ROAR
Regional - ORD Applied Research

EPA Office of Research & Development (ORD) and EPA Regions 1, 3, 5, 6, 7, 8

Waterbody Monitoring with Machine Learning Modeling

EPA

USGS
science for a changing world

AI for Good

NATIONAL GEOGRAPHIC
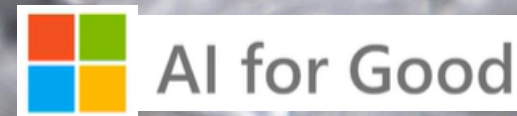
The views expressed in this presentation are those of the author and they do not necessarily reflect the views or policies of the U.S. Environmental Protection Agency or other collaborating agencies.

Mention of trade names or commercial products does not constitute endorsement or recommendation for use but is for descriptive purposes only.
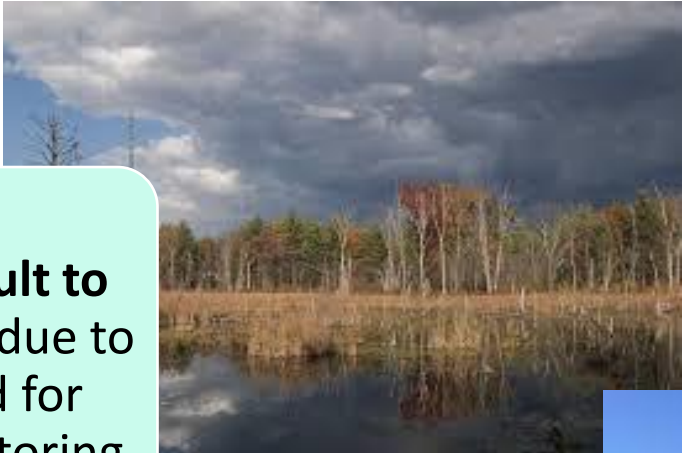
Background/ Problem

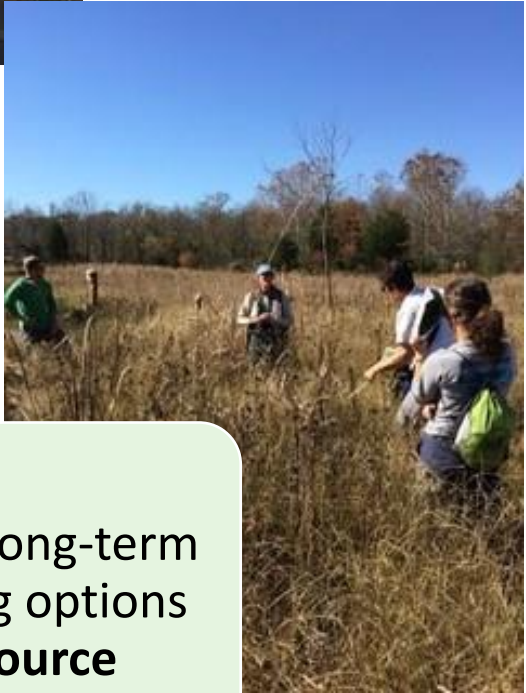**Waterbodies are highly vulnerable** to climate change.

It is very **difficult to assess impacts** due to detail needed for long-term monitoring.

Can we use imagery and ML to evaluate specific parameters for long-term monitoring?

Currently, long-term monitoring options are **resource intensive**.

NY Times

Can we use imagery and ML to evaluate specific parameters for long-term monitoring?

3 things needed

1. **Input data** for models

Continuous Imagery from Trail Cameras
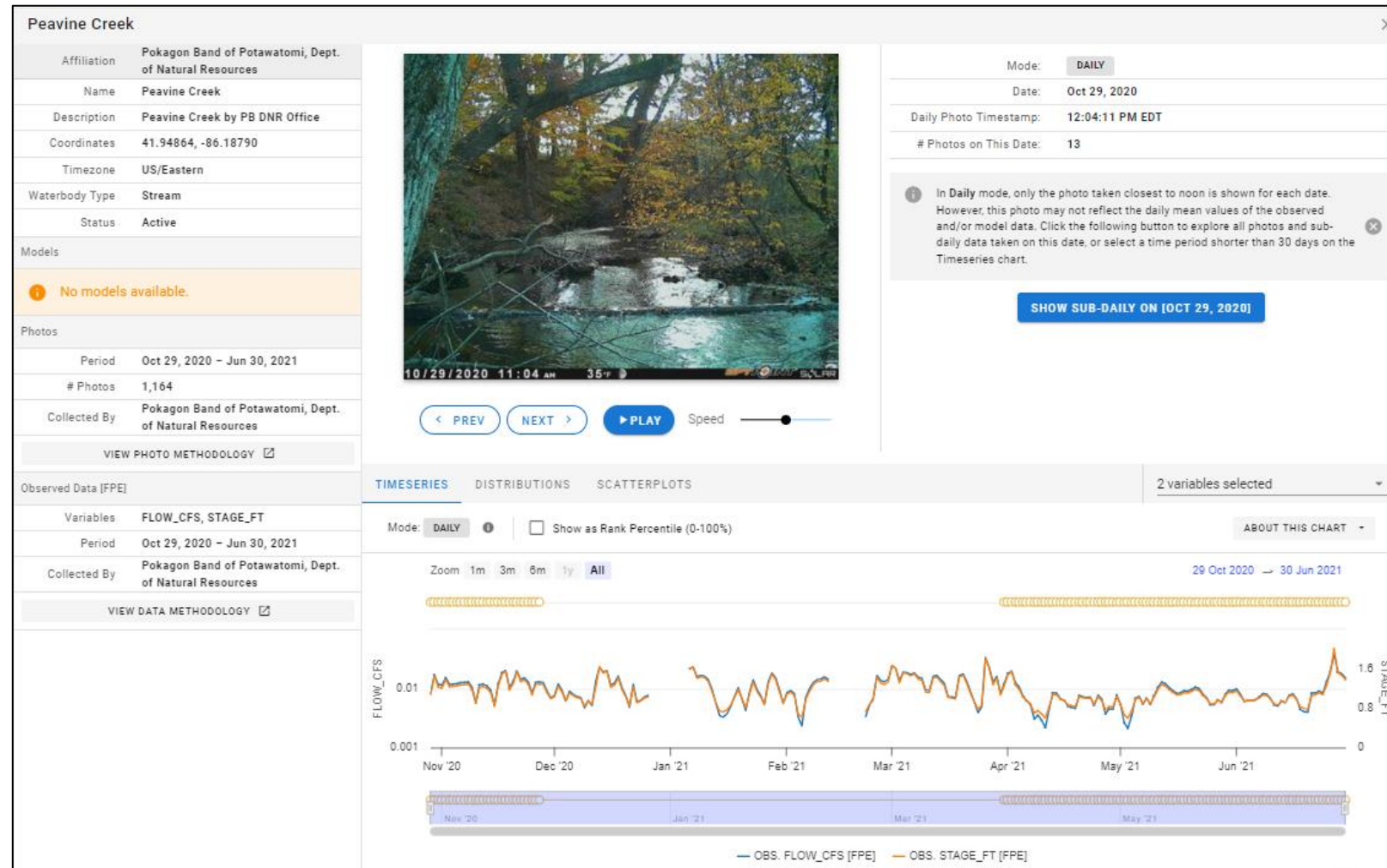
1. Input data for models

2. **Database**

   Flow Photo Explorer
   Free, public, USGS web-based database platform

   Can store:
   a) Images
   b) Optional Data

Flow	Water Temp
Stage	Air Temp
Pressure	Other
SpCond	

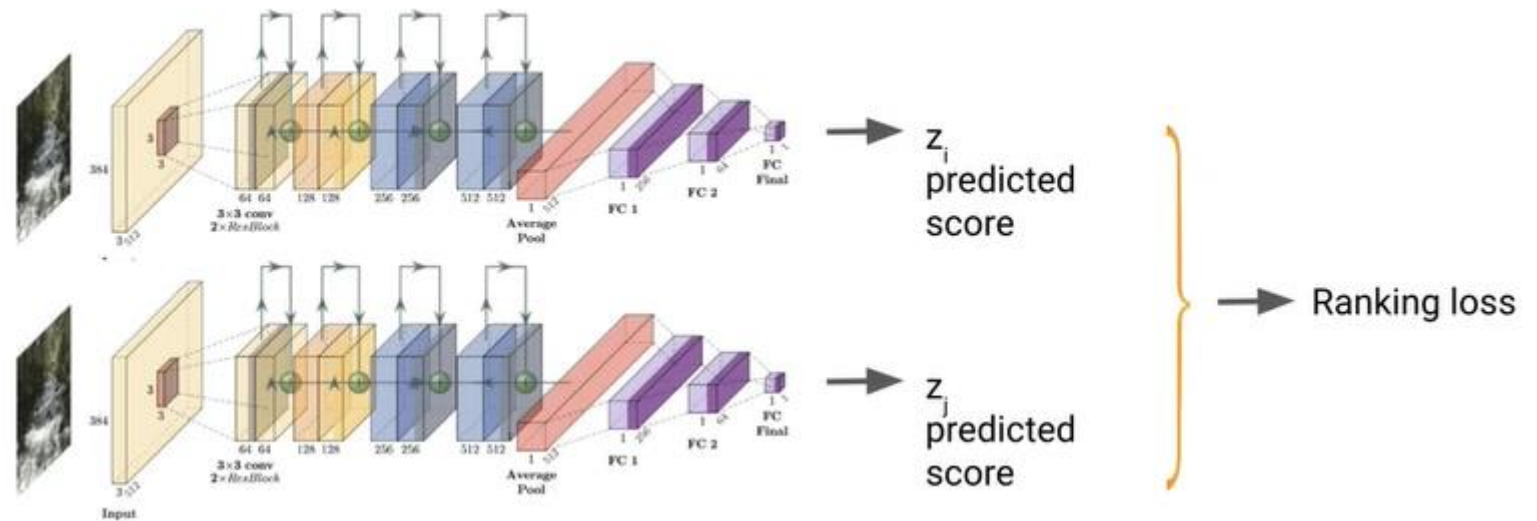https://www.usgs.gov/apps/ecosheds/fpe/#/

1. Input data for models

2. Database

3. **Machine Learning Models**

Neural Network

Next slides on neural networks originally
presented by Amrita Gupta, Microsoft AI for Good

How do we train a Machine Learning Model When NO Flow Data are Available?

With Rankings from Paired Photos

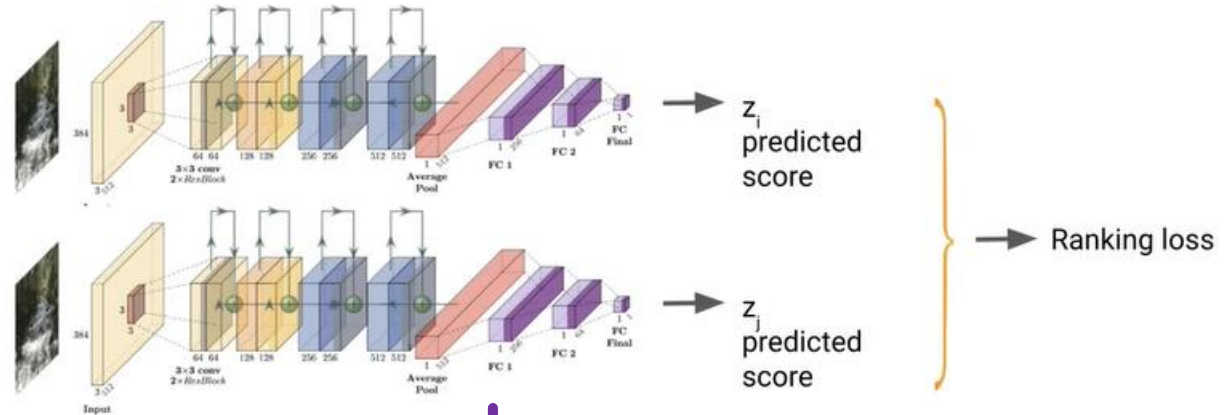Which of these 2 images has higher streamflow?

Inputs (from camera)

Labels (from annotator)

Which image has higher streamflow?

Model Training

Neural Network Model

z_i predicted score

z_j predicted score

→ Ranking loss

Ranking Scores for each photo (NOT flow values)

243.3   11.1   157.6   -20.9
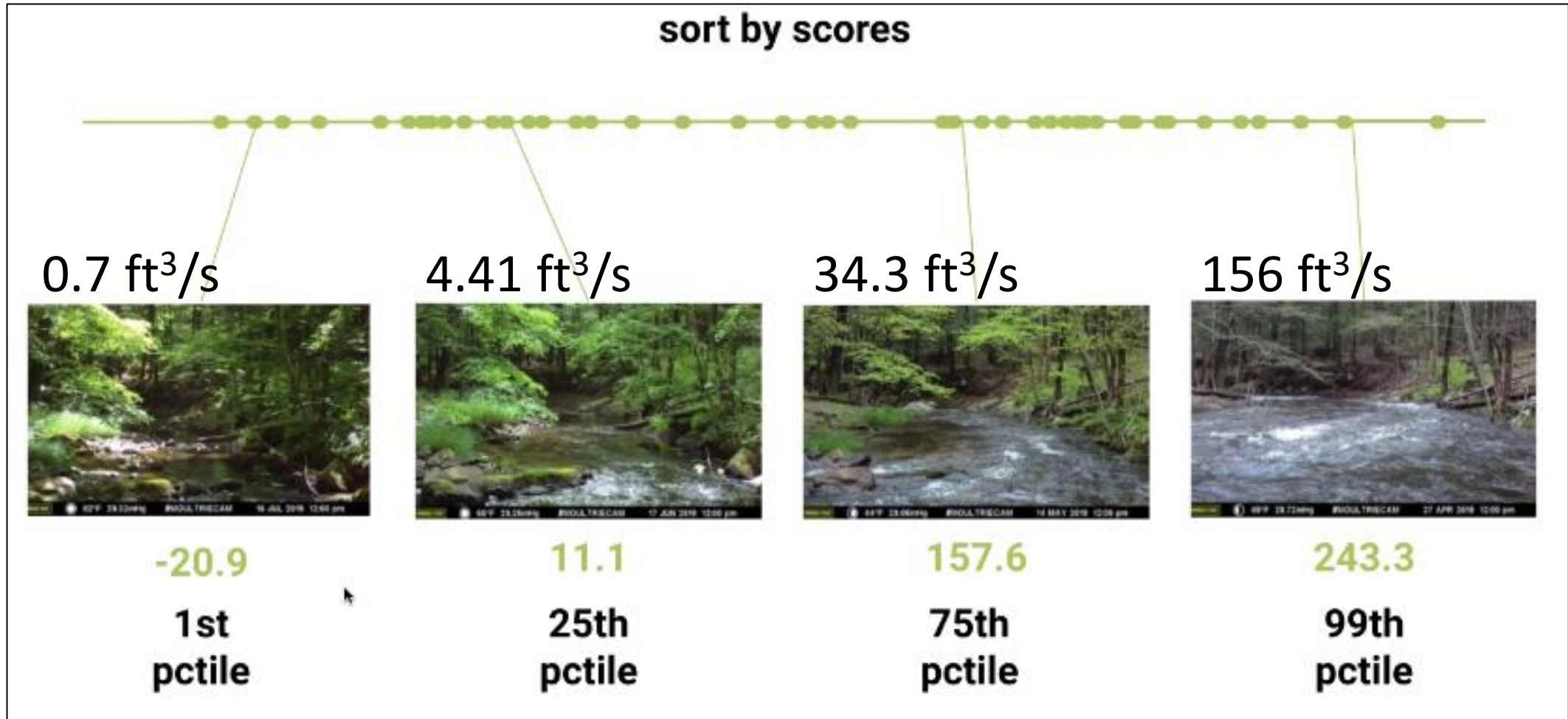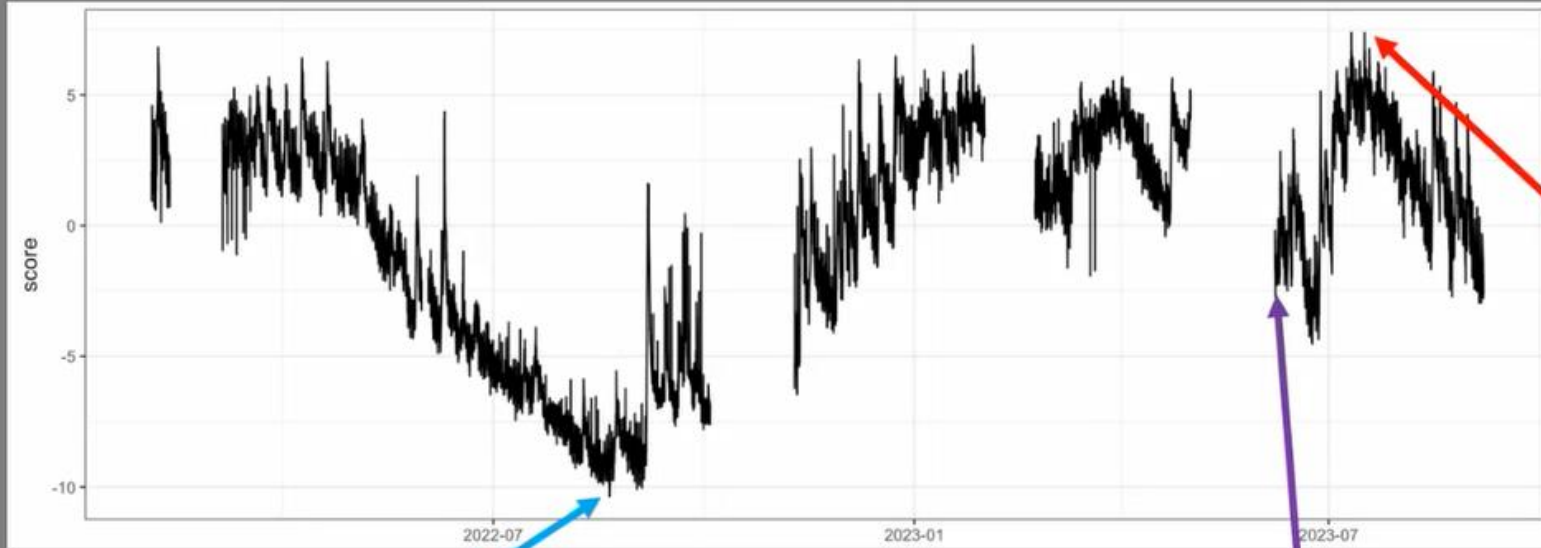
Model Training

Predicted Image "Score"

Highest Score

Lowest Score
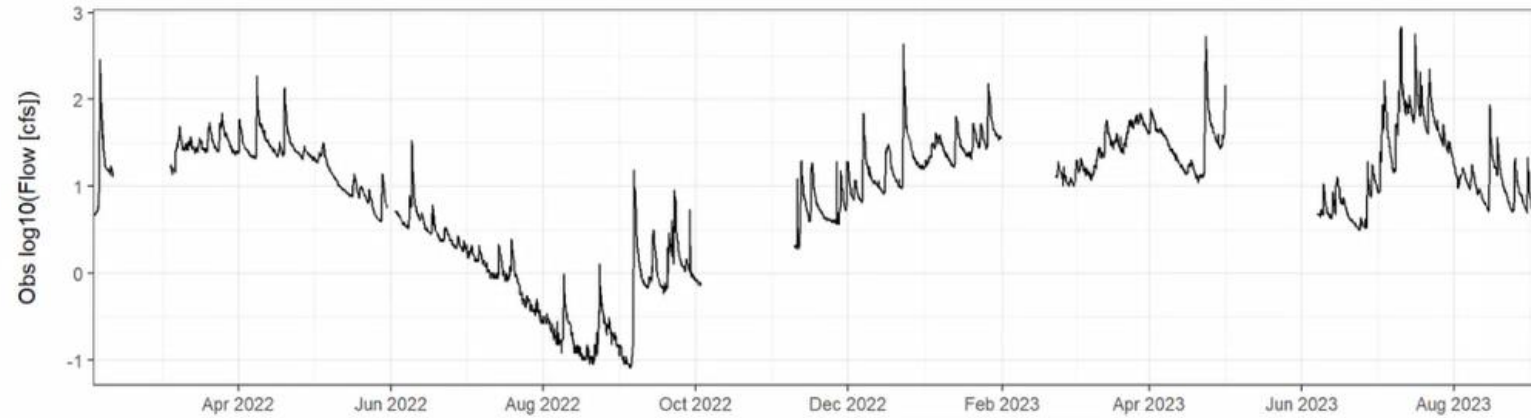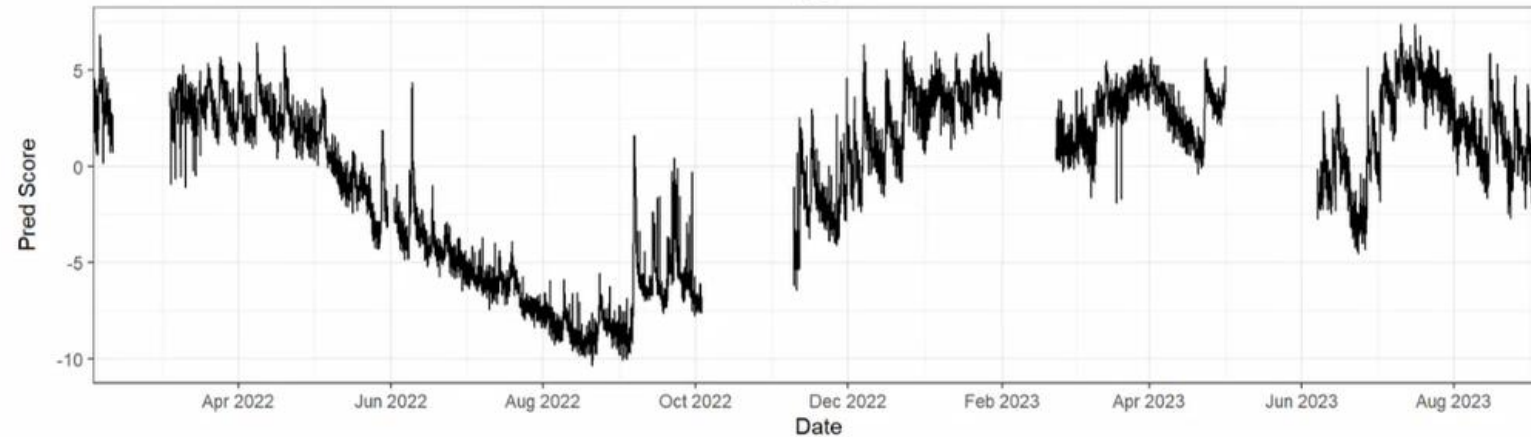
Median Score

Model Results for West Brook (MA)
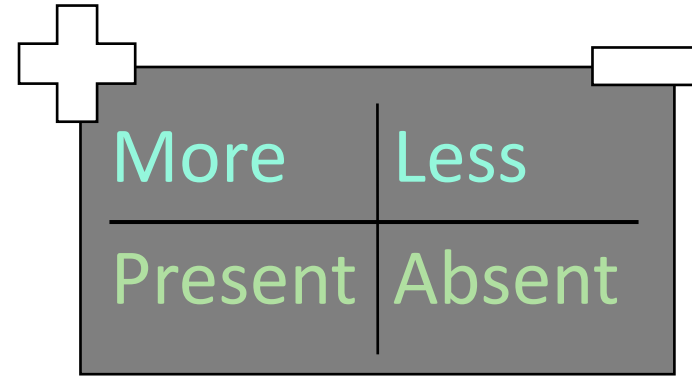
Observed Flow

Predicted Score

Performance (Kendall Tau):
 Train: 0.88
 Val: 0.87
 Test: 0.80
 Overall: 0.85

Any parameter that can be evaluated in photo pairs as:

More	Less
Present	Absent

Wetlands

Water presence/absence

% ice cover

Depth

Leaf on/off

Bloom date

Animal activity

Lakes

% ice cover

HABs

Water level

Leaf on/off
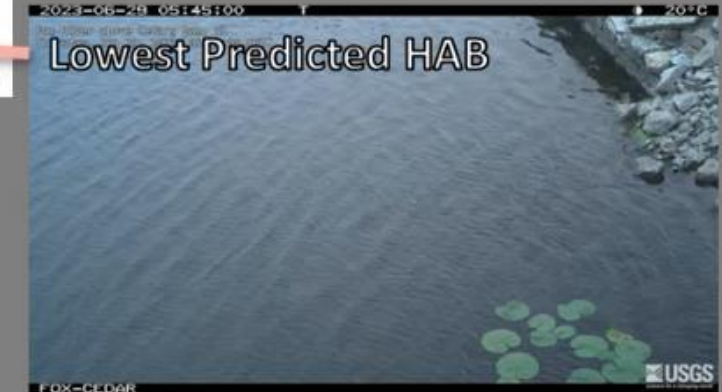
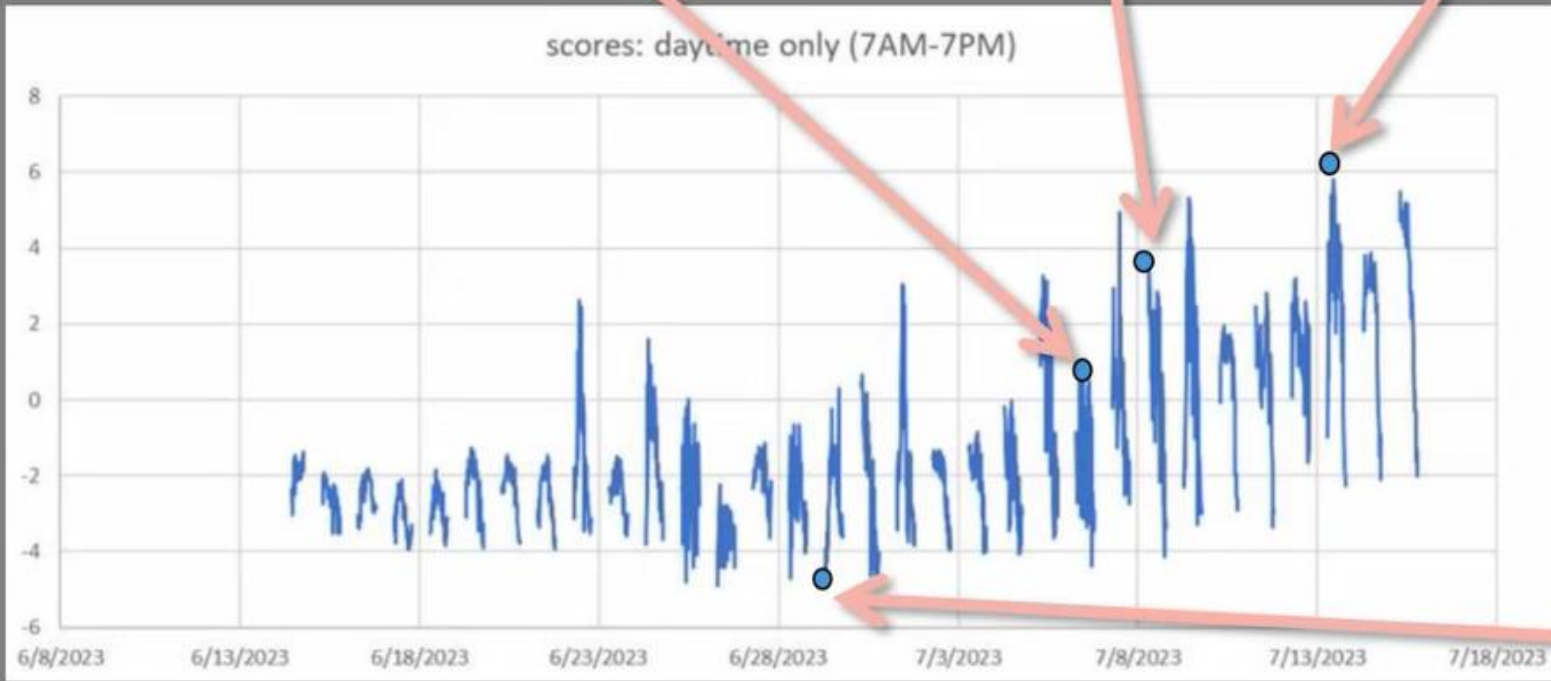Eutrophication

Riparian vegetation ID

FPE and HABs

Highest Predicted HAB

Lowest Predicted HAB

scores: daytime only (7AM-7PM)

Model-predicted score of "HAB" (unitless)

Time (5-week period)

Points of Contact: Keegan Johnson, Paul Reneau, Hayley Olds, Upper Midwest WSC

Project Roles
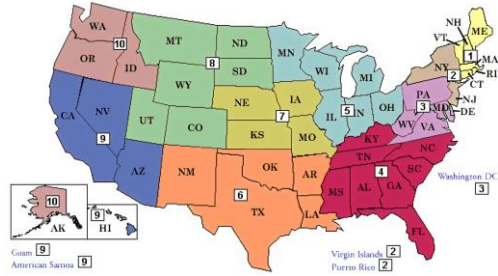
State, Tribal, & Other Collaborators:

- Collect trail camera continuous photos and upload into Flow Photo Explorer

- Provide feedback on developing products

- Rank photos with annotations

- Optionally attend tri-weekly meetings

Participation

Supplies Needed

Trail Camera with timelapse mode

Optional camera mount/ Security housing
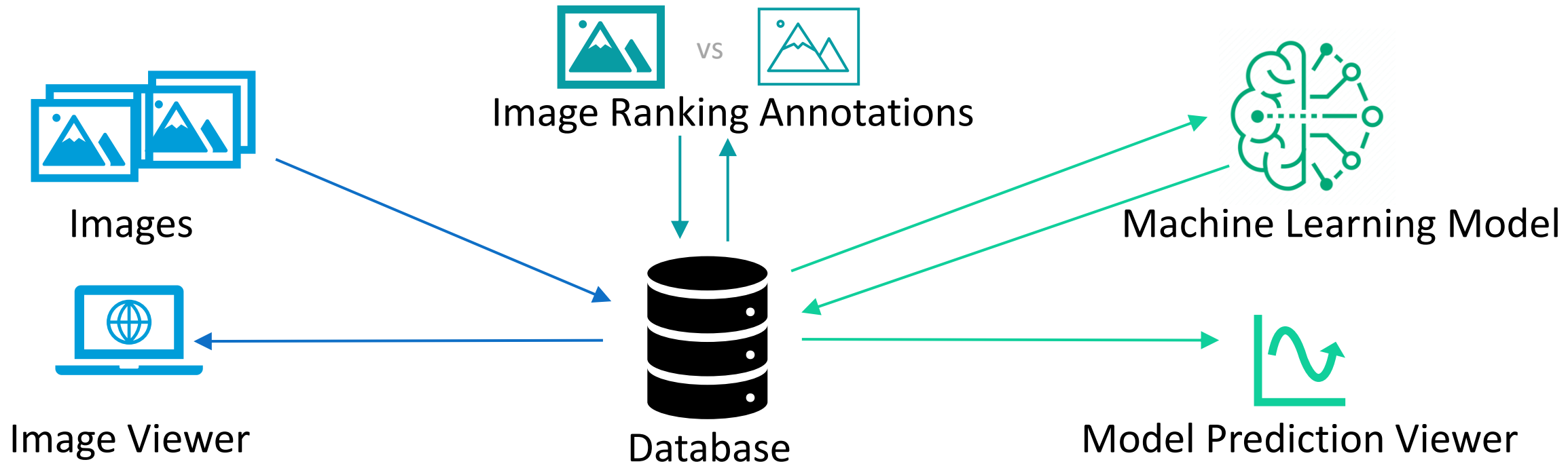
Memory card

Batteries (or solar panel)

Cable lock

Free Website Account

Final Product

12 mos. of Photos $+$ 2,000 Annotations $=$ Model Predictions

Image Ranking Annotations

Images

Image Viewer

Database

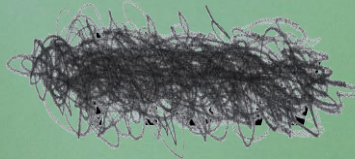Machine Learning Model

Model Prediction Viewer

Photo Explorer

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Website

Modeling Publication & Presentation