New frontiers for "big data" in fish biology and climate change research

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• We need intensive spatial data within stream networks to model fish population dynamics and forecast change

• Emerging video technology can address this need

• Imagery + crowdsourcing = powerful new opportunities for ecology
Hierarchical spatial structure of stream networks
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Spawning site selection, Egg incubation

Movement for spawning, feeding, refugia

Source/sink dynamics

Frissell et al. (1986)
Spatial variation in Q and T

More GW variation within HUC-12 watersheds than between them

Snyder et al. (2015)
Spatial variation in Q and T

- High GW influence
- Low GW influence

100-m prediction points
Spatial variation in Q and T

High GW influence
Low GW influence

100-m prediction points

Flow gage
Stream network structure in fish thermal habitat forecasts

https://chesapeake.usgs.gov/fishforecast
Video sampling widely used in marine environments

Freshwater applications?
360Fly 4K camera
64 G
Waterproof
~ $350

Mount on mini-tripod
15-minute samples
2 cameras/pool
Environmental covariates
Adipose fin
Video count

\[ \text{Slope} = 0.16 \]
\[ R^2 = 0.19 \]

\text{age 1+}

\[ \text{Slope} = 0.57 \]
\[ R^2 = 0.75 \]
Electrofish count (3 pass)

**YOY**
- Slope = 0.13
- $R^2 = 0.12$

**age 1+**
- Slope = 0.97
- $R^2 = 0.66$
Analysis of age 1+ model residuals via RPART

- Video counts exceeded dive counts with increasing pool volume
- Video counts exceeded electrofishing counts with increasing riffle crest depth
Riffle Crest Depth

- \( D_p \) = Depth of the riffle pool
- \( D_r \) = Depth of the riffle run
- \( D_{pt} \) = Depth at the riffle's crest

Water surface (flow →)
Spatial structure in age 1+ trout abundance

A Video

B Electrofish

C Dive count
Fish identification instructional video
1000s of fish counts from across the nation
Crowdsourced estimates vs biologist counts

Age 1+ trout abundance estimates

Pool ID

n=233 n=241 n=222 n=246 n=225 n=217 n=242 n=256 n=224 n=248 n=233 n=234 n=254 n=218 n=251
Statistical power via crowdsourcing
Statistical power via crowdsourcing
Statistical power via crowdsourcing

Precision

Accuracy
Opportunities for crowdsourcing data in National Parks

New technology + social media yield new opportunities for ecology
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Video demo