Water Resources Assembly and Research Symposium

Sponsored by:

**CFANS**
College of Food, Agricultural, and Natural Resource Sciences

**Water Resources Center**
University of Minnesota
Driven to Discover®

With assistance from the

Water Resources Science Graduate Program

and the

Minnesota Supercomputing Institute
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Water-Oriented Research at St. Anthony Falls Laboratory

Location of Saint Anthony Falls Laboratory
Saint Anthony Falls Laboratory (SAFL)

- SAFL is an interdisciplinary fluid mechanics laboratory in College of Science and Engineering at University of Minnesota.
- Built in 1938. Founding Director Lorenz Straub had the vision to found a world class hydraulic laboratory
  - Funded through Works Progress Administration
  - Designed to utilize the 50 ft drop of St. Anthony Falls
  - 2200 gallons/second (300 cfs) of Mississippi water diverted through the building
- Current research focuses on fluid mechanics problems with environmental, energy, biology/health applications
- Home of major national research initiatives
- The lab has 21 affiliated faculty members, and 37 research and administrative staff members
SAFL Research Facilities

- 7 flumes and channels
- 5 model basins
- 2 water tunnels
- 1 wind tunnel
- 3 calibration facilities
- Outdoor StreamLab
- Wind turbine
- State-of-the-art instrumentation
- Massively parallel computer clusters
- Lots of nerds...

NSF ARI-R2 Renovation of SAFL

Creating a shared national facility for research and training

St. Anthony Falls Lab has recently finished a $16M renovation to be more accessible than ever.

- Improving human health
- Improving water quality
- Quantifying impacts of climate change
- Advancing clean & renewable energy
- Restoring deltas, rivers and lakes
- Improving human health

The Intersection of Fluid Mechanics with Energy, Environment & Health:

- Stream & river restoration
- Wind Energy
- Flow/Biota interactions
- Cardiovascular fluid mechanics
SAFL Hydropower Research Facilities

**SAFL Main Channel**
- 8.5 m³/s (300 ft³/s) Mississippi River water, Continuous
- Flow through or ponded configuration
- Sediment transport for mobile bed studies; gravel and sand
- Wave generator
- Modular beach slope
- Precision data carriage – fully automated

**Physical Modeling Facilities**
- 1500 m² of space dedicated to physical modeling (16,000 ft²)
- 13 meters (45 ft) of water head
- High flow capacity for models up to 2.2 m³/s (80 ft³/s)
- Advanced design and fabrication facilities
- Projects: Intakes, outlets, gates, erosion/cavitation, performance verification

**High Speed Water Tunnel**
- Cavitation and other high-velocity flow phenomena
- Highly instrumented (PIV, force balance, high speed photography)
- Max velocity 20 m/s (66 ft/s)

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Research on Waterway Restoration

Manipulate turbulence to stabilize streambanks, restore aquatic habitats, and enhance nutrient processing
The SAFL Outdoor StreamLab

- $U_{mean} = 0.32 \text{ m/s}$
- Depth $\sim 0.3 \text{ m}$
- Width $\sim 2\text{m}$
- $Re = 95,000$
- Sand with $D_{50} = 0.75\text{mm}$
- Sediment feed rate: 2 kg/min
- Experiments by Palmsten, M. L. et al. 2012 – Infrared remote sensing
- Amplitude $\Delta \sim 12\text{cm}$
- Wave length $\lambda \sim 50\text{cm}$

The SAFL Outdoor StreamLab: LES of bankfull flow
Simulation Capability of Wave-Ocean-Wind: Simulate Accurately Fluid flows (WOW! SAFL!)

**WOW (Wave-Ocean-Wind)** is computational framework for high-fidelity simulation of multi-scale and multi-physics geophysical flows for naval applications. It has the following modules.

- WOW-spray
- WOW-wavebreaking
- WOW-terrain
- WOW-atmosphere
- WOW-bubble
- WOW-ocean
- WOW-wave
- WOW-FSI
- WOW-terrain
- WOW-wave

Besides the above modules, WOW also has the feature of data assimilation, and can be directly driven by mesoscale models.

**Data Assimilation**

- Synthetic Aperture Radar
- Satellite
- Marine radar
- Wave buoy
- Provides detailed description of the whole field
- Improves measurement performance

**Computer simulation**

- WOW-spray
- WOW-bubble
- WOW-wave breaking
- WOW-cavitation
- WOW-terrain
- WOW-ocean
- WOW-atmosphere
- WOW-weather
Collaboration between Simulation and Field Measurement

Dr. Dan Larkin

Minnesota Aquatic Invasive Species Center
Extending citizen science into aquatic invasive species management

A major area of need

• Early detection-rapid response critical for combating AIS
• But Minnesota has:
  • Nearly 12,000 lakes
  • >100,000 miles of streams
  • >13 million acres of surface water
• And....10 DNR AIS Specialists
Our solution: AIS Detectors

- Partnership between MAISRC and Extension, funded by LCCMR
- Empower Minnesotans to be “eyes on the water” through citizen science Extension

### AIS Detectors: Target Species

**Plants**
- Eurasian watermilfoil
- Hydrilla
- Starry stonewort

**Invertebrates**
- Spiny waterflea
- Rusty crayfish
- Zebra mussel
- Quagga mussel

**Fish**
- Silver carp
- Bighead carp
- Ruffe
- Round goby
Rigorous training

- “Flipped classroom”
  - Online content knowledge
  - In-person skills training
- Comprehensive knowledge exam
- Annual advanced training and service requirements

Statewide service network

- 121 Detectors certified via 7 workshops in spring 2017
- Contributed 1,899 service hours
Detectors spinoff: *Starry Trek*

• Single-day “bioblitz”-style search for new AIS, starry stonewort

• Open to all
  • Service opportunity for Detectors
  • Gateway for new volunteers

Photo: Scott Brown

Detectors spinoff: *Starry Trek*

• Collaboration w/ University of Wisconsin Extension

• One day, two states
Saturday Aug. 5, 2017

200 volunteers used simple search protocol in 20 counties
Supported by local host coordinators

Volunteers found 10th known MN population
Small, early infestation in Grand Lake (Stearns Co.)
Rapid response by lake association and DNR → hand pulling
Early detection and rapid response enabled by Extension
What unique role does our program fulfill at the U?

• Allows Minnesotans to help reduce spread and impacts of AIS
What unique assets does the U have that enables your work?

• Extension and the land-grant mission
• Colleagues that have done pioneering work in citizen science and volunteer engagement

What unique assets does the U have that enables your work?

• Extension and the land-grant mission
• Colleagues that have done pioneering work in citizen science and volunteer engagement
• Centers that support solutions-oriented research and outreach