

# Project Work Plan for Wellfleet Harbor Oyster Spawning Project

April 2011



**Town of Wellfleet  
Comprehensive Wastewater Planning Committee**

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A partnership for engineering solutions. GROUP

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# WELLFLEET HARBOR OYSTER SPAWNING PROJECT

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## 1. OVERVIEW

Wellfleet Harbor is a priceless economic resource because it is the life-blood of the Town's centuries old shellfishing industry and has a unique ecosystem and aquaculture tradition. It is also a major recreation, boating, fishing and tourist center. Tourism and shellfishing comprise the largest income generating activities in Wellfleet.

This proposed project involves establishing a 1.3 acre oyster spawning ground that is expected to provide the following benefits:

- approximately 18 million additional oysters annually;
- potential increase in commercial shellfish value of \$9 million;
- 500-900 million gallons of increased water filtration.

In general, much of the inland groundwater in the Town flows into nearby tributaries, all of which eventually discharge into the harbor. Currently, there is a concern about increasing nutrient loads from ground and surface water, and a simultaneous decline in historic levels of shellfish in the harbor. These trends could be directly related, or acting independently to exacerbate impacts on water quality. The decrease in total shellfish population has a direct effect on future shellfish productivity and over 100 other plant and animal species that depend on this critical part of the ecosystem. For a plan showing the location of water bodies in the Town, please see Figure 1 in Appendix A.

Land based septic systems in the town are widespread and have been estimated to produce over 2 million gallons per day of nutrient-laden effluent during the peak summer season. The Town's central district is one of the more densely populated areas, and is in the immediate vicinity of Mayo and Duck Creeks, which directly connect to the harbor as shown in Figure 1. Water quality trends from drinking water wells in this area show elevated levels of nitrate in the groundwater may be reaching the harbor. The study area abuts a very productive shellfish area that is presently at a historically low population density, despite decades of extensive seeding and propagation efforts.

The Massachusetts Estuary Program (MEP) will establish total maximum daily loads (TMDL) for nitrogen in the harbor at some point in the future. However, before these TMDLs are established, it is important to understand the source and quantity of excess nutrients and develop a solid scientific data base of groundwater quality, natural sources and nutrient sinks in the area.

One of the Town of Wellfleet's goals is to protect natural and estuarine resources in accordance with its Harbor Management Plan and Comprehensive Conservation and Management Plans. The Town has taken an important step towards reaching this goal by engaging Environmental Partners Group, Inc. (EPG) to develop a comprehensive wastewater management plan (CWMP). More specifically, EPG has begun developing a program for identifying wastewater management strategies and nitrogen removal alternatives with a priority on natural alternatives. At the same time Wellfleet Audubon has been working with the Town, NOAA and The Nature Conservancy to develop the State's first man-made oyster habitat. The Nature Conservancy has concluded

that oyster habitat decline is nearly 90% worldwide, including the Northeast, when compared to historic levels.

There is an ongoing and worldwide effort to assess and detect alterations in water quality due to the presence or absence of shellfish (bivalves), specifically addressing questions regarding the extent to which shellfish may improve water quality or exceed the system's carrying capacity (Dumbauld et al. 2009). With increasing discharge of nutrients to our coastal waters, shellfish provide an indispensable ecosystem service in mitigating eutrophication (Dame 1996; Rice 1999). However, measurable effects on water properties depend on the filtration capacity of shellfish relative to their species, size, and the residence time of water in the coastal embayment - the longer the residence time the more opportunity for filter-feeders to remove particulates (Prins et al. 1997; Prins and Escaravage 2005; Dumbauld et al. 2009).

Oysters (*C. virginica*, native to Wellfleet) are a keystone species and serve as ecosystem engineers. As a suspension feeder, an adult eastern oyster filters up to 60 gallons of water per day, and through bio-deposition and permanent removal of excess nutrients (N and P), they improve the water quality/clarity for eel grasses and juvenile fish. They also play a dominant role in benthic-pelagic coupling (Haven and Morales-Alamo 1970; Kennedy 1996; Kennedy et al. 1996; Newell et al. 2005; Coen et al. 2007).

Only recently have efforts focused on natural scale scientific studies about the influence of oysters on nitrogen cycling. We do believe that through this project we will apply ongoing science with successful results. This top-down control on phytoplankton through the enhancement of natural oyster populations was suggested as a possible management strategy for improving the water quality in the Chesapeake Bay estuary, Long Island Sound, the Carolinas, Virginia, New Hampshire, Rhode Island and Louisiana. It is also now being considered by the Towns of Falmouth and Mashpee. Falmouth has estimated that oyster habitats covering a mere 10% of bottom area may completely remediate nitrogen problems in 3 of its most affected embayments. The use of oysters to help attain water quality goals in Wellfleet harbor is an essential tool in our wastewater management tool kit, as there are few practical options to reduce nutrients once they have entered the estuary.

As part of this effort, the following groups are collaborating on a novel project to assess the value of an oyster spawning ground as a significant and cost effective part of our CWMP:

- Comprehensive Wastewater Management Planning Committee,
- Shellfish Advisory Board,
- Natural Resources Advisory Board,
- Shellfish Promotion And Tasting (S.P.A.T.),
- Health and Conservation Department,
- Shellfish Constable,
- The Environmental Partners project team, and
- UMASS Boston.

The proposed project is a preliminary step in establishing a comprehensive plan for monitoring marine and estuarine waters. Every oyster depends on the algae that consume dissolved

nitrogen. When in balance, this simple food cycle is one of nature's most essential and effective water quality management systems. This project is designed to rehabilitate severely degraded oyster habitat and determine optimal, sustainable oyster populations (e.g. carrying capacity) for long term wild oyster productivity and estuarine health.

## **2. GOALS and OBJECTIVES**

The proposed project will complement the overall goal of the Town to develop a CWMP and to comply with the MBP Comprehensive Conservation and Management Plan and the Wellfleet Harbor Management Plan. As part of CWMP development, the Town has the following goals:

- Protect and enhance the harbor ecosystem's health and resiliency;
- Gain a meaningful understanding of the relationship between nitrogen concentrations and the overall health of shellfish populations;
- Based on available science, promote shellfish enhancement - as a practical and cost-effective approach, thus improving harbor water quality and the traditional shellfishing industry.

Specifically, the proposed project will satisfy the Town's goal to gather sufficient information about the harbor, its environmental conditions and water quality and develop a reliable database. The information collected will be used to protect and enhance the harbor's ecosystem. This approach will also satisfy the goal of compiling a database to supplement water monitoring as part of the MEP and could serve as a quality assurance stamp for Wellfleet shellfish. Once the goal of data collection and analysis is reached, the Town and EPG will be able to recommend appropriate nutrient management solutions.

The project will establish a 1.3 acre pilot oyster spawning site at the confluence of Mayo Creek and Duck Creek, north of the marina complex. This will ultimately help improve conditions in the Town's Harbor – a key natural and economic resource. It will also provide useful data to support historic traditions of innovative best practices to increase shellfish and enhance estuary habitat in Wellfleet Harbor. Moreover, the project will undertake an ecosystem approach to study the nutrient filtering capacity of oysters, and to ensure a healthy nutrient balance that promotes long term ecosystem sustainability while meeting state and federally mandated nitrogen and water quality goals.

There are a variety of benefits to the proposed project location, including:

- Direct site line to the Harbormaster,
- Easy access for tours and public education,
- High visibility from the pier for easy signing/project description,
- Security monitoring possible with pier mounted camera,

- Too much muck and degraded for current wild oyster fishermen,
- Should dramatically improve adjacent fished area of Chipman Cove,
- No impacts on useable beaches,
- Could reduce dredge needs and/or make it easier,
- Could see bottom improvement, grass and mussel regrowth,
- Wild 4”+ oysters in the pier area could provide disease resistant spat.

### **3. APPROACH AND METHODOLOGY**

The project approach will be to satisfy the Town’s first goal, to protect and enhance the harbor ecosystem. The proposed project will accomplish this goal by installing a sentinel well above the proposed spawning area and conducting regular water quality monitoring within the spawning area to look at inputs, uptake and nutrient balance.

The sentinel well will be installed at the fresh water/salt water interface on the north side of the Town pier where Duck Creek and Mayo Creek meet. For a location plan of the proposed sentinel well, please see Figure 2 in Appendix A. Potential water characteristics to be monitored include salinity, temperature, dissolved oxygen, BOD, CBOD, TSS, pH, nitrogen (free ammonia, organic nitrogen), phosphorous, E. coli, and selective wastewater organics such as endocrine disruptors. A control sample will be taken in the center of the harbor.

Thirty-three loads (924 cubic yards) of cultch will be obtained from a processing plant in New Bedford. The DPW will move the cultch material in June to the town pier just before oyster spawning. The shellfish department will barge material to the spawning area.

This area of Duck Creek was selected for the pilot program because oyster productivity is ideal in the area and there is heavy year round occupancy upstream. With the applied oysters having an estimated 30% chance of survival to maturity, the spawning area is strategically located to provide a significant increase in natural spat which should lead to an increase in overall oyster recruitment and population in the area, increasing the abundance of wild oysters for harvest.

The pilot program will include a number of research monitoring activities to better understand the relationship between water quality and oyster population density:

- Study the relationship between an established oyster spawning area and shellfish populations and productivity;
- Monitor water quality and measure nitrogen remediation by increased oyster populations
- Attempt to compare nitrogen concentrations in the harbor against measured concentrations in groundwater entering the harbor, and to assess uptake by oyster populations;
- Evaluate different population densities on growth rates, survival and propagation;

- Monitor and compare biodiversity within the project site and adjacent wild fishery areas; and
- Monitor development of wild oyster stocks over 4", as it is widely believed to be a disease resistant size that could also produce disease resistant spats.

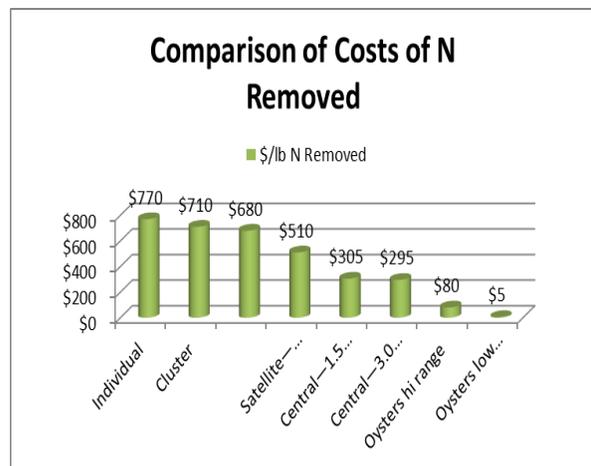
The research monitoring plan will include

- 1) water quality monitoring using YSI probes:
  - Establishing several transects with permanent markers to monitor sediment movement
  - Turbidity
  - Nutrients (e.g. ammonium, chl., nitrogen and phosphorus,)
  - DO, temp, salinity, pH (both water and sediment)
- 2) Environmental assessments before and during the project time:
  - Oyster abundance and demographics using quadrats for both cultch area and mud flats; same will be performed for biodiversity assessments
  - Presence of oyster disease
  - Biodiversity comparison between the cultch area and adjacent wild fishery
  - Predation
  - Video monitoring to visually record changes and deter poaching

The sentinel well construction will begin immediately pending funding. Water samples will be collected over a 6-12 month study window and data will be tracked and trended. The cultch program will begin immediately with the first cultch being placed in June as described above. All results will be delivered immediately following the study window and will be incorporated into future stages of the CWMP study.

**4. JUSTIFICATION AND BENEFITS**

With the implementation of the pilot shellfish spawning ground, the Town and EPG will be able gauge the effectiveness of cultch and habitat improvement as a solution to nutrient management while also achieving scientific and educational goals with the help of UMass Boston. The program represents an innovative yet natural and sustainable nitrogen management solution in a prominent harbor known throughout the United States for its oysters. If successful, as shown on the right, the cost to construct traditional wastewater facilities will be greatly reduced.



Expected program benefits also include:

- approximately 18 million additional oysters annually,
- potential increase in commercial shellfish value of \$9 million,
- 500-900 million gallons of increased water filtration.

This increase in commercial shellfish production will be a major economic benefit to the local community while the filtration and ecological benefits are large and meet other important goals

If all aspects of the proposed project are a success, a main source of groundwater nutrient will have been identified and an effective solution to excess nitrification management will have been established. Together these successes will satisfy the Town's ultimate goal, to protect and enhance the Wellfleet Harbor ecosystem by promoting aquaculture-based water quality management solutions in a practical and cost-effective manner. The Town and EPG will be able to use this information to work towards future goals of the CWMP.

## **5. QUALIFICATIONS**

EPG was unanimously selected by the Town of Wellfleet to develop the CWMP due to intimate knowledge and familiarity working with Cape Cod communities and extensive experience in developing wastewater planning solutions. The project team will be led by Principal-in-Charge Paul Gabriel, P.E., LSP, and CWMP Project Manager, Paul Millett, P.E., from EPG and Michael D. Scherer, Ph.D. of Normandeau Associates.

The overall success of the project and the QA/QC will be the responsibility of Paul Gabriel, P.E., LSP, President and founding partner of Environmental Partners. Mr. Gabriel will see that the appropriate resources are assigned to this project on a task-by-task basis, and will meet with the town management as necessary to ensure that EPG is providing appropriate service.

Mr. Millett will be responsible for the day-to-day progress of the project.

Dr. Scherer will provide the services of Normandeau Associates and their extensive experience in water resource management and related areas.

Dr. Anamarija Frankic is an Assistant Professor at UMass Boston and Director of the Green Boston Harbor Project ([ww.gbh.umb.edu](http://ww.gbh.umb.edu)). Dr. Frankic and her graduate student Anny Cataldo worked in 2007/08 in Wellfleet Harbor addressing shellfish management and provided recommendations for future shellfish enhancement and sustainable aquaculture. Dr. Frankic will work closely with the project team and identify a graduate student to work on the research monitoring activities in the proposed project.

Resumes for these key personnel are attached in Appendix B.

## **6. PROJECT BUDGET**

For a breakdown of the costs for the proposed project, please see the budget form in Appendix C.

## **7. SUPPORTING MATERIALS**

Appendix D - Letter of Support from the Town of Wellfleet.

Appendix E - Statement of Support from the Wellfleet Shellfish Advisory Committee. This letter was taken from meeting minutes from a Board of Selectmen meeting on November 23, 2010.

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***APPENDIX A***

***Figure 1 – Pilot Project Site***

***Figure 2 – Proposed Water Quality Monitoring Locations***



0 125 250 500 Feet

Figure 1  
Pilot Project Site  
April 2011



Proposed Monitoring Well



0 25 50 100 Feet



Figure 2  
Proposed Water Quality Monitoring Location  
April 2011

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***APPENDIX B***

***Resumes for Key Personnel***

# Paul F. Gabriel, P.E., LSP

## Principal-in-Charge

### Background

Mr. Gabriel has over 30 years of experience in water and wastewater engineering, hazardous and solid waste management planning, and remedial design and construction. He is the President and founding partner of Environmental Partners. He is a registered professional engineer and Licensed Site Professional. Through his past position as President of the Hazardous Waste Action Coalition (HWAC), a national association of engineering and science firms practicing in hazardous waste management, he has considerable insight on federal and state hazardous waste management programs and trends. This unique insight is invaluable in the strategic decision-making process involving clients, attorneys, and consultants that is so critical in today's hazardous and solid waste arenas.

### Education

- § M.S., 1979, Civil Engineering, University of Miami, FL
- § B.S., 1976, Biology, Bridgewater State College, MA

### Certifications

- § Professional Engineer – MA (Civil 32120), NH, ME, RI, VT
- § Licensed Site Professional – MA
- § Registered Sanitarian - MA
- § 40-Hour OSHA Hazardous Waste Operations Health and Safety Training

### Professional Affiliations

- § Hazardous Waste Action Coalition, Past President
- § American Council of Engineering Companies
- § Water Environment Federation
- § Solid Waste Association of North America
- § American Society of Civil Engineers
- § Past Member, U.S. Department of Defense Blue Ribbon Panel for the Analysis of the DOD Environmental Restoration Program
- § Past Member, USEPA Remedial Technologies Development Forum

**Wastewater Facilities Planning and Design/Construction Management, Provincetown, MA** - Mr. Gabriel managed and directed the successful completion of comprehensive wastewater facilities planning studies for Provincetown that have led directly to the design, construction and operation of new wastewater collection/treatment/disposal facilities. The project is being conducted as a Design/Build/Operate (DBO) project, with a project value of nearly \$20 Million.

**Water System Expansion, Wellfleet, MA** - Mr. Gabriel has been assisting the Town of Wellfleet with planning and design activities for an entirely new water supply and distribution system. Activities have included well site screening activities, permitting and performance of pump tests at selected well sites, design and construction of wells and new water distribution mains, and evaluation of various privatization options. The Town was relying solely on the Coles Neck well field for all of its supply needs. Mr. Gabriel is the Principal-in-Charge to assist the Town in a multi-staged approach to developing the Town's water system. The well investigation and aquifer testing phase was completed in 2003. The permanent well facility, water mains, and SCADA system will be in construction in the summer of 2009 and will be completed by July 2010. Design, permitting, bidding, and construction phase services activities at the Boy Scout Camp Well have included: Two (140 foot deep) new production gravel packed wells with submersible pumps; Pre-fabricated well house with KOH feed system electrical systems and propane emergency generator set; SCADA system in the radio telemetry; 12,000 linear feet of 8" water main; 7,000 linear feet of 12" water main; and an elevated storage tank (500,000 gallon).

**Sewer System Assessment, Weymouth, MA** - Project Director for a detailed evaluation of the entire Weymouth sewer system including metering, modeling and capacity analysis. Improvements to increase conveyance capacity were identified.

**MWRA Wastewater Pump Station, Reading, MA** - Served as lead planner, designer and construction manager for a 3,600 gpm wastewater pump station for the Massachusetts Water Resources Authority. The pump station was constructed 60 feet into bedrock, and included over two miles of 20-inch force main, and 24-, 36-inch interceptor sewers in dense commercial and residential areas.

**Wastewater Facilities Planning, Concord, Acton and Amesbury, MA** - Mr. Gabriel managed and directed the successful completion of comprehensive wastewater facilities planning studies for these communities. Project elements included full public participation programs, sewer needs studies, hydrogeologic evaluations of problem areas, and subsequent design of appropriate wastewater collection and treatment facilities. Particular emphasis was placed on innovative approaches, including pressure sewers and cluster septic systems.

# Paul Millett, P.E.

## CWMP Project Manager

### Background

Mr. Millett is a Project Manager with over twenty-four years of experience in investigation, design, and construction management on private, municipal, and federal projects, including wastewater, water and hazardous waste projects. His experience includes wastewater collection and pumping systems, water supply development, treatment and distribution systems, utilities, pumping stations, CSO/sewer separation, drainage systems, and hazardous waste-remediation projects.

### Education

- § M.S. Civil Engineering, Northeastern University, Boston, MA
- § B.S. Civil Engineering, University of Dublin, Ireland

### Certifications

- § Registered Professional Engineer (Civil) MA #32750; CT #19517; VT #6352
- § 40-hour OSHA Hazardous Waste Operations Health and Safety Training

### Professional Affiliations

- § New England Water Environment Association
- § Boston Society of Civil Engineers
- § American Society of Civil Engineers
- § New England Water Works Association
- § American Water Works Association

### Publications

“Integrating Combined Sewer Overflow (CSO) Controls, Inflow-Infiltration (I/I) and Sewer Separation in Cambridge, Massachusetts”, presented at the *New England Water Environment Association (NEWEA) annual conference, January 2001*, (presented with the City Engineer).

### Wastewater Collection System Expansion, Provincetown, MA

– Project Manager for the design review and construction administration of the \$6 million extension of the town’s collection system. Responsible for technical oversight of the design-build team’s design, resolution of technical issues, DEP coordination, and payment processing.

### Redevelopment of South Weymouth Naval Air Station, Weymouth, MA

– Owner’s Project Manager (OPM) for oversight of the wastewater collection treatment and disposal for a 1.5 mgd system. Assessed the capacity of Weymouth municipal sewers to convey some or all of the future flows from the redevelopment, considering average and peak flows and inflow infiltration concerns in the existing pipe network. Reviewed previous I-I reports to identify the most cost effective methods to reduce peak wet weather flows of 21 mgd entering the MWRA system with approximately 15 mgd of I-I.

### Wastewater Treatment Plant, Plymouth, MA

– Reviewed the headworks and septage receiving facilities for the DPW as part of contract negotiations between the Town and a large design-build-operate company. Reviewed the hydraulic capacity, layout, and redundancy.

### Water Supply System Expansion, Wellfleet, MA

– Project Manager for the design of the phased expansion of the water system including a new well and pump station at the Boy Scout Camp; approximately 19,000 feet of 8-inch and 12-inch water mains and a water storage tank and storm drains on Holbrook and Commercial Street. Responsible for client coordination, presentations to the Water Commissioners, DEP coordination and coordination of public interest survey to gauge citizen interest in connecting to the expanded system.

### CSO/Sewer Separation Program, Lowell, MA

– Project Manager for the design and permitting of sewer separation, and sewer and drain improvements on Meadowview Drive, West Meadow Road and Laplume Avenue. Responsible for hydraulic calculations of new storm drains (12” to 24” in size), replacement of an old 12-inch vitrified clay sanitary sewer, including bypass pumping, preliminary and final plan and profile drawings, technical specifications, bid forms and wetlands permits. Coordinated design reviews and easements with the City’s staff engineers. Reviewed shop drawings and payment requests. Provided part-time resident engineering services.

# Paul Millett, P.E.

## *CWMP Project Manager*

**Private Inflow Removal-Sump Pump Amnesty Program, Waltham, MA** - Project Manager for the planning, community outreach, home inspections, design, bidding, and construction administration for the amnesty program involving up to five construction contracts up to \$6 million. Responsible for scope development to meet MADEP consent order requirements, and creation of pilot-demonstration area project to test the effectiveness of the program. Responsible for coordination with the Engineering, Law and GIS departments on a variety of technical, legal and mapping issues, and presentations to the Public Works committee. Worked with the City Solicitor's Office to revise the sewer use ordinance.

**Sewer and Drain System Mapping, Rockland, MA** - Project Manager to assist the Town in their compliance with the EPA's Phase II Storm Water Rule. A critical component of the compliance with this program was the development of the Town's storm drain system map using record drawings and field investigations.

**Stormwater System and Outfall Mapping and Sampling, Kingston, MA** - Project Manager for the mapping using GIS software of the town's storm drain system including over 30 outfalls. Coordinated a 3-person crew of inspectors for a 2-month investigation and sampling program. Coordinated mapping and findings with various town departments.

**MICHAEL D. SCHERER, Ph.D****Vice President/Senior Marine Scientist**

Dr. Scherer is a Vice President and senior marine scientist at Normandeau Associates, Inc. with 36 years experience. He is an expert in marine fisheries biology. He manages entrainment and impingement studies at several power plant facilities and oversees diverse fisheries studies related to dredging, desalination, LNG and other projects related to shore line and offshore developments.

**SELECTED PROJECT EXPERIENCE**

Aquaria Desalination Facility, Dighton, MA. 2007 – 2009. Impact assessment resulting from entrainment and impingement on a Filtrex Filtration System intake, alternative to an Aquatic Filter Barrier.

Sconset Beach Nourishment Project (2005-2007) - Impact assessment related to the use of a dredge site off the east coast of Nantucket for nourishment of Sconset Beach.

Included nearshore and offshore fisheries sampling, habitat assessment dive surveys, and mitigation studies. Project Manager.

Town of Swansea, MA. with Epsilon Associates (2004-2007) - Benthos, ichthyoplankton, and fisheries studies related to a proposed desalination facility on the Palmer River. Project Manager.

Entergy Nuclear Generation Company (2001–2007) - Sediment, shellfish, and irish moss collections for the radiological environmental monitoring program at Pilgrim Nuclear Power Station.

New England Power Company, U.S. Generating, Dominion Energy (1992-2007) - Entrainment and impingement studies at Manchester Street Generating Station in Providence Rhode Island. River-wide ecological studies associated with inplant work included phytoplankton, periphyton, epibenthos, zooplankton, water quality, and fisheries monitoring programs. Project Manager.

New England Power Company, U.S. Generating, Dominion Energy (1974-2007) - Studies of the Mount Hope Bay portion of Narragansett Bay in the vicinity of Brayton Point Station to evaluate the effects of the open cycle cooling system for New England's largest fossil fuel power plant. Project Manager.

Boston Edison Company, Entergy Nuclear Generation Company (1974-2007) - Studies designed to determine the potential impacts of Pilgrim Nuclear Power Station on the abundance and distribution of ichthyoplankton and key finfish in Cape Cod Bay. Project Manager.

Northeast Gateway LNG Terminal with Woods Hole Group (2005-2006) - Equivalent adult, equivalent yield modeling and fisheries support for a proposed LNG terminal off the coast of Gloucester in Massachusetts Bay. Project Manager.

Wehran Engineering, Wheelabrator Saugus, G. E. Lynn Aircraft Division (1984-1997, 2005-2006) - Fisheries studies of the Saugus and Pines River estuaries, Saugus and Lynn, Massachusetts related to the impact of the open-cycle cooling systems of two industrial facilities. Project Manager.

Weaver's Cove Energy and Epsilon Associates (2003-2006) - Benthic sampling, analysis, and fisheries support related to dredging plans for a liquid natural gas terminal in Fall River, Massachusetts.

**EDUCATION**

Ph.D. 1974, Fisheries Biology major, Biometrics minor, University of Massachusetts  
 M.S. 1972, Fisheries Biology, University of Massachusetts  
 B.S. 1969, Fisheries Biology, Cornell University

**PROFESSIONAL EXPERIENCE**

2006-Present Normandeau Associates  
 1993-2006. President, Marine Research, Inc.  
 1974-1993 Marine Research, Inc.  
 1970-1975 Massachusetts Cooperative Fishery Research Unit

**PROFESSIONAL AFFILIATIONS**

American Fisheries Society

Massachusetts DCR/Parsons Brinckerhoff Quade & Douglas/Applied Coastal Research and Engineering (2001-2006) - Impact assessment related to the use of a Massachusetts Bay dredge site for beach nourishment in Winthrop. Included expanded essential fish habitat assessment. Project Manager.

Entergy Nuclear Generation Company (2001-2006) - Winter flounder hatchery release and survival feasibility study designed to determine whether stock enhancement can be used as a mitigation tool for 316a and b compliance. Project Manager.

Entergy Nuclear Generation Company (2000-2006) - Bottom trawl-based population estimate of adult winter flounder in Western Cape Cod Bay designed to improve the impact assessment of entrainment and impingement for Pilgrim Nuclear Power Station.

Commonwealth Engineers/ Rhode Island Dept. of Transportation (2000-2001, 2006) - Sakonnet River Bridge replacement project environmental impact statement designed to assess impacts to local fish populations.

Southern Company, Mirant and TRC Environmental Corp (1999-2006) - Fisheries and eutrophication studies in the Charles River for Kendall Square Station repowering project. Work included ichthyoplankton sampling in the lower basin as well as the lakes region and fish sampling with gill nets and push nets. Hydroacoustics and multiyear sonic tracking programs were employed to learn about adult river herring movements. Project Manager.

Keyspan LNG and Natural Resource Group, Inc. (2003-2004) - Fisheries support related to an LNG facility upgrade project in Providence, R.I.

Taunton Municipal Power and Light and EarthTech (2002-2003) - Fisheries and benthic invertebrate analyses and preparation of 316a and 316b document for a utility on the Taunton River. Project Manager.

ConEdison and TRC Environmental (2000-2003) - Preoperational and post operation studies for the Newington Power Facility on the Piscataqua River, New Hampshire and Maine that included ichthyoplankton, larval lobster and impingement sampling programs. Benthic sampling programs were conducted to assess construction and habitat related impacts of the facilities submerged diffuser. Project Manager.

Sverdrup-Jacobs, Inc./MBTA/ Town of Weymouth (2001) - Rainbow smelt migration and spawning study in Smelt Brook for the Weymouth Landing, Greenbush commuter railroad line. Project Manager.

Southern Company, Mirant and TRC Environmental Corp. (1999-2001) - Aquatic ecology studies for the Cape Cod Canal power plant located in Sandwich, MA. Work included entrainment and impingement sampling as well as ichthyoplankton sampling in the Cape Cod Canal, Cape Cod Bay, and Buzzards Bay. Sampling for larval lobster was also completed. Project Manager.

Raytheon Environmental Services/ Washington Group International/Sunset Energy (1999-2001) - Ichthyoplankton study in Gowanus Bay, New York for a proposed barge-mounted power station with once-through cooling system. Project Manager.

Sithe Edgar Development LLC. In conjunction Epsilon Associates, Inc. (1998-1999) - Fisheries studies in the Weymouth Fore, Smelt Brook, and Town River required for the proposed repowering of a fossil fuel power station. Project Manager.

Boston Edison Company, Sithe Energy (1989-1993, 1998-1999) - Studies of the Weymouth Fore River, Mass. including ichthyoplankton, fish, benthos, and water quality as part of a monitoring program for a proposed power station. Preparation of 316a and 316b documents was included. Project Manager.

Bluestone Energy Services, Inc. and Epsilon Associates, Inc. (1997) - Assessment of fish population issues related to a proposed desalination plant on the Taunton River in Deighton, MA. Project Manager.

General Electric Company (1994-1997) - Impingement and entrainment monitoring studies at G.E.'s Lynn, Massachusetts aircraft engine plant including ichthyoplankton studies in the Saugus River source water. Project Manager.

Camp, Dresser and McKee (1996) - Assessment of potential fisheries impacts associated with a proposed water diversion facility on the Taunton River for the City of Brockton, MA. Project Manager.

Boston Edison Company (1993) - Fish impingement study at Mystic Station in Everett, MA. Project Manager.

HMM Associates (1990-1992) - Entrainment and impingement studies at B. F. Cleary Station and multiphased in-river sampling of fish and benthos in connection with Taunton Cogeneration Facility Project. Project Manager.

Continental Shelf Associates (1990) - Analysis of ichthyoplankton samples from Mobil drilling site on Continental Shelf off Cape Hatteras. Project Manager.

National Park Service (1984-1986) - Ecological study of the upper Pamet River, Truro, Mass. including nutrient cycling, eutrophication, groundwater analyses, and river hydrology. Principal Investigator.

Lynn Massachusetts Sewer Commission (1982) - Study of the impact of sewage outflow after a rainstorm on the benthic invertebrate and water column plankton populations of Lynn Harbor. Principal Investigator.

Yankee Atomic Electric Company, New England Power Co (1974-1979) - Studies of Block Island Sound, Charlestown Pond, Quonochontog Pond, and Point Judith Pond, R.I. to assess possible environmental effects of a proposed power plant. Principal Investigator.

## **SELECTED PRESENTATIONS**

Scherer, M.D. and D. Lawrence. 2002. Macroalgal impacts on the nursery habitat of young-of-the-year winter flounder (*Pleuronectes americanus*), Mount Hope Bay. Poster presented at the NEER/SNECAFS joint meeting, May 8-10, 2003.

Scherer, M.D. and B. Morgan. 2001. Winter flounder stock enhancement. Poster presented at the Flatfish Biology Conference, December 2002. Mystic CT.

Scherer, M.D., with G. Klein-MacPhee, R. Satchwill, A. Keller, and C. Vasconcelas. 2000. Increase in numbers of smallmouth flounder, *Etropus microstomus*, in the ichthyoplankton of Narragansett Bay and Mount Hope Bay, Rhode Island. Poster presented at the Flatfish Biology Conference, December 5-6, 2000. Mystic Ct.

Scherer, M.D., with D. Galya., J. Herberich, S. Kelly, J. Scheffer. Assessment of Power Plant Entrainment in Comparison to Long-Shore Ichthyoplankton Transport. Presented at the 134th Annual Meeting of the American Fisheries Society, Madison, WI. August 22-26, 2004.

Scherer, M.D., with D. Rutecki, D. 2006. Assessment of hatchery reared winter flounder, *Pseudopleuronectes americanus*, as a mitigation tool in Cape Cod Bay, MA. Presented at the New England Estuarine Research Society, Spring 2006 Meeting.

Scherer, M.D., with D. A. Rutecki, J. F. Battaglia. 2009. A preliminary assessment of finfish and invertebrates on the east side of Nantucket, MA. Presented at the 3rd Nantucket Biodiversity Initiative Conference.

## SELECTED PEER-REVIEWED ARTICLES AND PUBLICATIONS

Author or co-author of seven scientific papers related to fish and larval lobsters.

R.S. McBride, M. D. Scherer and J.C. Powell. 1995. Correlated variations in abundance, size, growth, and loss rates of age-0 bluefish in a southern New England estuary. *Transactions of the American Fisheries Society* 124:898-910.

Scherer, M.D., T. Horst, R. Lawton, and R. Toner. Seasonal abundance and occurrence of some planktonic and ichthyofaunal communities in Cape Cod Bay: Evidence for biogeographical transition. *Lecture Notes on Coastal and Estuarine Studies*. 11. Observations on the Ecology and Biology of Western Cape Cod Bay, Massachusetts. 241-261. Springer-Verlag.

Scherer, M.D. 1984. The ichthyoplankton of Cape Cod Bay. In Davis, J.D. and D. Merriam (eds.), *Observations on the Ecology and Biology of Western Cape Code Bay*. Springer-Verlag, New York 289p.

Scherer, M.D. and G.C. Matthiessen. 1983. Observations on the seasonal occurrence, abundance, and distribution of larval lobsters (*Homarus americanus*) in Cape Cod Bay. In Fogarty, J.J. (ed.), *Distribution and Relative abundance of American Lobster, Homarus americanus, larvae: New England Investigations during 1974-1979*, p63-64. NOAA Technical Report SSRS-775.

Scherer, M.D. and R.L. Radtke. 1982. Daily growth of winter flounder (*Pseudopleuronectes americanus*) larvae in the Plymouth Harbor estuary. In *Proceedings of the Fifth Annual Larval Fish Conference*, Louisiana Cooperative Fisheries Research Unit, p1-5.

Scherer, M.D. and D.W. Bourne. 1980. Eggs and early larvae of smallmouth flounder, *Etropus microstomus*. *Fisheries Bulletin U.S.* 77(3):708-712.

Scherer, M.D. 1973. Some skeletal anomalies in American shad (*Alosa sapidissima*) with an example of vertebral curvature in blueback herring (*A. aestivalis*). *Chesapeake Science* 14(4):298-300.

## CURRICULUM VITAE

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**Anamarija Frankić**

Assistant Professor

[www.gbh.umb.edu](http://www.gbh.umb.edu)

### ADDRESS

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### PROFESSIONAL PREPARATION

Ph.D. 1998 Marine Science, Virginia Institute of Marine Science, College of William and Mary  
M.S. 1992 Ecology & Limnology, University of Zagreb, Natural & Mathematical Sciences, Croatia  
B.S. 1985 Biology, University of Zagreb, Natural & Mathematical Sciences, Croatia

### PROFESSIONAL EXPERIENCE

2007 - Present Adjunct Professor, University of Split, Croatia  
2005 – Present Special Advisor to the Ministry of Culture, the Government of Croatia  
2005 – Present Assistant Professor, UMB, Environmental, Earth and Ocean Sciences (EEOS)  
2002 – 2005 Research Faculty Associate, VIMS, College of William & Mary  
1999 – Present Ecologist and Biodiversity Specialist, Consultant for the World Bank and Global Environment Facility (GEF); initiating and working on environmental projects in Croatia and Adriatic Region  
1999 – 2000 Project Specialist, Coastal States Organization (CSO), Washington DC: Designed and conducted the Coastal and Estuarine Environmental Management and Technology Project, which now helps identification and evaluation of coastal and estuarine management, technology and science needs in all 35 coastal states and territories of the USA; project reports serve as the basis for the NOAA/CICEET grant program  
1997 – 1998 Sea Grant Congressional Fellow, Office of the US Senator Daniel Akaka (D-HI), Washington, D.C.: Initiated and worked on two bills that became laws signed by President Clinton: S. 1080 National Aquaculture Development, Research and Promotion Act; H.R. 1653 Public Law 106/562 - Coral Reef Conservation Act; while S.1500 Hawaiian Tropical Forest Products Certification Act received the McArthur Foundation award  
1993 – 1997 Research Assistant, Chesapeake Bay National Research Reserve, VIMS, VA  
1992 – 1993 Professor of Biological Sciences, International Baccalaureate, Zagreb, Croatia  
1985 – 1992 Ecologist and Limnologist, National Park Plitvice Lakes, Croatia

### AWARDS

2005 – 2007 VIMS/CCRM Research Fellow  
1997 – 1998 National Sea Grant Fellows Award (NOAA/Sea Grant Congressional Fellowship)  
1995 – 1997 International Fellowship Award, American Association of University Women (AAUW)  
1995 Dean's Prize Award for Advancement of Women in Marine Science, College of William & Mary, Virginia, USA  
1993 – 1995 International Fellowship Award, U.S. Agency for International Development (USAID)

### PEER REVIEWED PUBLICATIONS (\*student)

**Frankic, A.** and L. \*Greber.2011. Teaching and learning with nature by using biomimicry approach to restore three keystone habitats: salt marsh, eelgrass and shellfish beds. Biomimicry Institute. (Accepted)

**Frankic, A.** and L. \*Greber .2011. A Holistic Science Approach to Living within Coastal Ecosystems in Boston Harbor and Beyond. *The International Journal of Environmental, Cultural, Economic, and Social Sustainability* In press.

**Frankić, A.** \*A. Alao, \*T. Brown, \*L. Greber, \*J. Haskins, and \*C. McIntyre. 2010. April is 'the month when the eelgrass seed is mature:' A holistic approach to sustaining eelgrass (*Zostera marina*). Encyclopedia of Earth. URL: to be assigned

\*Greber, L., **A. Frankić**, and J. Muller. 2010. NERRs (National Estuarine Research Reserves) as Common Grounds: Towards a holistic science approach to research, education, and outreach with religious communities to enhance climate and eco-literacy at Waquoit Bay, Cape Cod MA, USA. (*Journal of Integrative Environmental Sciences, accepted*)

\*Vella, P., R.E. Bowen, **A. Frankić**. 2008. "An Evolving Protocol to Identify Key Stakeholder Influenced Indicators of Coastal Change: The Case of Marine Protected Areas" *ICES Journal of Marine Science*, 66: 203-213

\*Peharda, M., I. Župan, L. Bavčević, **A. Frankić** and T. Klanjšček. 2007. Growth and condition index of mussel *Mytilus galloprovincialis* in experimental integrated aquaculture. *Aquaculture Research*. 38: 1714-1720

Bowen, B, **A. Frankić**, and M. Davis. 2006. Human development and resources use in the coastal zone: influences on human health. *Oceanography*, Vol.19, No.2:62-71

**Frankić, A.** 2005. "A Protected Environment in the Adriatic Area: A Key for Sustainable Economic Development"; Chapter 3, pp 96-102, In: Global Marketing Briefings: Doing Business with Croatia. GMB Publishing Limited, 392p. ISBN-13: 9781905050031

**Frankić, A.** and C. Hershner. 2003. Sustainable Aquaculture: Developing the promise of aquaculture. *Aquaculture international*, 11 (6): 517-530.

**Frankić, A.** 2002. USA-Adriatic Cooperation in coastal affairs. In: B.C. Sain, I. Pavlin and S. Belfiore (ed.) Sustainable Coastal Management: A Transatlantic and Euro-Mediterranean Perspective, pp. 173-180. Kluwer Academic Publisher. pp. 291.

**Frankić, A.** and M. P. Lynch. 1996. **ECOSTAR**-A program for identifying ecotourism activities that support sustainable development in coastal regions. Coastal and Marine Tourism World Congress. Honolulu, Hawaii, June 19-22 1996. Proceedings, pp. 252-267.

#### **OTHER PUBLICATIONS AND TECHNICAL REPORTS**

Greber, L. and **A. Frankić** (PI). 2010. Stewardship as Common Ground: Towards a holistic science approach to research, education, and outreach with religious communities to enhance environmental literacy in the Waquoit Bay area. Report submitted to NOAA/NERRs (revised April, 2010).

**Member of the Science Advisory Council:** Massachusetts Ocean Management Plan, (Draft in June 30 2009); the final Plan Dec 2009. <http://www.mass.gov/eoeea>

**Frankić A.**, and C. McIntyre. 2009. Green Boston Harbor Project: Marine Invasive Species Monitoring in Boston Harbor Report. University of Massachusetts Boston, Environmental Earth and Ocean Sciences (EEOS). December 2009; [www.gbh.umb.edu](http://www.gbh.umb.edu)

**Frankić, A.** 2009. University of Massachusetts Boston: Division of Marine Operations; Environmental Earth and Ocean Sciences. 2009 *Head of the Harbor* Pump-out Boat Service, Research, Education and Outreach Report. September 30, 2009. [www.gbh.umb.edu](http://www.gbh.umb.edu)

**Frankić, A.** 2007. Coastal Ecosystem Management and Sustainable Aquaculture in Welfleet Harbor, MA. Assosiation of Scottish Shellfish Growers (ASSG) International Conference, Oban, October 18-19, 2007. <http://www.assg.co.uk/conference07.pdf>

**Frankić, A.** 2006. Capacity Development for Oceans and Coastal Management: Mobilizing to address needs. Global Forum on Oceans, Coasts and Islands. UNESCO, Paris, January 23-28, 2006. Report, p40, 43;

**Frankić, A.** 2005. Guidance and Key Questions on Integrated Oceans Policies. The Ocean Policy Summit, October 11-13, 2005, Lisbon, Portugal. The Ocean Policy Summit Bulletin, Vol. 117 No. 1, Sunday, 16 October 2005. p.11

**Frankić, A.** 2003. Integrated Coastal Zone Management Plan for Croatia with special focus on Aquaculture. Zagreb, Croatia, June 15-18 2003. Report. <http://ccrm.vims.edu/publications/pubs/Adriaticaquaculture.pdf>

**Frankić, A.** 2002. "Biocomplexity and Sustainable Ecosystem Management: Integrating natural, social and economic sciences." REPORT, (NSF grant ID#0231577), Workshop in Dubrovnik, Croatia, October 7-12, 2002;

**Frankic, A.**, and C. Hershner. 2001. Seafood recipes: balancing aquaculture development with coastal planning. **Invited Speaker**; Pp 83-100 in Burnell, G.; Gouletquer, P.; Mees, J.; Seys, J.; Stead, S. (edd.): Aquaculture and its role in integrated coastal zone management: handbook of contributions presented at the International Workshop, Oostende, Belgium, April 19-21, 2001. European Aquaculture Society. Flanders Marine Institute: Oostende, Belgium. <http://www.vliz.be/docs/libac/ac49.htm>

**Frankić, A.** 2000. Prevention and Legal issues of Marine Debris. **Invited Speaker** and Panelist. International Marine Debris Conference, Honolulu, Hawaii. August 6-11, 2000. Proceedings.

**Frankić, A.** 1999. Technology and information needs of the coastal and estuarine management community. Report, No. 40AANC801324, pp. 60, and Survey Report, pp. 202, NOAA/CICEET, Silver Spring, MD.

## **PUBLIC SERVICE**

**Environmental Advisor to the Ministry of Culture, the Government of Croatia (2005-present)**

**Co-President – New England Friends of Croatia (NEFC) (2006-2008)**

**Secretary – Meeting House Hill Civic Association, Dorchester, MA (2006- 2008)**

**Member- Mather Elementary School Site Council (2007 – present)**

**Project Coordinator (June 2009 – September 2010) – initiated and helped prepared proposal for the Mather School outdoor project which received \$300,000 grant from the Boston Schoolyard Initiative;**

**Volunteer - Women for Women in Bosnia (1994-1995);** American organization helping victims of the War in Bosnia; In 1994, she hosted two women that survived the rape camps during the war in Bosnia and came to the USA; Dr. Frankic and contributed in making the documentary film "**Calling the Ghosts**" that captured the women's stories and received the Emmy's and Human Rights Watch Awards 1995.

**Volunteer - Emergency Medical Technician (EMT) (1995-1997) -** Rescue Squad, Gloucester Pt VA; worked once a week for two years daily shifts as an EMT, and also as an ambulance driver;

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***APPENDIX C***

***Cost Breakdown***

**Appendix C**

**Town of Wellfleet  
Oyster Spawning Project Budget**

	<b><u>TOTAL \$</u></b>
<b>Task 1: Sentinel Well</b>	
Contractual - EPG	<u>\$5,000</u>
Administrative (printing, postage, etc.)	<u>\$200</u>
Equipment and materials One well, 4" diameter, 15-20 feet deep, 5' screen. See Note 1. 1 wells x \$4k each = \$4k	<u>\$4,000</u>
Water Quality Testing	<u>\$3,500</u>
<b><i>Subtotal</i></b>	<b><u>\$12,700</u></b>
<b>Task 2: Cultch Demonstration Project</b>	
Contractual – Cultch contractor costs (see Note 2)	<u>\$10,000</u>
Administrative (printing, postage, etc.)	<u>\$200</u>
Equipment and materials – YSI Station, Camera equip.	<u>\$20,000</u>
Travel	<u>\$1,200</u>
<b><i>Subtotal</i></b>	<b><u>\$31,400</u></b>
<b>TOTALS</b>	<b><u>\$44,100</u></b>

Note 1. One well will be installed at the suggested locations shown on Figure 2.

Note 2: 33 loads (924 yards) trucked from New Bedford to Wellfleet over the winter @ \$300/load = \$9,900 paid to hauling contractor. Cultch is free from the company; contractor provides Town a 50% discount because they only make the run when they are hauling something else to New Bedford to save a two way charge.

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***APPENDIX D***

***Letter of Support from the Town of Wellfleet***



# TOWN OF WELLFLEET

300 MAIN STREET WELLFLEET MASSACHUSETTS 02667

Tel (508) 349-0300 Fax (508) 349-0305

[www.wellfleet-ma.gov](http://www.wellfleet-ma.gov)

BOARD OF  
SELECTMEN

TOWN  
ADMINISTRATOR

ASSISTANT  
TOWN ADMINISTRATOR

December 3, 2010

Jay Baker  
Executive Director  
Massachusetts Bays Program  
251 Causeway Street, Suite 800  
Boston, MA 02114

Dear Mr. Baker:

The Town of Wellfleet is committed to protecting its unique and pristine Harbor, and its rich shellfishing resource. The Shellfish Advisory Committee, Board of Health and Wastewater Management Planning Committee are supporting a grant application through the Massachusetts Bays Program (MBP) administered by the Office of Coastal Zone Management.

The grant will support the installation of sentinel monitoring wells at up to eight (8) locations to measure nitrogen reduction in the marshes and estuary. In addition, a culching demonstration project is proposed. The culching project will collect and recycle oyster shells, increase shellfish population and investigate the potential natural benefits of nitrogen reduction by increasing the shellfish population.

The Town commits to match at least 25% of the total project costs and acknowledges that funding is provided on a reimbursement basis. Matching funds have been approved by the Town's Board of Selectmen.

Very truly yours,

Jacqui Wildes Beebe  
Chair, Board of Selectmen

cc: Paul Sieloff, Town Administrator  
Wastewater Planning Committee  
Board of Health

Andrew Koch, Shellfish Constable  
Shellfish Advisory Committee

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***APPENDIX E***

***Statement of Support from The Wellfleet Shellfish Advisory  
Committee***

November 23, 2010

Wellfleet Board of Selectmen,

The Shellfish Advisory Board at its November 18, 2010 meeting voted to pursue funds through the Towns shellfish department that have recently been made available as a grant from the Massachusetts Bays Program (MBP). Included is a summary of the grant announcement.

Grant funds could be used for any of the 6 items below depending upon what is most likely to be approved by MBP:

- Triple the culching program
- Continue shellfish disease monitoring
- Implement broader shell recycling program with wastewater committee
- Pilot project in Duck Creek of targeted oyster reef for nitrogen remediation and MEP program compliance
- Coordination with Shellfish Advisory Board and Comprehensive Wastewater Committee to increase oyster population density
- Investigate Oysterfest 2011 direct recycling of shells

We're requesting up to the \$40,000 that is available. There is a 25% matching requirement from the town, which is why we are bringing this to your attention, and seek your support.

The deadline for submitting an application is December 2nd, 2010.

Thanks in advance for your attention to this matter.

John Duane, on behalf of:

The Wellfleet Shellfish Advisory Board:

Barbara Austin, Barbara Brennessel, John Duane, Joel Fox  
James O'Connell, Helen Miranda Wilson, Rebecca Taylor.

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