EPA

PREDICTING CARBON DIOXIDE AND METHANE EMISSION RATES FROM U.S. RESERVOIRS USING BOOSTED REGRESSION TREES

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Freshwater Methane Emissions Offset the Continental Carbon Sink

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> Inland water CH$_4$ emissions significant.

> GWP of aquatic CH$_4$ emissions exceeds that of CO$_2$.

U.S. Anthropogenic CH$_4$ budget

Natural Gas
7.0 Tg/yr

Reservoirs
~2.9 Tg/yr
Beaulieu et al (2014)

Ruminants
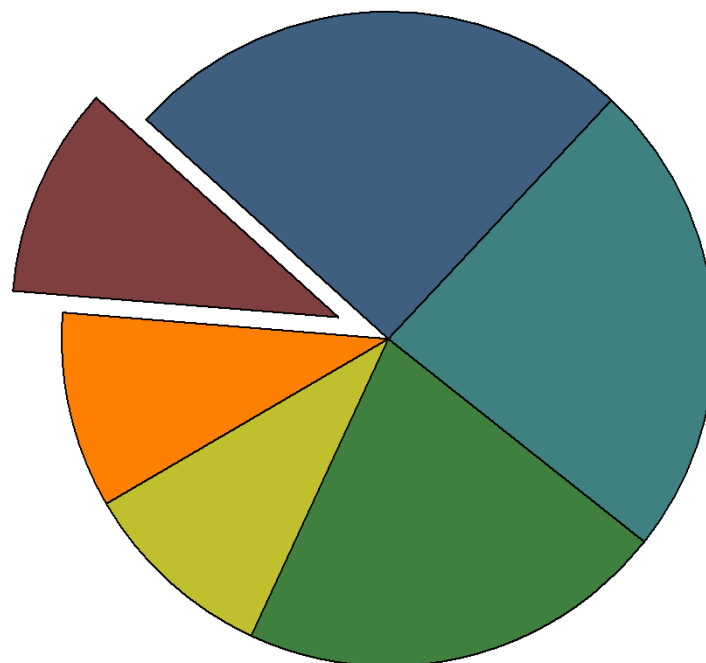6.6 Tg/yr

Coal Mining
2.7 Tg/yr

Pe...
2.7 Tg/yr

Landfills
5.9 Tg/yr

Environmental emission drivers and data accessibility vary by scale

Local

Regional

Global

Actual measurements
- Carbon
- Nutrient
- Temperature
- Solar radiation
- Depth
- Lake size
- Inflows
- Turbulence

Data resolution becomes coarser
- Climate
- Net ecosystem production

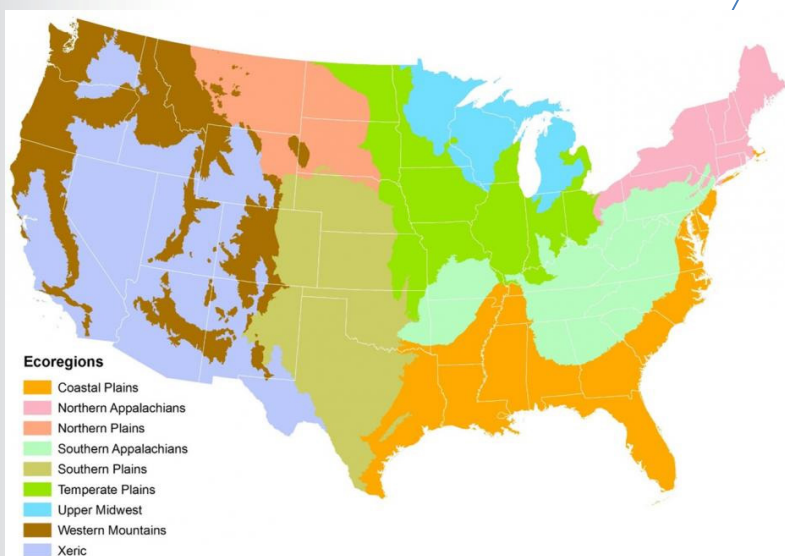Limited useful data sets exist
- Climate
- Biomes

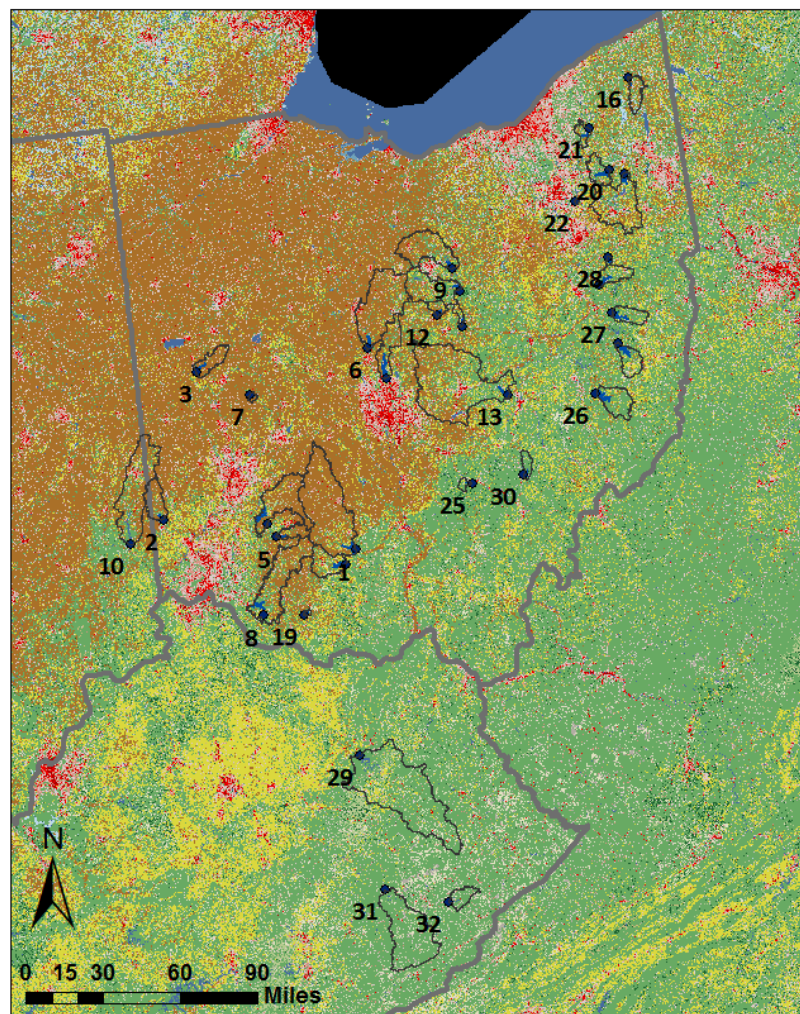Slide compliments of T. DelSontro

Surveyed Reservoir Locations and Watersheds

Ecoregions
- Coastal Plains
- Northern Appalachians
- Northern Plains
- Southern Appalachians
- Southern Plains
- Temperate Plains
- Upper Midwest
- Western Mountains
- Xeric
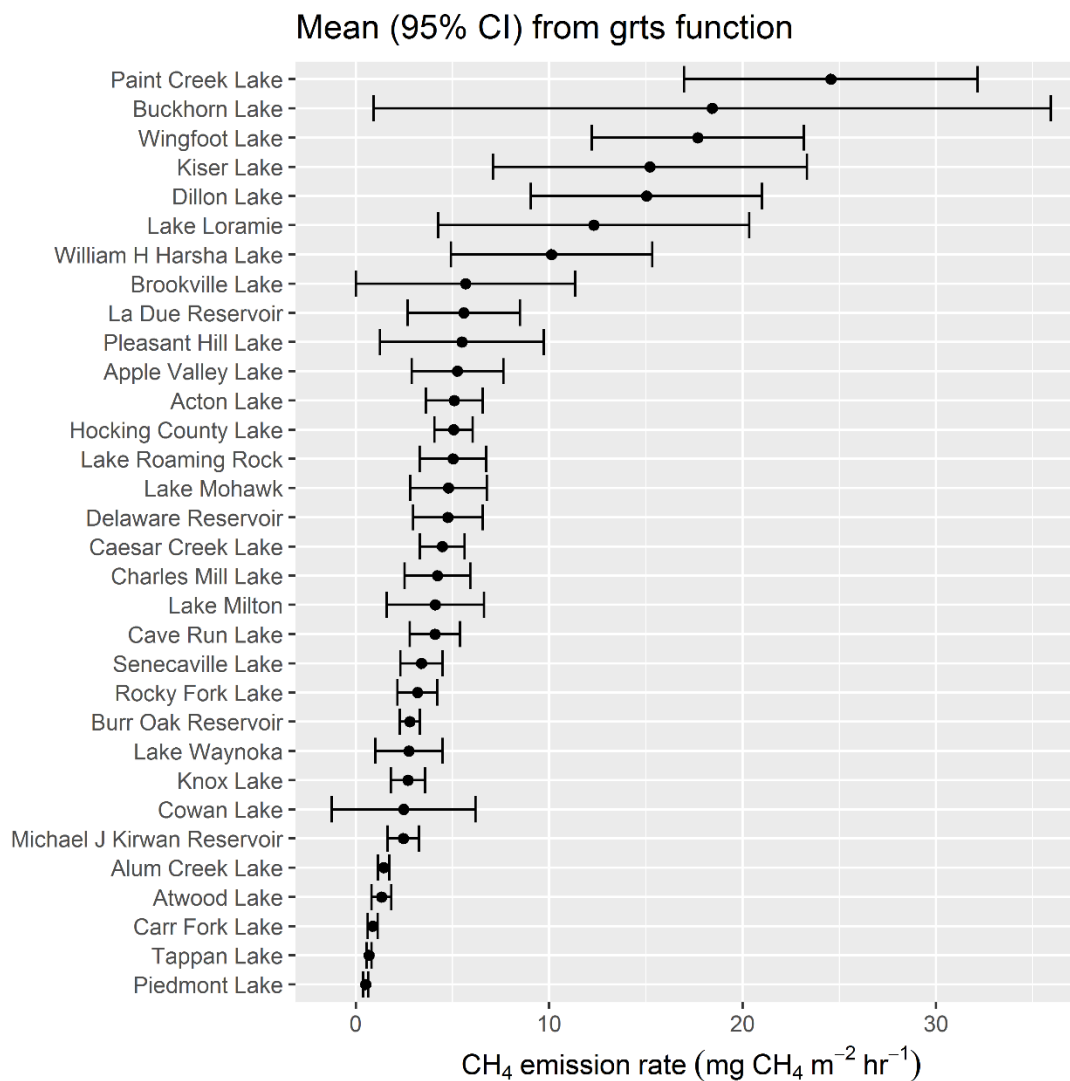
https://www.epa.gov/national-aquatic-resource-surveys/ecoregional-results-national-lakes-assessment-2012

Land cover data from:
http://www.mrlc.gov/nlcd201:

2016 Field Surveys

Mean (95% CI) from grts function

- National/Regional
  - NHDPlus
    - Morphology
      - Area
      - Max/mean depth
      - Proportion littoral
      - Perimeter
      - Shoreline development
    - Catchment
      - Size
      - Slope
      - Land use

- Local scale
  - All national/regional scale information.
  - Direct measures of nutrients, chlorophyll, DO, and dissolved CH_4

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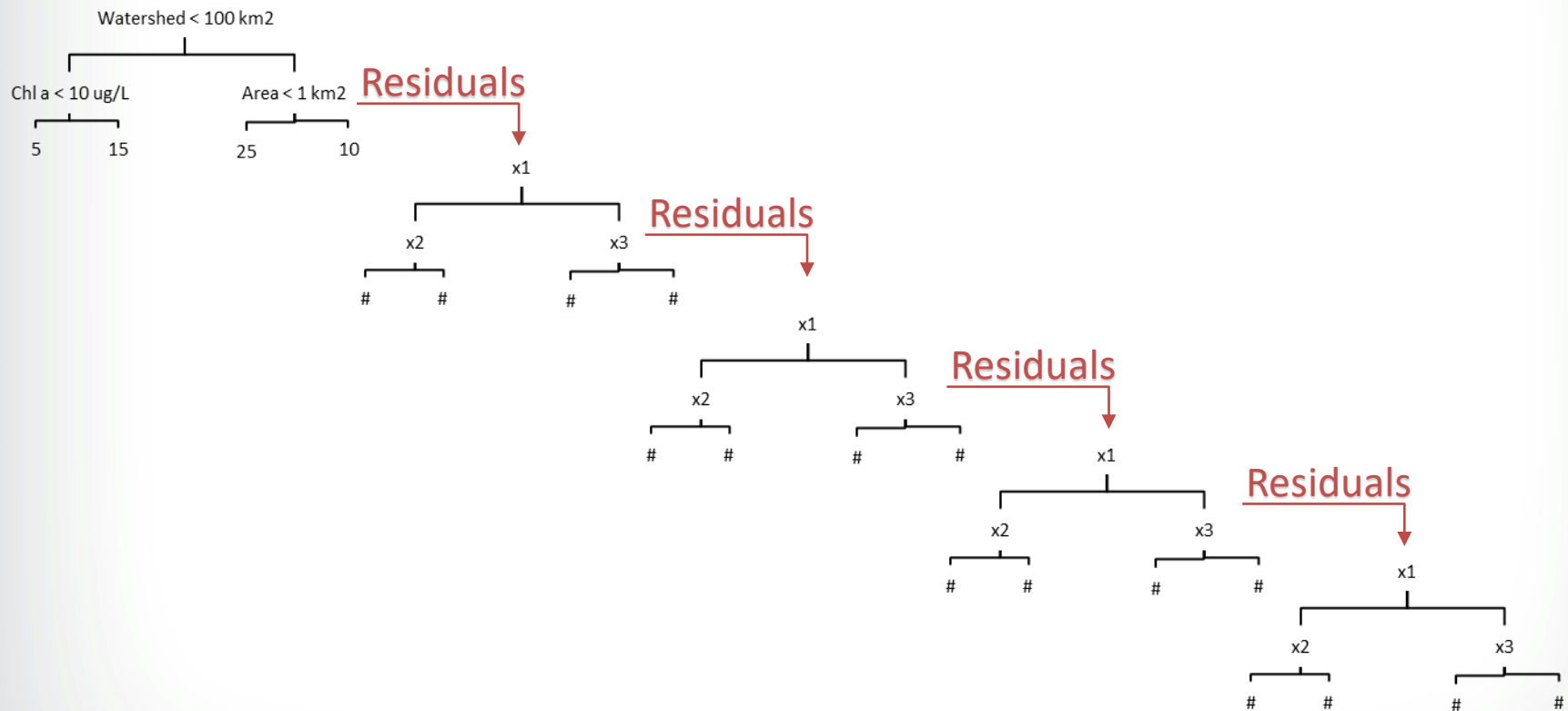   - Size
      - Land use

- Local scale
  - All national/regional scale information.
  - Direct measures of nutrients, chlorophyll, DO, and dissolved CH4

Does local scale information improve prediction accuracy?

- Boosted regression trees

Watershed < 100 km2

Chl a < 10 ug/L   Area < 1 km2

5   15   25   10
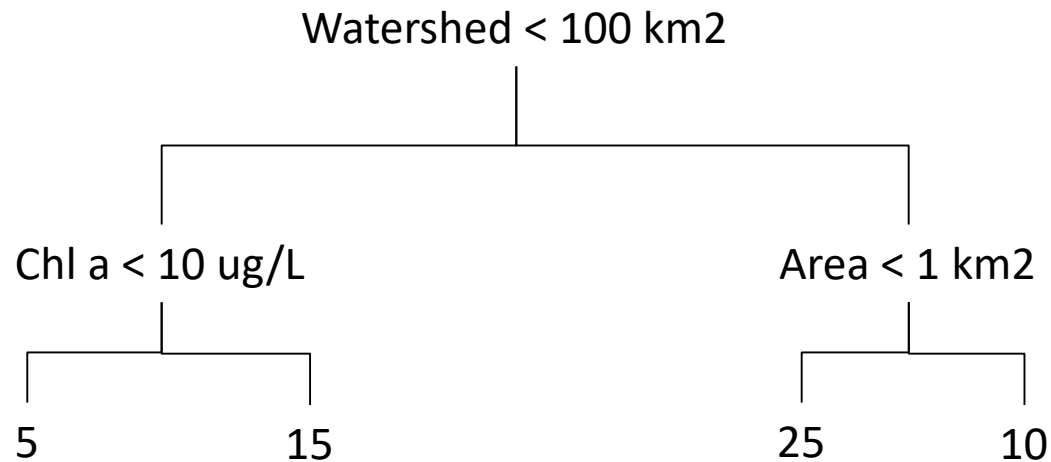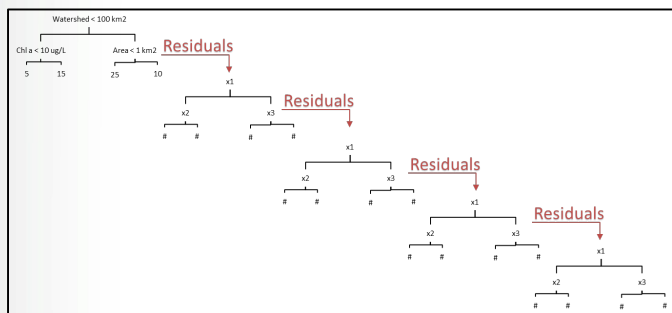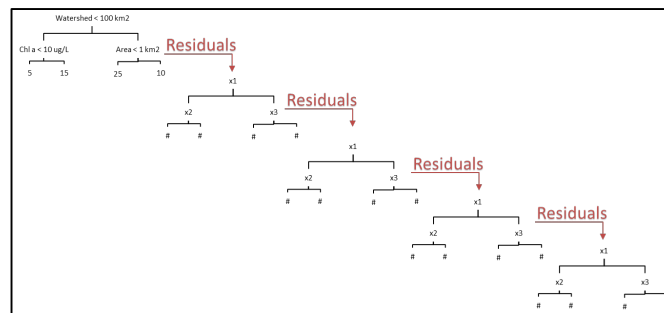
- Boosted regression trees

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Data subset 1

Data subset 2

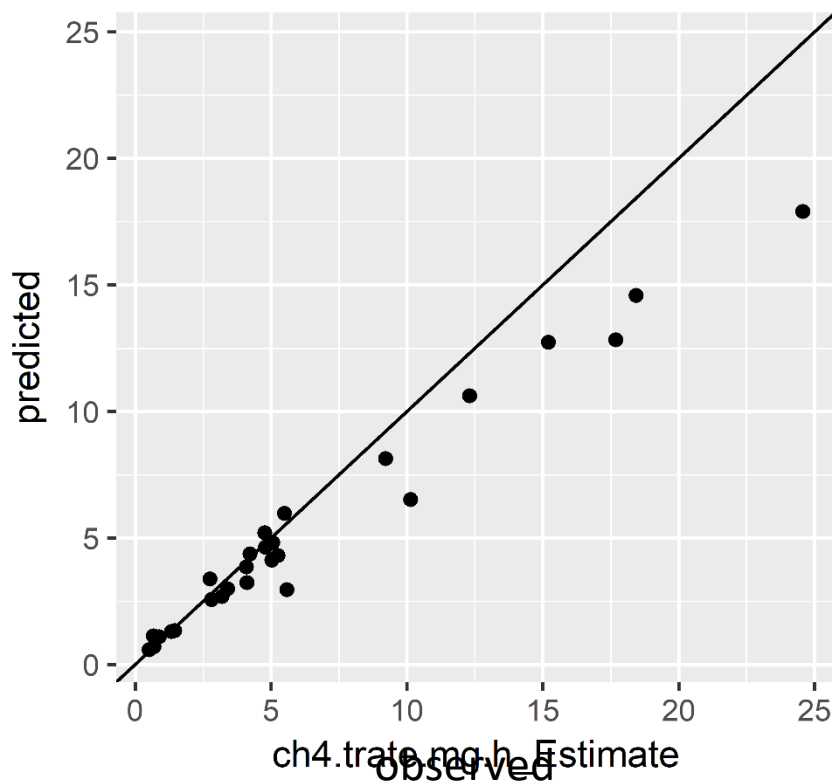
Data subset 3
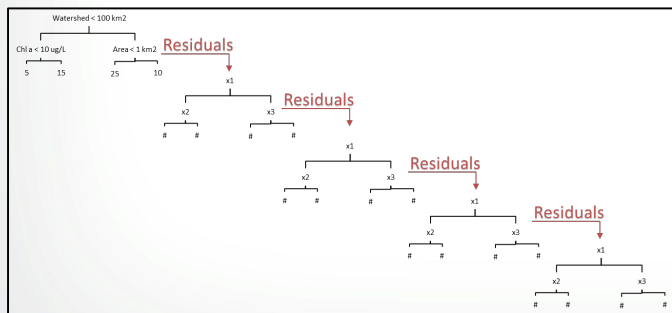
Repeat → *Thousands of trees!*

CH$_4$ emissions ~ national + local predictors
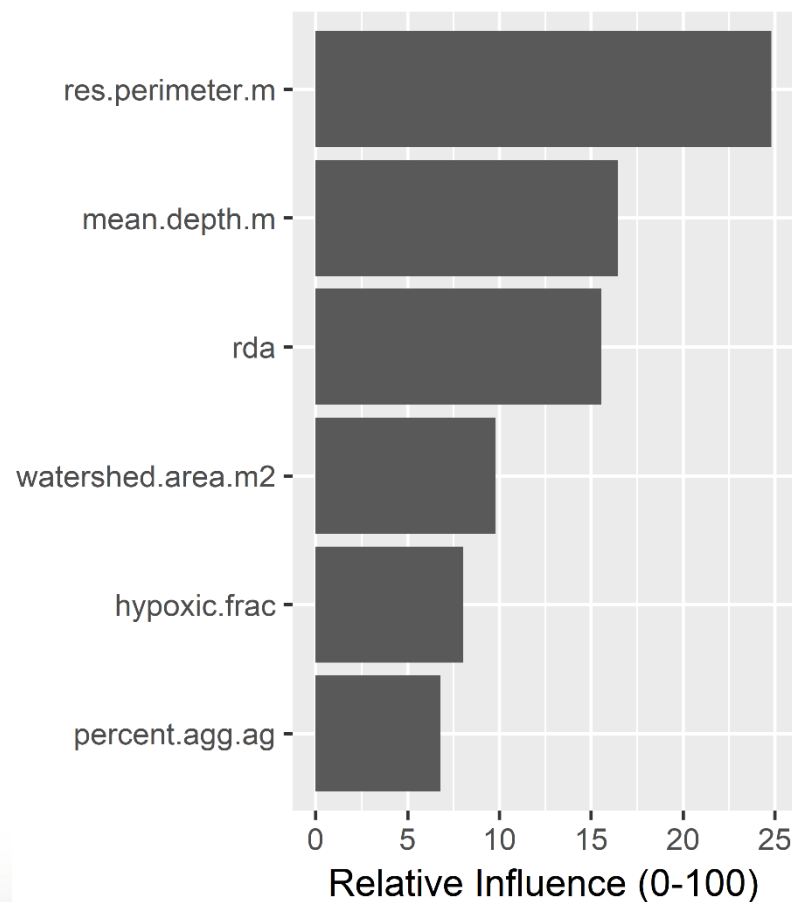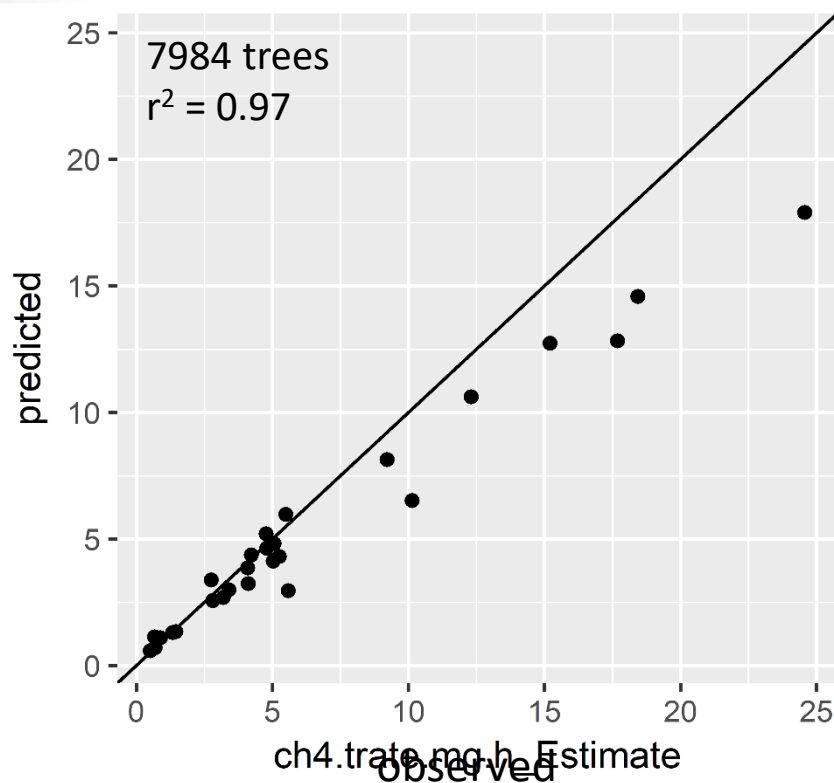
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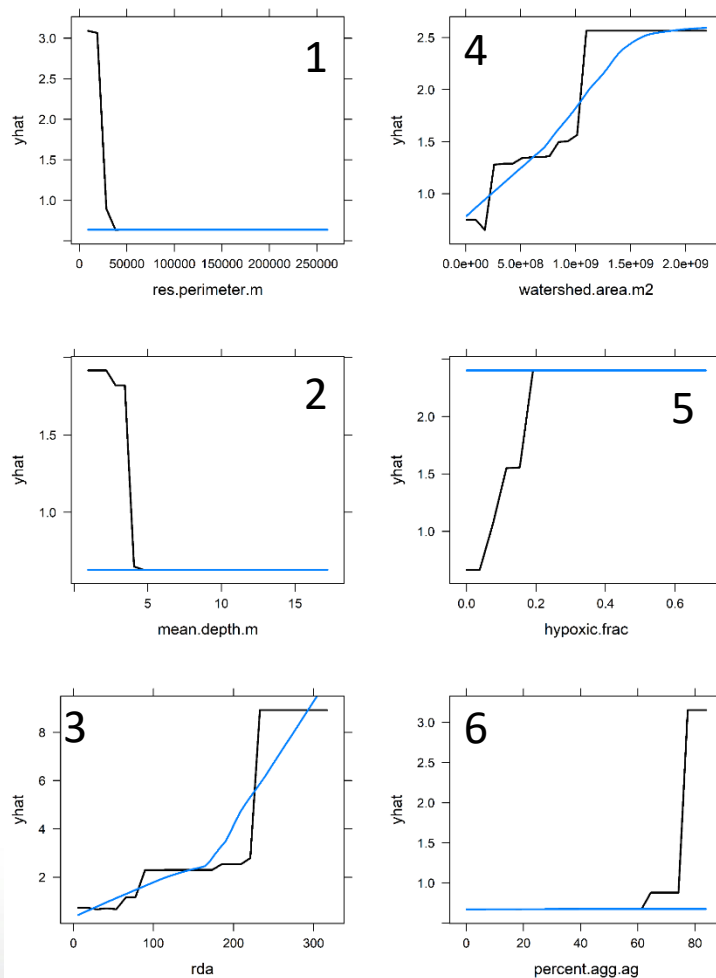
CH_4 emissions ~ national + local predictors

Predictor variables	Prediction error (MSE)
Local + National	4.7
National	6.1

CO_2 emissions ~ national + local predictors

1200 trees
$r^2 = 0.28$

16
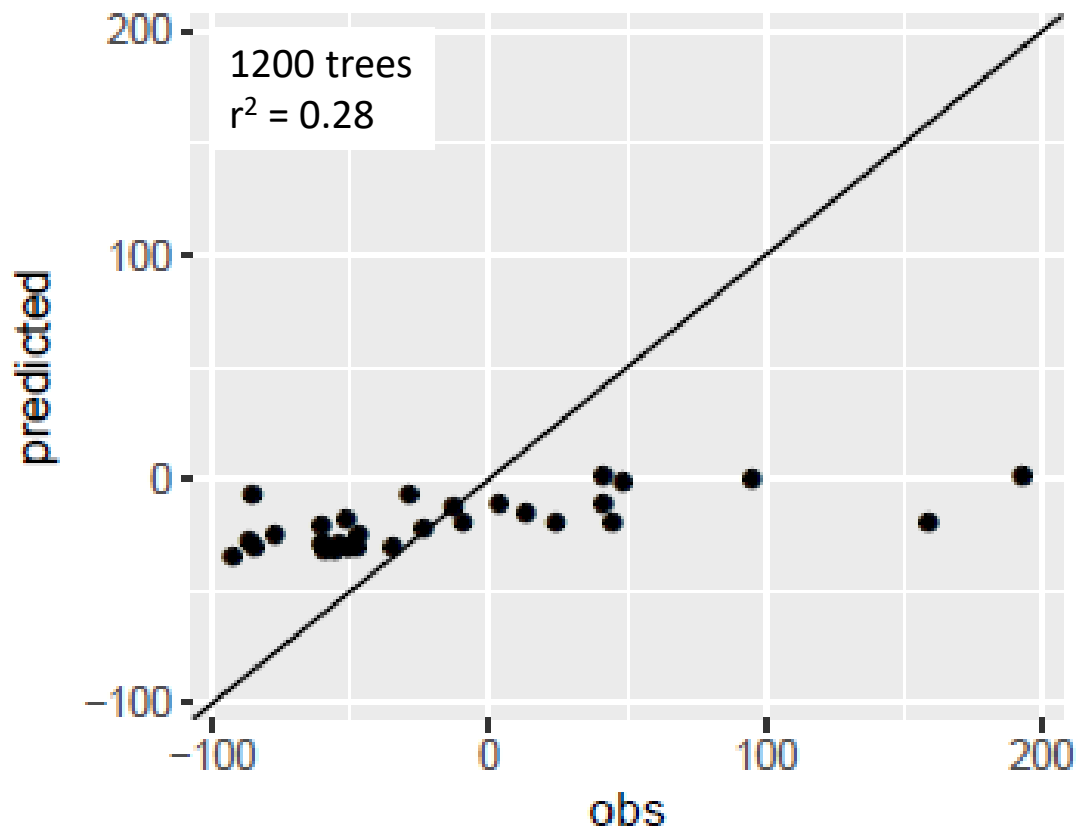
- Model improvement

  – Expand model to include data from southeastern US and Pacific Northwest

  – Include additional predictors

    - Air temperature

    - Lake shape indices

    - Sedimentation rates (Clow et al. 2015)

  – Upscale to US using NHDPlus
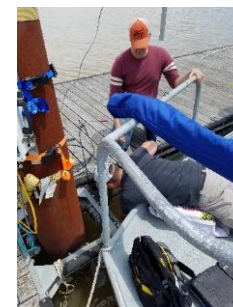
  – Repeat for CO_2

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