
- Government: Hexagon 
- Industry: Teardrop 
- Natural Science and Engineering: Cloud 
- NGO: Lightning Bolt 
- Social Science/Legal: Spiral 

Meeting Purpose

The purpose of today's meeting is to provide a forum for the discussion and development of research ideas and potential research projects to address issues important to further developing sustainable aquaculture. These aquaculture priorities may range in scale from Maryland-specific to international in scope. During this meeting, we intend to connect industry and research partners so that together they can collectively begin to develop project ideas with the goal of submitting proposals to various funding opportunities. We envision this meeting to be a foundation for building successful and innovative partnerships that will contribute to the Maryland aquaculture industry's success and to furthering sustainable aquaculture farming in the United States and beyond.

After the meeting, Maryland Sea Grant will summarize the findings of the meeting and then make this information available for all participants. Maryland Sea Grant and our Extension agents intend to provide discussion and facilitation support to help team and proposal development as needed. All the materials from both meetings will also be available on Maryland Sea Grant's website.

Morning Introductions and Talks

The morning session will provide baseline information for all participants regarding priority issues previously identified by the Maryland aquaculture industry and researchers. The talks will provide participants a common foundation of what is known and what are some of the problems facing the advancement of aquaculture. Project ideas should evolve during the discussion sessions building on this baseline of information.

Most importantly, we encourage participants to strike up conversations at breaks and lunch with people you may not know. The point of the meeting is to find people with similar interests whom you may not know and develop ideas for innovative research projects.

Roundtable Discussions

(see details below in section *Roundtable Discussion Topics*)

Topic Sign-Up

The final activity is for participants to write their top three project ideas developed during the group discussions on stickers provided to everyone. Once the stickers are complete, participants will attach them to flipcharts that correspond to the topic your project(s) would fall under. We encourage you to take this time to discuss further about collaborations with the people congregating at the flip charts. This is a key moment for furthering team development around research topics. A brief conclusion will follow this activity. After the meeting, Maryland Sea Grant will aggregate the information from the stickers on the flip charts into a list of research project suggestions and emails addresses of those participants who placed stickers on different topics.

Roundtable Discussion Topics

The afternoon session will include roundtable group discussions around the seven topics presented in the morning session talks and during the industry perspective session. Each roundtable will be assigned a discussion topic (more than one table may be assigned the same topic). *Roundtable Discussion 1* will focus on topics:

Legal/Marketing; Breeding and Genetics; On-Bottom/Water Column Production; and Business

Optimization. This session will primarily emphasize how we can improve on what we currently are doing in aquaculture in Maryland, but may also include discussions on non-oyster aquaculture issues. Each table will have six to seven participants and one to two facilitators. During the discussions, participants should develop draft research questions and ideas for potential research projects that can address the priority problems identified by the aquaculture industry and the research field. At the end of the 45-minute session and during the “Roundtable Group Reports” the facilitators will summarize the findings from each table for all participants.

The *Roundtable Discussion 2* session will run similarly to the first session, but the topic areas will be:

Diversification; Sustainability; and Environmental Threats, and we will assign sub-topics (A and B) to tables:

Diversification A) Other shellfish aquaculture and **B)** Other Aquaculture; **Sustainability A)** Closed system aquaculture and **B)** Open water aquaculture; **Environmental Threats A)** Aquaculture effects on the environment and **B)** Environmental effects on aquaculture production.

We encourage participants to mix up around different tables during the day and try to speak with other participants, especially those you have not met before. The topics listed below have been aggregated from interests voiced by both the aquaculture industry and researchers. Please note this is not to be viewed as an all-encompassing list. The topics are as follows:

Legal/Permitting

- Theft/poaching of product
 - Technologies to improve monitoring and prevention
 - Strengthening laws, prosecution, and penalties for theft
 - Improving relations with the Maryland Natural Resources Police and the aquaculture farmers
 - Better use of Maritime Law Enforcement Information Network (MLEIN)
- Permitting
 - Modification of the permitting process to be shorter
 - Siting leases in relation to water quality
 - Improved, clarified protest process for leases
 - Improved process for changing leases to adapt new gear
 - Remote setting on lease using shell from one’s own lease
 - Permits for transferring seed from one bottom lease to another
- Multi-user conflict
 - Resolving disputes over multiple uses of resources (i.e. viewsapes, other fishing, boating, land access, land use, etc.)
- Policy and governance
 - Determining optimal policy and governance frameworks for adoption and innovation
 - Subsidies: cash funding
 - Aquaculture Enterprise Zones
 - Improving communication and transparency between growers, resource managers, and policy makers
 - How to integrate social science research into aquaculture management decisions

- Other
 - Creating oyster information clearinghouse (e.g. a news report of oyster happenings, calls for proposals, etc.)
 - Create Maryland Grower's Association
 - Insurance that is more realistic and better-suited to aquaculture

Oyster Breeding and Genetics

- Oyster development
 - Triploids
 - Preventing early mortality
 - Creating a “super” oyster (e.g. low mortality, fast growing, good taste)
 - Creating a “Burpee” catalog for oyster seed
 - Enhancing settlement and grow-out
 - Scaling up to assess population-level effects
 - Improving growth, figuring out why slow growth occurs
 - Selective breeding by genomics approach
- Oyster seed/larvae availability
 - Improving hatchery technologies
 - Improving availability of seed/larvae
- Disease
 - Understanding the effects of disease/disease ecology
 - Preventing disease

On-Bottom/Water Column Production

- Alternative substrate
 - Mixing fines with cement to make shells
- Shell availability
- Site selection
- Building substrate for shell
- Improving on-bottom production outcomes
- Biomonitoring tools
- Ecosystem services
 - Understanding the values resulting from differing aquaculture approaches
- Taste
 - Product quality control including off-flavor problems
 - How to improve flavor/salt in oysters
- Effective management of pests/predators
- Gear
 - Reducing fouling, conditioning of cages
 - Gear selection: optimizing gear for a given farm
 - Improve anti-fouling paints

Business Optimization

- Marketing
 - Marketing resources for local businesses
 - Creating a Maryland aquaculture marketing campaign (including Chesapeake Bay oyster)
 - Understanding consumer preferences (i.e. shell aesthetics, taste, labeling)
 - Oyster branding/marketing
 - Improving chef-perceptions on aquaculture products versus wild
- Nutrient credits
 - Understanding the relationship between nutrient removal and oyster production
 - Creating a nitrogen credit/nutrient credit trading system
- Labor costs
 - Improved efficiency to address issues of labor availability and size grading
- Systems optimization/mechanization relative to cost and farm scale
- Socio-cultural aspects of oyster aquaculture and impacts of oyster farming
- Social dimensions of shellfish aquaculture
- Mechanization
 - Automated oyster processing including shucking
- Shipping
 - Improved temperature control
- User-friendly mapping/lease tracking (for within-farm activity)
- Creating best management practices
 - Identify key data points most important to track
 - Improved record keeping and tracking
- Improved access and use of MARBIDCO
- Economics of supply and demand
- Economic valuation of aquaculture ecosystem services

Diversification

- Other bivalve aquaculture
 - Scallops, razor clams, hard clams
- Finfish
- Seaweed
- Blue crab
 - Soft-shell blue crab production
 - Improving blue crab shedding with water quality control and disease management
 - Robotic automated meat picking
- Learning from other successes
- Poly- and multi- aquaculture
 - Multi-tropic aquaculture
- Societal and ethical responsibility of using modified fish and shellfish
- Public resources for private production
- Automation/mechanization
 - Creating automation/artificial intelligence for improvement on labor efficiency, productivity, food safety and quality, and enhanced market values

Sustainability

- Multi-tropic aquaculture
- Land-based production/closed system
- Bio-security
- Water quality/waste management
 - Understanding the biogeochemical effects of aquaculture
 - Improving waste treatment technologies
- Sustainable feed
 - Algae-based feed
 - Alternative feeds
- Disease Management
 - Creating viral vaccines for the aquaculture industry

Environmental Threats

- Acidification
 - Understanding the effects of acidification on suitability of habitat for oyster aquaculture
- Water Quality
 - Understanding the effects low oxygen levels on suitability of habitat for oyster aquaculture
 - Understanding the hydrodynamics of reefs
 - Sediment (particulate) transport modeling
- Preventing suffocation from siltation
- Nutrients
- Eco-ramifications of aquaculture
- Wildlife interactions with gear and harvest methods
- Pollution
 - Understanding the accumulation of contaminants of emerging concern and their effects
 - Creating environmentally friendly systems
- Understanding potential impacts on forage fish and plankton
 - Creating corresponding baseline data for these species

Appendix A

Participant Biographies

Maryland Sea Grant invited participants to provide a brief statement about themselves as part of the meeting registration information. We hope this is helpful as a reminder of who attended the meeting and for future reference for building and continuing research teams.

Karen Akerlof

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George Mason University; American Association for the Advancement of Science; Johns Hopkins University

Dr. Karen Akerlof is currently a visiting scholar with the American Association for the Advancement of Science (AAAS). As a research assistant professor at George Mason University, she has been interested in the ways in which communities interpret scientific information and bring experience, values, and local knowledge to bear in making policy choices. She is currently exploring the role of identity in environmental risk perceptions and decision-making.

Mike Allen

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Maryland Sea Grant

Dr. Michael Allen is the Associate Director for Research and Administration at Maryland Sea Grant located in College Park, Maryland. He received his Ph.D. in ecology, evolution and conservation biology from the University of Illinois at Urbana-Champaign in 2009 where he studied population and community dynamics of zooplankton in ponds and lakes across the Midwest. After completing his PhD, Mike spent two years at the National Oceanographic and Atmospheric Administration in Washington, D.C as a Sea Grant Knauss Fellow and contractor. In his current position at Maryland Sea Grant, Mike works with the scientific community to advance research and education on issues affecting the Chesapeake Bay region. He oversees the management of Maryland Sea Grant's diverse research portfolio, its graduate and undergraduate research fellowship programs, and the Sea Grant business office.

Kelly Barnes

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Oyster Recovery Partnership

Ms. Kelly Barnes manages Oyster Recovery Partnership's public fishery and aquaculture programs. Prior to joining the Partnership, she worked at the Maryland Department of Natural Resources supporting seafood marketing and at the Maryland Watermen's Association.

Jessica Beck-Stimpert

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National Sea Grant College Program

Dr. Jessica Beck-Stimpert is currently the Acting Aquaculture Program Manager for the National Sea Grant College Program. She has been the Southeast Regional Aquaculture Coordinator for the Aquaculture Office since 2008, based out of the NOAA Fisheries Southeast Regional Office located in St. Petersburg, Florida. Jess works with federal and state agencies, industry, and members of the scientific, academic, and NGO communities on a variety of marine aquaculture issues. In 2016, Dr. Beck-Stimpert finalized rulemaking efforts for the Gulf of Mexico Aquaculture Fishery Management Plan which marks the first comprehensive permitting program for aquaculture in U.S. federal waters. She received an M.S. in Biological Sciences from Florida Institute of Technology and a Ph.D. in Wildlife and Fisheries Sciences from Texas A&M University, where she conducted research on larval finfish feeding behaviors and pre-release conditioning for state stock enhancement programs.

James Dale Blackwell, Jr.

JDBLACKWELL@ME.COM

38° North Oysters

Mr. J.D. Blackwell is an oyster farmer from Southern Maryland who also represents the oyster aquaculture industry on state and regional commissions.

Rebekah Borgert

REBEKAH.BORGERT@MORGAN.EDU

Morgan State University, Patuxent Environmental and Aquatic Research Laboratory

Ms. Rebekah Borgert is the manager of the shellfish hatchery at Morgan State University Patuxent Environmental and Aquatic Research Laboratory (PEARL) in St. Leonard, MD. Morgan State PEARL research is designed to increase the understanding of coastal ecosystems so that they may be properly managed and protected. PEARL's aquaculture research program aims to advance shellfish aquaculture through the areas of genetics, ecosystem services, technology transfer, education and outreach. Recent projects include development of commercial hatcheries, larval performance on different algal feeds, diversification of shellfish species and monitoring of *P. marinus* (Dermo) in the Patuxent River.

Suzanne Bricker

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NOAA

Dr. Suzanne Bricker has done research at NOAA on eutrophication assessment and potential mitigation of nutrient degradation in US estuaries and elsewhere (Europe, China). Her current research is focused on production of shellfish, primarily oysters, and quantification and valuation of the water cleaning ecosystem service that they provide through filtration as they feed. Their ongoing modeling project in Maryland Chesapeake Bay includes case studies of the nutrient removal capacity of several MD oyster growers from Rock Hall to Crisfield with the intent of adding to the discussion of giving 'credits' to oyster growers for the nutrient removal ecosystem service their oysters provide. Eventually the growers may be compensated for that service but that is a longer discussion. Dr. Bricker has been involved in similar

studies in Long Island Sound, Great Bay Piscataqua, Potomac River and European and Chinese water bodies. She is a member of the Chesapeake Bay Oyster BMP Panel that is reviewing studies and making recommendations for crediting of oyster tissue, shell and denitrification in MD's BMP process. In December 2016 harvested oyster tissue was approved as a BMP for Chesapeake Bay - consideration of credit for shell and oyster related denitrification is ongoing. She is looking forward to continued discussion of the inclusion of oyster cultivation and harvest as a component of a comprehensive nutrient management plan in Chesapeake Bay.

Rebecca Briggs

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NOAA National Sea Grant Office

Dr. Rebecca Briggs is a federal program officer at the NOAA National Sea Grant Office. Dr. Briggs is the regional lead for the Mid-Atlantic and Southeast programs and oversees seven Sea Grant programs (GA, SC, NC, VA, MD, DE, and NJ). In this role, Rebecca maintains and advances the creation of strategic partnerships to facilitate transfer of knowledge, tools, and priorities, and enhance the effectiveness of the National Sea Grant College Program and Sea Grant's National Strategic Investments.

Scott Budden

SCOTT@ORCHARDPOINTOYSTERS.COM

Orchard Point Oyster Co.

Mr. Scott Budden is the founder and operator of Orchard Point Oyster Co, which was established in 2015. They are the producers of Orchard Points who are raised in the Chester River.

Colleen Burge

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University of Maryland Baltimore County, Institute of Marine and Environmental Technology

Dr. Colleen Burge is a native to the US West Coast where she grew up on the shores of Hood Canal learning marine ecology from a young age. Colleen is an Assistant Professor at the Institute of Marine and



Environmental Technology with dual appointments at University of Maryland Baltimore County, Department of Marine Biotechnology and the University of Maryland Baltimore, Department of Immunology & Microbiology. Colleen received her BS (2002) and PhD (2010) in Aquatic & Fishery Sciences at the University of Washington. Colleen held two postdoctoral positions; her first was in the Department of Ecology & Evolutionary Biology at Cornell University and the second in the School of Aquatic & Fishery Sciences at the University of Washington. Colleen's research program, the "Aquatic Animal Health lab (see: <http://imet.umces.edu/cburge/>)" focuses on marine host-pathogen-environment interactions that underlie the health of marine invertebrates (primarily oysters and corals) and eelgrass. Specifically, her work encompasses disease ecology, organismal physiology and immunology, and development of disease diagnostics. Within the Aquatic Animal Health lab, marine disease is studied using both traditional and molecular techniques in field and laboratory based experiments. Colleen enjoys the applied aspect of working with the US aquaculture industry on disease/health related-issues, and has over 15 years of experience working with the U.S. shellfish aquaculture industry. Current aquaculture related projects in the Aquatic Animal Health lab are focused on 1) providing tools and solutions for emerging variants of the Ostreid herpesvirus 1 and 2) the potential health benefits of co-culture of oysters and eelgrass.

Kelton Clark

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OpenShell Environmental Services LLC

Dr. Kelton Clark is the founder and managing partner of OpenShell Environmental LLLC. OpenShell is focused on creating sustainable growth in the shellfish aquaculture industry by identifying and implementing market-based solutions to industry challenges. Dr. Clark is the former Director of Morgan State University's Patuxent Environmental and Aquatic Research Laboratory (PEARL). At the PEARL, he created the Oyster Aquaculture Program that was built on the question "How can we help." While directing the program, he oversaw the design and construction of the first hatchery in the state dedicated

solely to aquaculture. His expertise and insights are often sought after at the State and Federal level. His present appointments include the Ocean Research Advisory Panel, which provides advice to the White House Office of Science and Technology, and the Maryland Oyster Advisory Commission which provides direction to the Maryland Department of Natural Resources. Dr. Clark received his PhD in Marine Ecology in 2001 from the University of Maryland Marine Estuarine and Environmental Sciences Program. He is second of nine children and has been the other half of America's Couple for 30 years and counting.

Ted Cooney

TED@MADHOUSEOYSTERS.COM

Madhouse Oysters, LLC

Mr. Ted Cooney founded Madhouse Oysters in 2012 after 20+ years as a partner in a Healthcare Financial Services firm. He has a BS in Biology from the University of Maine, trained in wooden boatbuilding in England has worked as a commercial fisherman in Alaska and in Africa on aquaculture projects in the Peace Corps.

Jeffrey Cornwell

CORNWELLJEFFREY@GMAIL.COM

University of Maryland Center for Environmental Science, Horn Point Laboratory

Dr. Jeffrey Cornwell is a biogrochemist who works with the chemistry of sediments, wetlands, water column redox and nutrient processes, and nitrogen and phosphorus cycling in bivalve aquaculture and restoration. Dr. Cornwell has 31 years of experience working on the Chesapeake Bay and chair a panel on oyster ecosystem services. They are completing a 4 year study of denitrification at the large scale Harris Creek restoration.

Stuart Dawson

STU@MUDGIESOYSTERFARM.COM

Mudgies Oyster Farm

Mr. Stuart Dawson is the Farm Manager at Mudgies Oyster Farm. He is the TFL holder and have been a commercial fisherman for over 35 years. Mudgies, established in 2014, has six bottom culture lease sites

encompassing 78 acres. Mr. Dawson is charged with production and the nursery facility. Mudgies has a storage facility located in Royal Oak, Maryland and they utilize both triploid and diploid spat on shell for production as well as seed oysters.

Jennifer Dindinger

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University of Maryland Sea Grant Extension

Ms. Jennifer Dindinger is a Regional Watershed Restoration Specialist with University of Maryland Sea Grant Extension. Based in Cambridge and serving four counties on the Eastern Shore, she is developing a program that builds community development while promoting natural resource protection. Jennifer holds a Master's degree in Environmental Policy from Bard College and a Bachelor of Science in Medical Technology from the University of Delaware. She is a Senior Fellow in the Environmental Leadership Program, and in 2014 Jennifer was awarded the Off-Campus Junior Faculty Award for her contribution to the UME 2014-2019 Strategic Plan.

Jon Farrington

JOHNNYOYSTERSEED@GMAIL.COM

Johnny Oysterseed, LLC

Mr. Jon Farrington is the owner/operator of Johnny Oysterseed; manufacturing commercial oyster farming equipment, seed oysters for industry clients, as well as operating our own oyster farm. He has 12 years of experience in industry as well as environmental policy.

Drew Ferrier

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Hood College

Dr. Drew Ferrier is a Professor of Biology at Hood College and Director Hood's Center for Coastal and Watershed Studies. He has over 25 years of experience teaching biology and ecology in classrooms, laboratories, and a variety of field locations along the Eastern Seaboard from the Chesapeake Bay to South Florida and the Caribbean. Through research with students, Drew has investigated such diverse topics as the invasion

ecology of freshwater crayfish, coral physiology, ultraviolet and salinity stress in cnidarians, and the ecology of cownose rays in the Chesapeake Bay. His interests in aquaculture focus on freshwater recirculating systems and aquaponics.

Shirley Fiske

University of Maryland, College Park, Anthropology Department

Dr. Shirley J. Fiske is an environmental anthropologist with career experience in academia and the Executive and Legislative branches of the US government in ocean and fisheries policy, climate change, and natural resources policy and governance. In addition to the NOAA Policy office, she was the NOAA/Sea Grant social scientist for nearly 17 years, and head of SG Outreach (Communications, Education, Knauss Fellowships, and Marine Extension). Currently Research Professor in the Anthropology Department at the University of Maryland. Recent research includes an NSF study, with Michael Paolisso, on cultural models of climate change among farmers, watermen, and new homeowners on the Eastern Shore of Maryland; National Park Service cooperative agreement on urban subsistence fishing along the Potomac and Anacostia rivers. Recent Chair of the American Anthropological Association (AAA) Task Force on Climate Change, establishing association statement and policy (Changing the Atmosphere). Delegate to UNFCCC COP-23 in Bonn, Germany. Recent book: *The Carbon Fix: Forest Carbon, Social Justice, and Environmental Governance*, with Stephanie Paladino. 2016. Routledge. Awarded the 2016 Solon T. Kimball Award by the American Anthropological Association for contributions to public and applied anthropology.

Amy Freitag

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NOAA Oxford Laboratory

Dr. Amy Freitag is part of the NOAA NCCOS Social Science team based out of the Cooperative Oxford Laboratory on the Eastern Shore. Her work centers around ensuring the health and well-being of coastal communities. In the past, she organized the Chesapeake Oyster Summit and researched the social



community around oysters. She has a PhD from the Duke Marine Lab.

Michael Gerst
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University of Maryland, College Park

Dr. Michael Gerst specializes in improving the quality of decisions made in design, planning, and governance processes at the nexus of society, technology, and the environment. This involves using systems and decision analysis techniques (i) to understand stakeholder needs and (ii) to integrate the social and natural science knowledge necessary for making quality decisions. The applied and scientific contributions for his work range from higher focus on technique development, such as developing new scenario approaches or improving modeling practice, to more stakeholder-driven work. This component has included understanding processes of agricultural technology adoption, and designing and testing the efficacy of decision support tools, such as the visualization of trend indicators.

Paul Goeringer
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University of Maryland, Department of Agricultural & Resource Economics

Mr. Paul Goeringer, JD, is the Extension Legal Specialist at the University of Maryland. He grew up on his family's wheat and cattle operation in Western Oklahoma. Upon graduating from high school, Paul attended Oklahoma State University and graduated with a Bachelor of Science in Agricultural Economics. After graduating from OSU, Paul for some strange reason still unknown to him decided to attend law school and graduated with a Juris Doctorate from some school in Norman, Oklahoma (also known as the University of Oklahoma). After law school, Paul received a LL.M in Agricultural Law and a Master of Science in Agricultural Economics from the University of Arkansas, and is licensed to practice in Oklahoma. Paul is an active member of the American Agricultural Law Association, Agriculture Law Section of the Maryland State Bar Association, and Southern Agricultural Economics Association and a member of the Agricultural & Applied Economics Association.

Matthew W. Gray
MGRAY@UMCES.EDU

University of Maryland Center for Environmental Science, Horn Point Laboratory

Dr. Matt Gray is an ecophysiologicalist who specializes in understanding the interplay between oysters and the environment. Products include growth and ecosystem services models that can be used for aquaculture site selection as well as understanding the ecological benefits of large oyster populations.

Lora Harris
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University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory

Dr. Lora Harris is an estuarine ecologist who applies field and modeling approaches to address questions regarding nutrient dynamics, primary production and ecosystem structure and function in a range of estuarine ecosystems. She is especially interested in how climate and management actions interact to affect water quality characteristics in estuaries and lagoons. Some of her most recent work involves collaboration with engineers to understand the restoration trajectories of hypoxic estuaries, the contribution of wastewater to estuarine receiving waters, and ongoing efforts to develop fine scale models of oyster reefs. Dr. Harris works closely with state and regional agencies in both a research and advisory capacity. She is committed to efforts that increase diversity in the geosciences as a founding principal investigator of Centro Tortuga, an institutional collaboration based in Puerto Rico that is focused on exposing first year undergraduates to the marine sciences. Dr. Harris is committed to community engagement in her work, and takes just as much satisfaction in talking about water quality to a Board of County Commissioners as she does in giving a talk at a scientific conference. She received her B.S. from Smith College and her Ph.D. from the University of Rhode Island. Dr. Harris moved to her faculty position in Maryland following a postdoctoral position at the Marine Biological Laboratory in Woods Hole.

Tuck Hines

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Smithsonian Environmental Research Center

Dr. Anson “Tuck” Hines has served as director of the Smithsonian Environmental Research Center (SERC) since 2005 and as Principal Investigator since 1979. Located on Chesapeake Bay 25 miles east of Washington, D.C., SERC studies human impacts, natural processes and land-sea connections in coastal ecosystems. SERC programs extend around world with global research networks in forest and marine ecosystems. Dr. Hines has a B.A. in Zoology from Pomona College and a Ph.D. in Zoology from the University of California at Berkeley. He has conducted research on coastal ecosystems in Chesapeake Bay, Florida, California, Alaska, Belize, Japan, and New Zealand. Dr. Hines has been leader on a diverse array of 130 extramural grants and contracts on: effects of coastal power plants; sea otters and kelp forest ecology; long-term ecological change in Chesapeake Bay; marine food web dynamics; predator-prey interactions; impacts of fisheries, aquaculture and fishery restoration; crustacean life histories; and biological invasions of coastal ecosystems. An expert on blue crabs, he has studied the biology of crabs around the world. He has published more than 150 articles in technical journals and books. He is an adjunct professor at the University of Maryland, College Park, and served as major advisor for 22 post-doctoral fellows, 11 Ph.D. students and 10 M.S. students, and 165 undergraduate interns. As SERC director, Dr. Hines oversees research, professional training and public programs in global change, landscape ecology, coastal ecosystems, and population and community ecology. He advanced SERC’s land conservation program for 2,650 acres on Chesapeake Bay and led an innovative master plan for sustainable management of the Rhode River site, including construction of the new \$57-million Mathias Laboratory. He promoted establishment of the Smithsonian Marine Global Earth Observatory Network for comparative studies of coastal ecosystems.

Jorge Holzer

University of Maryland & Maryland Sea Grant

Dr. Jorge Holzer is an Assistant Professor in the Department of Agricultural and Resource Economics at the University of Maryland, College Park. His research focuses on the management of natural resources, with an emphasis on the allocation of harvest rights in the absence of markets, the study of uncertainty, risk-aversion and the value of information, and the interaction between the commercial and recreational fishing sectors.

Tom Ihde

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Morgan State University, Patuxent Environmental and Aquatic Research Laboratory

Dr. Tom Ihde is a quantitative fisheries scientist and applied ecologist. He has worked on the Chesapeake Bay for more than 20 years. Dr. Ihde was trained as a stock assessment scientist at the Virginia Institute of Marine Science, and completed his post-doctoral studies at the UMCES Chesapeake Biological Laboratory. At Morgan State University’s PEARL, he is currently involved in lab trials designed to improve the production capacity of marine aquaculture, with a focus on shellfish. He has active interests in developing new approaches to mitigate current challenges faced by the rapidly developing oyster aquaculture industry, and to quantify the ecological benefits of both cage and bottom oyster aquaculture for Maryland’s tributary and bay systems.

Patrick Kangas

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University of Maryland, Department of Environmental Science and Technology

Dr. Patrick Kangas is a systems ecologist with extensive experience with algal ecology and ecotechnology. He received his B. S. degree from Kent State University in Biology, his M. S. degree from the University of Oklahoma in Botany and Ecology and his Ph. D. degree in Environmental Engineering Sciences from the University of Florida. Since 1990 he has taught ecology courses at the University of Maryland where he is an Associate



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Melissa A. Kenney
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*University of Maryland, Earth System Science
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Dr. Melissa A. Kenney is an Associate Research Professor in Environmental Decision Analysis and Indicators at the University of Maryland (indicators.umd.edu). Her research broadly addresses how to integrate both scientific knowledge and societal values into policy decision-making under uncertainty. Her research expertise includes conceptual modeling and decision structuring, indicators, systems analysis, multi-attribute methods, and evaluation of decision support to address environmental policy decisions. These methods have been applied to a range of topics including participatory global change indicators, setting environmental policy criteria, economic analyses for restoration alternatives assessment, expert elicitation, and value of information of indicators. Dr. Kenney was an AAAS Leshner Leadership Institute Public Engagement Fellow, focusing on stakeholder engaged research to create climate resilient solutions in the U.S. and Chesapeake Bay region. She earned a Ph.D. from Duke University, focusing on water quality modeling and decision analysis.

Rona Kobell
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Maryland Sea Grant

Ms. Rona Kobell is a former reporter for the Chesapeake Bay Journal and the Baltimore Sun. She has written extensively about oysters. She is now a science writer and editor with Maryland Sea Grant, where she will be producing Chesapeake Quarterly.

Cathy Liu
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*University Maryland Extension Sea Grant Program,
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Dr. Chengchu (Cathy) Liu is a Seafood Technology Specialist with the University of Maryland Extension Sea Grant College Program hosted at University of

Maryland Eastern Shore. Dr. Liu's primary job is to provide training, education and outreach service for the Maryland seafood industry and consumers, support the growth of a viable seafood industry in Maryland and the region.

Ming Liu
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*Morgan State University, Patuxent Environmental
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Dr. Ming Liu is an oyster genomics researcher working at PEARL, Morgan State University. Her research is mainly on oyster genomics and breeding. Currently, Ming is working on developing superior oyster stock lines such as fast growing, disease resistant, abiotic stress tolerant or specific shell through marker-assisted selection. The markers highly associated with favorable characteristics would be identified through a genomic approach. In the past four years, she has worked at Haskin Shellfish Research Laboratory in New Jersey as a post-doc. She identified candidate genes and markers associated with disease resistance in eastern oyster, and produced new disease-resistant lines by genotype-based selection. Ming also worked on genetic improvement of tetraploid and triploid oysters.

Katrina Lohan
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Smithsonian Environmental Research Center

Dr. Katrina Lohan's research uncovers patterns of parasite diversity and disease around the globe and investigates the underlying mechanisms that shape those patterns. She primarily study parasites that infect commercially important shellfish (e.g., bivalves and crustaceans) and ecosystem engineers (e.g., seagrasses), whose loss would be devastating to an array of stakeholders. Katrina's research addresses three main questions: where are parasites, how are they moving around the world, and how do they cause harm? For the first question, she uses genetic tools to determine distributional patterns and the many factors that influence them such as host specificity and environmental tolerance. For the second question, she focus on human-mediated dispersal of parasites, with ships as the primary vector in marine systems for the global dispersal and invasion of marine parasites.

Finally, she uses genomic tools to explore host-parasite interactions such as variations in disease virulence and pathogenicity.

Donald Marsh

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South Point Oyster Farm

Mr. Donald Marsh is operating manager at South Point Oyster Farm and co-founder of Priv8Pay Inc., Director of Global Brass and Copper Holdings Inc., and former banker and public company CFO. He is married (Joan) with two sons (Nicholas and Collier). College grad and MBA (Princeton University and Harvard University). Interests include woodworking, gardening, competitive rowing.

Steve McHenry

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Maryland Agricultural and Resource-Based Industry Development Corporation

Mr. Stephen R. McHenry has served as the Executive Director of the Maryland Agricultural and Resource-Based Industry Development Corporation (MARBIDCO) since December 2006. Prior to this, he held the positions of Executive Director of the Rural Maryland Council (9 years) and Director of Government Affairs for the Maryland Municipal League (12 years). Steve's professional career was focused for many years on policy development and advocacy for small and rural communities, and more recently on agricultural business capital and credit availability/deployment and commercial food systems development. MARBIDCO, Maryland's quasi-public agricultural development finance authority, has provided upwards of \$50 million in low-cost loans and small grant incentives to nearly 500 food/feed/fiber business production or processing projects over the last decade (including 65 oyster aquaculture projects totaling about \$3.5 million). Steve has served on many local, state, and national boards of directors, commissions, and advisory groups related to sustainable agriculture and forestry, rural economic and community development, and agricultural education. Additionally, he is a member of several trade and professional organizations, including the Maryland Farm Bureau and the Maryland Economic Development Association. Steve

holds undergraduate (St. Mary's College of Maryland) and graduate degrees (UMUC Graduate School of Management and Technology), and was a member of the 2000 Class of LEAD Maryland, the agricultural and rural leadership development program, and the 2002 Class of Leadership Maryland, a statewide executive leadership development program.

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Dr. Don (Mutt) Meritt is the Hatchery Program Director at the Horn Point Oyster Hatchery.

Thomas Miller

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Dr. Thomas Miller is a Professor and Director at Chesapeake Biological Laboratory. He is working on oyster settlement and growth issues at production scale.

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Maryland Sea Grant

Dr. Fredrika Moser is the Maryland Sea Grant Director. Maryland Sea Grant has a commitment to facilitating the building of interdisciplinary teams that include researchers, outreach personnel, and end-users to solve challenging socio-environmental problems. She has interests in higher education and increasing diversity in the marine science workforce.

Andrew Muller

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United States Naval Academy

Dr. Andrew Muller is a Professor of Oceanography with almost 30 years' experience in coastal, estuarine, and triplet chemistry, physics, and biology. Lately, he has been using wavelet and neural networks to create innovative models in the Chesapeake Bay and tidal tributaries.



Diana Muller
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Chesapeake BaySavers

Ms. Diana Muller specializes in "triblet" water quality, estuarine physics, and modelling research in the Chesapeake Bay. She is currently the Executive Director of Chesapeake BaySavers Group, which one of the focuses on science to legislative issues for oyster restoration and legislation.

Megan Munkacsy
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Oyster Recovery Partnership

As the Oyster Restoration Specialist, Ms. Megan Munkacsy spends her time working out on the water with watermen and in the office working with data that helps us better visualize the Chesapeake Bay—particularly in how it can be used by oysters.

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Ms. Ginger Myers is a Marketing Specialist with the University of Maryland Extension program. She is the Director for the Maryland Rural Economic Development Center.

Elizabeth North
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Dr. Elizabeth North is a fisheries oceanographer who works at the interface of science and management. She specializes in the transport of tiny things in the water, including fish and shellfish larvae.

Matt Ogburn
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Dr. Matthew B. Ogburn is a Marine Ecologist at the Smithsonian Environmental Research Center. He has a broad range of interests related to sustainable aquaculture and fisheries issues, in part through the Smithsonian Working Landscapes and Seascapes

Initiative. His research experience includes work on blue crabs, river herring, oysters, soft clams, population and community ecology, and restoration.

Matt Parker
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Mr. Matt Parker is an Aquaculture Business Specialist with Maryland Sea Grant Extension. He provides business development support to the aquaculture industry in Maryland.

Salina Parveen
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Dr. Salina Parveen is a Professor in Food Science and Technology Program, Department of Agriculture, Food and Resource Sciences at the University of Maryland Eastern Shore, MD. Dr. Parveen holds a B.S. in Botany and an M.S. in Microbiology from the University of Dhaka, Bangladesh and a Ph.D. in Food Science and Human Nutrition, specializing in Microbiology and Molecular Biology from the University of Florida, FL. Dr. Parveen teaches graduate level courses in Microbiology and Toxicology. She is a certified trainer for Seafood HACCP and SCP, and has over 25 years' experience in teaching, research and outreach service associated with food safety, water quality, food and environmental microbiology. Dr. Parveen has an excellent record of grantmanship and received several awards for outstanding academic performance. Dr. Parveen published more than 150 peer-reviewed journal articles, book chapters and abstracts, and made over 55 invited presentations. She also serves on several national and international scientific committees and the Editorial Board member of many peer-reviewed journals.

Kennedy Paynter
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Dr. Ken Paynter has worked with many types of oyster aquaculture in Maryland including floating cage culture and traditional leased-bottom aquaculture. He has also studied the important role of

understanding the impact and management of oyster disease epidemiology in oyster aquaculture.

Kuan-Chieh Peng
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Mr. Kuan-Chieh Peng is in Dr. Ten-Tsao Wong's lab. Dr. Wong's laboratory focuses on sterility technique and vaccine developing.

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The Place laboratory has work for over 30 years on developing diets for cultured species, including cobia, striped bass, gilthead seabream, European seabass, blue crab, and crustaceans.

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Dr. Louis Plough is an Assistant Professor at Horn Point lab—interested in applying genetic and genomic tools to improve oyster and shellfish aquaculture.

Elka T. Porter
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Dr. Elka T. Porter received her Vordiplom (B.S.) and her Diplom (M.S., 1992) in Zoology with minors in Physical Oceanography and Botany at the Christian-Albrechts Universität zu Kiel, Germany. Her Master's research at W.H.O.I. with Dr. Scott Gallagher dealt with the transport of bivalve larvae in Waquoit Bay. Dr. Porter earned her PhD in Marine Estuarine Environmental Sciences at UMCP, 1999, and did her research on the physical and biological scaling of benthic-pelagic coupling in experimental ecosystem studies. She did postdocs with Dr. Larry Sanford at the Horn Point Laboratory, (1999-2000) and with Dr.

Robert P. Mason at the Chesapeake Biological Laboratory (2000-2005) and designed Shear Turbulence Resuspension Mesocosms (STURM) to study the effect of water flow and organisms on benthic-pelagic coupling processes. She then studied the effects of tidal and episodic resuspension on mercury, PCB, nutrient and ecosystem dynamics. After a series of Visiting Appointments at American University, UMCP, and Washington College teaching undergraduate students, she spent six months as a Visiting Scientist at the Smithsonian Environmental Research Center. In collaboration with Dr. Denise Breitburg, she studied the effects of diel-cycling hypoxia and cyclical pH on oyster valve gape. Since January 2014, Dr. Porter has been an Assistant Professor at the University of Baltimore. She teaches Environmental Chemistry, Fundamentals of Biology, Chemistry, Ecology and Environmental Science classes to undergraduates. Dr. Porter performs her summer research at the Patuxent Environmental and Aquatic Research Laboratory (PEARL), Morgan State University and works with 2-3 undergraduates per summer. In summer 2015, Dr. Porter's group built the STURM facility at PEARL and in summers 2016 and 2017 they performed six-week long benthic pelagic coupling STURM experiments. Dr. Porter is especially interested in the effects of high bottom shear stress (with sediment resuspension) and bivalves (e.g., biodeposit resuspension, sediment stabilization/destabilization) on the nutrient and ecosystem dynamics.

Aria Remondi
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NOAA National Sea Grant Office

Ms. Aria Remondi is a member of NOAA's current Leadership Competencies Development Program (LCDP) class and is on detail to the NSGO as Assistant Director for Programs and Partnerships. In this role she oversees the Program Officers in Sea Grant and ensures that Sea Grant is connecting internally with other parts of NOAA as well as externally. She also oversees the NSGOs Aquaculture team, ensuring that Sea Grant's important contribution to Aquaculture is aligned with work in other NOAA offices and that work undertaken by the Sea Grant programs aligns with NOAA and NSGO priorities.



Scott M. Robinson, Jr.
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Madhouse Oysters, LLC

My name is Scott Robinson, Jr., I am a partner in Madhouse Oysters, LLC. I worked with my Dad on the water as a kid. When I graduated high school he made/encouraged me to go to college and get a "real job." I went to Wyotech to get a degree in Collision and Refinishing. I worked in that field for five years at a large body shop locally. During that time my life changed I got married, started a family and decided that I wanted to make a career change. I wanted something new and deep down always wanted to work on the water. My Dad and I started looking into Aquaculture and Oyster Farming. We met up with Ted Cooney that had started Chesapeake Island Oysters but was in need of some help. We joined him and Madhouse Oysters, LLC was created. It has taken us a few years to build up our farm. At this point we have seeded 4 million oysters over the past few years with goal of selling over 2.5 million oysters a year to retailers and seed to other farmers. We hope to grow Madhouse Oysters and in the industry in the upcoming years.

Karl Roscher
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Maryland Department of Natural Resources

Mr. Karl Roscher is the Director of the DNR Fishing and Boating Services', Aquaculture and Industry Enhancement Division. The Division is made up of 9 staff with the responsibilities of issuing aquaculture leases and permits, managing the responsible development and operation of the aquaculture industry in Maryland and running the Maryland Artificial Reef Initiative (MARI) Program. Karl has served as Maryland Aquaculture Coordinator since 2000 and has worked with the State's aquaculture industry since 1996, when he was hired as Maryland's first Aquatic Animal Health Inspector. He is the current Industry/Non-Land Grant University representative on the Northeastern Regional Aquaculture Center's Board of Directors. Karl graduated from the University of Miami, Coral Gables, Florida and is a Coast Guard licensed Captain and certified scuba diver. He lives in Annapolis and enjoys woodworking, hunting and fishing.

Kenneth Rose
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Dr. Kenneth Rose's research centers on the use of ecological and fisheries modeling to quantify and better understand how populations and food webs respond to multiple environmental and biological factors and how this information informs management actions.

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Dr. Keiko Saito studies microbial ecology associated with aquaculture including microbial-mediated waste treatment in marine recirculating aquaculture system (RAS) focusing on the nitrogen and carbon cycles in the RAS closed ecosystem.

Larry Sanford
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Dr. Larry Sanford serves as Interim Vice President for Education at UMCES and is also a Professor at UMCES Horn Point Laboratory. He maintains an active research program in fine sediment transport processes, coastal and estuarine physical oceanography, waves, and turbulence, with a special interest in interactions between fluid flow and estuarine ecology. Interactions between oyster reefs, aquaculture farms, flow, and biodeposit dispersal are a recent area of research focus. Larry has served on the Chesapeake Bay Program Scientific and Technical Advisory Committee, the Bay Program Modeling Subcommittee and Sediment Workgroup, and various other Chesapeake Bay advisory committees. He also serves on the Steering Committee of the International Conference on Cohesive Sediment Transport Processes.

Eric Schott

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University of Maryland Center for Environmental Science, Institute of Marine and Environmental Technology

Dr. Eric J. Schott received his B.A. from Reed College, Portland OR and his Ph.D. in genetics from Harvard University Medical School, Boston, MA. Dr. Schott has had postdoctoral training at Johns Hopkins University and the Center of Marine Biotechnology, and assumed his present position in 2010 as Research Assistant Professor for the University of Maryland Center for Environmental Science at the Institute of Marine and Environmental Technology (IMET). The Schott lab focuses on understanding aquatic health, particularly the discovery and tracking of estuarine pathogens in shellfish. This includes protozoan and viral diseases of oysters, clams and blue crabs. His current focus is on a pathogenic virus of blue crab that plagues captive blue crabs and is also prevalent in wild crabs. His lab has discovered two additional novel viruses in blue crab that have yet to be fully characterized. This is a reminder that numerous undiscovered viruses are out there, and are potential threats to aquaculture.

Hal Schreier

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University of Maryland Baltimore County, Institute of Marine and Environmental Technology

Dr. Hal Schreier is an Associate Professor in the Department of Marine Biotechnology at the Institute of Marine and Environmental Technology, UMBC. Dr. Schreier's research takes molecular microbial genetic, physiological, and ecological approaches towards examining the interactions of microorganisms with their environment. His lab has examined the microbial communities and processes associated with recirculating marine aquaculture biofiltration systems and has been part of the team that developed a near-zero discharge system at IMET. Over the last few years, research in his lab has focused on understanding the role(s) of probiotic bacteria in inhibiting growth of pathogenic bacteria in aquaculture systems, using molecular genetic tools to assess probiotic/host/pathogen relationships. In addition, his lab group has been identifying and

characterizing new probiotic bacterial isolates that target activities of a variety of highly virulent *Vibrio* sp. that are pathogenic to finfish and shellfish, including the *Vibrio parahaemolyticus* strain responsible for early mortality syndrome in shrimp larvae. Understanding the mechanisms utilized by probiotic bacteria will enable the development of highly active and effective strains to be used by the aquaculture industry for disease prevention, thereby decreasing its reliance on antibiotic treatments.

Adel Shirmohammadi

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University of Maryland, Maryland Agricultural Experiment Station

Dr. Adel Shirmohammadi is a Professor of the Department of Environmental Science and Technology and affiliate professor of MEES and Civil and Environmental Engineering. Currently, Dr. Shirmohammadi is the Associate Dean for Research and Associate Director of Maryland Agricultural Experiment Station. His research area has focused on hydrologic and water quality modeling and monitoring at multiple scales (process based, field, and watershed). He has also been conducting research on evaluating the impact of climate change on meeting ecosystem sustainability, our production systems, and water resources. He also serves as a Board member on behalf of AGNR on the Northeast Regional Aquaculture Center for last eight years.

Johnny Shockley

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Hoopers Island Oyster Co.

Mr. Johnny Shockley is the Founding Partner and Chief Operations Officer of Hoopers Island Oyster Company.

Cecily Steppe

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Dr. Cecily Steppe's research focuses on the physical and biological processes that drive population dynamics of commercially and ecologically important marine and estuarine taxa. She began her work validating models of blue crab larval transport in



Delaware Bay by tagging patches of crab larvae with Lagrangian drifters. Since arriving at USNA in 2002, however, she shifted to studies on oyster larval transport, set, and juvenile growth. This has led to publication on oyster grow-out studies and methods of "in situ setting" of oyster larvae at aquaculture sites in Chesapeake Bay. Collaborating with colleagues at the Smithsonian Environmental Research Center, she also investigated the effects of co-occurring cycling hypoxia and pH on oyster gametogenesis, with the goal of providing data that will facilitate siting oyster restoration and aquaculture sites. While primarily an "observationalist," she works closely with modelers and values the combined approach to address the complex challenges that face estuaries and small tributaries. To this end, she serves as the Director of the US Naval Academy's Center for Chesapeake Bay Observation and Modeling, an interdisciplinary research group that brings faculty and students together from across the Academy to focus on Chesapeake Bay issues. She currently serves as the Chair of USNA's Oceanography Department, and works to engage midshipmen in studying both local and environmental systems.

John Stubblefield

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Mr. John Stubblefield has nearly 25 years of applied aquaculture and fisheries research experience, including co-inventorship on a recirculating aquaculture patent and co-authorship on many peer-reviewed publications. As part of the Zohar Lab team, his work has emphasized sustainable and environmentally-responsible production approaches, as well as technology/end-products that are fully transferrable to aquaculture/fisheries personnel, the seafood industry and end-users. He has worked on research projects to induce captive spawning in many hard-to-culture coastal Atlantic fish species including, among others, greater amberjack, snook, cobia, and Atlantic bluefin tuna, as well as more traditional aquaculture species such as European seabass, Mediterranean seabream, and Chesapeake striped bass. He has also been involved in efforts to develop aquaculture and stock restoration technologies for the Chesapeake blue crab and for several other heavily

exploited species along the Gulf Coast and internationally. More recently, he was part of the UMBC-IMET team working to raise larval tunas in captivity. He holds a MSc. in Marine, Environmental, and Estuarine Science from the University of Maryland.

Taryn Sudol

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Ms. Taryn Sudol is the new hire for the Chesapeake Bay Sentinel Site Coordinator with Maryland Sea Grant. Previously, she was an Extension Agent with the University of Florida. Ms. Sudol received her Masters of Science in Conservation Biology and Sustainable Development from the University of Maryland.

Yang Tao

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Dr. Yang Tao received his Ph.D. from Penn State University in 1991. He worked in a former FMC company from 1991 to 1996 as a director of research and development on apple sorting and packing equipment. He moved to the academia in 1996 and worked a faculty first in the University of Arkansas and then to the University of Maryland. Professor Tao's research areas include imaging, robotics, sensors, and automation.

Jeremy Testa

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Dr. Jeremy Testa is an Assistant Professor at the Chesapeake Biological Laboratory in Solomons, Maryland. Jeremy is a systems ecologist who studies how nutrients are moved within estuaries as a result of biological, chemical, and physical processes. Jeremy has investigated how aquaculture operations in Maryland effect underlying sediments and is currently investigating the impact of ocean acidification in Chesapeake Bay.

Lisa Wainger

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University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory

Dr. Wainger is a research professor of environmental economics at the University of Maryland Center for Environmental Science. She has over 25 years of experience in integrating ecological and economic analysis tools to evaluate costs, benefits and risks of environmental policies. Her expertise includes nutrient (water quality) trading, wetland mitigation, measurement of ecosystem services, and cost-effective multi-objective policy design. She is currently working with watermen and aquaculture businesses to understand effects of policies on operational costs and viability. She is recent past chair of the Scientific and Technical Advisory Committee to the US EPA Chesapeake Bay Program and serves on several advisory committees to governmental and non-governmental agencies.

Don Webster

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University of Maryland, AGNR

Mr. Don Webster is a Regional Specialist with UMD Extension with background in commercial fisheries, aquaculture, pond management and aquatic weed control. Currently he manages the Oyster Aquaculture Education & Training Program that provides a range of instruction for those interested in raising shellfish, as part of UMD Extension's Seafood Production Action Team. Publications include technical training manuals, policy development papers and several chapters in aquaculture reference texts. Experienced in organizing and managing educational conferences including "Aquaculture In The Mid Atlantic" a long-running multi-state annual program, the "National Aquaculture Extension Conference", the "Maryland Aquaculture Development Conference" and the annual seminar program at the East Coast Commercial Fishermen's and Aquaculture Trade Expo. Provides information on impoundment management to individuals and groups and conducts annual required certification update training for Maryland Aquatic Pesticide Applicator license holders. Served as a member of the Maryland Seafood and Aquaculture Task Force, Oyster Advisory

Committee and was the Chair of the UMD Senate from 2014-15. Currently serves as Chairman of the state's Aquaculture Coordinating Council.

Eric Wisner

Eric Wisner Oysters, LLC

Mr. Eric Wisner has been farming oysters for nine years. He holds 29 submerged land leases in the Nanticoke area of the Eastern Shore totaling 650 acres of active production. He has been an active participant in Extension's Remote Setting Training Program since it began in 2011, which provides instruction on system operation and Horn Point Hatchery larvae for growers to set spat on shell to seed their grounds. He produces both diploid and triploid seed oysters and has been a leader in adopting new technology to increase production.

Lan Xu

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Lan Xu is a first year PhD student in Institute of Marine and Environmental Technology of Dr. Ten-Tsao Wong's lab. Previously, Lan worked in pacific oyster selective breeding and focused on quantitative genetics and population diversity of black shell strain. Now, Lan's focus is on inducing sterility in oyster and salmon using morpholino oligomer which is carried by molecular transporter-Vivo. Their technology is aiming at knock down the primordial germ cell-specific gene to cause mis-migration of primordial germ cell, which resulted in generation of infertile organism.

Yonathan Zohar

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Yonathan Zohar is Professor at the Institute of Marine and Environmental Technology, past Director of the Center of Marine Biotechnology and current Chair of the Department of Marine Biotechnology and Head of the Aquaculture Research Center at the University of Maryland Baltimore County. His expertise covers the application of biotechnology in sustainable



aquaculture. The primary focus of his research is on basic and applied aspects of fish reproductive physiology and endocrinology. He uses endocrine, biochemical and molecular approaches to study interactions along the brain-pituitary-gonadal axis leading to reproductive development, gamete maturation, ovulation and spawning. He builds upon his basic research to develop applied technologies for spawning induction, broodstock management and for generating reproductively sterile fish. He has also led programs on blue crab hatchery production and on fully recirculating, land-based marine aquaculture. Professor Zohar has worked extensively with the aquaculture industry domestically and globally, published over 230 peer-reviewed papers and book chapters, and is the inventor of 10 issued international patents in aquaculture and biotechnology.

Appendix B

Maryland Shellfish Aquaculture Industry Roundtable Summary

November 29th, 2017 • Annapolis Maryland

A decade ago, Maryland oyster aquaculture was not much of an industry. Only a handful of oyster farms existed, and many counties had laws so restrictive that new ones could not open. But, since the state legislature changed the law and allowed shellfish aquaculture in every county (2009), the number of leases has increased. As of Fall 2017, more than 170 oyster farmers had leased more than 6,500 acres of Maryland's part of the Chesapeake Bay and its tributaries. The value of that fishery, according to the state Department of Natural Resources, is \$5 million.

Research helped fuel the growth in aquaculture in Maryland and Virginia. Geneticists have developed lines that will resist diseases, and improved upon the original triploid oysters. New technology has yielded better equipment, and better coordination among agencies has meant shorter wait times for permits to grow oysters. Where do we go from here? How can scientific research, social science, and collaboration with extension agents and the industry propel oyster aquaculture forward in Maryland?

Maryland Sea Grant convened a meeting of about 30 oyster growers (from across the state), extension specialists, and facilitators on Nov. 29 in Annapolis to discuss those questions and frame possible research projects that could answer them. The Shellfish Aquaculture Industry Roundtable is one step in a process that will also include a research meeting on Jan. 10 to share the industry's ideas with scientists and develop research projects.

At the Industry Roundtable, attendees broke out into groups, each with a facilitator to lead discussion on previously identified industry priorities. The groups met and then presented some potential research questions to some of their issues. While some concerns pertain to individual growers, or certain regions, below is a list of seven identified priorities in which research could make a difference.

- **Theft:** Theft from oyster leases has long been a problem. Among the ideas was the idea of developing some technologies that would let oyster farmers and the Maryland Natural Resources Police (NRP) know that an unauthorized person was on their lease after hours using new or existing systems such as the NRP's Marine Law Enforcement and Information Network (M-LEIN) system. Growers also discussed the possibility of stronger punishments for thieves and disincentives to theft, suggesting creating an "oyster docket," where one judge hears all the natural resources violations cases. Other needs included better coordination with law enforcement and an improved legal structure to combat theft.

- **Permitting:** The discussion noted that the wait time for getting a lease in Maryland is still less than ideal. Growers would like more flexibility if they wish to change the gear they use on a lease, and rules that make it easier to move seed from one lease to another. Growers are seeking solutions to simplify the process, and particularly so with interactions from other species that may not live in the oyster-lease area, such as sea turtles (National Marine Fisheries Service gets involved) or SAV (multiple agencies).

- Shell, larvae, and seed availability/production: Oyster growers who use spat-on-shell struggle to procure shell for their operations and are interested in hearing about alternative substrates. Other oyster farmers suggested using shells from their own operations to re-seed their leases, and the idea of making their own substrates with research assistance. Another idea was for a Burpee's seed catalog of sorts for oysters, so that farmers are planting the right crops in the right places. Certain lines may do better in low or high salinity, open water or protected coves. It would be good to know the probability of what would work where. Growers also expressed a desire to know what kinds of gear would be most appropriate for which settings and how best to mechanize operations. Currently, the demand for seed and shell exceeds availability. They are also concerned about diseases.
- Increased production: Oyster farmers would like to know how to increase their survival rates for their crops and increase their profitability. More research is needed to improve both diploids (more common in spat-on-shell aquaculture), and triploids – sterile oysters – (preferred for cage aquaculture). While there may be no single “super-oyster,” farmers are interested in developing oysters that produce more offspring that survive. They would like to develop techniques to farm more effectively. Oyster farmers have to contend with fouling on their cages which restricts water flow to the animals and slows growth.
- Business, marketing, and sales: Oyster farmers are concerned that Chesapeake oysters are fetching less at market than their counterparts from New England and Prince Edward Island. They are interested in ways to get the word out about the quality of the Bay oyster. They are also contending with difficulty in getting crop insurance, and wish to engage the U.S. Department of Agriculture to assist with that.
- Farm optimization: Oyster farmers would like to keep their labor costs down. Labor is a major input in water column leases. They support the development of more shucking houses to produce oyster meats for sale so that shells shucked here stay here for reuse.
- Post-harvest processing: Once the oysters are ready, farmers wish to get them out the door with little labor costs. They are interested in research on how best to control temperature to reduce vibrio and other practices to improve storage and transport.
- Other points: Research to determine the value of nitrogen-removal credits from oyster leases. Maryland has a nutrient trading program which recognizes the value of that removal for TMDL requirements for the Bay, but no trades yielding money have yet been made. The growers noted this industry is poised to keep growing. Many sell every oyster they grow.

Appendix C

Shellfish Aquaculture Industry

Potential Research Interests

Maryland Sea Grant recognizes industry needs and research interests surrounding the topic of aquaculture have been well articulated in multiple forums. However, sometimes gaps occur between understanding the problems and designing effective approaches to solving them. Our goal for these two roundtable discussions (November 2017 and January 2018) is to bring together the unique knowledge of aquaculture farmers and researchers to understand better and help solve some of the more vexing problems limiting the sustainable and economically sound growth of the aquaculture industry in Maryland and the nation.

Below, we summarize eight potential aquaculture research topics generated by industry from the Maryland Shellfish Aquaculture Industry Roundtable meeting on November 29, 2017. Under each general topic is a list of specific research interests. Specific research interests ranked as a top priority by more than three industry participants are highlighted in bold and listed in order of priority (some research interests were ranked as a priority by up to 9 participants).

Theft

- **Technology to improve monitoring of poaching (e.g. surveillance app that alerts by phone, real-time monitoring)**
- **Strengthen laws, prosecution, penalties for theft**
- **Improving relations with the Maryland Natural Resources Police (NRP) (better communication, better training for NRP officers)**
- Better use of Maritime Law Enforcement Information Network (MLEIN)

Shell, Larvae, and Seed Availability/Production

- **Alternative substrate**
- **Make a “super” oyster (e.g. low mortality, fast growing, good taste)**
- **Shell access and availability**
- Remote setting on lease using shell from one’s own lease
- Seed and larvae supply
- Creating a seed catalog for oysters (“Burpee Model”)
- Demand exceeds availability
- Economics of supply and demand issues

Increased Production

- **Management of pests and predators (mudworms, cliona, flatworms, sea squirts, etc.)**
- Alternative substrate for bottom stabilization
- Suffocation from siltation
- Early mortality in triploids
- Reducing oyster disease
- Mixing fines with cement to make artificial shell substrate
- Why slow growth of some oysters under different estuary and grow out conditions

Farm Optimization

- Systems optimization/mechanization relative to cost and farm scale
- Improved efficiency to address issues of labor availability (e.g. counting/washing/boxing) and size grading
- Shucking mechanization

Permitting

- Wildlife (including plants) interactions with gear and harvest methods (e.g. SAV, waterfowl, endangered species (sea turtle, sturgeon))
- Time: USACE needs more employees to reduce wait
- User-conflict for multiple uses
- Improved, transparent protest process for resolving permitting/legal issues
- Aquaculture enterprise zones
- Changing leases to adapt to new gear
- Permits for transferring seed from one bottom lease to another

Post-Harvesting Processing

- Research on how to reduce fouling; conditions of cages
- Gear selection: optimizing gear for a given farm
- How to flavor/salt oysters
- Improved anti-fouling paints

Business, Marketing, and Sales

- Improving chef-perception on wild versus aquaculture products
- Subsidies including cash funding
- Personal marketing
- Temperature control in shipping
- Identifying key data points that are the most important to track
- Create Maryland Grower's Association
- Improve record keeping and training
- Better marketing of Chesapeake Bay oyster (statewide oyster trail)
- Price of MD oysters versus VA oysters (VA bushels are cheaper so shucking houses buy from VA, shells stay in VA and supply to MD is restricted)
- Insurance that is more realistic, better-suited/tailored to aquaculture
- Improved access and use of MARBIDCO

Other

- **Nitrogen credits/Nutrient credit trading**
- User friendly mapping/lease tracking (for within farm activity)
- Oyster information clearinghouse (e.g. a news report of oyster happenings, calls for proposals, etc.)
- Diversification of what's grown in Maryland aquaculture
- Transparency in and timeliness of closures; improved communication among growers, resource managers, policy makers

Appendix D

Funding Opportunities

Below we list of some currently open funding opportunities in aquaculture and other potential sources for funding of both research and industry development. This is not a comprehensive list, but a starting point for exploring potential areas for support.

Open Funding Opportunities

NOAA National Sea Grant College Program 2018 Ocean, Coastal and Great Lakes National Aquaculture Initiative
NOAA-OAR-SG-2018-2005489

Applications due to Sea Grant Programs by March 2, 2018 at 5 pm local time.

Funding Opportunity Description: NOAA National Sea Grant College Program (NOAA Sea Grant) expects to have available a total of \$7,000,000 to \$11,500,000 across fiscal years 2018, 2019 and 2020 as part of the Sea Grant National Aquaculture Initiative (NAI). As part of the NAI, this competition is designed to foster the expansion of a sustainable U.S. ocean, coastal and Great Lakes aquaculture sector by addressing one or more of the following priorities: (a) supporting the development of emerging systems or technologies that will advance aquaculture in the U.S., including projects that will help stimulate aquaculture production by nascent industries; (b) developing and implementing actionable methods of communicating accurate, science-based messages and information about the benefits and risks of U.S. marine aquaculture to the public; and (c) increasing the resiliency of aquaculture systems to natural hazards and changing conditions. Successful applications must describe projects that clearly address major constraints, barriers or hurdles limiting aquaculture production in the U.S.

Atlantic States Marine Fisheries Commission: Marine Aquaculture Pilot Projects

http://www.asafc.org/files/JobAnnouncements/ASMFCAquacultureRFP_Dec2017.pdf

Proposals due February 1, 2018 at 5 pm EST

The Atlantic States Marine Fisheries Commission is requesting proposals to develop regional pilot projects in support of sustainable aquaculture. Specifically, pilot programs should partner with industry to develop techniques and business models to grow domestic seafood production. A priority is to consider promising but less commercially developed technologies for finfish, shellfish, seaweed, and other relative newcomers to the domestic aquaculture industry.

FY2018 NOAA Small Business Innovation Research Phase I Solicitation

<https://www.sbir.gov/node/1332333>

Applications due January 31, 2018 at 4 pm EST

The U. S. Department of Commerce (DOC), National Oceanic and Atmospheric Administration (NOAA) plans to seek proposals from small business firms for participation in Phase I of the Fiscal Year 2018 (FY18) NOAA Small Business Innovation Research (SBIR) Program. Through a competitive awards-based program, SBIR enables small businesses to explore their technological potential and provides the incentive to profit from its commercialization. Specific aquaculture topics include:

- 8.3.2 Automated Tools for Detecting Entanglement Risks Associated with Aquaculture
- 8.3.3 Development of “Permit Wizard” Software for Assisted Permit Application Completion
- 8.3.5 Developing Low-Cost, High-nutrition Plant-based Feed for Finfish Aquaculture Operations
- 8.3.6 Developing Monitoring Tools to Detect Disease in Marine Aquaculture Operations

Other Federal Funding Potential Opportunities

Saltonstall Kennedy Competition

http://www.nmfs.noaa.gov/mb/financial_services/skhome.htm

Annual competition. Primarily focused on fisheries research but can support aquaculture research on species that could improve sustainability of wild stock. 2018 grant cycle closed January 8, 2018.

Agriculture and Food Research Initiative - Foundational Program

<https://nifa.usda.gov/program/agriculture-and-food-research-initiative-afri>

NIFA's AFRI funding portfolio includes both single- and multi-function research, education, and extension grants that address key problems of national, regional, and multi-state importance. AFRI-funded projects sustain all components of agriculture, including...aquaculture, rural communities and entrepreneurship...AFRI-funded integrated projects must include at least two of the three functions of agriculture knowledge – research, education, and extension – to ensure delivery of science-based knowledge to people, allowing them to make informed practical decisions.

The Foundation for Food and Agriculture Research's (FFAR) Sustainable American Aquaculture

<http://foundationfar.org/challenge/protein-challenge/aquaculture-rfa/>

The Foundation was established by the Farm Bill passed in 2014 and charged with complementing and furthering the important work of the U.S. Department of Agriculture. The objective is to stimulate innovative research in farmed production of fish and shellfish, providing economic opportunities to U.S. farmers and increasing the supply of domestically-produced, nutritious foods to meet growing consumer demand.

USDA Northeastern Regional Aquaculture Center (NRAC)

<https://agresearch.umd.edu/nrac>

Headquartered at the University of Maryland, College Park, is one of five Regional Aquaculture Centers established by the U. S. Congress for the United States. Funded by the U.S. Department of Agriculture at an annual level of approximately \$700,000, and representing 12 states and the District of Columbia, NRAC develops and sponsors cooperative regional research and extension projects in support of the aquaculture industry in the northeastern United States.

USDA Special Research Grants Program - Aquaculture Research

<https://nifa.usda.gov/funding-opportunity/special-research-grants-program-aquaculture-research>

The Aquaculture Research program will fund projects that directly address major constraints to the U.S. aquaculture industry and focus on one or more of the following program priorities: (1) genetics of commercial aquaculture species; (2) critical disease issues impacting aquaculture species; (3) design of environmentally and economically sustainable aquaculture production systems; and (4) economic research for increasing aquaculture profitability.

Other Federal Resources

USAID has some international opportunities for support of aquaculture research. <https://www.usaid.gov/what-we-do/agriculture-and-food-security/investing-agricultural-research-and-development>

NOAA's Office of Aquaculture has a useful page that aggregates funding opportunities in aquaculture.

<http://www.nmfs.noaa.gov/aquaculture/funding/funding.html>



Maryland Funding Potential Opportunities

MARBIDCO Agricultural Development Programs

<http://www.marbidco.org>

These first two programs are highly specific to aquaculture, feature low loan interest rates, provide a 25% grant incentive, and also require that no (or little) collateral security be offered.

1. **Remote Setting Shellfish Aquaculture Loan Fund** (working in collaboration with DNR and using MPA funds) provides affordable financing to commercial watermen who want to start or expand shellfish remote setting (nursery) aquaculture operations.
2. **Maryland Shellfish Aquaculture Financing Fund** (working in collaboration with DNR and using a combination of state capital and federal NOAA funds) helps watermen (and others) who wish to transition from wild oyster harvesting to start or expand underwater shellfish farming enterprises using leased growing areas in the Chesapeake or Coastal Bays plans. The loan proceeds can be used to purchase shell, seed, spat or equipment (depending on the source of funds). Bottom culture and water column (cages or floats) projects are eligible.
3. **Southern Maryland Revolving Loan Fund** has been established by the Southern Maryland Agricultural Development Commission (SMADC) and MARBIDCO to help assist Southern Maryland agricultural producers with smaller agricultural projects that typically might not be financed by traditional commercial lenders. It offers some special incentives for farmers (including aqua farmers) in its 5-county region through MARBIDCO.
4. **Maryland Resource-Based Industry Financing Fund** (MR BIFF) offers low-interest (3.25% initially) loans to Ag/RBI-industry enterprises for the purchase of land and capital equipment for production and processing activities (including building construction).
5. **Local Government Ag/RBI Project Cost Share Program** is designed to lend support to local and regional rural business development efforts. MARBIDCO will consider a project cost-share request from a local or regional economic development office if the project fits within MARBIDCO's statutorily established mission area.

Maryland Energy Administration

<http://energy.maryland.gov/Pages/EnergyFinance.aspx>

Mathias Agriculture Program offers energy efficiency grants on a competitive basis to Maryland Agriculture Businesses located around the state. This includes support for the aquaculture industry.

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Maryland Industrial Partnerships (MIPS) Program, Grants for Technology Product Development

<http://www.mips.umd.edu/applying.html>

Proposals due at MIPS office May 1, 2018

MIPS promotes the development and commercialization of products and processes through industry/university research partnerships. MIPS provides matching funds to help Maryland companies pay for the university research. Projects are initiated by the companies to meet their own research and development goals.



TEDCO

<http://tedco.md/programs/>

TEDCO was created by the Maryland State Legislature in 1998 to facilitate the transfer and commercialization of technology from Maryland's research universities and federal labs into the marketplace and to assist in the creation and growth of technology-based businesses in all regions of the State. TEDCO provides mentoring, funding, and networking opportunities to entrepreneurs for the accelerated success of an innovation economy in Maryland and beyond. Multiple grant opportunities.

Farm Credit (national and mid-Atlantic specific)

<https://www.mafc.com/>

<https://www.farmcreditnetwork.com/>

Provide loan programs for aquaculture, though not as specialized as MARBIDCO. They look to customize loan structure depending on the business needs and cash flow of the borrowers.

Contact: Andrew Rose.