PolyWAG (Water Acquired Genomics) System: A Field Programmable and Customizable Auto-sampler for eDNA

Bao Nguyen[1], Kawin Pechetratanapanit[1], Chet Udell[1], Cara Walter[1], John Selker[1], and Taal Levi[1]

[1]Oregon State University

November 24, 2022

Abstract

Organisms leave traces of DNA as they move through their environments. The extraction of these DNA traces is known as environmental DNA (eDNA). eDNA provides scientists and researchers a non-invasive, rapid, cost-effective and sensitive way to detect and quantify species. Traditional eDNA sampling consists of manually filtering water, which is labor and cost-intensive for remote locations. Furthermore, commercialized solutions are expensive and require a field operator. This eDNA sampler project aims to provide an affordable, open-sourced, remotely deployable, fully automated, and customizable alternative. The PolyWAG (Water Acquired Genomics) system can run up to 24 inline filter units with support for different conditions including pressure, time and volume limit. The pumps deliver maximum 400mL/min with solenoid valves separating each inline filter to minimize cross-contamination. At the end of each sample, the desired stabilizing solution can be injected to fully submerge the filter for preservation. An optional river depth sensor can provide a proxy for flow to correct eDNA concentrations to allow for improved quantification of organisms. Data acquired during operation including water depth, pressure, temperature, and flow rate will be stored on microSD card in CSV format, which allows easier data export and analysis. A web application provides an intuitive UI for in-field programming, real-time sensor updates, scheduling tasks, and manual operations. We present data from multiple tests showing the length of the preservation period and the contamination level between samples. The PolyWAG system is estimated to be $3000 each, with add-on river depth sensor and 10ah 12V battery.

PolyWAG : eDNA Sampler

A Field Programmable and Customizable Auto-sampler for eDNA

Bao Nguyen[1], Kawin Pechetratanapanit[1], John S Selker[1,2], Chet Udell[1,2], and Taal Levi[3]

[1]Openly Published Environmental Sensing Laboratory, [2]Department of Biological & Ecological Engineering, [3]Department of Fisheries and Wildlife

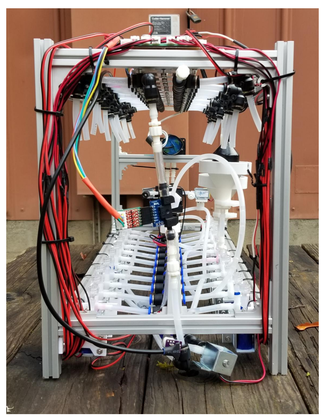
ABSTRACT AND PURPOSE:

Organisms leave traces of DNA in their environments (eDNA). eDNA provides sensitive, non-invasive, detection and quantitation of resident species. Current eDNA sampling consists of manually filtering water, which is labor and cost-intensive for remote locations.

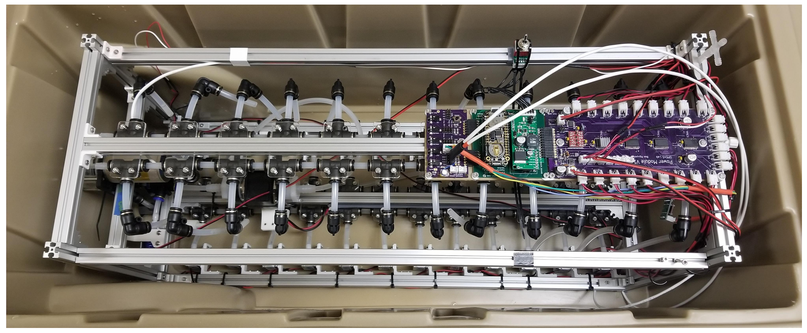
This eDNA sampler project aims to provide:

- **Affordable**
- **Open-sourced**
- **Remotely deployable**
- **Fully automated**
- **Customizable alternative.**

The full sampler is estimated to be **$1500 for parts and $1500 for labor**.



Rear View



Top View

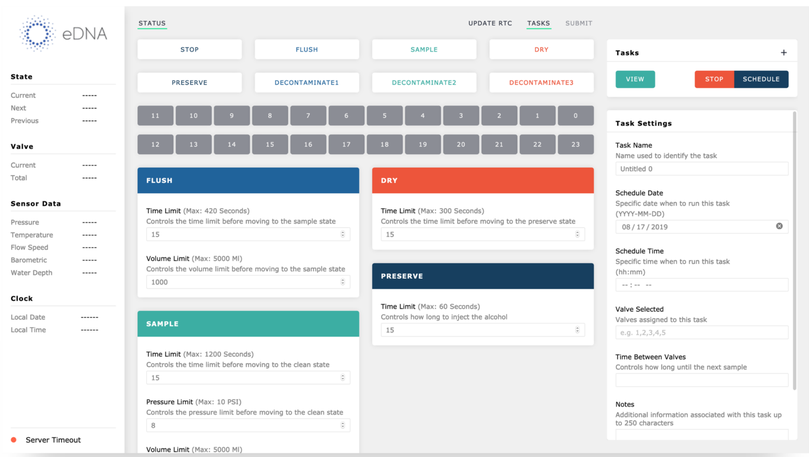
DEVELOPMENT

- Push-to-connect tubing
- Modular PCBs for easy replacement/upgrade
- WiFi enabled with Browser Application
- Internal pressure sensor for stop condition
- Flow sensor for filtered volume
- Reusable filter casing

FEATURES

- 24+ inline replaceable and reusable filter units
- Sleep mode enabled (≈130uA)
- 350mL/min flow rate
- Openly published, modular design
- Browser app for real-time monitoring, scheduling tasks, and manual operation
- Data logging: time, pressure, flow, filtered volume, and water temperature
- Fits in Pelican's 80QT Wheeled Cooler which retains ice for up to 10 days
- Option: Data-logged river depth sensor to flow-weight eDNA data

BROWSER-BASED APPLICATION



A **graphical user interface** was a key element of the design. This **browser-based** interface eliminates errors that may arise from manipulating the on-board electronics via user changes in programming.

- In person wireless communication within **30 feet** via **2.4GHz WiFi**
- Endpoints open to third-party developers

Feature:

- Responsive design across different screen sizes
- Realtime status updates
- Ability to set the onboard real-time clock automatically
- Log file viewer
- Password protected

Task scheduling:

- Option to schedule a task to be executed at a later date and time
- Ability to assign multiple filters to run automatically after one another
- Manual operation

SAMPLING PROCESSES

The filter casing is designed for 47mm disc filters. After each use, the whole casing can be submerged in diluted bleach to remove DNA residue, before placing a new filter for reuse.

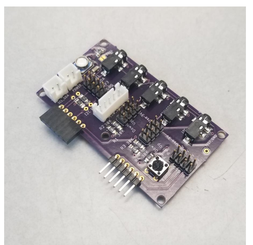
Internal of Filter Casing

Samples are collected in **5 steps**:

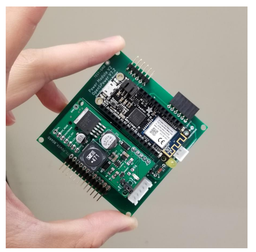
FLUSH	Wash main line with new water
SAMPLE	Pushing water through filter casing
CLEAN	Pushing air to minimized water retention
PRESERVE	Pushing pure ethanol for preservation
DECONTAMINATION	Clear main pipe and intake of water

Filter Casing Unit

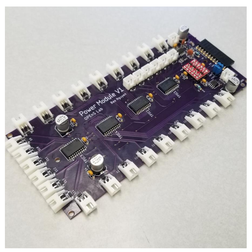
ELECTRONICS



Sensor Module



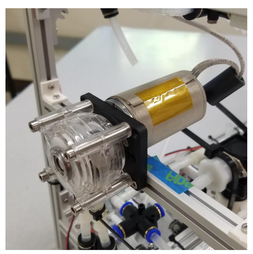
Logic Module



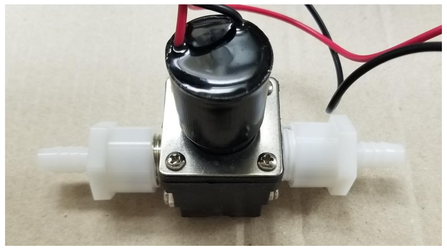
Power Module

Inline Pressure Sensor

$LiFePO_4$ battery



Shielded motor



Solenoid Latch Valve

CROSS-CONTAMINATION TEST

We are performing a cross-contamination test with Rhodamine dye and fluorometer measurements. Further DNA cross-contamination tests are scheduled to quantify any cross-sample contamination. A solution heavily infused with DNA and cell tissue of one species will be drawn into the sampler, followed by taking two samples with de-ionized water. The degree of cross contamination will be quantified following DNA amplification of all the samples.

ACKNOWLEDGMENTS

This work is supported by the USDA, National Science Foundation, and Open Sensing Lab

Contact Information:
Kawin Pechetratanapanit, pechetrk@oregonstate.edu
Bao Nguyen, nguyenb5@oregonstate.edu
Chet Udell, udellc@oregonstate.edu
John Selker, john.Selker@Oregonstate.edu
Taal Levi, taal.levi@oregonstate.edu

OpenSlab Website

eDNA GitHub

*OpenSampler Project

eDNA Project