Northwest **Power** and **Conservation** Council

September 6, 2017

MEMORANDUM

TO: **Fish and Wildlife Committee members**

FROM: **Kendall Farley**

SUBJECT: **Developing a field-based environmental DNA sampling and detection system**

BACKGROUND:

Presenter: Dr. Austen Thomas
Director of Molecular Species Detection Technologies at Smith-Root Inc.

Summary: Environmental DNA is an emerging tool that can be used for sensitive detection and quantification of rare or invasive species, identifying pathogenic bacteria and disease as well as determining habitat range of an individual species. In light of growing threats of invasive mussels and other invasive species in the Columbia Basin, there is a need for rapid detection of these species to facilitate quick decision-making and efficiency and efficacy for planning and mitigation efforts.

Smith-Root has been developing a hand-held device that can produce quantitative results on the relative abundance of a species' DNA detected right in the field in less than an hour, versus sending data to a genetics lab and waiting for results. This type of emerging technology could help Columbia Basin researchers and managers in recovery and restoration efforts across the basin. The presentation will show examples of studies and proof-of-concept in which this technology produced results similar to

those generated from a lab. It will offer ideas for differing applications and usage of this technology across the Columbia Basin and in Pacific Northwest watersheds.

Relevance: The 2014 Fish and Wildlife Program's list of emerging priorities includes priority #3: Preserve program effectiveness by supporting: (1) expanded management of predators; (2) mapping and determining hotspots for toxic contaminants; and (3) aggressively addressing non-native and invasive species.

More Info: Dr. Austen Thomas is a molecular ecologist and the Director of Molecular Species Detection Technologies at Smith-Root Inc. in Vancouver, Washington. Austen received his PhD from the University of British Columbia and his MSc from Western Washington University. His work has mainly focused on seal and sea lion interactions with fisheries, in addition to a recent focus on new applications of environmental DNA in fisheries management. He is currently working on novel methods for integrating environmental DNA survey techniques into the fisheries scientist's toolbox.

Design of a field-based eDNA sampling and detection system

Austen Thomas, Jesse Howard, Mieke Sinnesael, Caren Goldberg

Smith-Root

Technology for fisheries conservation

Species detection with environmental DNA (eDNA)

USGS
science for a changing world

Prepared in collaboration with the University of Minnesota

Detection of Environmental DNA of Bigheaded Carps in Samples Collected from Selected Locations in the St. Croix River and in the Mississippi River

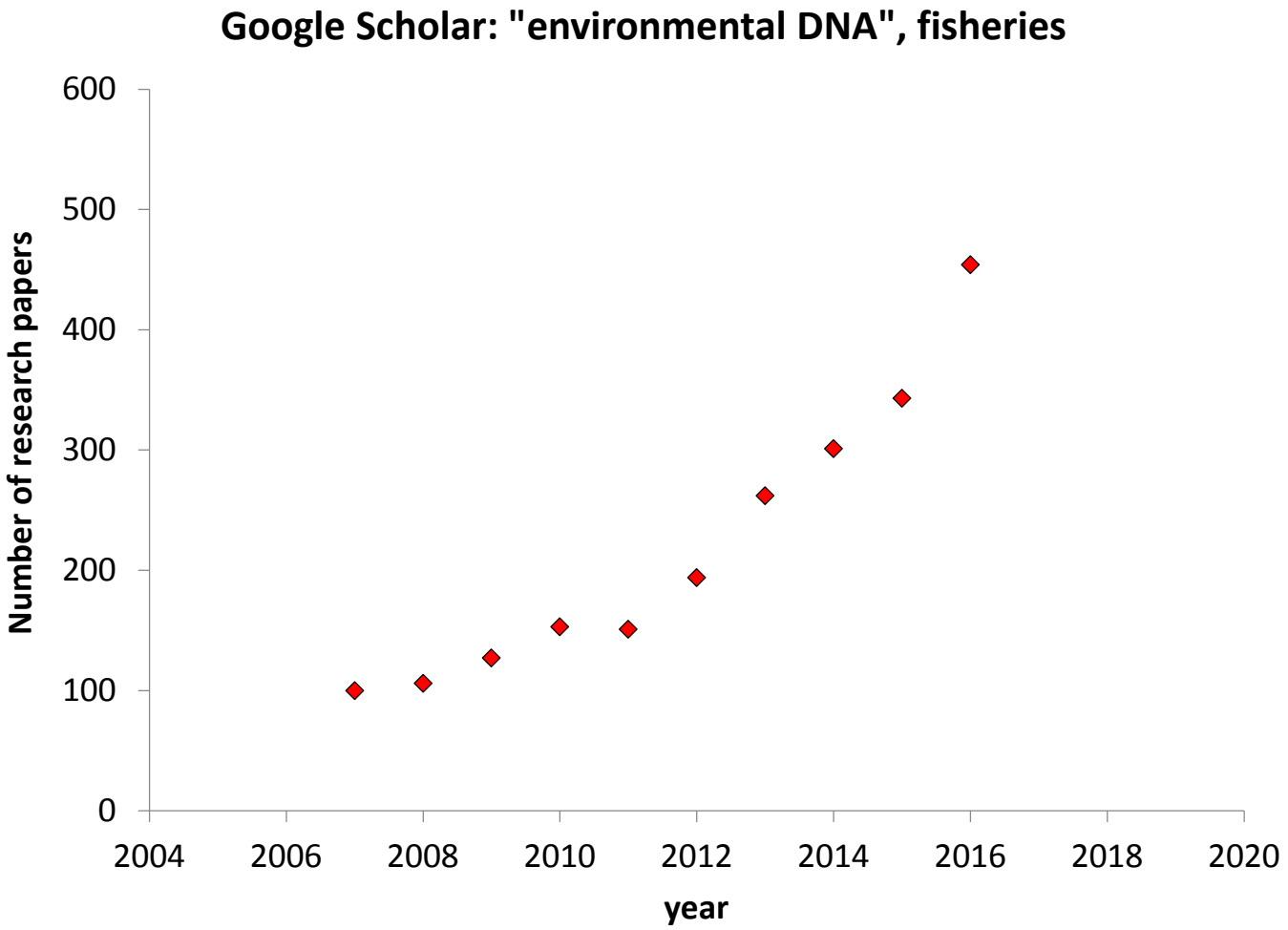
SCIENTIFIC REPORTS

OPEN

Validated methodology for quantifying infestation levels of dreissenid mussels in environmental DNA (eDNA) samples

Received: 12 February 2016
Accepted: 17 November 2016
Published: 14 December 2016

Why do we care about eDNA?



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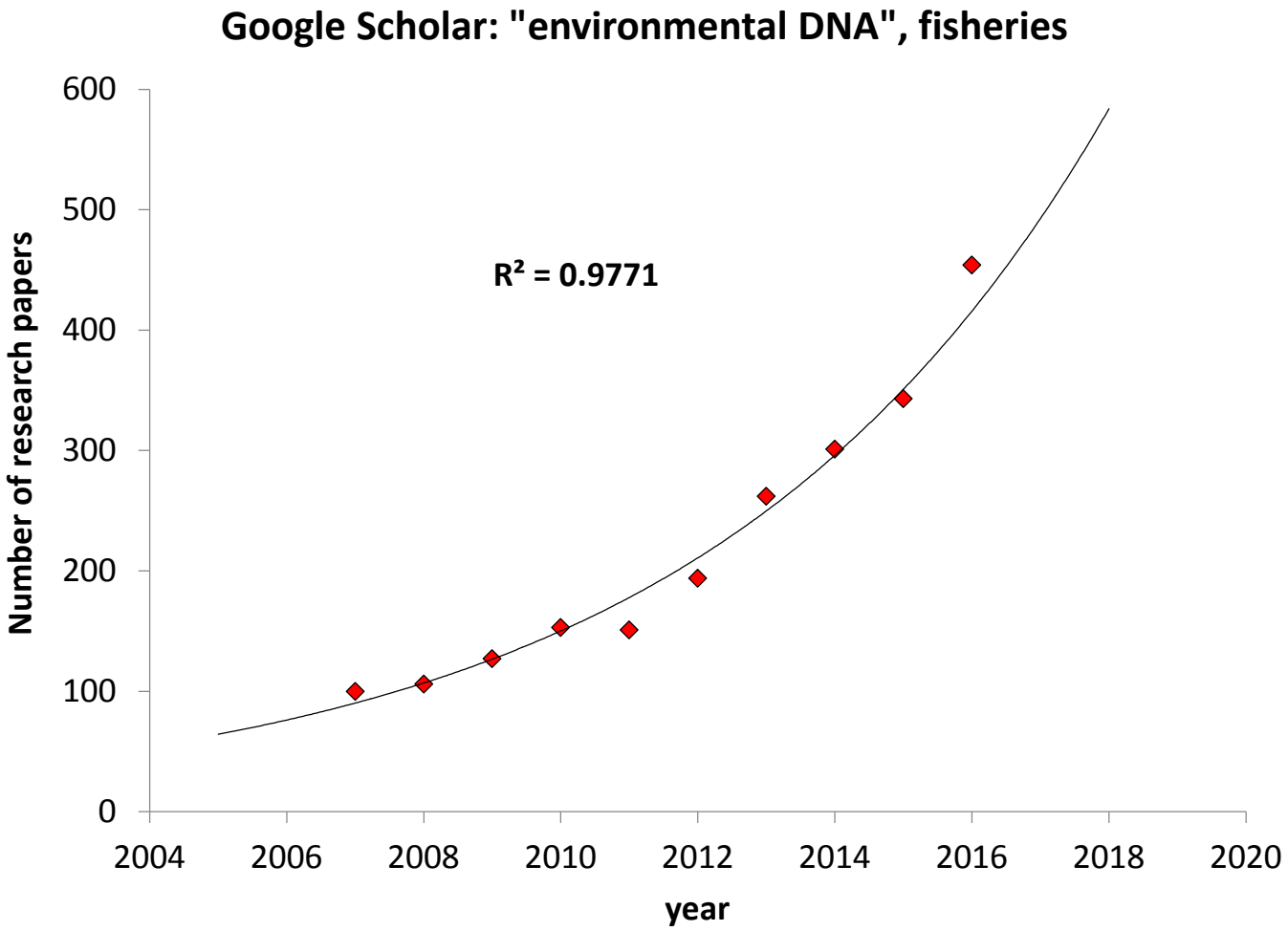


USGS
science for a changing world

Laramie et al., 2015

Prepared in cooperation with Washington State University

Environmental DNA Sampling Protocol—Filtering Water to Capture DNA from Aquatic Organisms

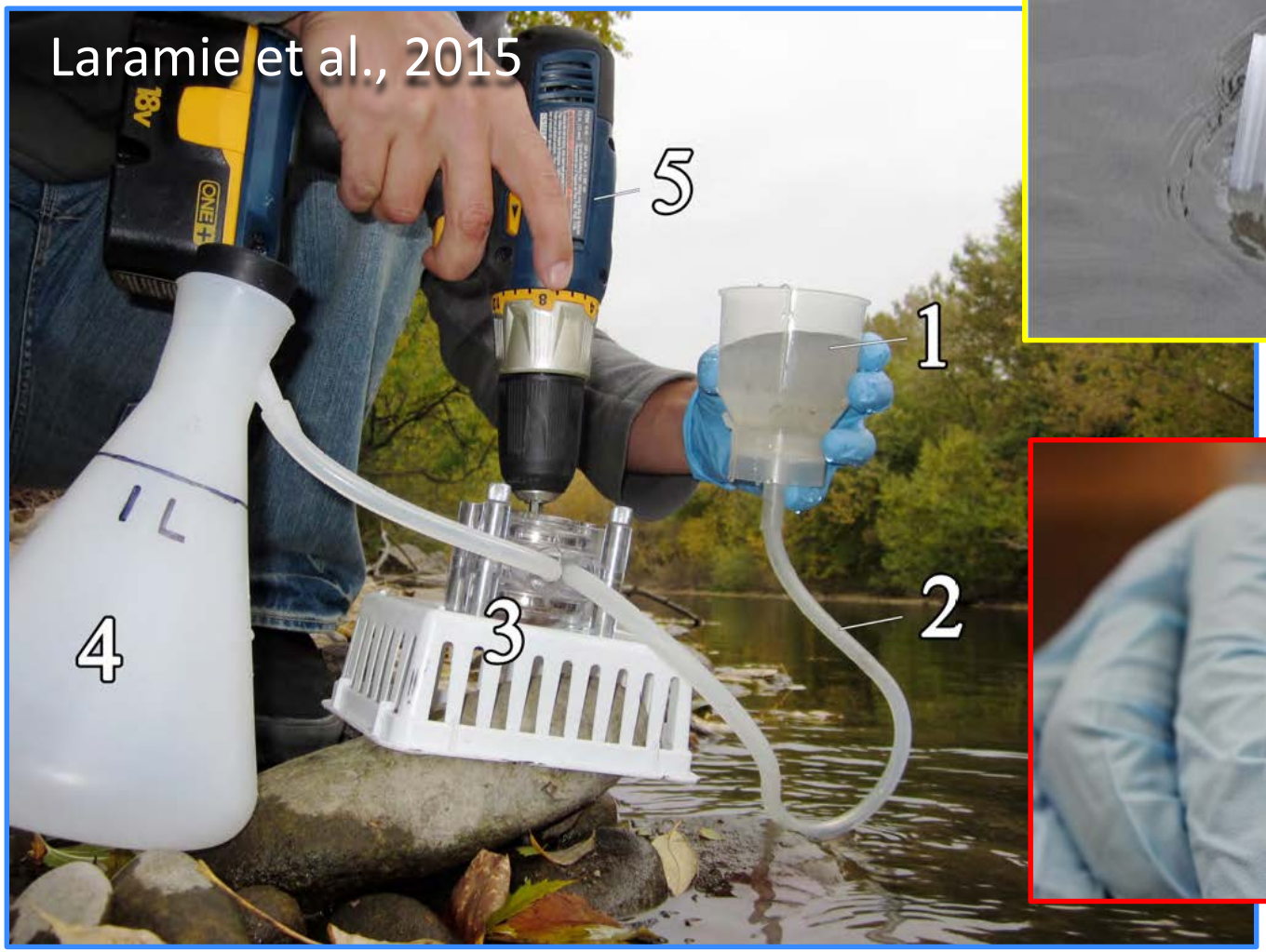
Carim et al., 2015

Rocky Mountain Research Station

Protocol for collecting eDNA samples from streams

Version 2.3- July 2015

eDNA sampling methods



Current Tool Limitations

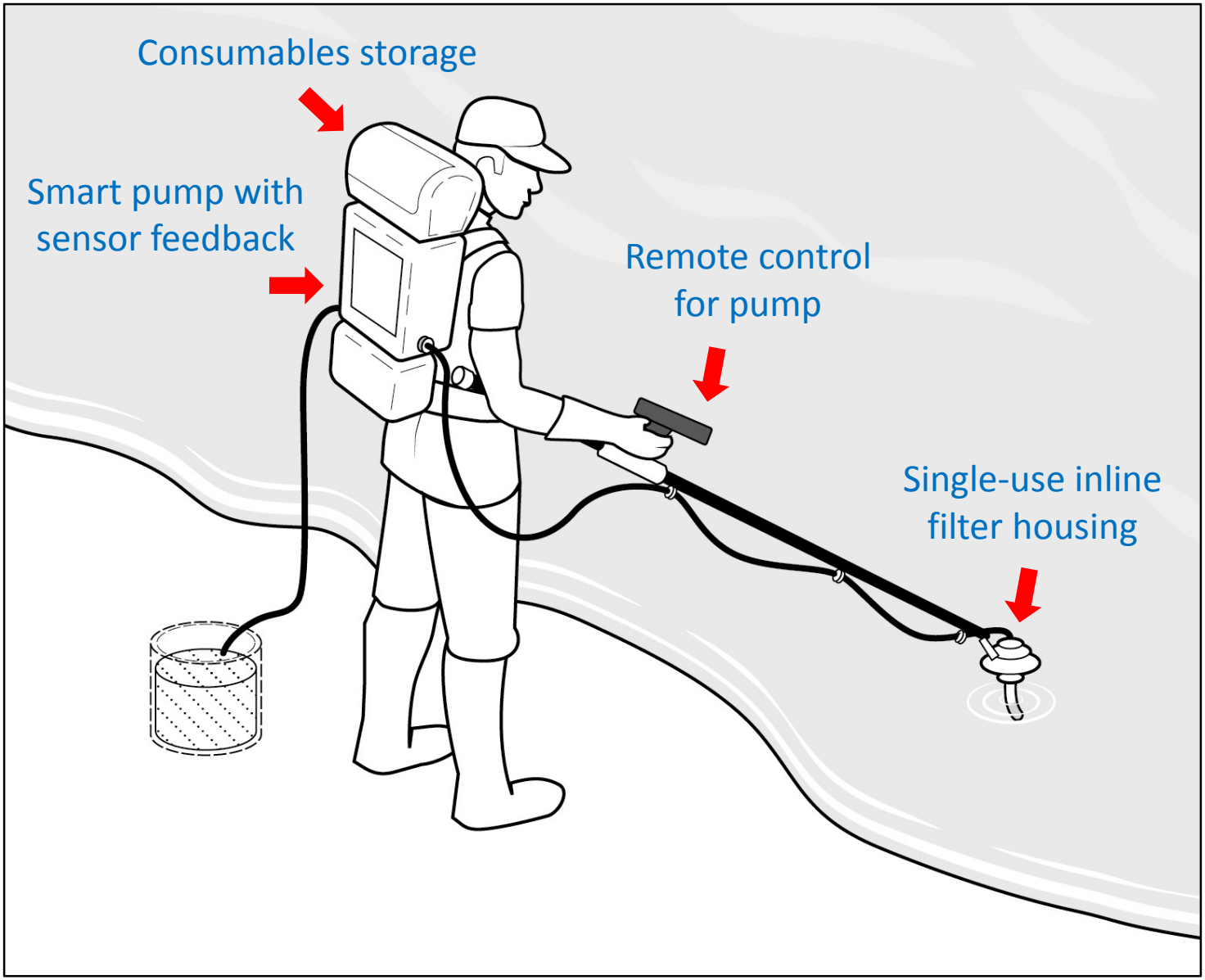
- Sampling gear is not purpose-built (highly cumbersome)
- Inefficient use of technician time

Carim et al., 2015

USGS
science for a changing world

The eDNA Sampling Backpack

(A fully integrated eDNA sampling system)



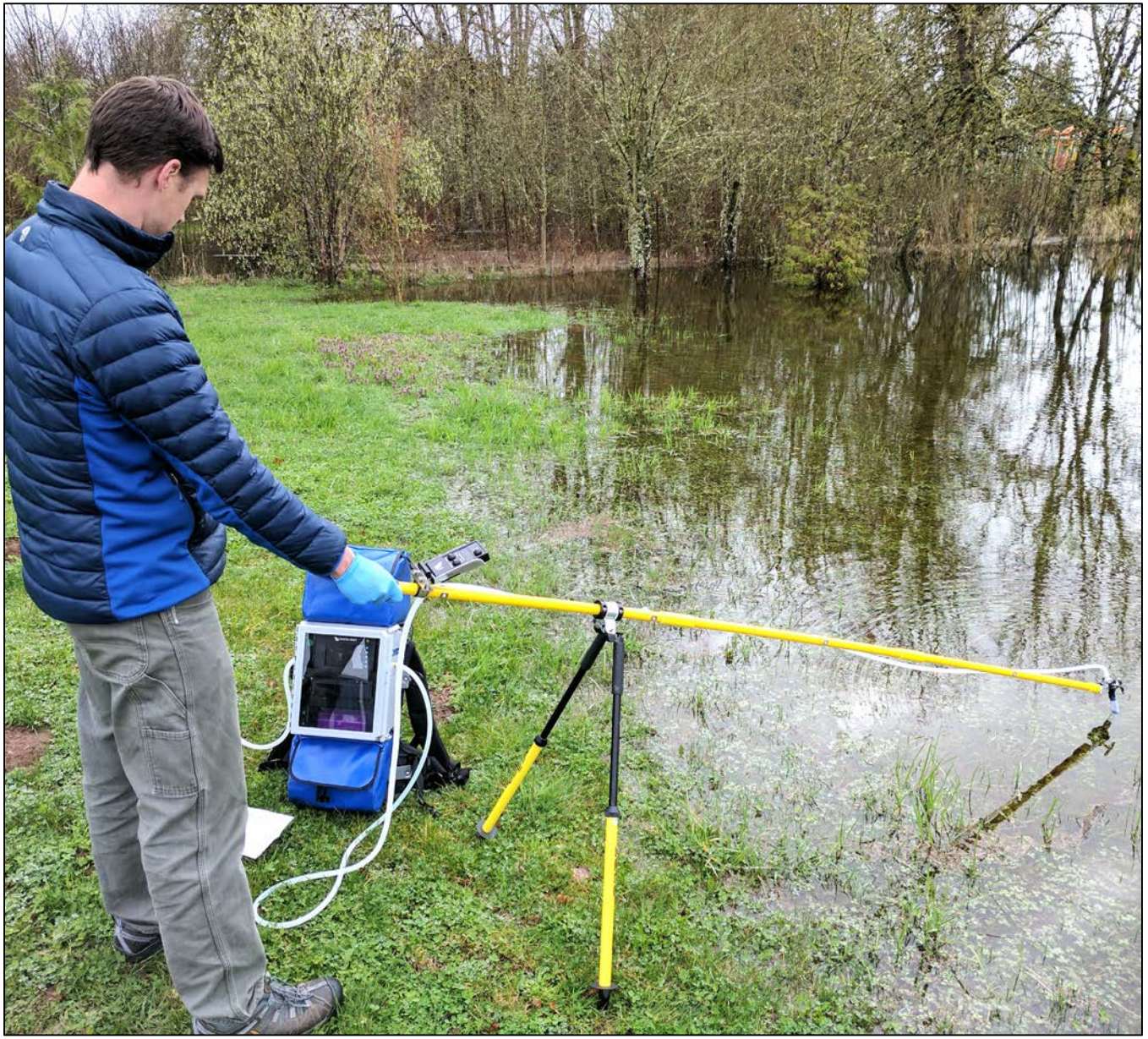
ANDe™

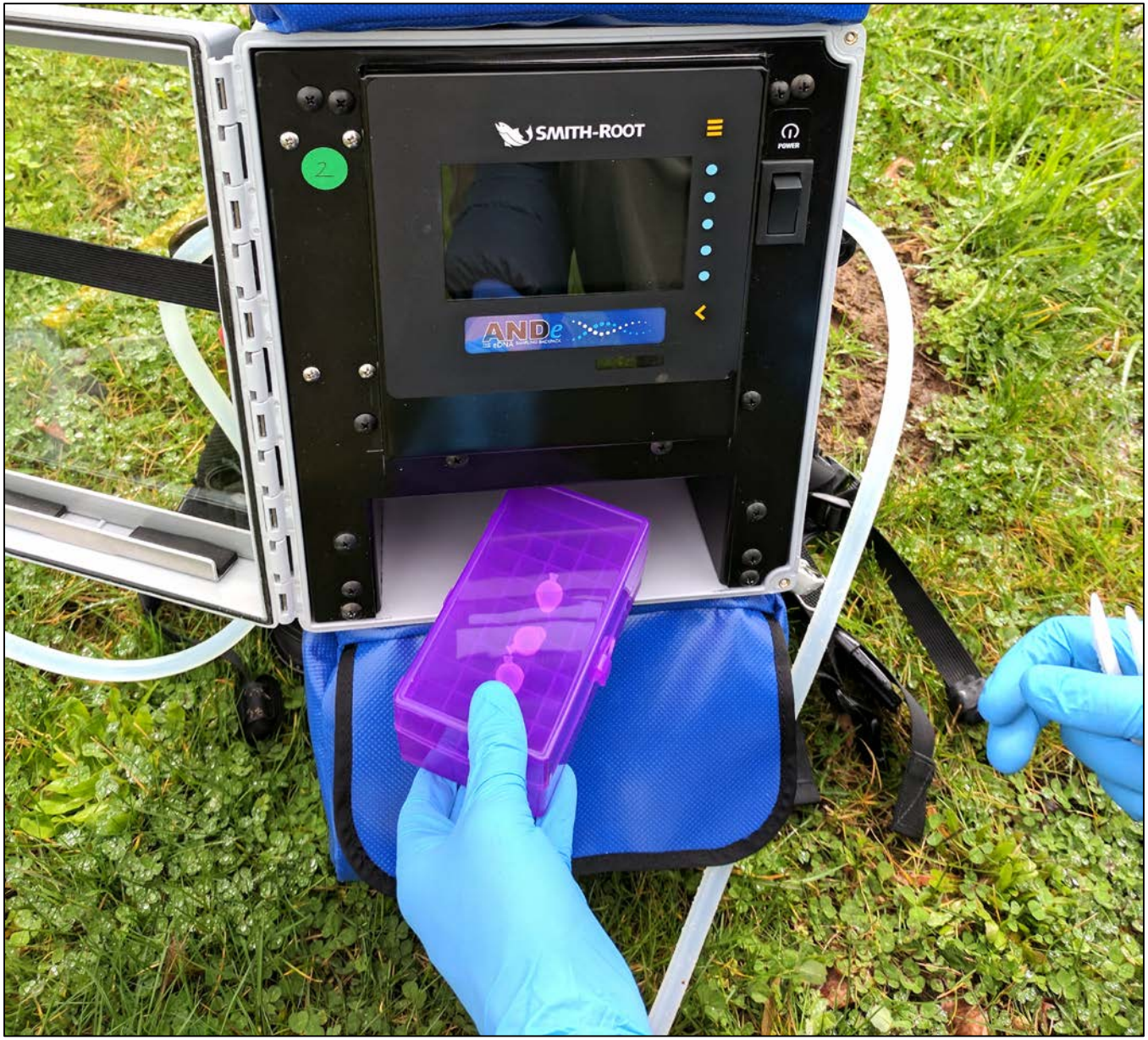
THE eDNA SAMPLING BACKPACK


SMITH-ROOT
POWER
AND


SMITH-ROOT
Manual
0.0
L/min
-0.2
psi
OFF
0.00 L
1.0 L
Volume Limit
0.5 L/min
Flow Limit
12.0 psi
Pressure Limit
ANDe
THE eDNA SAMPLING BACKPACK

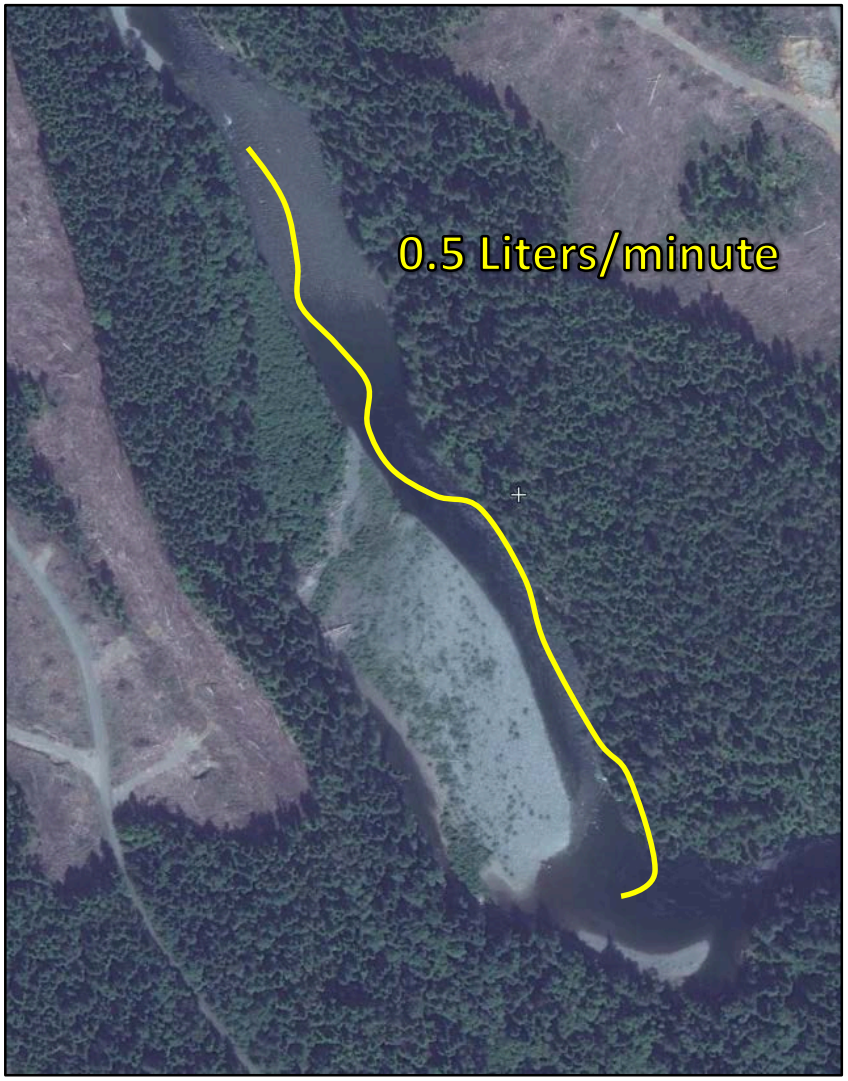

ON/OFF
0
VOLUME FILTERED (LITERS)
AUTO/MANUAL
START/STOP
AUTO WHEN LIT
RUNNING WHEN LIT



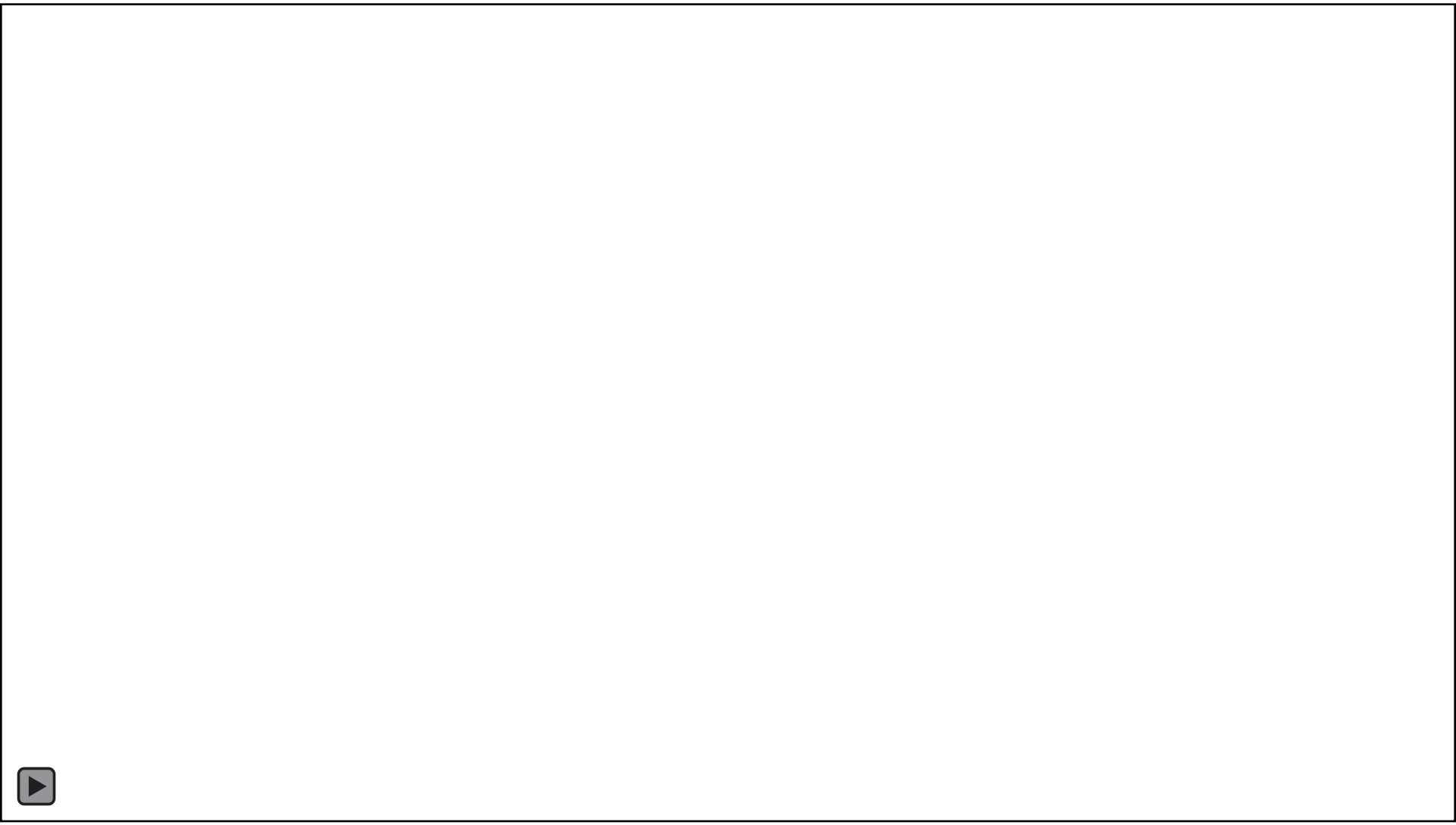

SMITH-ROOT
POWER
2
ANDe

Continuous transect sampling for eDNA

Sampling Standardization



Movie 1



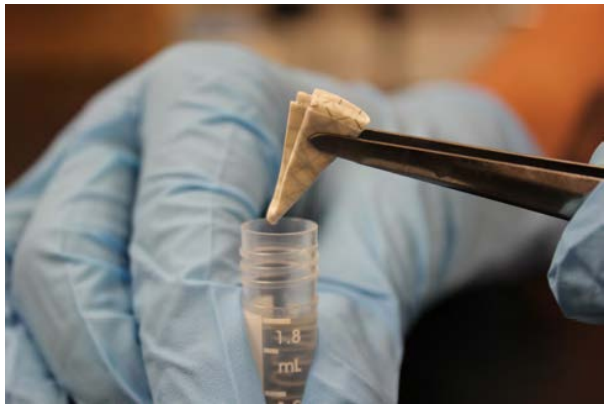
ANDe
THE eDNA SAMPLING BACKPACK

eDNA sampling

- **Sterility**
- **Optimization**
- **Standardization**
- **High-throughput**

Current model of eDNA detection

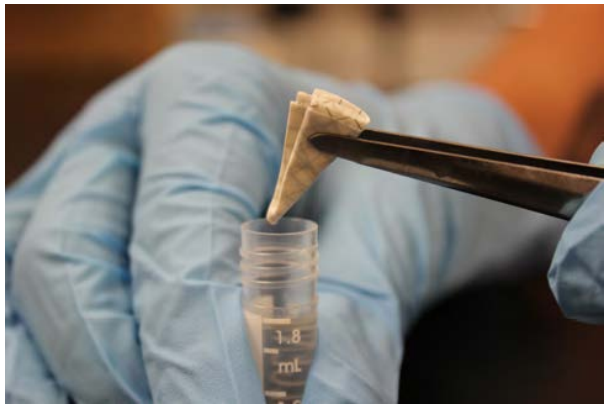
Field sample preservation



Benchtop DNA extraction/detection

Current model of eDNA detection

Field sample preservation

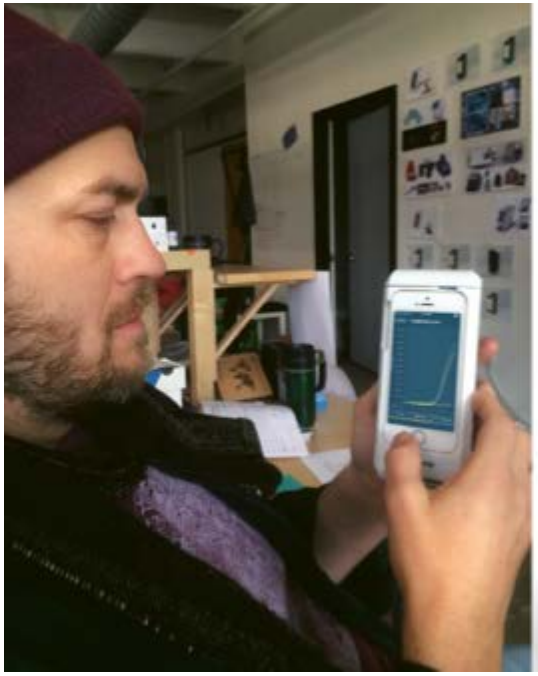


Benchtop DNA extraction/detection

Model Limitations

- Not all users have access to a lab
- Results can take weeks to get back
- Prevents adaptive monitoring

A revolution in diagnostics portability (Bringing the lab to the sample)



PCR heads into the field

NATURE METHODS | VOL.12 NO.5 | MAY 2015 | 393

Vivien Marx

Analyzing samples with PCR is routine in the lab. New approaches let researchers do this assay wherever they need.

A revolution in diagnostics portability (Bringing the lab to the sample)

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NATURE METHODS | VOL.12 NO.5 | MAY 2015 | 393

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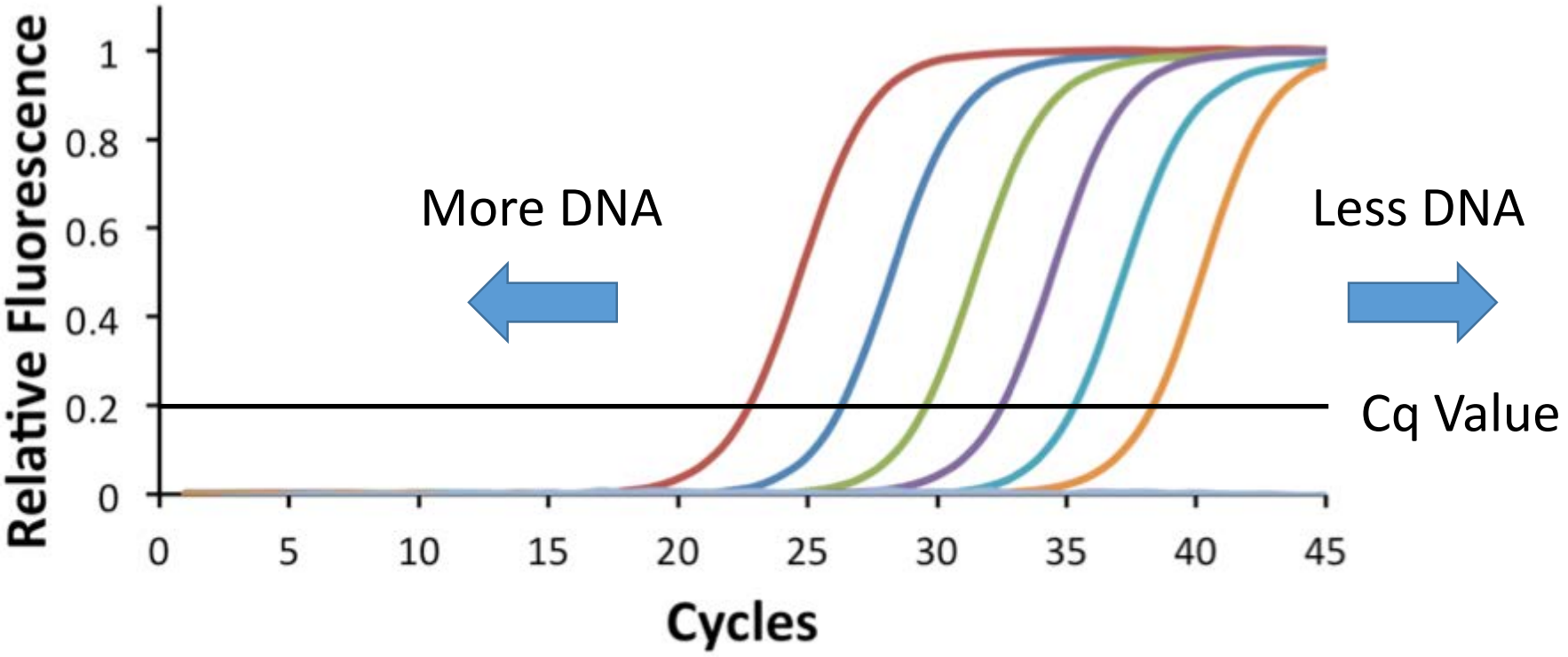
What is quantitative PCR (qPCR)?



Biomeme field-portable qPCR system

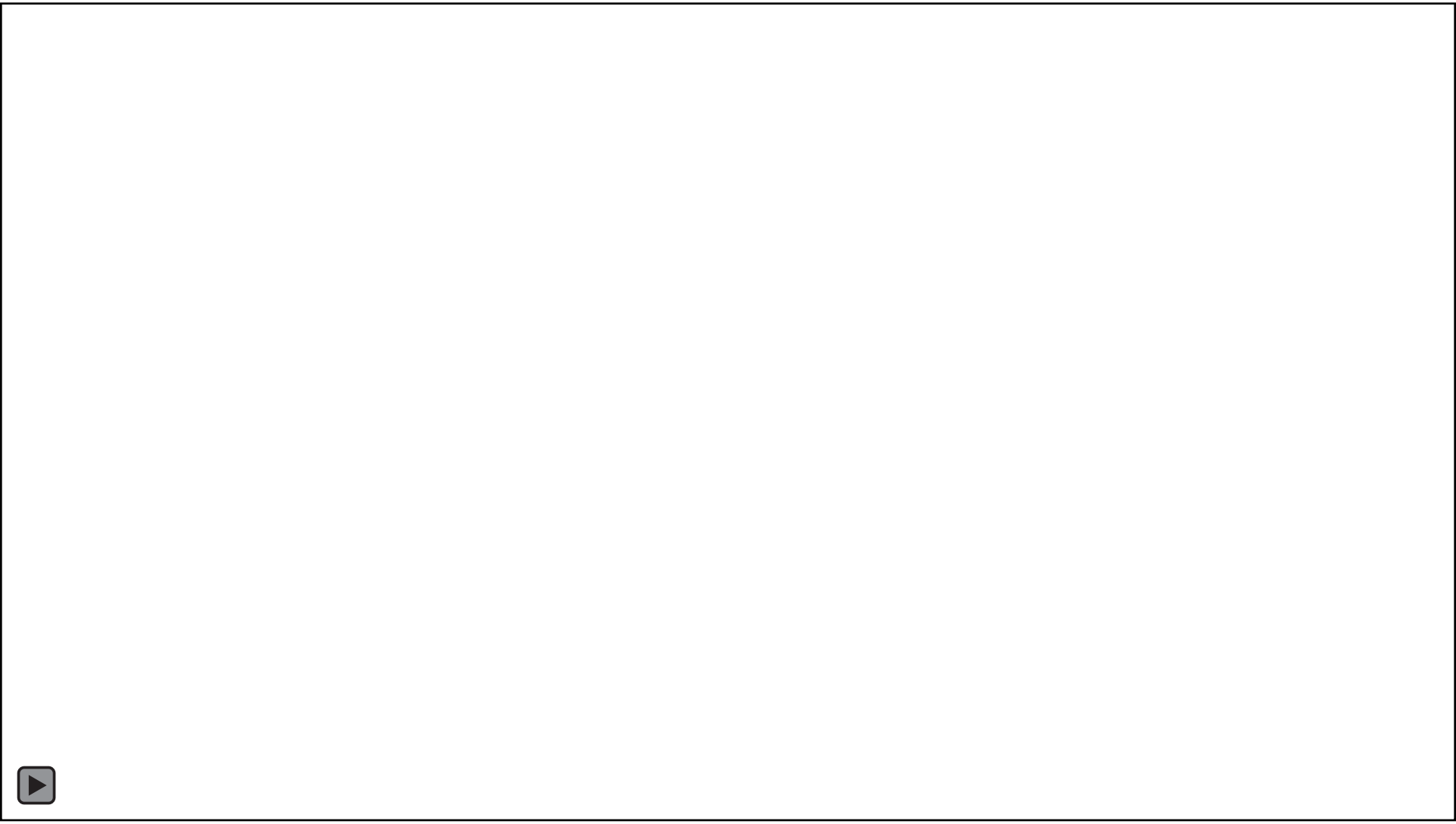
1. Field DNA sample prep

4. Data portal services

3. Portable qPCR device

2. Species-specific test packets

Movie 2



DNA detection using species-specific packets

Customizable App displays +/- or DNA quantity

Biomeme

Logged in as:
SRI-01

HOME | LOGOUT

Data Portal > Folder Hub > View Basic Data

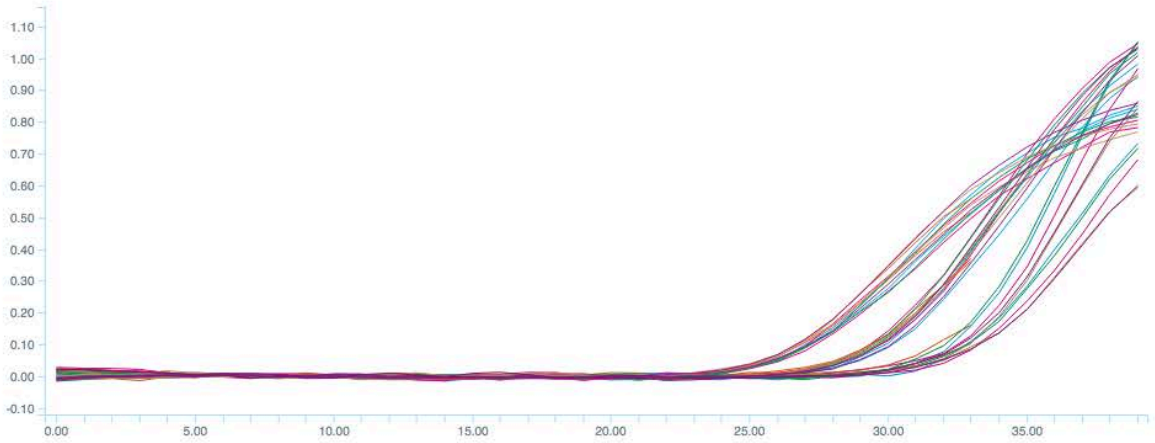
View Basic Data

Experiments	1	2	3
XMS 003: HW 104 run 3	Unk	Unk	Unk
XMS 003: HW 104 run 4	Unk	Unk	Unk
XMS 003: HW 104 run 5b	Unk	Unk	Unk
XMS 003: HW 104 run 2	Unk	Unk	Unk
XMS 003: HW 104 run 6b	Unk	Unk	Unk
XMS 003: HW 104 run1	Unk	Unk	Unk

SHOW THRESHOLDS SHOW RAW DATA

Targets

E3	E2	E1



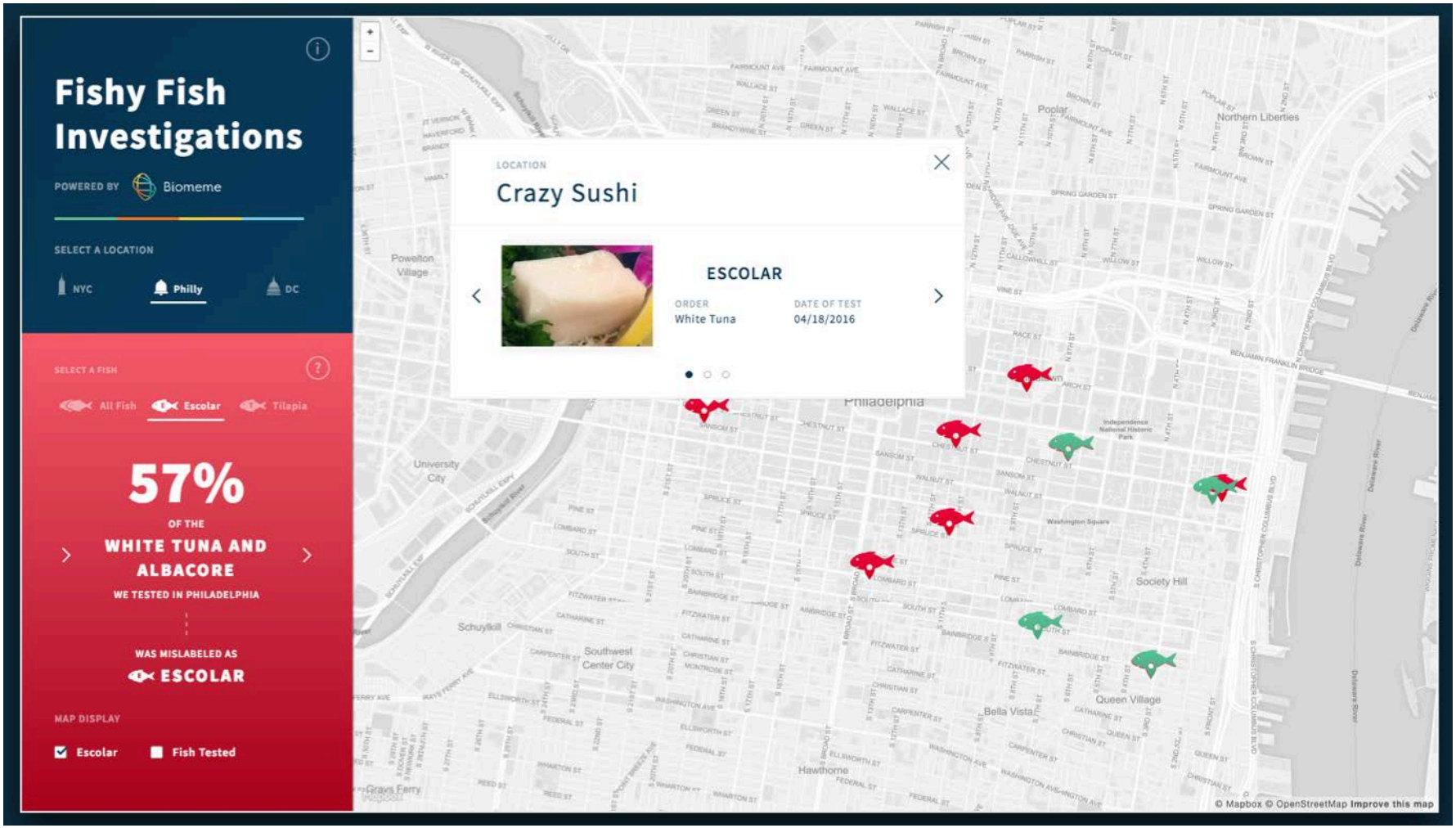
1			
FAM	Cq: 27.80	Cq: 27.68	Cq: 27.66
JUN	Cq: 28.03	Cq: 28.90	Cq: 26.63
FAM	Cq: 28.85	Cq: 26.77	Cq: 26.68
JUN	Cq: 28.72	Cq: 27.18	Cq: 27.86

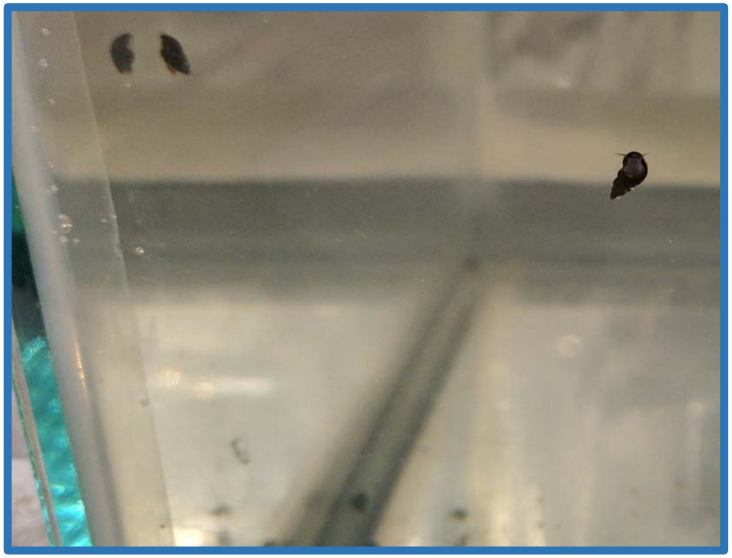
2			
FAM	Cq: 29.39	Cq: 30.36	Cq: 28.75
JUN	Cq: 31.72	Cq: 30.74	Cq: 28.88
FAM	Cq: 30.12	Cq: 30.51	Cq: 30.35
JUN	Cq: 30.49	Cq: 30.97	Cq: 31.55

3			
FAM	Cq: 32.58	Cq: 33.44	Cq: 31.49
JUN	Cq: 33.11	Cq: 33.88	Cq: 32.59
FAM	Cq: 32.13	Cq: 33.06	Cq: 33.68
JUN	Cq: 33.47	Cq: 33.92	Cq: 33.54

XMS 003: HW 104 run 3 | XMS 003: HW 104 run 4 | XMS 003: HW 104 run 5b | XMS 003: HW 104 run 2 | XMS 003: HW 104 run 6b | XMS 003: HW 104 run1

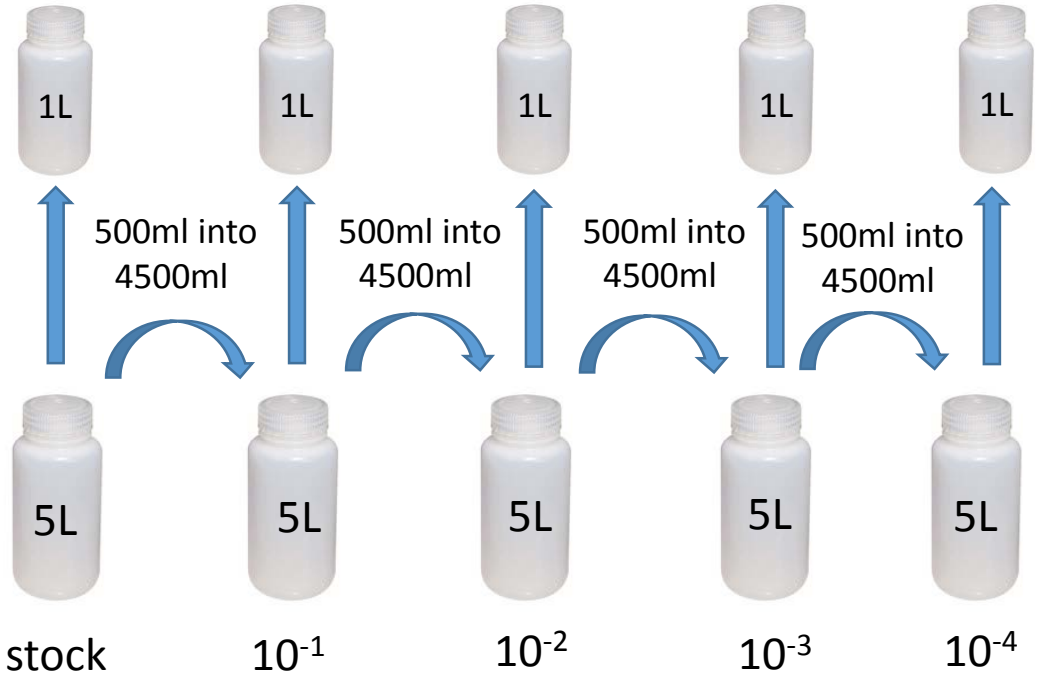
Data portal for real-time analysis



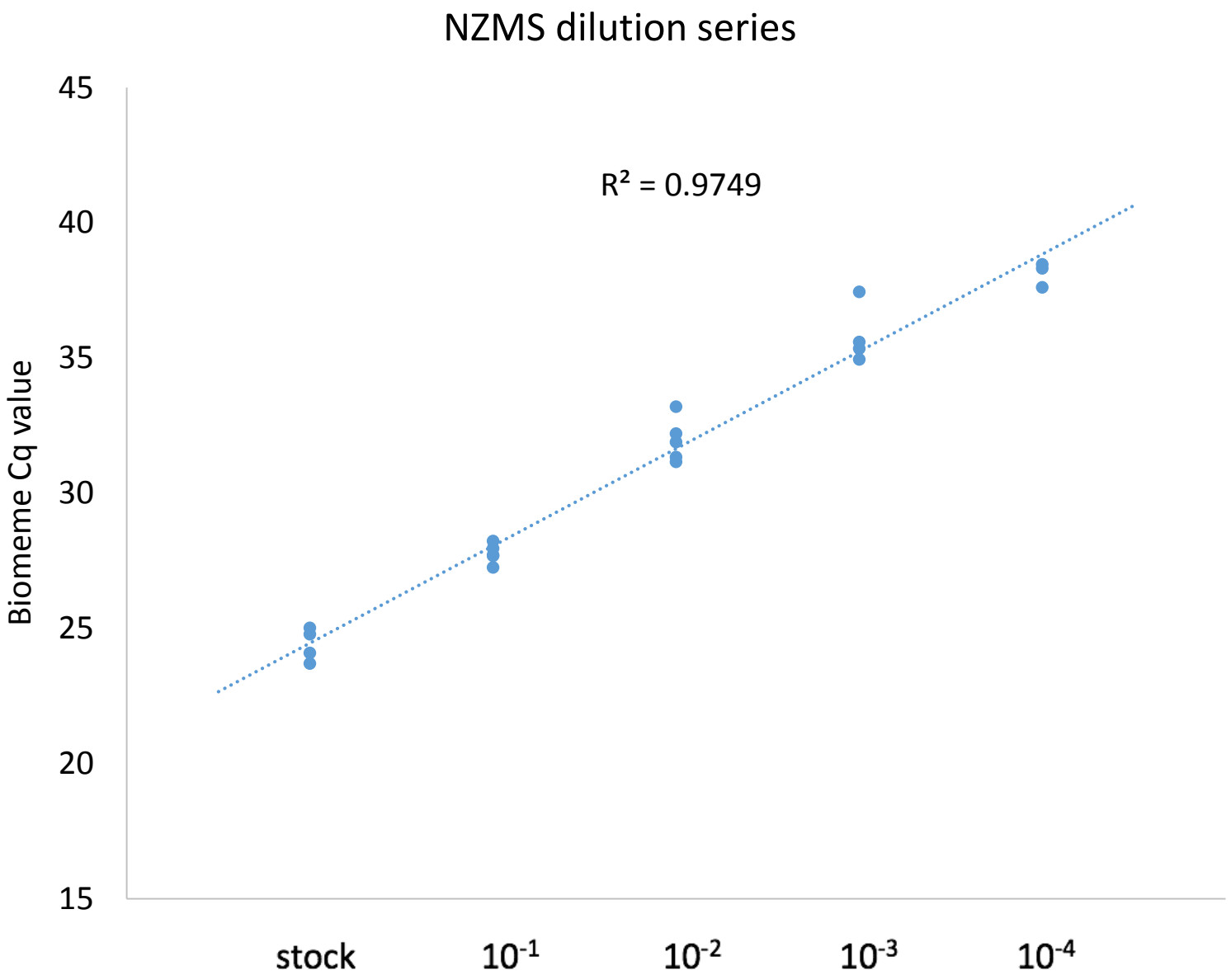


New Zealand Mudsnail exp.

- 50 snails in aquarium
- Diluted with river water



Proof of concept study with mudsnails



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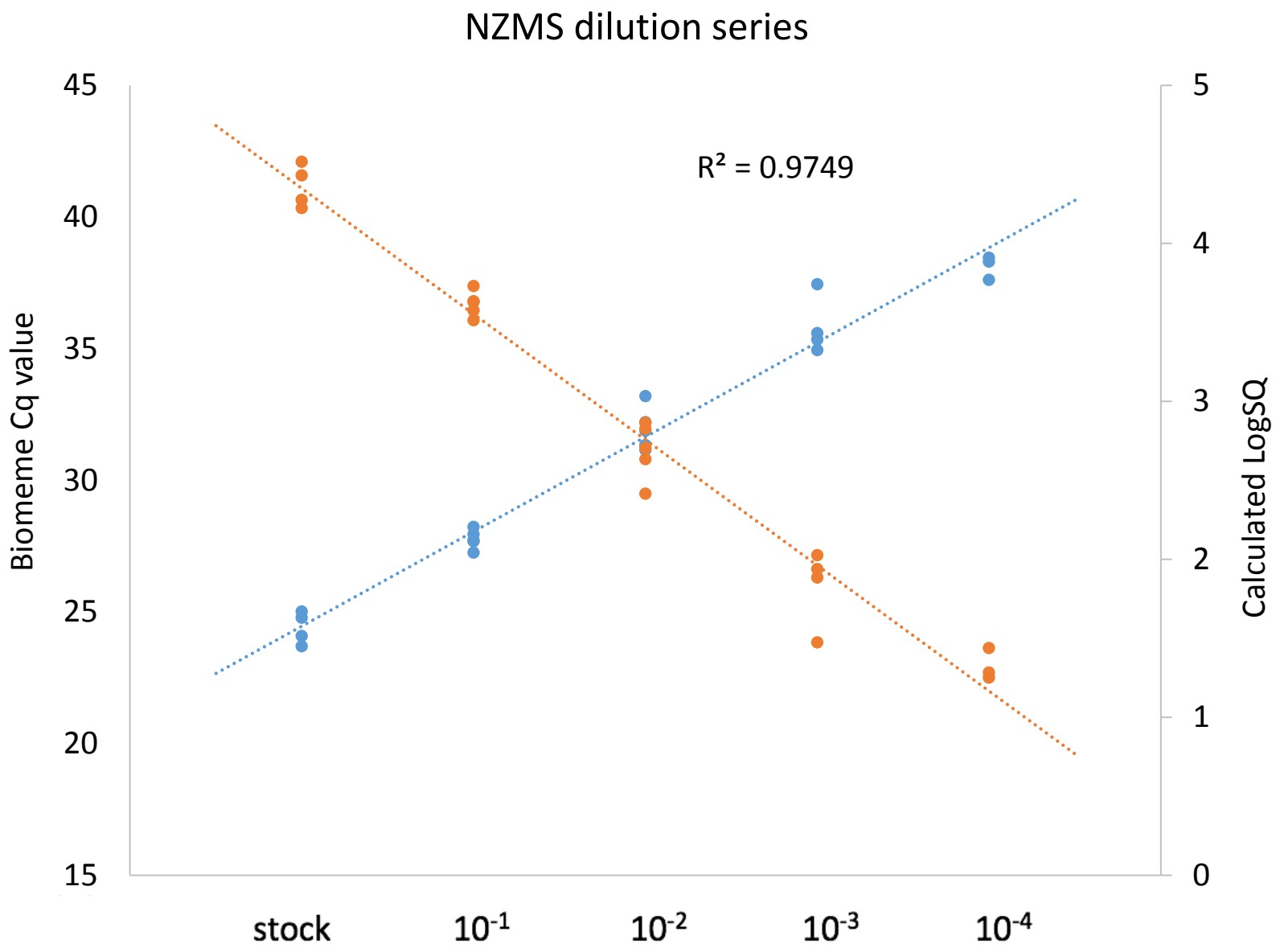
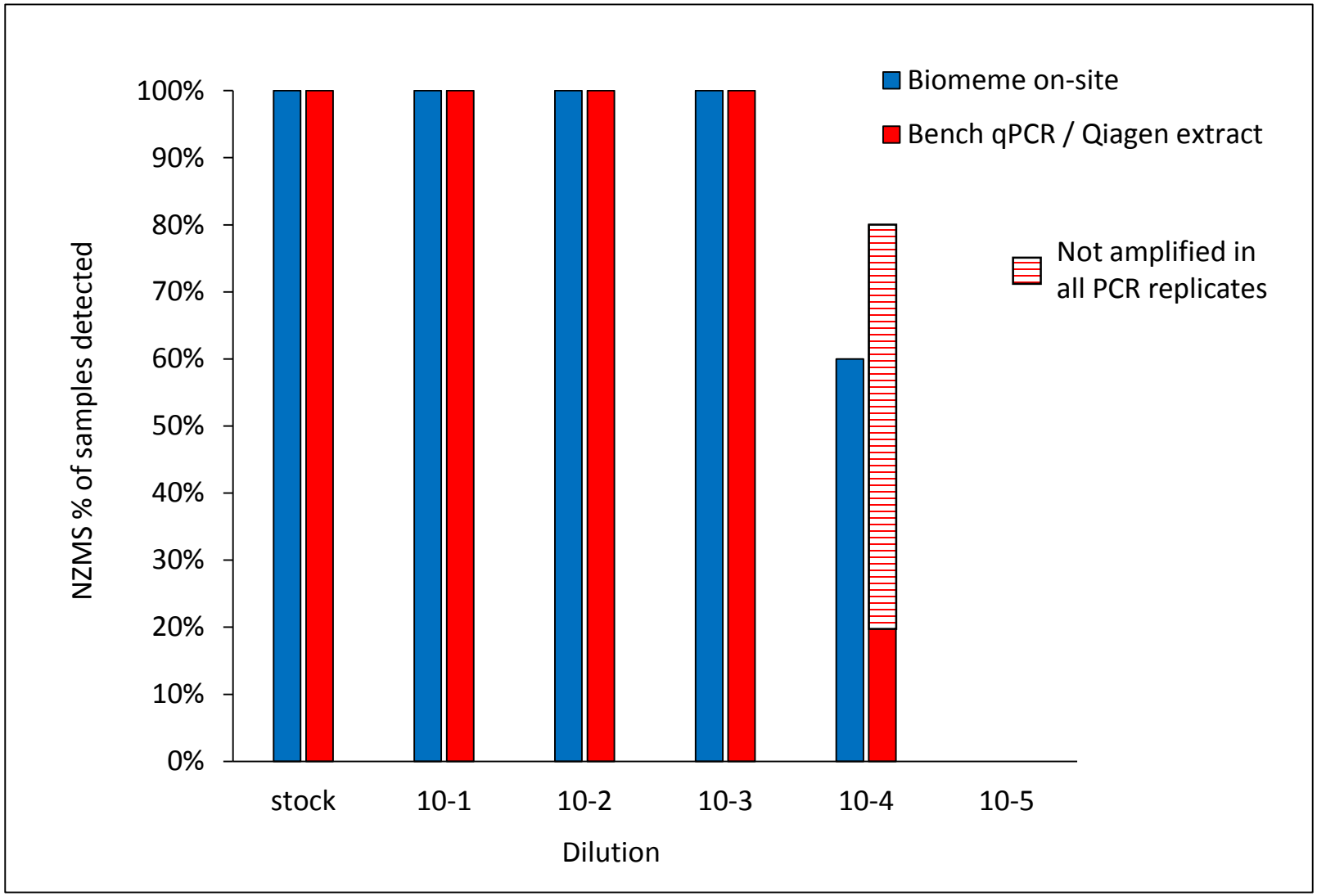


Biomeme compared to Bench qPCR

Bench qPCR credit: Goldberg lab



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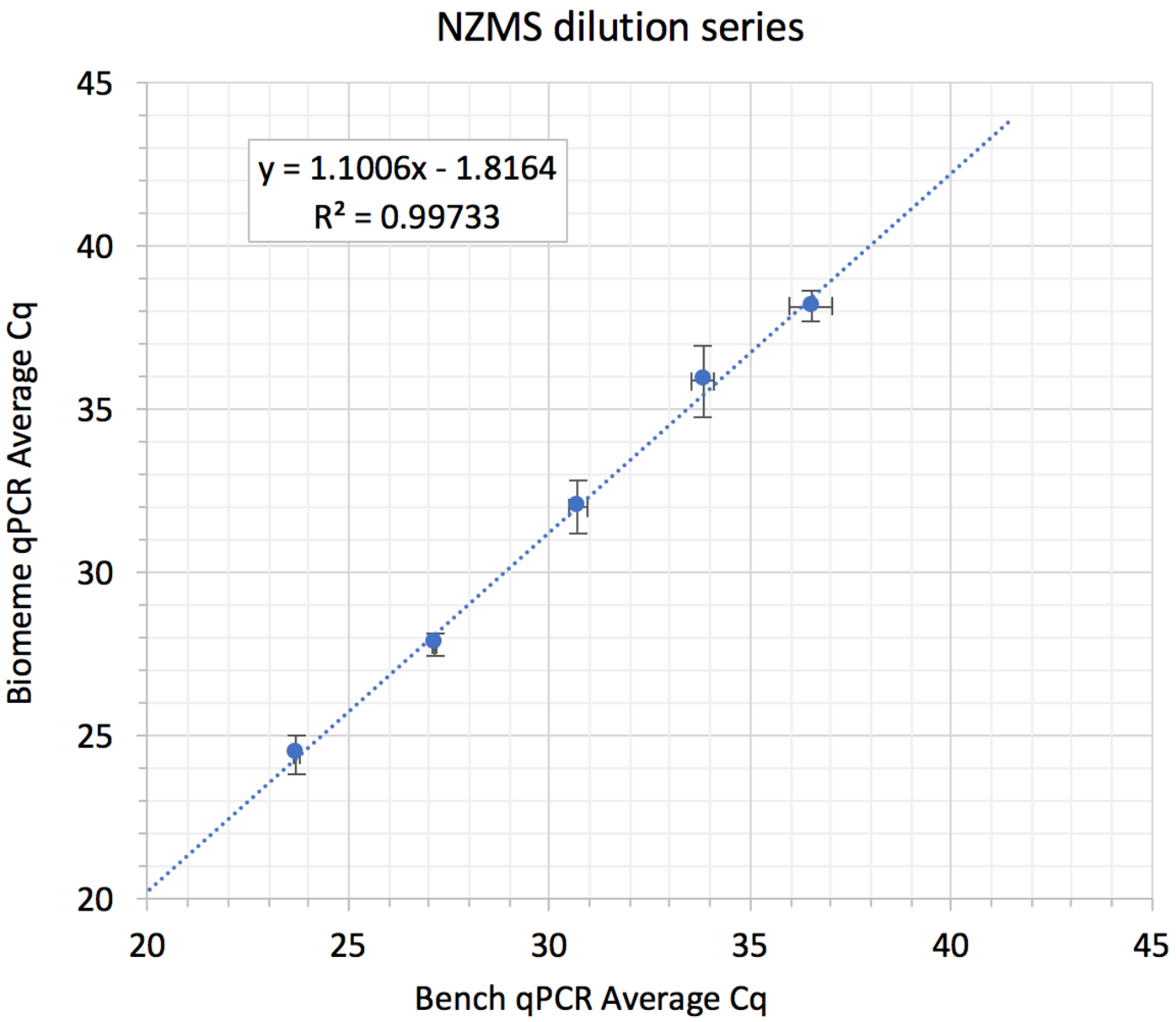


Michigan DNR NZMS detection with ANDe/Biomeme

Environmental fish pathogen monitoring

Flavobacterium psychrophilum Test Kit

Not a diagnostic test for Bacterial Coldwater Disease

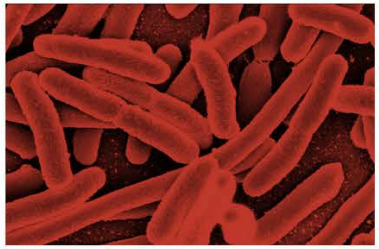
Environmental fish pathogen monitoring

Flavobacterium psychrophilum Test Kit

List of eDNA tests on Smith-Root website

Environmental Microbes**

Renibacterium salmoninarum Test Kit



Not a diagnostic test for Bacterial Kidney Disease

Purchase Kit

Flavobacterium columnare Test Kit

Not a diagnostic test for Columnaris Disease

Purchase Kit

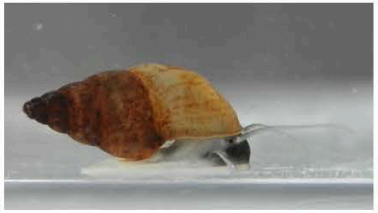
Aquatic Species

Bighead Carp and Silver Carp Test Kit

Hypophthalmichthys nobilis and *Hypophthalmichthys molitrix*

Purchase Kit

New Zealand Mudsnail Test Kit



Potamopyrgus antipodarum

Purchase Kit

Northern Pike test recently developed

NORTHERN PIKE INVADE UPPER COLUMBIA RIVER

JUL 16, 2015 / JOHN HARRISON /

Northern pike, a voracious predator considered an invasive species in two of the four Northwest states, have been found in the Kettle River, a northeastern Washington tributary of the Columbia River, a sign that they are continuing their downstream migration from lakes and rivers in Idaho and Montana. What's worse, the pike found in and near the Kettle River were several different ages, indicating the species is breeding and proliferating.

That is bad news for the Columbia because if pike keep spreading downriver they could wind up below Grand Coulee and Chief Joseph dams where they could prey on threatened and endangered species of salmon and steelhead.

Council staff reported in July that between June 29 and July 3, 21 adult pike were captured at five locations around the mouth of the Kettle River, near Colville, Washington. Northern pike are classified as game fish in Montana and Idaho, and as prohibited species in Washington and Oregon, where they also are listed as aquatic invasive species. All four states prohibit live transport of northern pike.

This map by the Washington Department of Fish and Wildlife shows the known distribution of northern pike in the state. The northern-most red line represents the Pend Oreille River and the Columbia River to the mouth of the Kettle River. The southern-most red line represents the Spokane River. The northern and southern red circles represent Newman Lake and Liberty Lake, respectively, in Spokane County.

Can this be used to detect (*insert species*)?

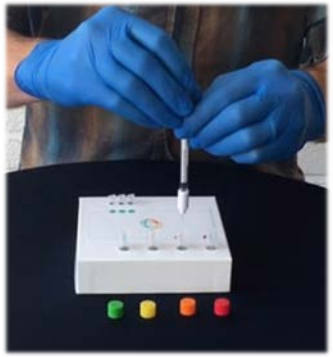
Can this be used to detect (*insert species*)?

YES

End to end field eDNA process

Sampling/Filtration

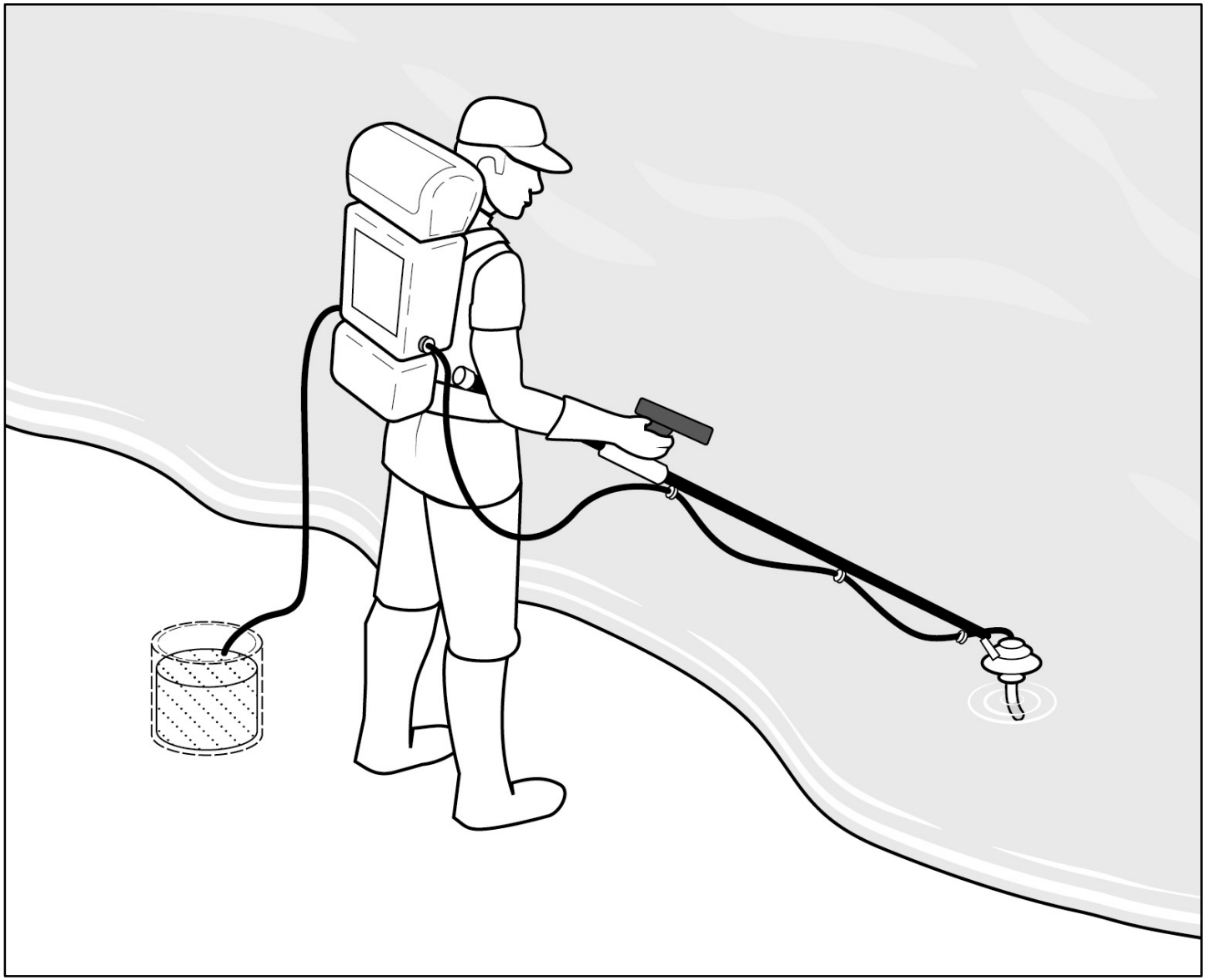
DNA extraction



Detection/Visualization

Data transfer

Help us build the right tools for you



Thank you!

SMITH-ROOT

Biomeme

ANDe Beta testing program completed (April)

- **Michigan DNR**
- **Wildlife Conservation Society**
- **Biodiversity Institute of Ontario**
- **Washington State University**