URI Superfund Research Center: STEEP
(Sources, Transport, Exposure and Effects of PFASs)
Challenging compounds

• Everyday exposure for all
  • Consumer products/dust
  • Diet
  • Drinking water

• Unique physical-chemistry, unlike traditional hydrophobic POPs
  • Amphiphilic compounds, ionized in solution
  • Bind to proteins/ partition into cell membranes
PFASs

• Widespread human and environmental exposure
  • Particularly perfluorinated C$_8$ compounds – PFOS and PFOA

• Wide range of adverse effects (humans/animals)
  • Immunosuppression (Grandjean et al., 2013)
  • More PFOA, higher risk of being overweight (Haldersson et al., 2012)
  • Link [PFOA] in blood and insulin resistance (Timmermann et al., 2014)

• Regulatory action (PFOS withdrawal and PFOA action plan)

• Replacement with other fluorinated compounds (shorter, polyfluorinated; more complex molecules - precursors)
How about PFAS across the US?

- Based on UCMR3 data
- Long-chain PFASs (PFHxS, PFOS, PFOA, and PFNA) more in groundwater
- Short-chain compounds (PFHpA and PFBS) more in surface waters.
The recipe?

Take a PFAS production/use facility and train firefighting with AFFFs

Known knowns:
• 6 Mio w/ [PFAS] > EPA advisory

Unknowns:
• Small public water suppliers; Private well owners
• Is the EPA advisory sufficient?
• Do we target all relevant PFASs? Totals?
Present concerns / STEEP goals

• Fate and transport of PFASs in groundwater plume
• Availability and uptake of PFASs by animals
• Human health effects of PFASs
• Novel sampling approaches for PFASs
• Engage communities to reduce exposure
  • Water testing…
• Safe chemicals for wanted applications?
  • Various replacement compounds
Overall center structure

Leadership
Director Lohmann (URI)
Co-Director Grandjean (HU)

Community engagement core
McCann (URI)/Schaider (Sil Spr)

Research translation core
Swift/Rohr/Neville (URI)

Training core
Cho, Stevenson (URI)

Admin core
Lohmann, Grandjean Coordinator Lucht(URI)

Biomedical II
Epi-study of metabolic effects on PFASs Grandjean (HU)

Biomedical II
Metabolic effects of PFCs in mice Slitt, Bothun (URI)

Environ Eng-Sci I
Transport and Fate of PFASs Sunderland (HU)

Environ Eng-Sci II
Detection of PFAS Lohmann (URI), Schaider (Sil Spr)
Project 2: Health effects

• determine the possible links between exposure profiles for PFASs
• key outcomes, i.e., immune dysfunction and metabolic abnormalities in 8-to-9-year-old children
• already established birth cohort at the Faroe Islands (N = 490).
Infancy is critical for risk assessment due to peak PFAS exposure and crucial development of the adaptive immune system.

Mogensen et al., ES&T, 2015

**Figure:**
- Exclusive breastfeeding for 6 months + 12 months partial
- Breastfed for less than 1 month
Significance

The needs for Project 2 are four-fold:

1. Redefinition of Benchmark Dose Levels (BMDLs)
2. Address developmental vulnerability
3. Address possible impact on inflammation and metabolic disturbances
4. Provide insight into pathogenesis
Project 3: New mechanisms

Aim 1 (Slitt)
In vitro assays
Adipocytes
Hepatocytes

Aim 2 (Slitt)
In vivo developmental exposure
PFAS-Diet interactions
Does mom’s diet impact PFAS risk?

Aim 3 (Bothun)
Physiochemical properties

PFASs to be tested:
Legacy and some emerging (based on Projects 1 and 4)

Measures in pups and dams related to immune response and liver endpoints
Serum measures to uncover new biomarkers
- Lipidomics

Reveal known versus novel/new pathways
Using targeted transcriptomics and proteomics

Measures related to Project 2:
Immune: cytokine/adipokine secretion
Obesity: adipogenesis & lipid accumulation

Angela Slitt,
College of Pharmacy, URI (co-lead)

Geoff Bothun,
College of Engineering, URI (co-lead)
Project 1: Fingerprinting PFAS Sources in Water and Fish

Zhang et al., 2016
Project 1: Understanding Geochemical Factors Affecting PFAS Mobility

Natural Log of PFOS Concentrations

Meters Above Sea Level

Groundwater flow

In(PFOS Concentration(ng/L))

FTAs

WWIBs

Land Surface Elevation

Project 1: Understanding Geochemical Factors Affecting PFAS Mobility

Weber et al., 2017

Collaborative Research with USGS Researchers (A. Weber, D. LeBlanc, L. Barber)
**Project 4: Novel Detection Tools**

Lohmann (URI), Schaider (SSI)

- Testing various passive samplers for the detection and quantification of dissolved PFASs – link to bioavailability.

![Graph showing correlation between log K_{PA, W} and carbon chain length.](image1)

![Graph showing the concentration of various PFASs over time.](image2)
Project 4: A PE-based sampler for (volatile) precursor PFASs

• Other than AFFFs, there are also precursor compounds
• Also indoor exposure to PFASs
• Testing of simple polymer sheets to detect these compounds in air and

[Graphs showing data for 8:2 FTOD C_{106} and 10:2 FTOD C_{106}]
Training Core
Bongsup Cho, John Stevenson, Alicia Crisalli

• Spring 2018 PFAS Colloquium: STEEP & guest speakers (Knappe & Guelfo)
• Monthly Trainees Group Meetings
• URI STEEP trainees visited Harvard on 8/23 for seminar and facilities tour
• STEEP trainees attended 2018 Northeast SRP Meeting
WHAT’S IN YOUR WELL WATER?

Find out! Volunteer for FREE private well testing.

Why study well water?

In some areas of Cape Cod, PFASs have been found in drinking water.

What are PFASs?

PFASs are chemicals found in household products and firefighting foam. They’ve been around for 60 years, but their harmful health effects have only drawn concern in the last 20 years.

How can PFASs get into my well water and what are the harmful effects?

They can seep into the ground and move through groundwater to your well. They suppress certain immune system functions, particularly in kids, impact metabolic and liver functions, and are linked to some cancers and adverse effects in pregnancy, such as low birth weight.

Who can participate and how much time will it take?

Private well owners who live in Barnstable County on Cape Cod are eligible to participate, and participation will take about three hours.

What’s the purpose of this study?

The goal of this study is to test 50 private wells on Cape Cod each year over the next 5 years. Wells will be chosen from areas in Barnstable County that may be impacted by PFASs. The benefit to Cape Cod residents is a better understanding of PFAS exposure and contamination.

What’s happening next?

The STEEP project is funded by the National Institutes of Health Superfund Research Project led by the University of Rhode Island. URI and Silent Spring Institute will collect well water samples and Harvard University will analyze them.

Will I receive the test results?

We will report individual results and interpret them for each participant. We will share summaries of our findings with Cape residents in reports and public meetings. Names and addresses of participants will be kept confidential.

For more info, or to apply, contact either:

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Silent Spring Institute University of Rhode Island
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STEEP is funded by the Superfund Research Program, National Institute of Environmental Health Sciences under award number P42ES027726. This URI research approved by URI’s Institutional Review Board.
Research Translation Core
Judith Swift, Nicole Rohr, Amber Neville

www.uri.edu/steep

The UNIVERSITY of RHODE ISLAND

STEEP
Sources, Transport, Exposure & Effects of PFASs

About STEEP
Communities  Research  Cores  About PFASs  Resources  News & Events

Mission & Vision
Take a deeper dive into STEEP’s plans for research, communities, cores, about PFASs, resources, and news & events.

Partners
A partnership of the University of Rhode Island, and core leaders, and partners.

Team
Meet the directors, project leaders, and core leaders.

Support
STEEP is funded through a Multi-project Center Grant.

5 Maintenance
Doing a new behavior for more than six months

4 Action
Have made overt lifestyle changes in the past six months

3 Preparation (READY)
Evaluated and are ready to take action in the next thirty days

2 Contemplation (GETTING READY)
Intending to take action in the next six months

1 Precontemplation (NOT READY)
Not intending to take action in the next six months

Transtheoretical Model of Behavior Change
Broad-spectrum outreach

@steepsuperfund

STEEP trainee and NOAA Nancy Foster Scholar Anna Ruth Robuck aboard the R/V Warren Jr. collecting passive samplers for PFAS from across Massachusetts Bay on a series of acoustic moorings, as well as gathering water samples from across Stellwagen Bank as part of STEEP’s Detection Tool’s research: https://web.uri.edu/stEEP/stEEP-research/detection-tools/

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URI STEEP Superfund @steepsuperfund · May 18

EPA’s “Leadership Summit” on PFOA pollution to exclude victims and community groups. Grandjean, “EPA today is at least 10 years behind the scientific evidence.” interc.pt/2kQG4Y by @fastiemor @NIH_STEEP PFAS @SilentSprings @HarvardChanSPH @universityofrI @SRP_NIEHS

The EPA’s “Leadership Summit” on PFOA Pollution Will Exclude Victi...

The EPA doesn’t want to hear from people who have PFOA and other PFAS chemicals in their drinking water.

theintercept.com
Thanks – Questions?

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www.uri.edu/steep

STEEP is funded under award number P42ES027726.
More information about STEEP is available at: https://web.uri.edu/steep/