Fish Population Status & Monitoring: How Many Fish are in the River?

Rethinking the logic of riverine population abundance assessments

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Poisson Consulting

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How Many Trout are in the River?

Obtaining a reliable answer to the question of ‘**how many trout are in the river**?’ plays an important role in *monitoring threats to fish populations*.

Although approaches to answering this question are often formulated in terms of statistical procedures, we present the underlying logic and rethink some misconceptions.

Counting Fish In a Barrel

Scenario A: The entire river is surveyed using a method with 100% observer/capture efficiency.

The population abundance (N) is the number of fish observed/captured!

Counting Fish Through a Glass Darkly

Scenario B: Just 10% of the river is surveyed using a method with uncertain observer/capture efficiency!

How many fish did we not observe/catch at each site?

How many fish were at the sites we did not survey?

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Relative Abundance?

Methodology: Divide catch by effort.

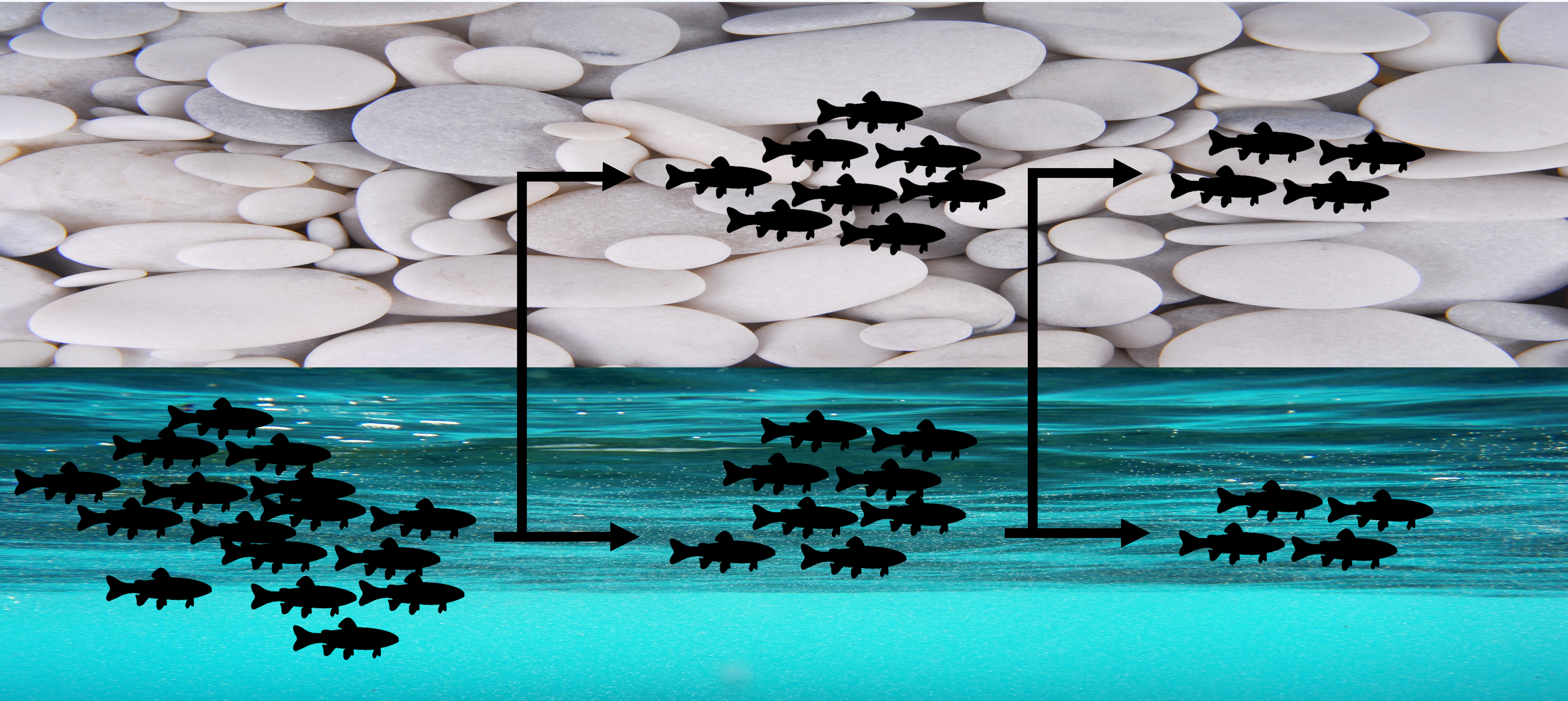
Justification: We are only interested in changes in relative abundance as opposed to the absolute abundance and so can ignore the fish we didn't' catch

Limitation: Efficiency can change over time even with constant effort.

*"It is recommended that single-pass and timed electrofishing methods **should not be used** to assess trends in fish populations **without regular (annual) calibration**."*

Glover et al. 2019. These are not the trends you are looking for: poorly calibrated single-pass electrofishing data can bias estimates of trends in fish abundance. J Fish Biol.

Depletion-Removal



Depletion-Removal Bias!

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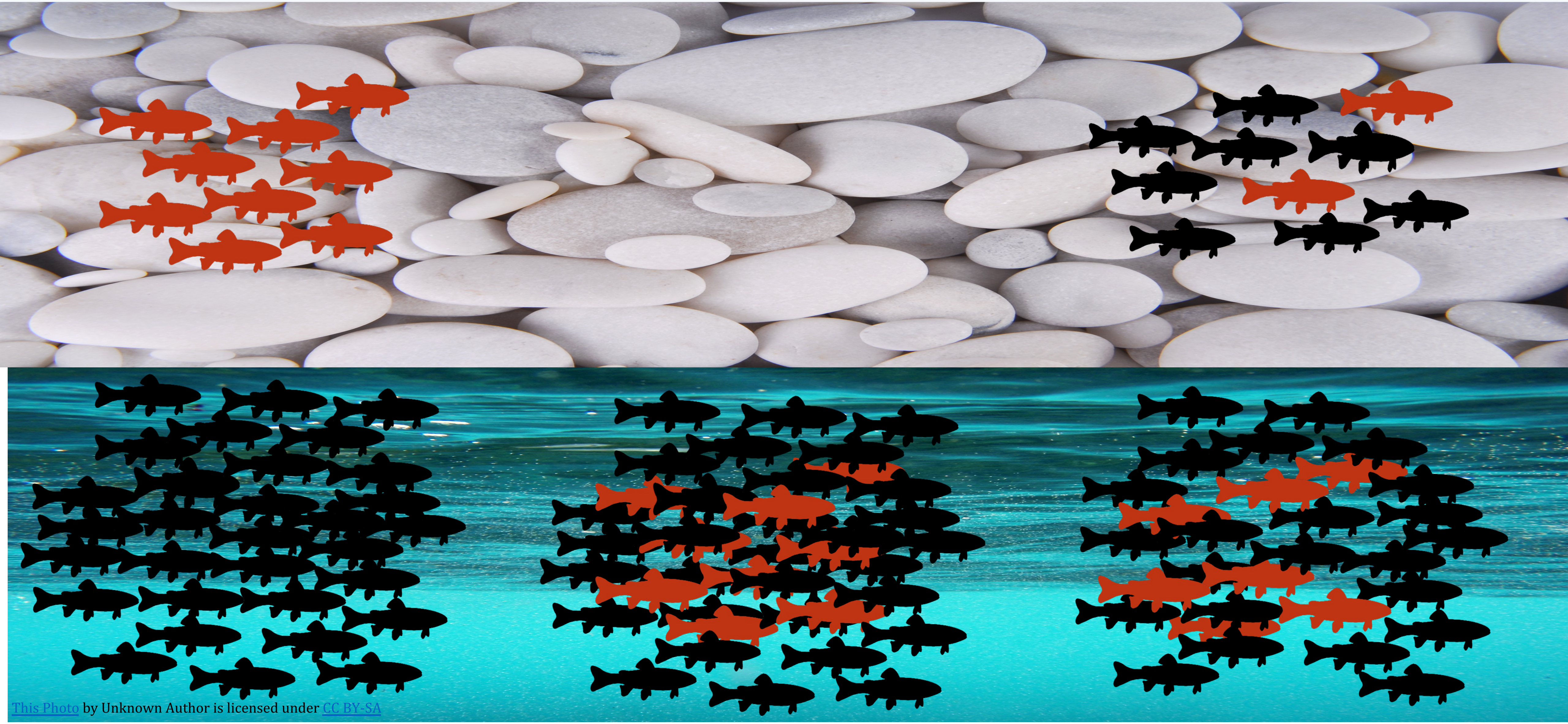
DEPLETION-REMOVAL BIAS!

"*On average, the removal methods … under-estimated fish abundance by 88%.*"

Peterson, Thurow & Guzevich 2004. An Evaluation of Multipass Electrofishing for Estimating the Abundance of Stream-Dwelling Salmonids. TAFS.

Mark-Recapture



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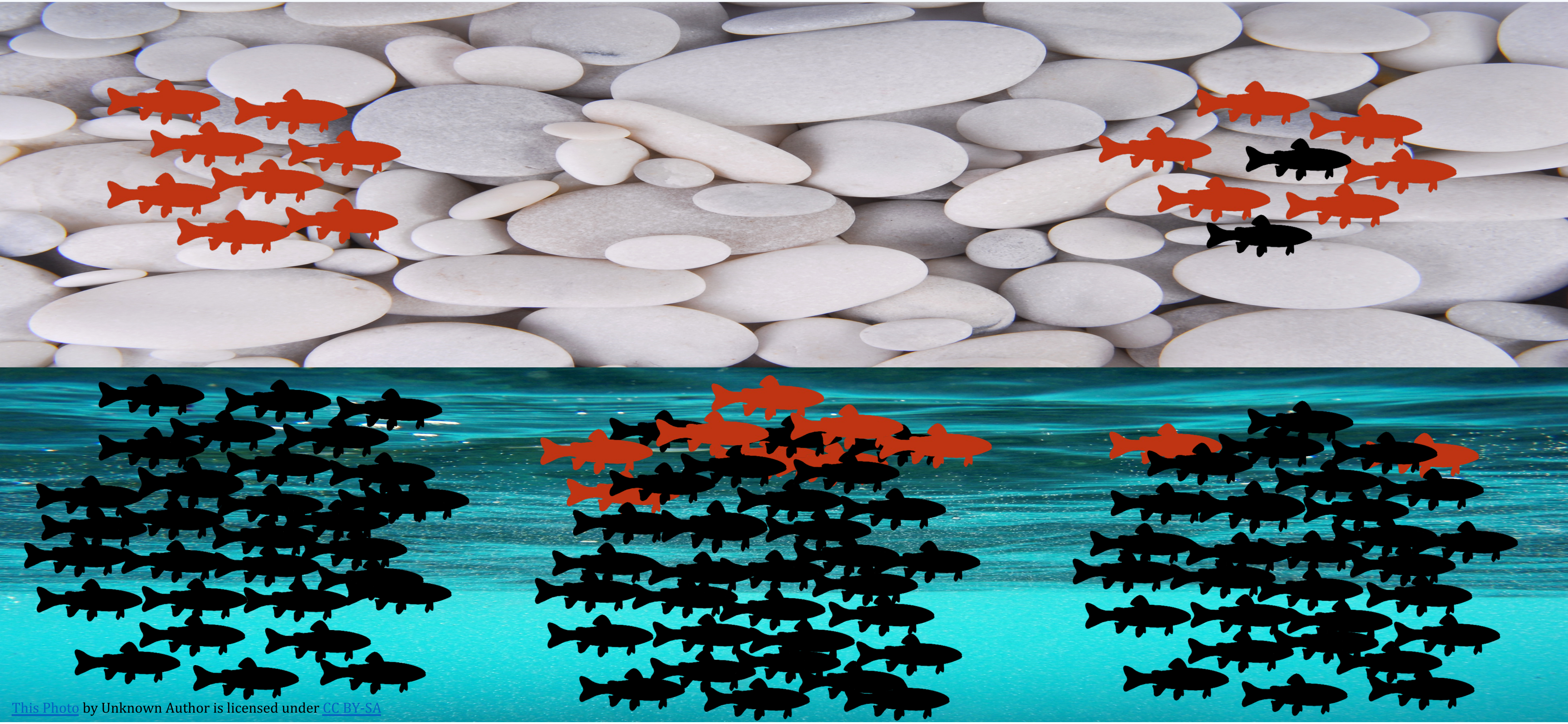
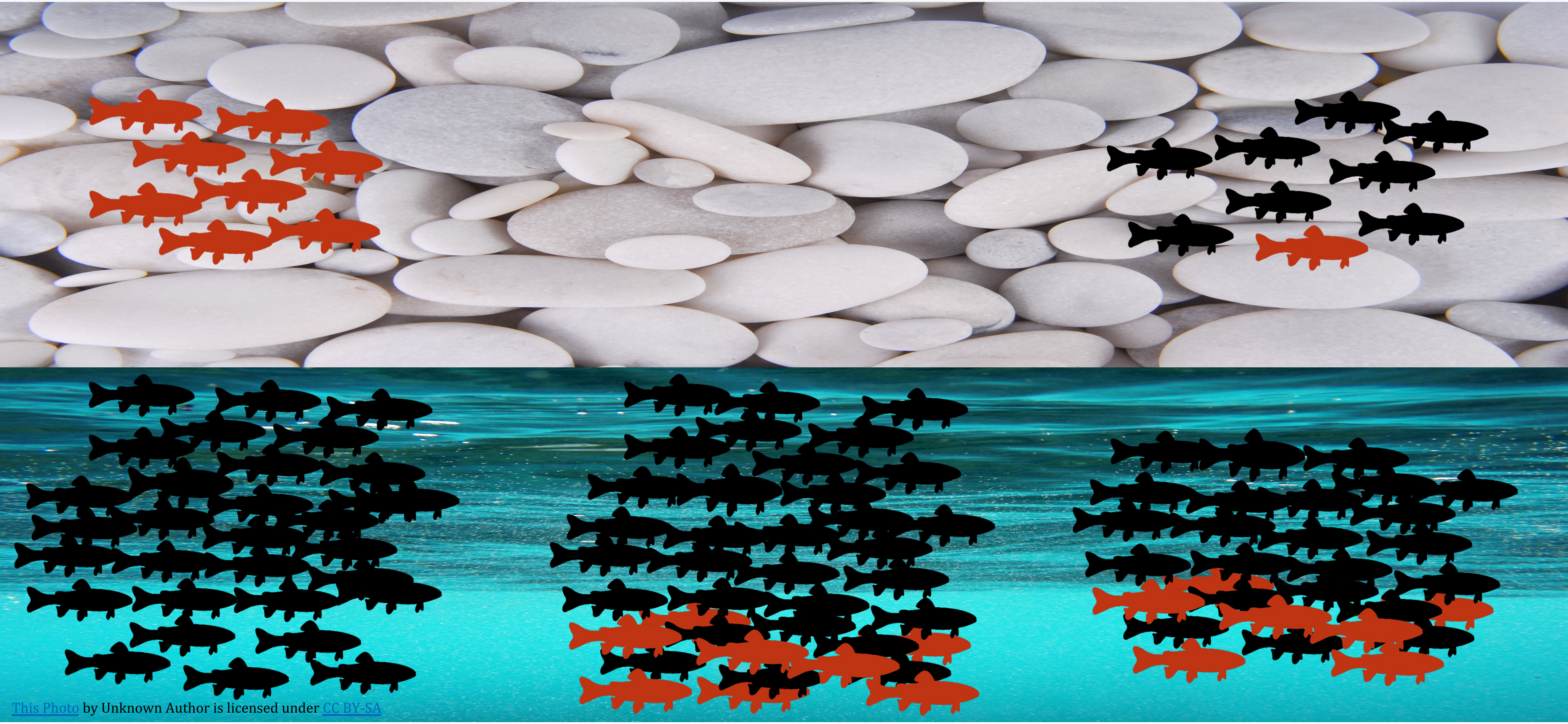
MARK-RECAPTURE TRAP-HAPPY!



Mark-Recapture Trap-Shy…



Mark-Recapture

*"In contrast, we found that rainbow trout abundances **could be rigorously assessed with the mark–recapture model** as long as sufficient numbers of fish were recaptured."*

Rosenberger & Dunham 2005. Validation of Abundance Estimates from Mark–Recapture and Removal Techniques for Rainbow Trout Captured by Electrofishing in Small Streams. NAJFM.

Which Sites?

- High Density
- Random
- Stratified

High Density

Methodology: Select sites where there are lots of fish (and revisit each year).

Justification: Only requires relative abundance.

Limitations:
- Fish numbers at high quality sites can be relatively insensitive to changes in population abundance.
- Some rivers are highly dynamic causing ‘regression to the mean’ in habitat quality.

RANDOM SITES

Methodology: Select sites at random.

Justification: Unbiased.

Limitations: Requires lots of resources.

"*It appears to be a quite general principle that, whenever there is a randomized way of doing something, then there is a nonrandomized way that delivers better performance but requires more thought*."

Jaynes, E.T. 2003. Probability Theory: The Logic of Science. Cambridge University Press.

Stratified Sites

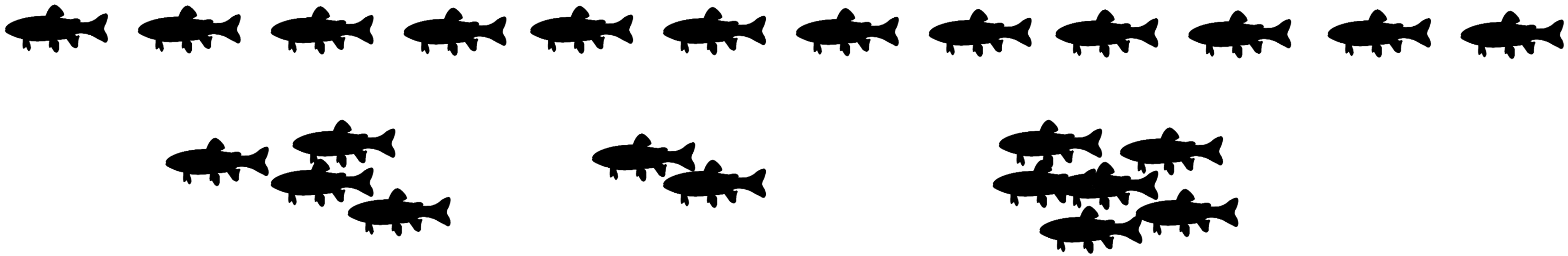
Methodology: Select sites to understand spatial and temporal variation in population abundance.

Justification: Informative.

Limitations:

- Requires lots of thought.
- May require lots of resources (but necessary!).

Sampling Intensity



"The extent of variation in fish densities … was the most important factor influencing the precision of river-wide abundance estimates."

Korman, Schick & Mossop 2016. Estimating Riverwide Abundance of Juvenile Fish Populations: How Much Sampling is Enough? NAJFM 10.1080/02755947.2015.1114542.

Which Fish Habitat Variables?

Habitat Assessment

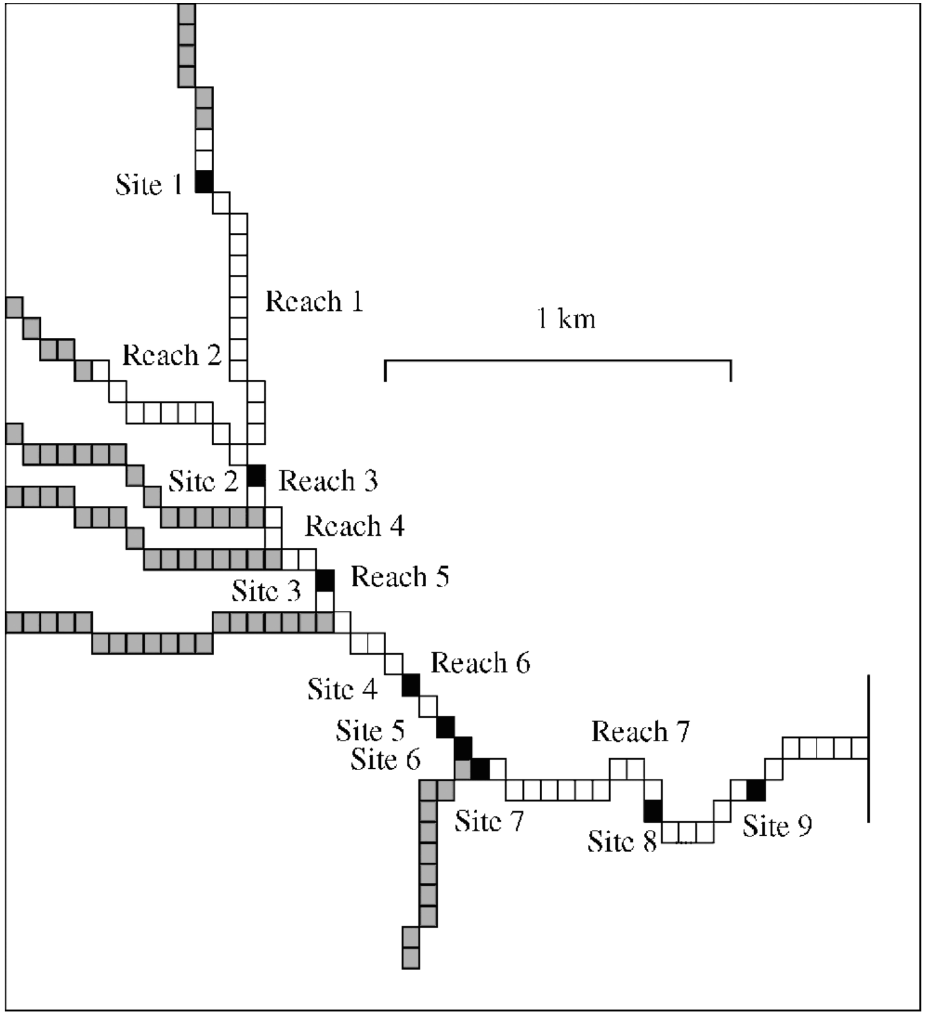
Habitat Use

Abundance

WHICH FISH HABITAT VARIABLES FOR ABUNDANCE?

Capture Efficiency
- Visibility (and/or TSS)
- Water Temperature (fish behavior)
- Conductivity (for Electrofishing)
- …

Fish Density
- From GIS and/or river wide survey!



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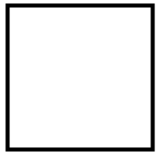
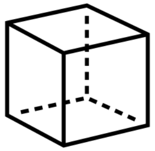
Which Site Dimensions?

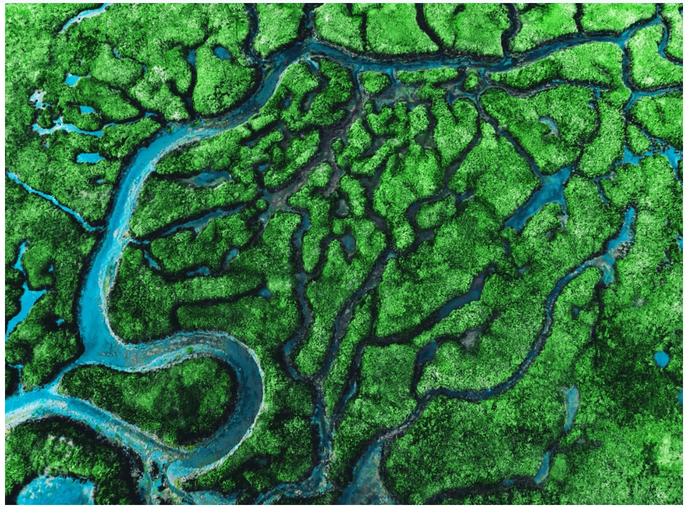
Lineal



Areal

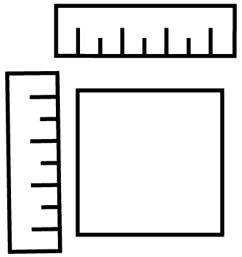


Volumetric



Areal Density in Rivers

Justification: Solar input is the primary limiting factor?



Limitations:

- Sensitive to discharge.
- Complicates comparisons.
- Assumes doubling width same as doubling length.
- Abundance needs wetted width for entire river.

Similar limitations apply to weighted useable area!

Lineal Density in Rivers

Justification:

Channel length has a linear relationship with fish density.

Benefits:

- Facilitates comparisons.
- Abundance just needs stream network.
- Can include wetted (or weighted useable) width as a predictor.

Limitations:

- Changes with flooding of side channels (less sensitive than wetted width).

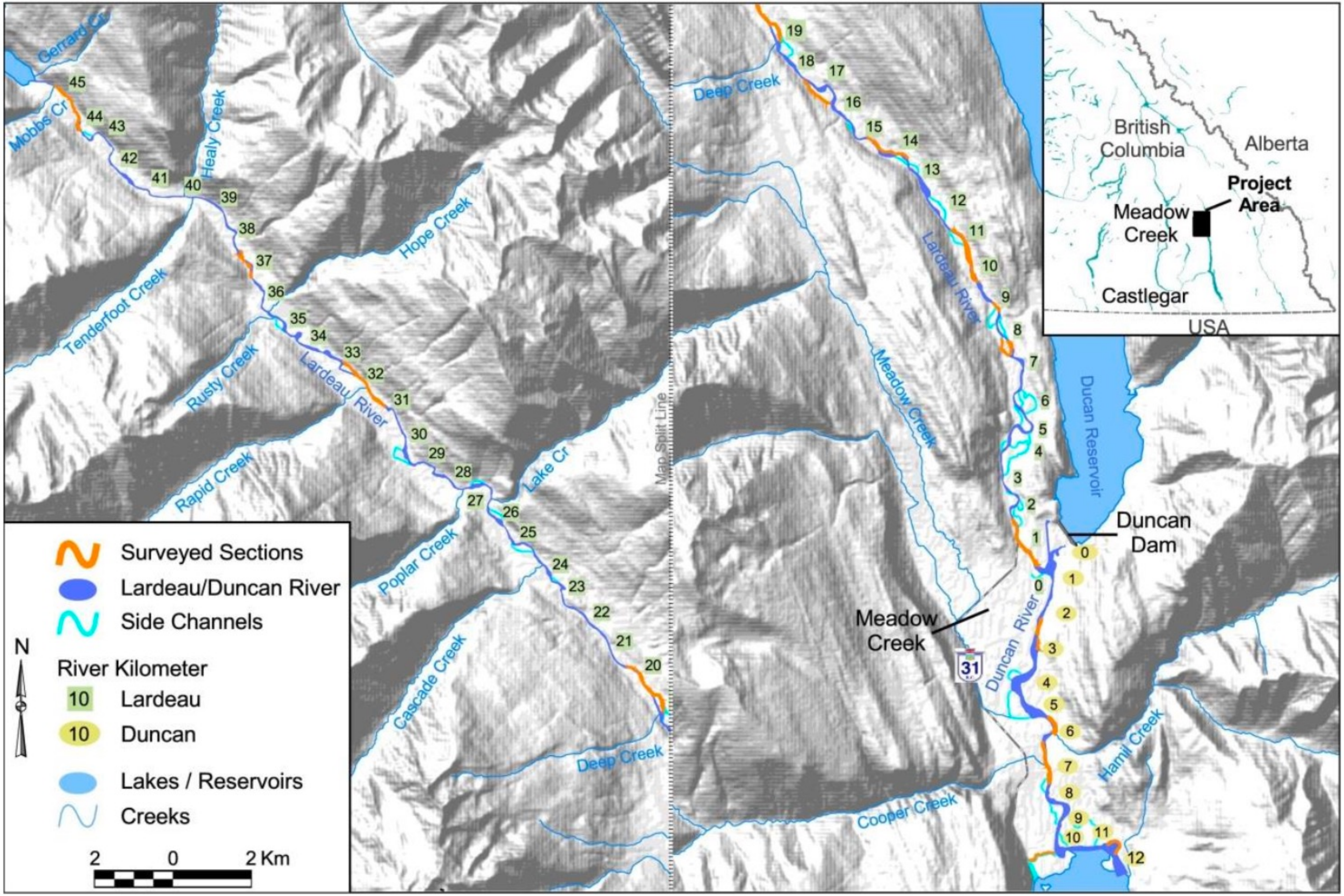
Gerrard Rainbow Trout Age-1 Abundance

A Case Study

with

Greg Andrusak, RPBio
Provincial Rivers Management Biologist
BC Ministry of Water, Lands and Resource Stewardship (WLRS)

Evan Amies-Galonski, RPTech
Poisson Consulting Ltd.



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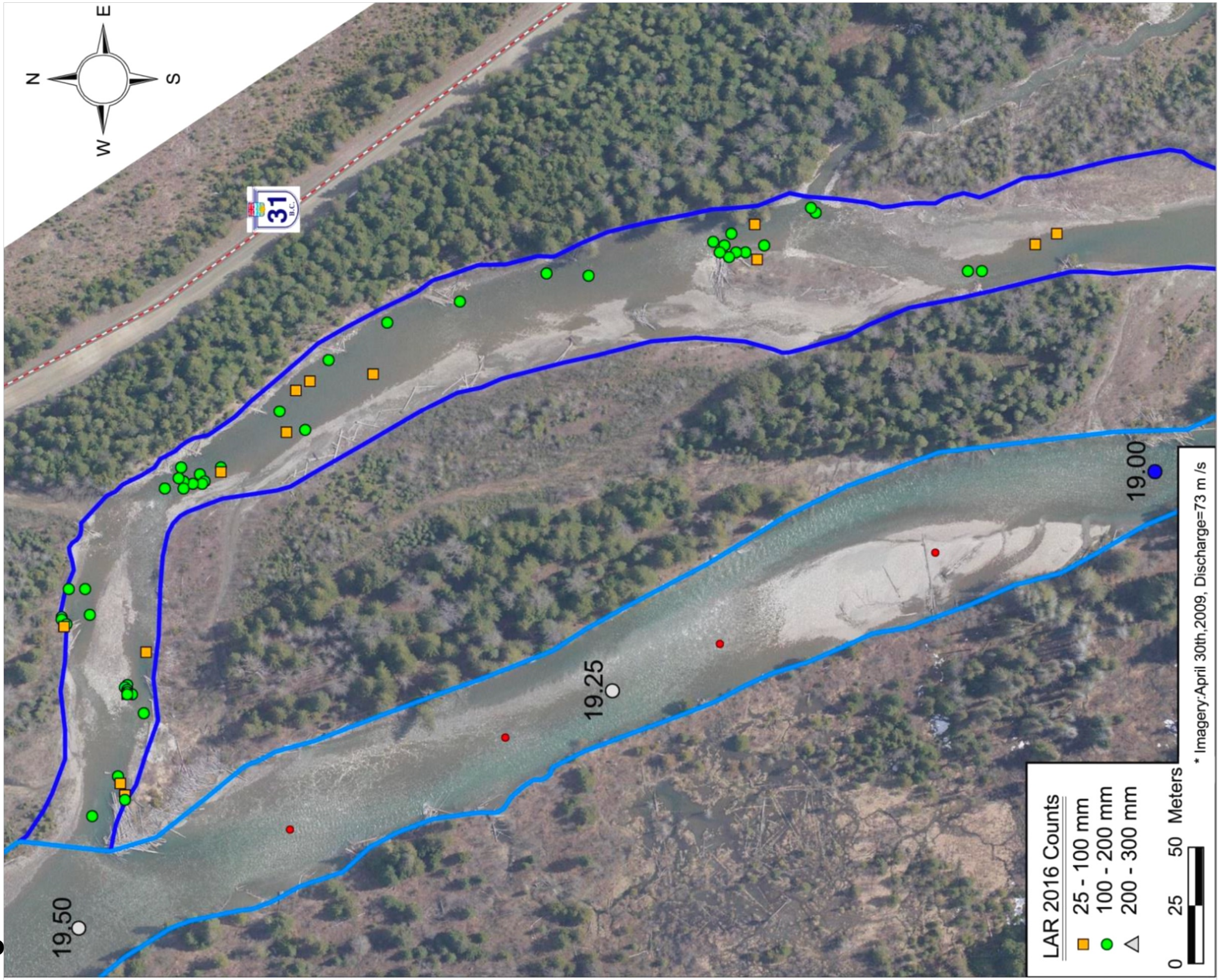
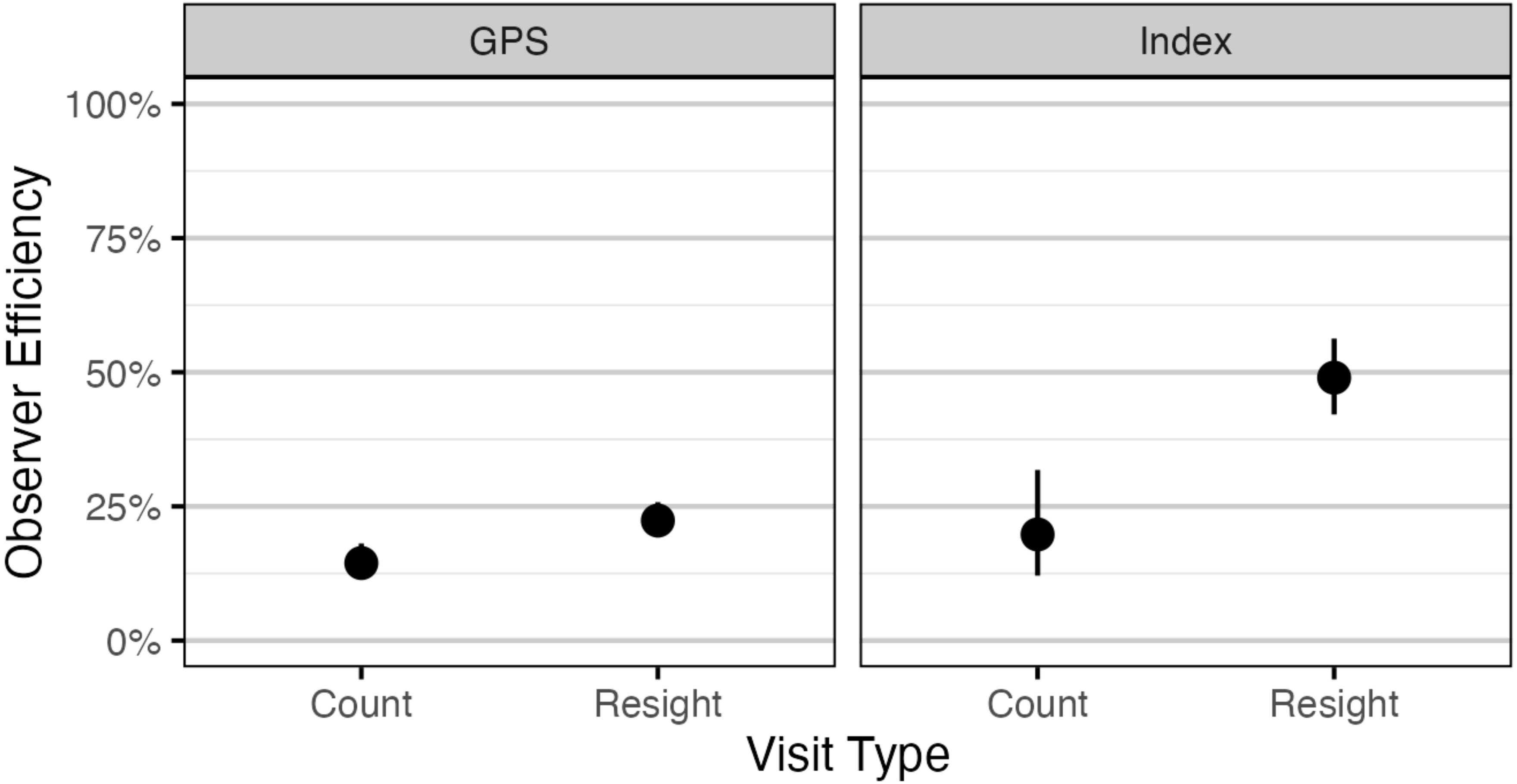
GERRARD RAINBOW TROUT

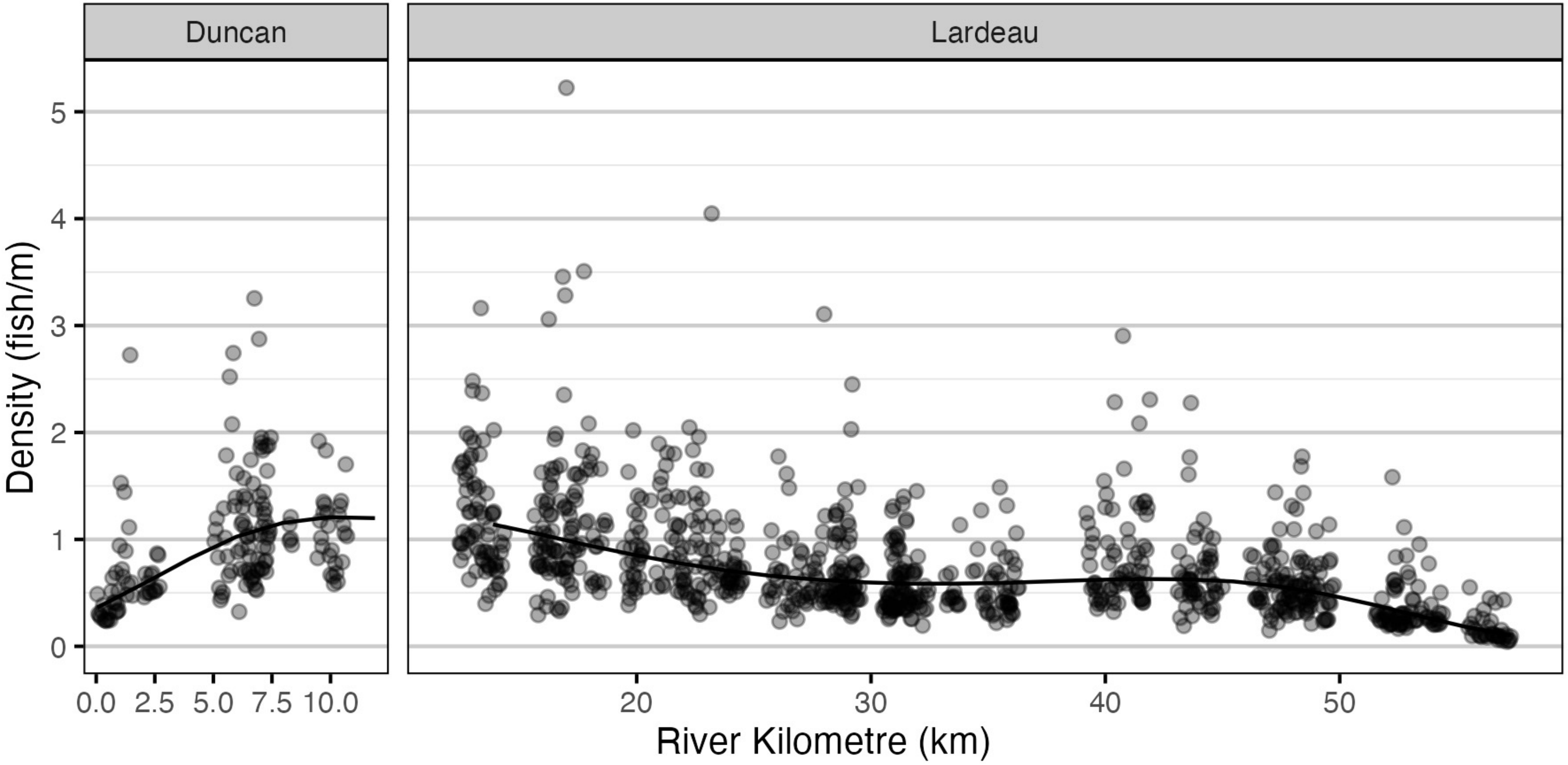


GERRARD RAINBOW TROUT



Predicted observer efficiency for age-1 Rainbow Trout by visit type and study design (with 95% CRIs).

GERRARD RAINBOW TROUT



Predicted lineal density of age-1 Rainbow Trout in 2010 by river kilometre (with 95% CRIs).

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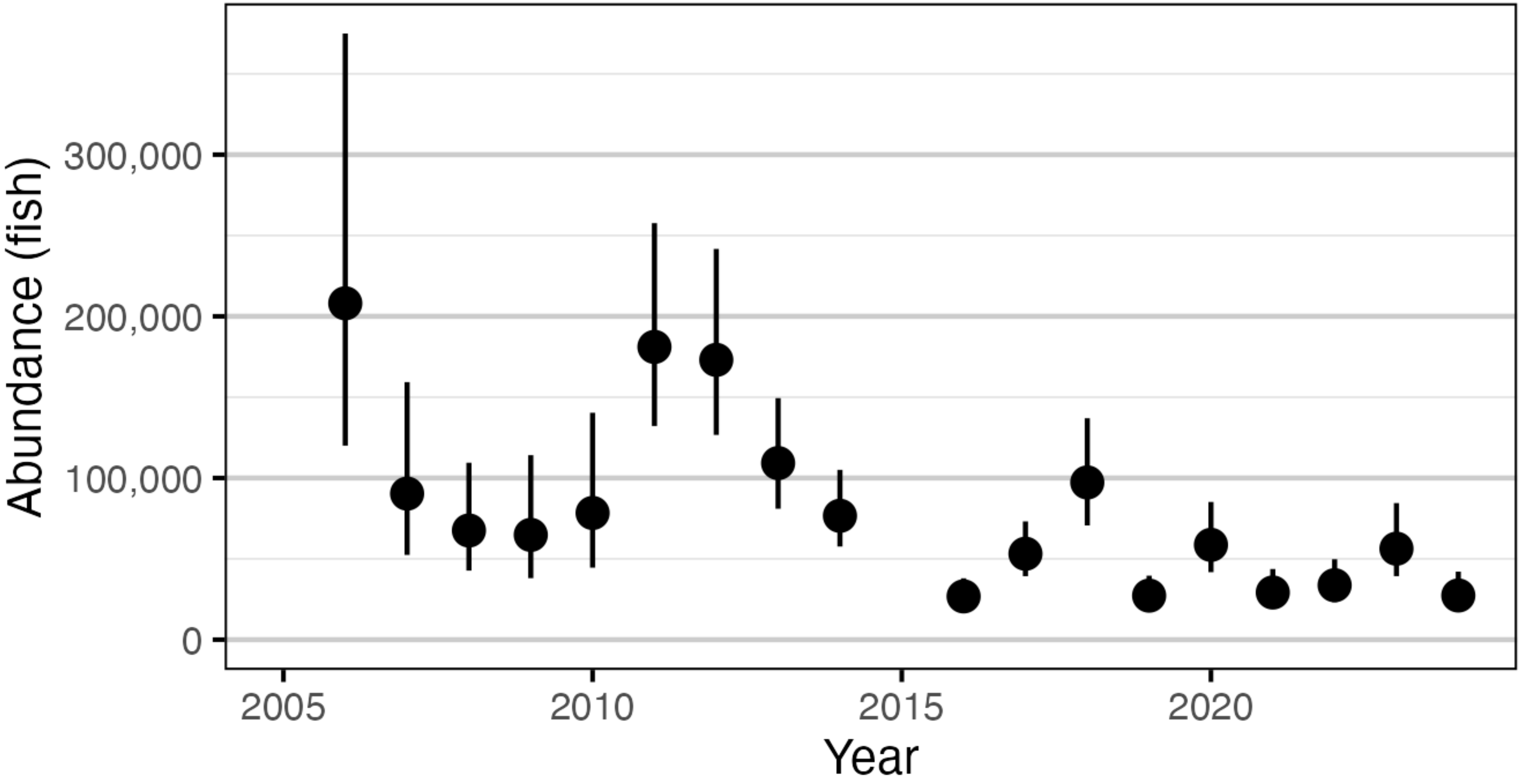
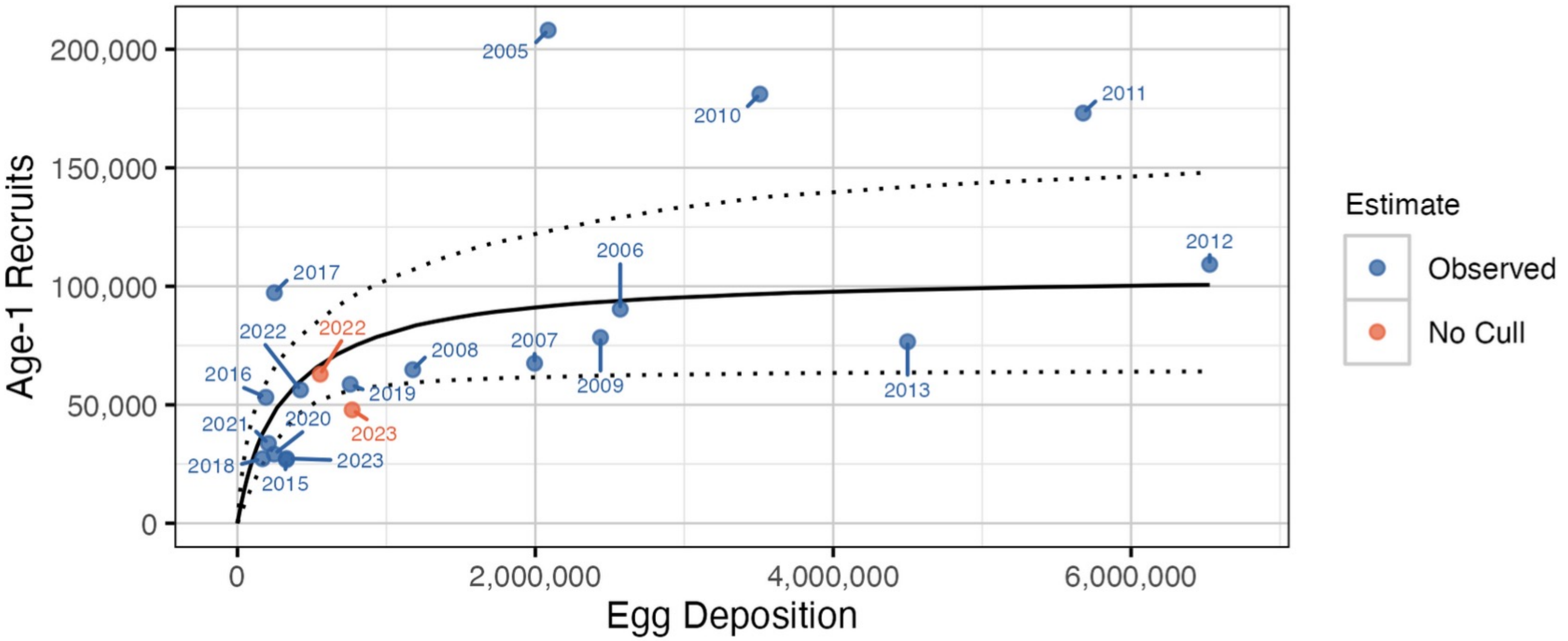
GERRARD RAINBOW TROUT



Predicted abundance of age-1 Rainbow Trout in the Duncan and Lardeau Rivers by year (with 95% CRIs).

GERRARD RAINBOW TROUT



Predicted stock-recruitment relationship between spawners and age-1 recruits (with 95% CRIs). The estimated number of recruits if no spawners were culled is also shown in red, assuming the same residual variation from the expected value as with the recruits actually observed in each year.

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RECOMMENDATIONS

- Use **mark-recapture** to estimate efficiency (capture w other method if possible)
- Select sites using **stratified sampling** (w random component if unsure)
- Sampling intensity should reflect site variation in density (determine pilot study)
- Record habitat variables likely to affect capture efficiency (visibility etc)
- Determine other habitat variables using **GIS** (and/or whole river surveys)
- Estimate **lineal densities** (with width as a predictor if informative)