

The BK BioReactor

A Mobile Research Library for the Unseen Microbiology of the Gowanus Canal

N: Bio' reactor; an engineered device or system that supports a biologically active environment, esp. to synthesize useful substances or to break down harmful ones.

The Gowanus Canal is scheduled to undergo dredging and sub-aquatic capping as part of the USEPA Superfund Cleanup plan beginning in 2016. Alternatively microbiologists are drawing attention to polluted urban environments as they discover new communities of microorganisms capable of biologically processing pollutants. In reaction to the announcements to cap the canal, the study team commenced a microbiome analysis of sediment samples to ensure the taxonomy and potentially unique cellular functions of microbial communities in the Gowanus Canal are catalogued and studied before dredging operations eliminate access.

The BK BioReactor is an infrastructural BioNetwork designed to support and propel these investigations into the future and generate an active space for the community to inquire, investigate and project findings back to the community. Akin to the canoes in which our D.I.Y. investigations occurred and central to the BK BioReactor is a roving watercraft, which is capable of docking at specific locations along the canal for sampling events and to showcase research findings through the activation of vestigial spaces. As an open platform to support individual study, community engagement, and synthetic biology, the mobile research station aspires to embody the public library of the future. The station is supported by a network of vertical Smart Docks that expand upon the 14 original locations where seasonal sampling has occurred. These responsive interventions visibly delineate the site; collect and visualize information on water temperature, pH, salinity, and dissolved oxygen; and most importantly grant researchers and citizen scientists access to the microbiome below the cleanup cap.

THE BioNETWORK

- Nucleus - The BK BioReactor
- Nodes - Smart Docks
- Nodes - Analog Docks
- Horizontal Surfaces - Event Spaces
- Vertical Surfaces - Projection Walls

The BK BioReactor

- Mobile Watercraft
- Research Library
- Roll-Out Program Venue

The mobile research library, genetic laboratory, and event venue embeds itself into the industrial shipping history by appropriating the formal language of the industry's most ubiquitous object: the barge. Its nautical nature allows researchers, students, and guests the experience of being on the water, where it carries out its mission of programmatic versatility: research, recreation, residencies, and outreach.

Smart Dock

- Site Delineator
- Responsive Indicator
- Instrument of Access

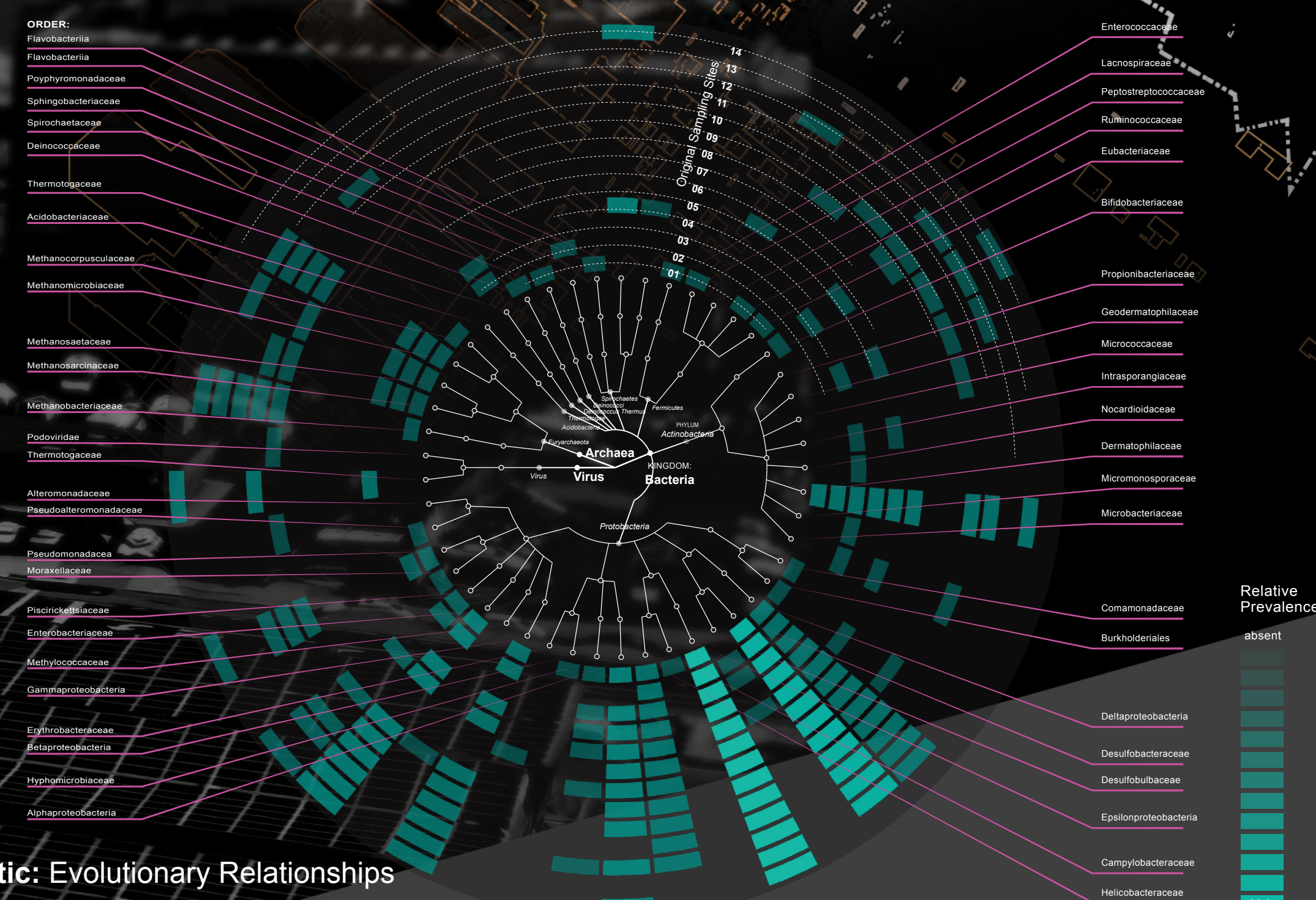
The Smart Dock can take several site-specific forms based on the needs of the researcher and the community: from light beacon to species composition flag bearer. Of particular interest and innovation is the use of genetic engineering to pair bioremediation functions with the visible phenomenon of bioluminescence. By associating pathways that break down toxic compounds with a gene similar to the firefly light-generating enzyme luciferase, bacteria will glow when they are actively breaking down these compounds, providing a direct, visible readout for the community of otherwise invisible molecular performances.

MAPPING MODES

Geospatial: Environmental Influences

Historically a productive estuary, the waterfront was claimed by industrial and cultural needs that dramatically altered the habitat and ecological flow. Beginning when Gowanus Creek was dredged into Gowanus Canal in 1869, and perpetuated until 2013 when the record of decision was reached designating the Gowanus Canal Superfund Site, the canal has collected 150 years of industrial byproducts. Icing the cake CSO systems overflow raw sewage following each rain event, adding to the unique slurry of hydrocarbons and heavy metals mixed with estuarine silt deposits. The study team, collaborating with geneticists, environmental scientists, community activists, and bioinformaticians, has seasonally sampled 14 sites along the canal to extract and sequence the DNA of this invisible world.

- Original Sampling Site
- Sewers
- Industrial Land Use
- Gowanus Watershed Boundary
- Historic Shoreline
- Dry Land
- Wetland
- Open Water



Genetic: Evolutionary Relationships

The Gowanus Canal's microbial population is a result of its parent microbiological makeup, the introduction of foreign materials through increased trade and shipping, and subsequent adaptations to the urban, industrial environment. Many of the species identified in preliminary samplings are also found in the human gut (a result of raw sewage) while other species reveal influence of the canal's proximity to the ocean. Regardless of their source, the microbial melting pot of the canal has fine-tuned its metabolism, swapping genes with neighboring communities and evolving novel functions to develop real-time strategies for the unique state of the canal. The above Phylogenetic Tree illustrates the diversity of life found in this toxic environment and its relative prevalence across the 14 original sampling locations.

Functional: Metabolic Pathways

To further understand specific roles in the microbiome's performance, the study team mapped the metabolic pathways collected through three seasonal samplings. Genes are the functional component of all organisms, and complex biological functions depend on the coordinated activity of many genes, which in turn form a metabolic pathway. The study team generated a functional map of the microbiome at each of the 14 sites, with a particular focus on pathways identified as potentially useful for bioremediation. These pathways include breakdown of toxic compounds, such as:

- cresol, a phenolic compound commonly found in fuel processing activities with high acute toxicity.
- arsenite, a potent carcinogen.
- toluene, an industrial solvent which can cause asthma.
- atrazine, an herbicide which affects the endocrine (hormonal) system.
- aniline, used in the production of dyes and plastics, and affects the transport of oxygen in the blood, as well as the biosynthesis of glutathione, a protein that enables plants and bacteria to assimilate heavy metals from their environment.

The Gowanus Canal is an incubator for the evolution of such bio-remediating functions, attesting to its industrial past and its capacity for self-renewal. The design of the BioReactor will augment these capabilities while providing the community an opportunity to witness the biochemical reactions that are actively metabolizing the concentrated materials in the canal.

SPATIAL CATALYST

- Horizontal Surfaces - Event Spaces
- Vertical Surfaces - Projection Walls

When the BioReactor pulls up to a lot, people notice. Not only are few craft operated on the Gowanus, but even fewer are those that represent a communal wellspring of information fitting of a Public Library in the era of big data. You can spot the gathering from anywhere in Gowanus with the vessel hacking into the industrial fabric with a projector casting building surfaces alight and activating underused open space with 15,000 lumens of local investigative info.

