Exponent®
Engineering & Scientific Consulting

Morgan Petrovich, Ph.D.
Associate | Environmental & Earth Sciences
475 14th Street, Suite 400 | Oakland, CA 94612
(510) 268-5094 tel | mpetrovich@exponent.com

## Professional Profile

Dr. Petrovich has a background in environmental engineering with an emphasis on environmental microbiology, wastewater treatment bioprocesses, microbial ecology, environmental biotechnology, drinking water treatment processes, public and environmental health, and sustainability.

She has extensive experience with shotgun metagenomics analysis of DNA sequences and qPCR. During her graduate studies, she worked on a variety of projects using molecular methods to study abundances and fate of genes that may be associated with negative human health impacts, or genetic contaminants, in wastewater treatment systems and their potential to disseminate into natural aquatic environments. Genetic contaminants can confer traits to bacteria such as antibiotic resistance, which is a major global public health threat. Bacterial resistance to antibiotics can render infections untreatable by clinically important pharmaceuticals. When antibiotic resistance genes are released into the environment, they can have the potential to spread to bacterial communities in natural water bodies. Dr. Petrovich characterized viral taxa in municipal and hospital wastewater, as viruses can significantly shape bacterial communities by killing bacteria and influencing species composition, as well as by transferring genetic material between bacteria. She analyzed associations between viruses, their predicted bacterial hosts, and bacteria harboring antibiotic resistance genes in hospital wastewater, and assessed the potential for viruses to contribute to transfer of antibiotic resistance determinants between bacteria in wastewater treatment systems.

Dr. Petrovich has a background in environmental engineering with an emphasis on environmental microbiology, wastewater treatment bioprocesses, microbial ecology, environmental biotechnology, drinking water treatment processes, public and environmental health, and sustainability.

She has extensive experience with shotgun metagenomics analysis of DNA sequences and qPCR. During her graduate studies, she worked on a variety of projects using molecular methods to study abundances and fate of genes that may be associated with negative human health impacts, or genetic contaminants, in wastewater treatment systems and their potential to disseminate into natural aquatic environments. Genetic contaminants can confer traits to bacteria such as antibiotic resistance, which is a major global public health threat. Bacterial resistance to antibiotics can render infections untreatable by clinically important pharmaceuticals. When antibiotic resistance genes are released into the environment, they can have the potential to spread to bacterial communities in natural water bodies. Dr. Petrovich characterized viral taxa in municipal and hospital wastewater, as viruses can significantly shape bacterial communities by killing bacteria and influencing species composition, as well as by transferring genetic material between bacteria. She analyzed associations between viruses, their predicted bacterial hosts, and bacteria harboring antibiotic resistance genes in hospital wastewater, and assessed the potential for viruses to contribute to transfer of antibiotic resistance determinants between bacteria in wastewater treatment systems.

Additionally, Dr. Petrovich quantified structural parameters of wastewater treatment biofilms based on 3D microscopy and image analysis and assessed spatial stratification of genes in biofilms. The spatial organization of genes associated with resistance to antibiotics is important in the context of engineered bioprocesses that utilize biofilms, such as trickling filters for wastewater treatment, since upper portions of biofilms are more likely than deeper regions of biofilms to detach and move downstream, where they may eventually be discharged into the environment.

Dr. Petrovich has collaborated with public utilities to analyze microbial ecology in full-scale enhanced biological phosphorus removal systems and to investigate relationships between community composition and reactor performance. Quantifying functionally important bacterial taxa using molecular methods allows utilities to monitor changes in relative abundance of species involved with nutrient cycling over time in these engineered systems.

Further, Dr. Petrovich has a background in environmental planning and landscape architecture with project experience related to ecological and landscape design. She has planned green infrastructure improvements in dense urban areas to improve air quality and reduce public health impacts from diesel emissions. She has also drafted plans for living walls and green roof systems and has worked on the design and construction of composting toilets.

## Academic Credentials & Professional Honors

Ph.D., Civil and Environmental Engineering, Northwestern University, 2019

M.S., Civil and Environmental Engineering, Northwestern University, 2015

B.A., Landscape Architecture and Environmental Planning, University of California, Berkeley, 2011

Northwestern University Terminal Year Fellowship, 2018 – 2019

Royal E. Cabell Fellowship, 2014 – 2015

University of California, Berkeley Undergraduate High Honor Roll, 2007 – 2011

American Society of Landscape Architects Honor Award for team project “PlantLAB”, 2011

## Licenses and Certifications

OSHA Hazardous Waste Operations and Emergency Response 40-Hour Certifications

## Prior Experience

Environmental Microbiology and Biomonitoring Intern, Metropolitan Water Reclamation District of Greater Chicago, 2017

Teaching Assistant, Northwestern University, 2016 – 2018

Ecological Design and Engineering Intern, Hyphae Design Laboratory, 2013

## Publications

Petrovich, M., Ben Maamar, S., Hartmann, E., Murphy, B., Poretsky, R., and Wells, G. (2019). "Viral Composition and Context in Metagenomes from Biofilm and Suspended Growth Municipal Wastewater Treatment Plants". Microbial biotechnology. doi.org/10.1111/1751-7915.13464

Petrovich, M., Rosenthal, A., Griffin, J., Wells, G. (2019). "Spatially Resolved Abundances of Antibiotic Resistance Genes and intI1 in Wastewater Treatment Biofilms". Biotechnology and bioengineering, 116(3).

Petrovich, M., Chu, B., Wright, D., Griffin, J., Elfeki, M., Murphy, B., Poretsky, R., Wells, G. (2018). "Antibiotic resistance genes show enhanced mobilization through suspended and biofilm growth wastewater treatment processes". FEMS microbiology ecology, 94(5).

Chu, B., Petrovich, M., Chaudhary, A., Wright, D., Murphy, B., Wells, G., & Poretsky, R. (2017). "Metagenomic analysis reveals the impact of wastewater treatment plants on the dispersal of microorganisms and genes in aquatic sediments." Applied and environmental microbiology, 84(5).

Petrovich, M., Wu, C. Y., Rosenthal, A., Chen, K. F., Packman, A. I., & Wells, G. F. (2017). "Nitrosomonas europaea biofilm formation is enhanced by Pseudomonas aeruginosa". FEMS microbiology ecology, 93(5).

**Presentations**

Petrovich, M., Rosenthal, A., Griffin, J., Wells, G. (August 2018) Spatial distribution of antibiotic resistance genes and community composition in wastewater biofilms. Oral presentation at the American Chemical Society (ACS) Conference, Boston, MA.

Petrovich, M., Rosenthal, A., Griffin, J., Wells, G. (April 2018) Spatial distribution of antibiotic resistance genes and community composition in wastewater biofilms. Poster presentation at the Madison Microbiome Meeting, University of Wisconsin, Madison, WI.

Petrovich, M., Chu, B., Wright, D., Griffin, J., Elfeki, M., Murphy, B., Poretsky, R., Wells, G. (September 2017) Antibiotic resistance gene abundances, mobilization, and co-occurrences with antibiotic production genes in biofilm and suspended growth wastewater treatment bioreactors. Oral presentation for the Chicagoland Specialized Metabolite Community, University of Illinois Chicago, Chicago, IL.

Petrovich, M., Chu, B., Wright, D., Griffin, J., Elfeki, M., Murphy, B., Poretsky, R., Wells, G. (August 2017) Metagenomic analysis of composition, retention, and mobilization of antibiotic resistance and production genes in biofilm and suspended growth wastewater treatment bioreactors. Poster presentation at the 4th International Symposium on the Environmental Dimension of Antibiotic Resistance (EDAR-4) Conference, East Lansing, MI.

Petrovich, M., Chu, B., Wright, D., Griffin, J., Elfeki, M., Murphy, B., Poretsky, R., Wells, G. (June 2017) Metagenomic analysis of antibiotic resistance gene composition, mobilization, and co-occurrence with antibiotic production genes in different wastewater treatment systems. Oral presentation at the Association of Environmental Engineering and Science Professors (AEESP) Conference, Ann Arbor, MI.

Petrovich, M., Chu, B., Wright, D., Griffin, J., Elfeki, M., Murphy, B., Poretsky, R., Wells, G. (October 2016) Comparative metagenomic analysis of antibiotic resistance genes throughout attached and suspended growth wastewater treatment systems. Poster presentation at the Emerging Contaminants in Water and Wastewater Short Course, Marquette University, Milwaukee, WI.

## Project Experience

Conducted research in collaboration with the Metropolitan Water Reclamation District of Greater Chicago to analyze abundances of polyphosphate-accumulating organisms (PAOs) and glycogen-accumulating organisms in enhanced biological phosphorus removal systems in two full-scale municipal wastewater treatment plants using qPCR and 16s rRNA Amplicon sequencing. Identified correlations between PAOs, reactor performance, and water quality parameters in the wastewater treatment plants. These approaches to quantifying PAOs and characterizing community composition make it possible to monitor

temporal changes in relative abundances of key functional miroorganisms and to assess how fluctuations in community structure may be related to bioreactor performance.

Quantified antibiotic resistance genes, mobile genetic elements, viruses, and microbial community composition in a biofilm reactor operated at the lab-scale and in full-scale wastewater treatment bioreactors (including a trickling filter biofilm system and an activated sludge system) using shotgun metagenomics, 16S rRNA Amplicon sequencing, and qPCR. Conducted similar analyses for a pilot-scale hospital wastewater treatment system in Tel Aviv, Israel which intends to reuse treated wastewater effluent to irrigate on-site landscaping. Antibiotic resistance is a major global public health threat, and antibiotic resistance determinants can contribute to reduced efficacy of clinically important antibiotics for treating bacterial infections. Thus, analyzing the abundance and diversity of antibiotic resistance genes as well as their potential to spread between bacteria in engineered systems is important for informing risk assessment.

Collaborated with an interdisciplinary team of microbiologists, chemists, and environmental engineering researchers to evaluate the impact of bacteria and antibiotic resistance genes from treated wastewater effluent on Lake Michigan using shotgun metagenomics. This included collecting water and sediment samples at various distances from wastewater effluent discharge sites and sampling as part of the U.S. Environmental Protection Agency's Summer Survey onboard the Lake Guardian, then tracking the fate of genes potentially associated with wastewater discharge.

Cultured microorganisms relevant to wastewater treatment, including the slow-growing ammonia oxidizing bacteria Nitrosomonas europaea and the heterotrophic organism Pseudomonas aeruginosa. Operated a controlled lab-scale system to grow single-species and mixed-species biofilms with these organisms. Used optical coherence tomography, confocal laser scanning microscopy, and epifluorescent microscopy to image biofilms, then analyzed 3D images and quantified biofilm structural parameters. Enhanced retention of ammonia-oxidizing bacteria can be beneficial in the context of biofilm reactors for wastewater treatment.

Worked with the non-profit organization Urban Biofilter on "Adapt Oakland," a project that aimed to reduce high asthma and cancer risk in West Oakland associated with particulate matter. Strategized plans to add urban greenbelts, living walls, and bamboo buffers against high-density transportation networks with vehicles that emit diesel contaminants which contribute to negative public health impacts in low-income communities. Utilized ArcGIS to map out zoning constraints and opportunities as well as parcel ownership and demographic data in order to identify areas that would most benefit from remediation by urban greening. Participated in the design and construction of a trial iteration of the PPlanter with Hyphae Design Laboratory. The PPlanter is a self-contained composting public urinal system that used bamboo planters to treat gray water and urine in the Tenderloin neighborhood of San Francisco to address the issue of human waste in the streets. Also worked with Hyphae Design Laboratory on a 100-foot long living wall and roof system for the San Francisco Museum of Modern Art. This included drafting plans for roof irrigation, structural components, piping and instrumentation, and detail specifications in AutoCAD.

**Software Skills**

Python, Bash scripting for Mac, IDBA, Velvet, QIIME, CutAdapt, MetaGeneMark, ImageJ/FIJI, Volocity, MATLAB, AutoCAD, ArcGIS, Adobe Photoshop, Adobe Illustrator, and Adobe InDesign.