Aquatic Research and Environmental Assessment Center

Brooklyn College, City University of New York

AREAC

Annual Report 2023-2024

AREAC researchers sample for invasive fish using a seine in Oneida Lake, upstate NY.

AREAC: History, Mission, and Facilities

The Aquatic Research and Environmental Assessment Center (AREAC), was founded in 1997 by Dr. Martin Schreibman, Distinguished Professor (Emeritus) at Brooklyn College. The mission of AREAC is to serve as a hands-on experimentation laboratory and a center of innovation for aquatic ecosystem sustainability science. Themes at AREAC include: 1) fisheries and aquaculture science, 2) environmental assessment and management, and 3) biology and ecophysiology of aquatic organisms. AREAC's goal is to serve as a primary aquatic research and education facility for Brooklyn College, CUNY campuses, and external cooperators including city, State, and Federal agencies. AREAC welcomes students and faculty at the City University of New York to participate in research and educational opportunities at AREAC.

AREAC is on the campus of Brooklyn College in the New Ingersoll building. AREAC consists of three brick and mortar facilities. The aquaria facility is a 7,000 sq. ft set of labs dedicated to basic and applied studies of aquatic organisms. The aquaria facility includes multiple rooms plumbed with air and re-circulating water systems, allowing control of temperature, salinity, and photoperiod while maintain healthy animal rearing conditions. Seawater is artificially prepared from filtered New York City municipal water and added salt. Adjacent to the aquaria facilities are 2,000 sq. ft of analytical lab space for environmental chemistry and biology. Finally, the AREAC greenhouses sits atop Ingersoll Extension roof space on the Brooklyn College campus. The 2,000 sq. ft greenhouse spaces are used for aquatic ecosystem experimentation. AREAC also hosts office space for faculty, staff, and students.

AREAC Directors:
Suresh A. Sethi, 2023-present
Frank Grasso, 2022-2023
John Marra, 2007-2022
Marin Schreibman, Founding Director, 1997-2007

AREAC Lab Manager:
Rob Dickie, 2009-present

AREAC website:
https://www.brooklyn.edu/areac/

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This annual report covers activities at AREAC over the 2023-2024 academic year from August 2023 through August 2024.

AREAC Research Activities

Research activities at AREAC span field studies, lab bench experimentation, animal studies, and 'desktop' analyses related to aquatic ecology and aquatic ecosystem science. Select current research activity highlights among AREAC's three core themes are provided below. A complete list of current research activities is provided in Table 1.

Fisheries and aquaculture science

Scaling the potential for reusing seafood processing wastes

One-fifth of the human population relies on commercial fisheries' catches as a primary source of dietary protein, but seafood processing can generate substantial amounts of offal. AREAC director Suresh A. Sethi and Brooklyn College Earth & Environmental Science Master's student Shamina Israt are conducting a systematic review to estimate global seafood processing recovery rates. This work will provide estimates needed to scale the amount of nutrients potentially available for use in the global seafood processing waste pool. This work is advancing the sustainable use of what we harvest from the ocean. Photo: Commercial fishermen in Kilkeel, Northern Ireland stack nets onboard in preparation for fishing (photo credit: S.A. Sethi).

Environmental assessment and management

Nature-based solutions to improve water quality in New York City's estuaries

Dr. Brett Branco, Director of the Science and Resilience Institute at Jamaica Bay, is working with the New York City Department of Environmental Protection to investigate ribbed mussel installations as a means to improve water quality in the city's estuaries. Ribbed mussels provide multiple ecosystem benefits as they clean the water. Dr. Branco's group is placing 'settlement' devices that can track ribbed mussel reproduction in Jamaica Bay and processing results at AREAC. Photo: Ribbed mussels in an urban estuary (photo credit: NOAA.gov).

Biology and ecophysiology of aquatic organisms

Aquatic soundscapes in NYC's marine waters

Oyster toadfish produce sounds for social communication and mate attraction, and are common along the eastern seaboard. Brooklyn College Biology Professor Paul Forlano's lab is investigating how variable noise in aquatic soundscapes within New York City affect toadfish vocal behaviors. Photo: Oyster toadfish in tanks at AREAC (photo credit: P. Forlano).

Table 1. Current research activities at AREAC.

Project	**Lead Investigators**	**Thematic area**
Hormonal regulation of the dopaminergic auditory efferent system: improving detection of social acoustic signals at the level of the inner ear	Dr. Paul Forlano	Biology & ecophysiology of aquatic organisms
Neural adaptations to living in noise: oyster toadfish communication in NYC waters	Dr. Paul Forlano	Biology & ecophysiology of aquatic organisms
Neural development and acoustic communication in the striped cusk eel	Dr. Paul Forlano and Xylo Lazrinth	Biology & ecophysiology of aquatic organisms
Fiddler crab mating behavior	Dr. Frank Grasso	Biology & ecophysiology of aquatic organisms
Targeting the duckweed microbiome for plant growth and bioremediation	Dr. Theodore Muth	Biology & ecophysiology of aquatic organisms
RCN-UBE for microbiome CUREs	Dr. Theodore Muth	Biology & ecophysiology of aquatic organisms
Salinity tolerance of invasive round goby	Dr. Suresh A. Sethi	Biology & ecophysiology of aquatic organisms
Genomic diversity, adaptive immunity and immune memory	Dr. Tony Wilson	Biology & ecophysiology of aquatic organisms
Relative parental investment in nearshore pipefish	Dr. Tony Wilson	Biology & ecophysiology of aquatic organisms
Sex determination in the seahorse	Dr. Tony Wilson	Biology & ecophysiology of aquatic organisms
In vitro synthesis of hippocampus immunoglobulin	Dr. Tony Wilson	Biology & ecophysiology of aquatic organisms
Researching the efficacy of nature-based solutions for water quality improvements in New York City coastal waters.	Dr. Brett Branco and the Science & Resilience Institute at Jamaica Bay	Environmental assessment & management
Linking public perceptions in Prospect Park with cyanobacteria bloom mitigation	Dr. Jennifer Cherrier	Environmental assessment & management
Assessing green stormwater infrastructure for NYC stormwater management	P. Rushing with Dr. Jennifer Cherrier	Environmental assessment & management
Assessing the potential of traditional and hybrid green infrastructure for phosphate and nitrogen removal from NYC urban lakes	K. Pak, Z. Strein with Dr. Jennifer Cherrier	Environmental assessment & management
Effect of biochar and compost on the mobility of Pb and As in two urban soils	Dr. Joshua Cheng	Environmental assessment & management
Effect of leaf mulching on urban soil health – pilot study on NYCHA lawns	Dr. Joshua Cheng	Environmental assessment & management
Quantifying benthic carbon release resulting from fishing gear disturbance on the seafloor	Dr. Suresh A. Sethi	Environmental assessment & management
Implication of round goby introductions on mercury biomagnification in predatory fish	Dr. Suresh A. Sethi	Environmental assessment & management
Scaling the global seafood offal pool: meta analysis of fisheries processing practices	Dr. Suresh A. Sethi	Fisheries & aquaculture science
Advancing autonomous vehicles for acoustic fisheries surveys: Great Lakes saildrones	Dr. Suresh A. Sethi	Fisheries & aquaculture science

AREAC Education and extension Activities

AREAC facilities provide a hands-on experience to introduce community members to aquatic ecosystem science. AREAC hosts educational groups ranging from high school students, undergraduates, and graduate students, providing tours, demonstration workshops, and support for Brooklyn College courses. AREAC also supports multiple extension activities at Brooklyn College, including providing space for student groups related to ecosystem sustainability and providing greenhouse resources for urban gardening programs. AREAC's educational and extension activities for this year are detailed in Table 2.

Table 2. AREAC education and extension activities in the 2023-2024 year.

Activity	**Category**
Provided facilities for the Brooklyn Urban Ecology and Environment Program NSF Research Experience for Undergraduates leg by PI Dr. Tony Wilson, Professor in Biology	Education
Provided facilities to support an Urban gardening undergraduate course at Brooklyn College	Education
Provided an introduction on urban aquaculture short course for the Brooklyn College Now high school to university education transition program	Education
Provided instruction for the Earth & Environmental Sciences 7161G Field Course: scaling global seafood waste	Education
Provided a short course on aquatic science for the Brooklyn College CSTEP student education and mentorship program	Education
Provided space for the Brooklyn College Sustainability Club meetings	Extension
Provided seedling facilities for the Brooklyn College community garden program	Extension
Provided facilities tour for Brooklyn College high school student admissions events	Tour
Brooklyn College new student orientation facilities tour	Tour
Provided an introduction on aquaponics and aquaculture science for the Brooklyn College SEEK undergraduate education and mentorship program	Tour
Provided a facilities tour for a Des Moines, IA, high school group for a former AREAC community member, now high school teacher	Tour
Provided a facilities tour for NYC's Hunter College high school students	Tour
Provided facilities tour for over 40 prospective transfer students considering Brooklyn College	Tour

AREAC Funding

AREAC receives support for facilities and staff from Brooklyn College, whereas our research and education activities are supported primarily through external grants. Grantsmanship at AREAC is active, generating significant financial resource flows to Brooklyn College and CUNY. Current grants associated with AREAC activities are provided in Table 3 below. Combined, AREAC facilities supported activities on grants led by Brooklyn College principal investigators totaling over $5.8M in the 2023-2024 academic year.

Table 3. Active grants led by CUNY principal investigators associated with AREAC activities.

Project	Lead Investigator	Thematic area	Source	Funding amount
Hormonal and acoustic regulation of the dopaminergic auditory efferent system: improving detection of social acoustic signals at the level of the inner ear	Dr. Paul Forlano	Biology & ecophysiology of aquatic organisms	National Institutes of Health	$462,160
Targeting the Duckweed Microbiome for Plant Growth and Bioremediation	Dr. Theodore Muth	Biology & ecophysiology of aquatic organisms	US Department of Agriculture	$750,000
NSF RCN-UBE for Microbiome CUREs	Dr. Theodore Muth	Biology & ecophysiology of aquatic organisms	National Science Foundation	$255,000
Salinity tolerance of invasive round goby	Dr. Suresh A. Sethi	Biology & ecophysiology of aquatic organisms	NY Water Resources Institute	$39,000
MCA: Genomic diversity, adaptive immunity and immune memory	Dr. Tony Wilson	Biology & ecophysiology of aquatic organisms	National Science Foundation	$372,060
REU: Brooklyn Urban Ecology and Environment Program	Dr. Tony Wilson	Biology & ecophysiology of aquatic organisms	National Science Foundation	$398,763
REPS supplement: Brooklyn Urban Ecology and Environment Program	Dr. Tony Wilson	Biology & ecophysiology of aquatic organisms	National Science Foundation	$21,800
Alley Creek wetland pathogen reduction and Bergen and Thurston basins Ribbed Mussel performance	Dr. Brett Branco and the Science & Resilience Institute at Jamaica Bay	Environmental assessment & management	NYC Dept. of Environmental Protection	$3.2M
Effect of leaf mulching on urban soil health	Dr. Joshua Cheng	Environmental assessment & management	Sloan Foundation	$30,000
Interdisciplinary solutions for urban water resource management: Prospect park cyanobacteria	Dr. Jennifer Cherrier	Environmental assessment & management	CUNY-Office of Research	$50,000
Scaling the global seafood offal pool	Dr. Suresh A. Sethi	Fisheries & aquaculture science	CUNY PSC 55	$5,000
New York state commercial fisheries monitoring: Vessel Trip Reporting analysis	Dr. Suresh A. Sethi	Fisheries & aquaculture science	NY State Dept. of Environmental Conservation	$340,000

AREAC Publications

As a primary research facility, investigators at AREAC are leading cutting-edge science spanning a range of fields including commercial fisheries science, evolutionary biology, stormwater management, and urban food production, among others. Publications associated with activities at AREAC from the 2023-2024 academic year are provided below.

Biondi TC, Kruse CPS, Koehler SI, Kwon T, Davis AK, Eng W, Kunde Y, Gleasner CD, You Mak KT, Polle J, Hovde BT, Hanschen ER, Starkenburg SR (2024) The telomere-to-telomere, gapless, phased diploid genome and methylome of the green alga Scenedesmus obliquus UTEX 3031 reveals significant heterozygosity and genetic divergence of the haplotypes. *Algal Research*, 79: 103431.

Brown TA, Rudstam LG, Sethi SA, …, Honsey A (2024) Synthesizing professional opinion of lake whitefish and cisco recruitment drivers across the Great Lakes. *Laurentian*, In press.

Choat B, Pulido A, Bhaskar AS, Hale RL, Zhang HX, Meixner T, McPhillips L, Hopkins KG, Cherrier J, Cheng C (2023) Assessing stormwater control measure inventories from 23 cities in the United States. *Environmental Research Infrastructure and Sustainability*, 3:025003.

Couto T, Sethi SA (2023) River-to-sea ecosystem management. *Nature Sustainability*, November 2.

Dick CM, Larson WA, Karpan K, Baetscher D, Shi Y, Sethi SA, Fangue N, Henderson MJ (2024) How do predator species, temperature, and prey ration influence molecular diet analyses? Insights from a controlled feeding experiment. *Molecular Ecology Resources*, In press.

Evans T, Rudstam LG, Sethi SA, …, Esselman P (2024) Paired comparisons with quiet surface drones show evidence of fish behavioral response to motorized vessels during acoustic surveys in Lake Superior. *Canadian Journal of Fisheries and Aquatic Sciences*, In press.

Ghanbari M, Dell T, Saleh F, Chen Z, Cherrier J, Colle B, Hacker J, Madaus L, Orton P, Arabi M (2024) Compounding effects of changing sea level and rainfall regimes on pluvial flooding in New York City. *Natural Hazards*, 120:6377-6400.

Hom KH, Forlano PM (2023) Dopamine in the auditory system of toadfishes: potential adaptation for living in noisy environments. *In* Popper AN, Sisneros JA, Hawkins AD, Thomsen F (Eds). *Effects of Noise on Aquatic Life: Principles and Practical Considerations*. Springer Nature, Switzerland.

Hom KH, Quigley TD, Rodriguez R, Gdanski S, Lazrinth X, Jones R, Forlano PM (2024) Characterization of anthropogenic noise and oyster toadfish (*Opsanus tau*) calling behavior in urban and small-town coastal soundscapes. *Journal of the Acoustical Society of America*, 155:1230-1239.

Kim M, Kim J, Lee S, Khanh N, Li Z, Polle J, Jin E (2024) Deciphering the β-carotene hyperaccumulation in *Dunaliella* by the comprehensive analysis of *Dunaliella salina* and *Dunaliella tertiolecta* under high light conditions. *Plant Cell and Environment*, 47:213-229.

Koeberle AL, Pearsall W, Hammers BE, Mulhall D, McKenna JE, Chalupnicki MC, Sethi SA (2023) Whole-lake acoustic telemetry to evaluate survival of stocked juvenile fish. *Scientific Reports*, 13:18956.

Lutter S, Cuppett S, Sethi SA, Rahm B (2024) Social considerations for the removal of dams and other aquatic barriers. *BioScience*, biae037.

Poulton AJ, Villegas-Rios D, Freitas C, Moland, E, Olsen EM, Sethi SA, Ellner SP. Bayesian estimation of spatially varying mortality risk using tagged animal data. *Methods in Ecology and Evolution*, In press.

Sethi SA, Koeberle AL, Poulton AJ, Linden DW, Diefenbach D, Buderman F, Casalena MJ, Duren K (2024) Multistage time-to-event models improve survival inference by partitioning mortality processes of tracked organisms. *Scientific Reports*, 14:14628.

Shi Y, Dick CM, Karpan K, Baetscher D, Henderson MJ, Sethi SA, McPhee M, Larson WA (2024) Towards absolute abundance for conservation applications: estimating the number of contributors via microhaplotype genotyping of mixed-DNA samples. *Molecular Ecology Resources*, In press.

Wilson AB (2024) Parental behavior in fish. *In* Skinner MK (Ed.) *Encyclopedia of Reproduction*, *3rd edition*, Academic Press, New York.

Wilson AB, Whittington CM, Meyer A, Scobell S, Gauthier ME (2023) Prolactin and the evolution of male pregnancy. *General and Comparative Endocrinology*, 334:114210.

AREAC Cooperators

AREAC conducts cooperative science. We collaborate with a wide range of conservation, governmental, industry, and academic allies to advance aquatic ecosystem science and aquatic ecosystem sustainability. Our community extends well beyond Brooklyn College's campus:

Alaska Pacific University
CUNY Advanced Science Research Center
Cornell University
Cornell Cooperative Extension
Baruch College
Exeter University
Hazen & Sawyer
Molise University
NY City Department of Environmental Protection
NY City Department of Parks and Recreation
NY City Department of Sanitation
NY City Housing Authority
NY Department of Environmental Conservation
NY Water Resources Institute
Pace University
Ramboll
Stony Brook University
SUNY Downstate
Ulster University
University of the Algarve
University of Maryland
University of Washington
USGS Great Lakes Science Center
US Fish & Wildlife Service

AREAC lab manager Rob Dickie tends to an integrated aquaculture – aquaponics demonstration project in the AREAC greenhouses (photo credit: S.A. Sethi).

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