

Pool Study

An investigation of summer dissolved oxygen in coho rearing streams in relation to multiple habitat parameters



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- Oversummer survival of coho salmon in Russian River streams positively associated with dissolved oxygen (Obetzinski et al. 2018)
- As flows recede over dry season, DO impairment threatens fish even in reaches that remain wet
- Is there an **easily measurable** indicator that can predict DO impairment?
- Pilot study: evaluate relationships between habitat conditions and DO to determine whether specific, measurable habitat parameters influence **DO suitability** through the summer dry season
 - **DO suitability = Regional objective - daily minimum 6.0 mg/L**

Study sites



- 4 riffle/pool complexes on three high priority coho streams (12 sites)
 - Dutch Bill Creek
 - Green Valley Creek
 - Mill Creek
 - Multiple geologic reach types (high-level classification, May and Lee 2004)
 - Bedrock
 - Alluvium
 - Alluvium on bedrock
 - Multiple hydrologic reach types
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Dutch Bill Creek Study Sites



Russian River Salmon & Steelhead Monitoring Program

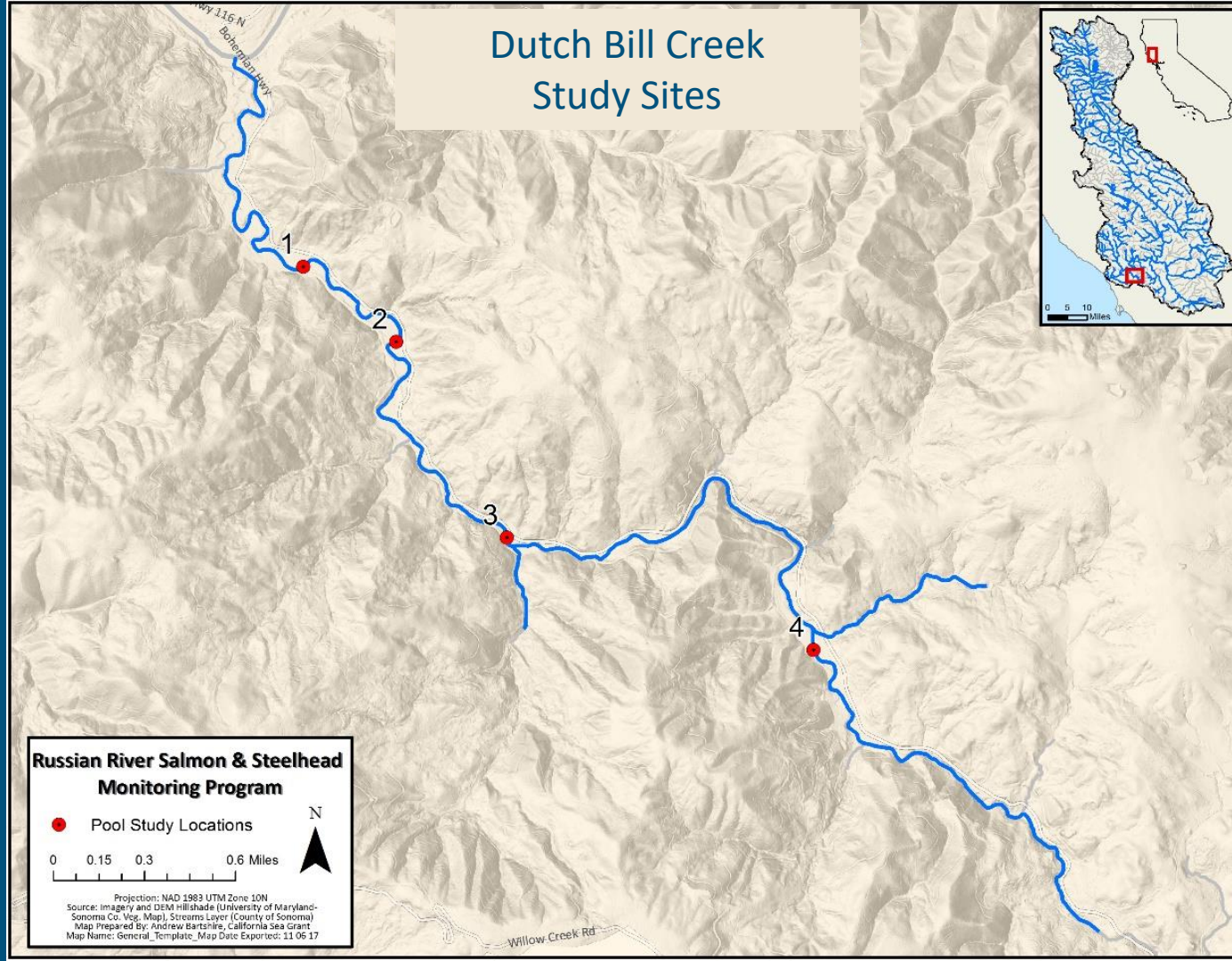


Pool Study Locations

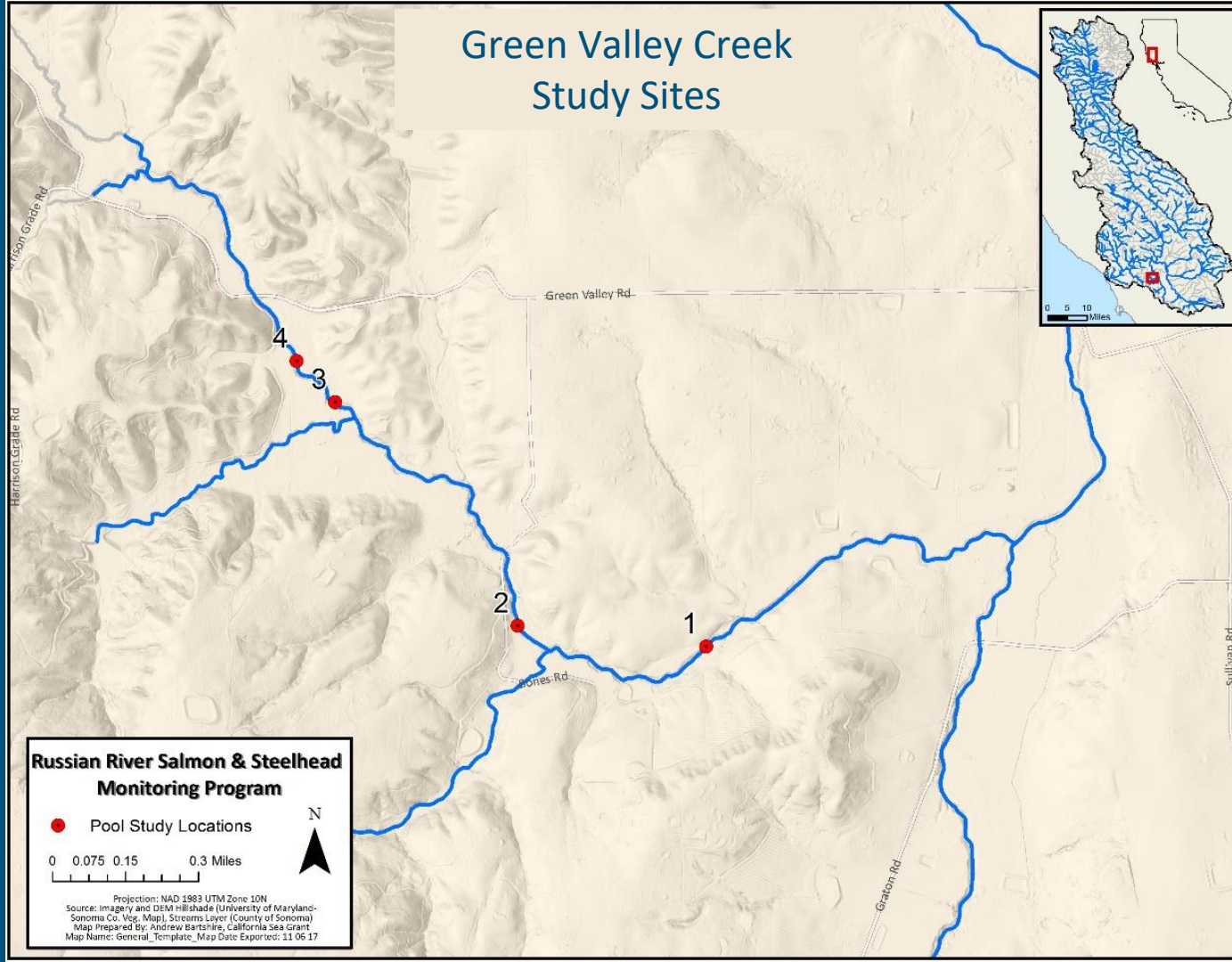
N

0 0.15 0.3 0.6 Miles

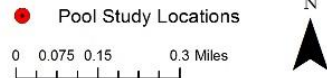
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Source: Imagery and DEM Hillshade (University of Maryland-
Sonoma Co. Veg. Map); Streams Layer (County of Sonoma)
Map Prepared By: Andrew Bartschke, California Sea Grant
Map Name: General_Template_Map Date Exported: 11 06 17



Green Valley Creek Study Sites



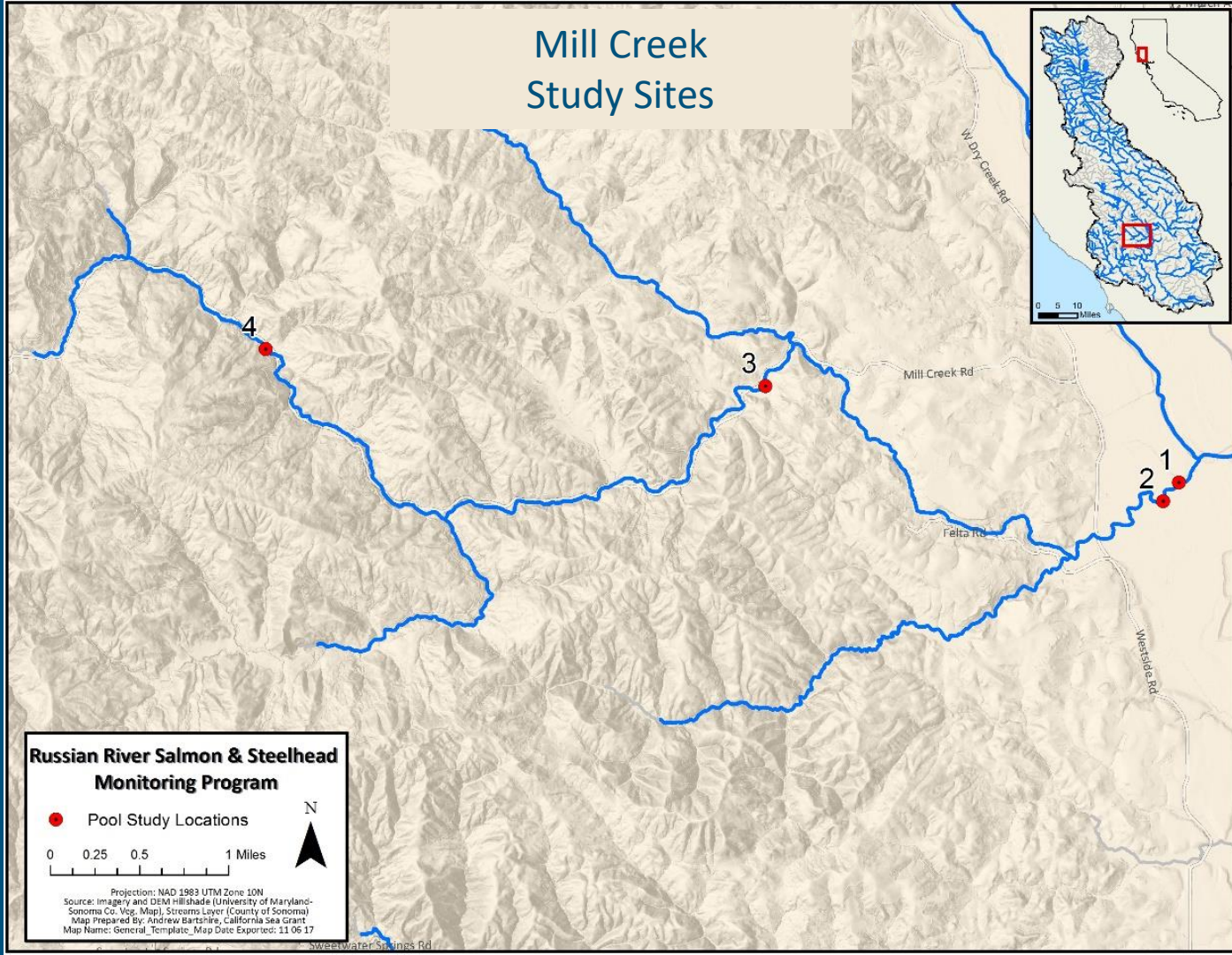
Russian River Salmon & Steelhead Monitoring Program



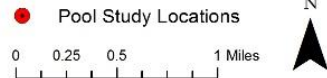
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Projection: NAD 1983 UTM Zone 10N
Source: Imagery and DEM Hillshade (University of Maryland-
Sonoma Co. Viz. Map), Streams Layer (County of Sonoma)
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Mill Creek Study Sites

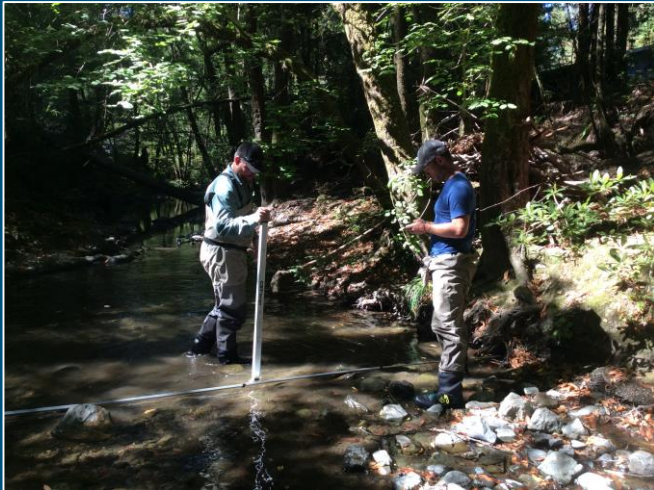


Russian River Salmon & Steelhead Monitoring Program



Projection: NAD 1983 UTM Zone 10N
Source: Imagery and DEM Hillshade (University of Maryland-
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Data collection



- Continuous:
 - Pool DO
 - Water temperature
 - Stage depth
- Biweekly:
 - Discharge
 - Riffle crest thalweg (RCT) depth (u/s)
 - Pool tail crest depth (d/s)
 - Riffle area
 - Pool area/wetted volume
 - Pool max depth
 - Connectivity
 - Algae cover/color
- Riffle slope
- Dominant substrate at RCT

- Biweekly sampling
- June to October 2017 and 2018
- ~10 samples/year/site



Potential DO predictors

- Pool
 - ✓ Max depth
 - ✓ Length
 - ✓ Average width
 - ✓ Average depth
 - ✓ Area
 - ✓ Volume
- Riffle
 - ✓ Riffle crest thalweg depth
 - ✓ Pool tail crest depth
 - ✓ Length
 - ✓ Width
 - ✓ Area
 - ✓ Riffle slope
- Discharge
- Temperature
 - ✓ At minimum DO
 - ✓ Max daily
 - ✓ Average daily
 - ✓ Previous day max
- Study day
 - ✓ # days since started
 - ✓ Sine of day of year
 - ✓ Cosine of day of year
- Site
- Year
- Reach type
- Tributary
- Sample number
- RCT dominant substrate
- Disconnection
- Algae cover/color

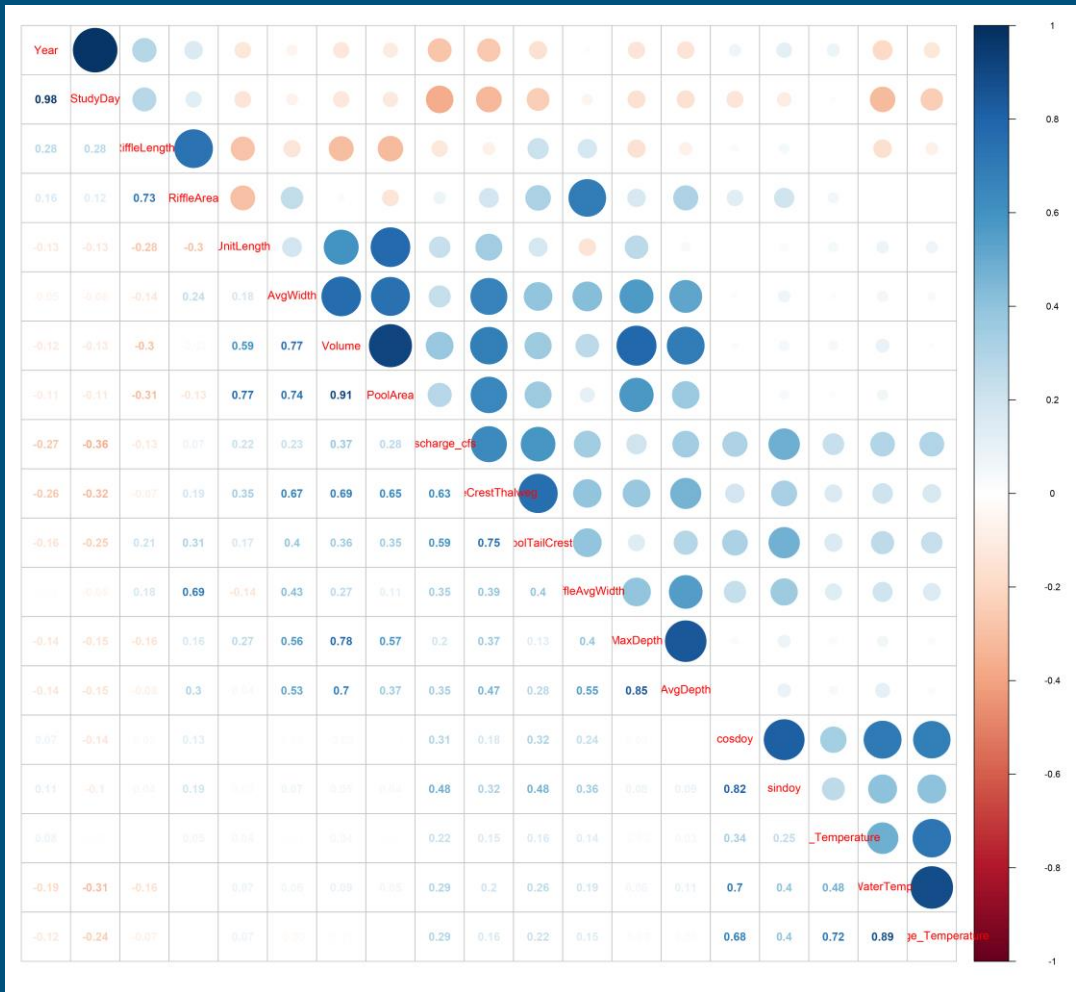


- Compare all to minimum DO on sample date
- How well does each variable predict whether DO meets objective of 6.0 mg/L?
- Inform future research, evaluate potential management applications



Collinearity analysis

- Correlation matrix
 - Principal component analysis (PCA)
 - p-value Pearson's r partial correlation
- Used to group variables into correlated groups
- Logic used to validate and revise groupings (e.g., pool v. riffle processes, categorical data v. quantitative)



Potential DO predictors

POOL

- Pool
 - ✓ Max depth
 - ✓ Length
 - ✓ Average width
 - ✓ Average depth
 - ✓ Area
 - ✓ Volume

RIFFLE

- Riffle
 - ✓ Riffle crest thalweg depth
 - ✓ Pool tail crest depth
 - ✓ Length
 - ✓ Width
 - ✓ Area
 - ✓ Riffle slope

FLOW

- Discharge

- Temperature
 - ✓ At minimum DO
 - ✓ Max daily
 - ✓ Average daily
 - ✓ Previous day max
- Study day
 - ✓ # days since started
 - ✓ Sine of day of year
 - ✓ Cosine of day of year

- Site
- Year
- Reach type
- Tributary
- Sample number
- RCT dominant substrate
- Disconnection
- Algae cover/color

TEMPERATURE/TIME

CATEGORICAL

Potential DO predictors

POOL

- Pool
 - ✓ Max depth
 - ✗ Length
 - ✗ Average width
 - ✓ Average depth
 - ✗ Area
 - ✓ Volume

RIFFLE

- Riffle
 - ✓ Riffle crest thalweg depth
 - ✗ Pool tail crest depth
 - ✗ Length
 - ✓ Width
 - ✗ Area
 - ✗ Riffle slope

FLOW

- Discharge


- Temperature
 - ✓ At minimum DO
 - ✗ Max daily
 - ✗ Average daily
 - ✗ Previous day max
- ✗ Study day
 - ✗ # days since started
 - ✗ Sine of day of year
 - ✗ Cosine of day of year

TEMPERATURE/TIME

- Site
 - Year
 - Reach type
 - Tributary
 - Sample number
 - RCT dominant substrate
 - Disconnection
 - Algae cover/color

CATEGORICAL

Most promising predictors

- Group 1: Pool max depth
 - Group 2: RCT depth
 - Group 3: Water temperature
 - Group 4: Discharge
 - Similar predictive accuracy as RCT
 - Time-intensive and difficult to measure accurately at low flows
 - Group 5: Site
 - Did not predict DO independent of other variables, not more important
 - Not useful for generalizing outcomes beyond study sites
 - Collect data in future regardless
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- **Pool max depth**
 - **RCT depth**
 - **Water temperature**
 - **Reach type**
 - Important in 2017 dataset
 - Likely to play a role in variable DO response, thresholds, management implications
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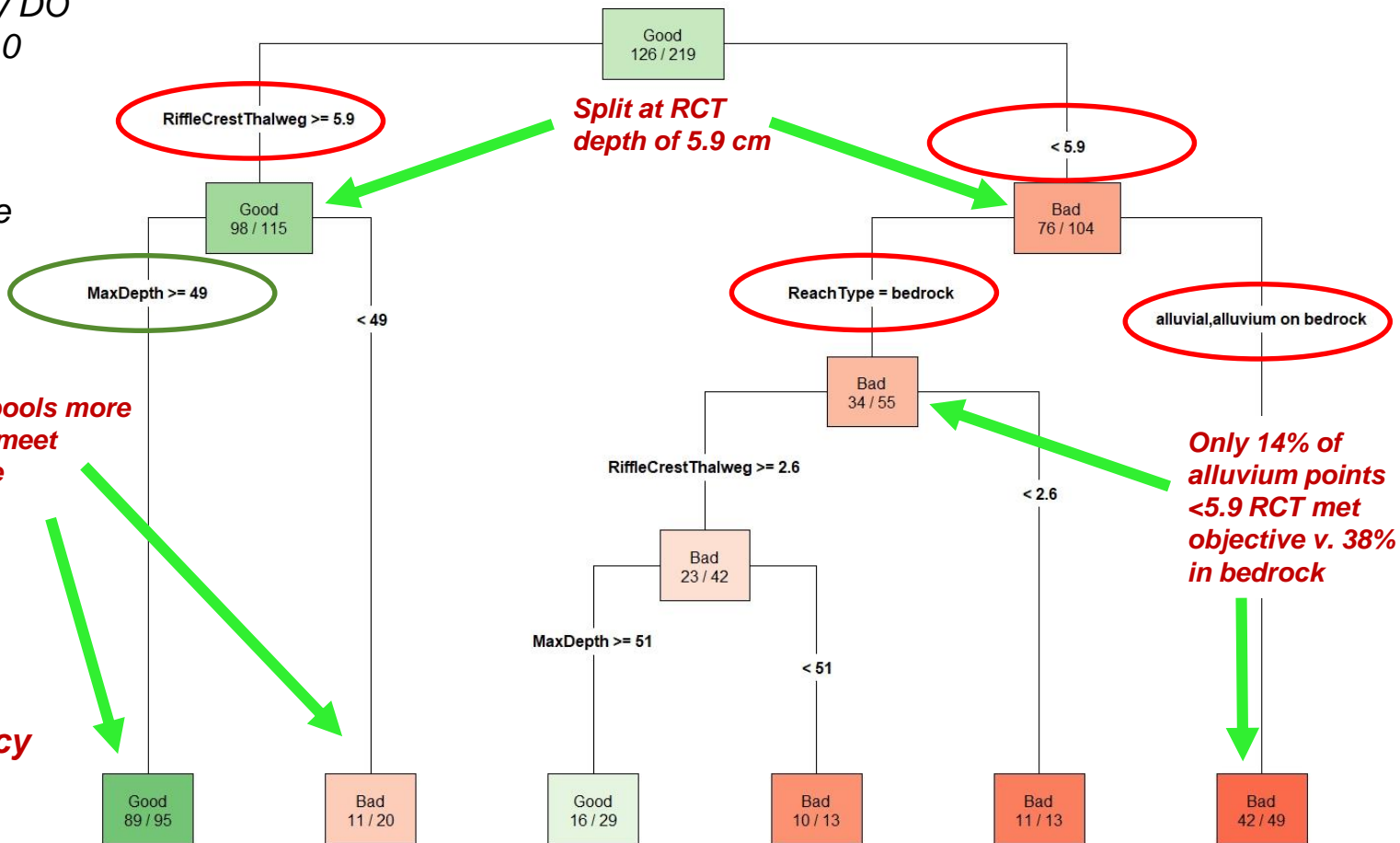
**Based on modeling results and field applicability (i.e., ease and accuracy of measurement)*

Minimum Daily Dissolved Oxygen Classification Tree

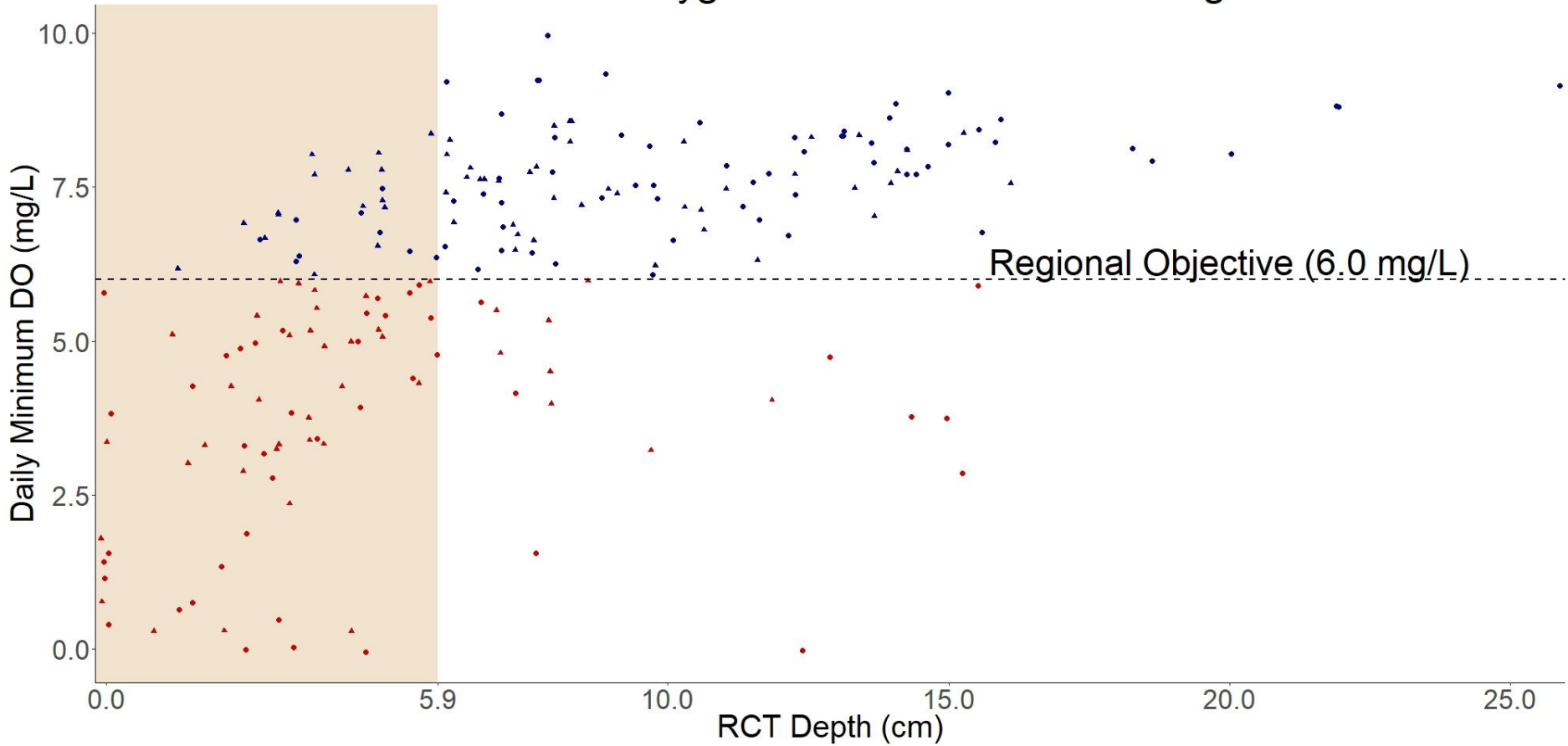
Good = met
minimum daily DO
objective of 6.0
mg/L

Bad = did not
meet objective

**Model accuracy
= 82%**

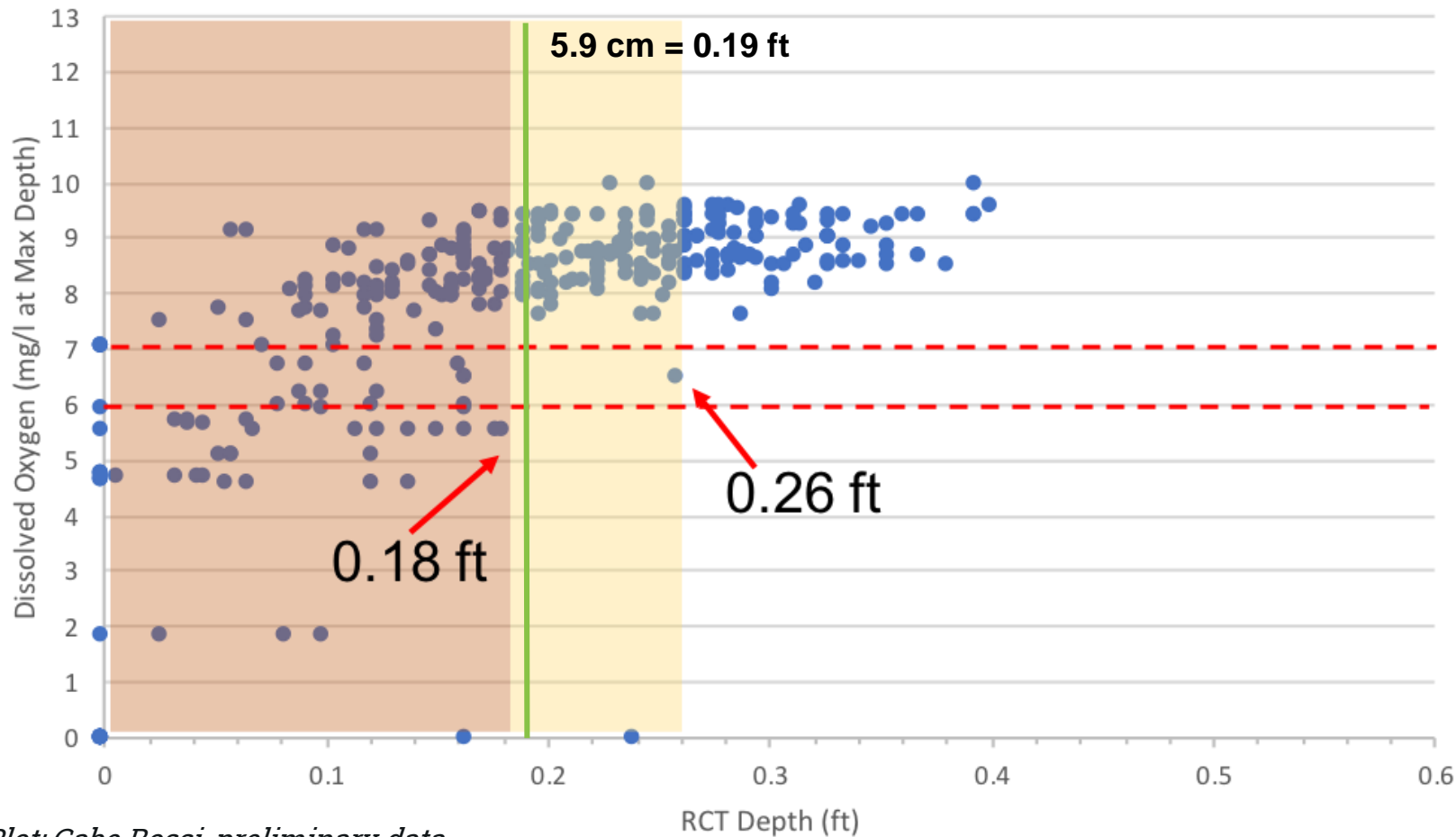


Dissolved Oxygen and Riffle Crest Thalweg



RCT depth of 5.9 cm predicted whether DO met objective with 80% overall accuracy

Porter Creek DO vs RCT Depth



Plot: Gabe Rossi, preliminary data

Take aways

In the lower Russian River study streams:

- RCT depth, pool max depth stood out as most important predictors of DO suitability, temperature warrants inclusion
- RCT depth of ~6 cm predicted whether DO met objective with 80% overall accuracy – suggests threshold
- Deeper pools more likely to meet DO objective
- Bedrock pools more resilient than alluvium
- Role of reach type warrants further investigation



Next steps



- Paired down data collection for next phase of study:
 - RCT
 - Max depth
 - DO and temperature
 - Reach type – better classification?
- Collaborate to incorporate new study streams:
 - NCRWQCB
 - CDFW
 - Others?
- Work with partners to evaluate applications:
 - RCT : Discharge curves?
 - Predictive model?
 - Other tools?

Thanks to the North Coast Regional Water Quality Control Board and CA Department of Fish and Wildlife

