

Week 5 Lecture 2:

Linear regression inference

EDS 222: Statistics for Environmental Data Science



Ocean acidification

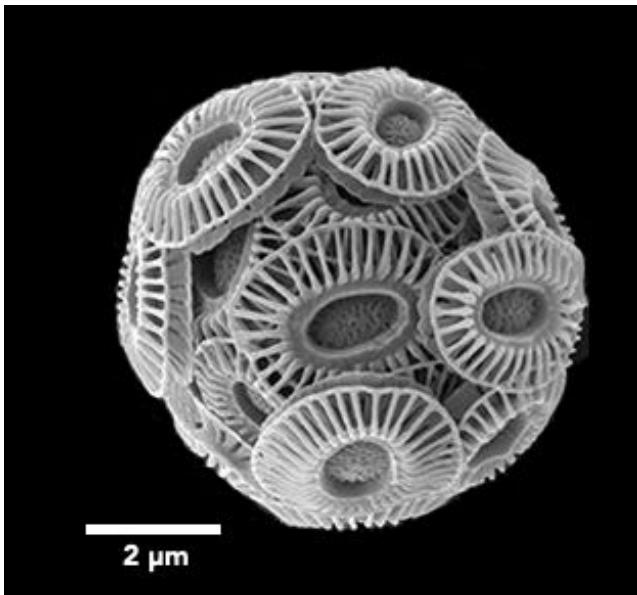
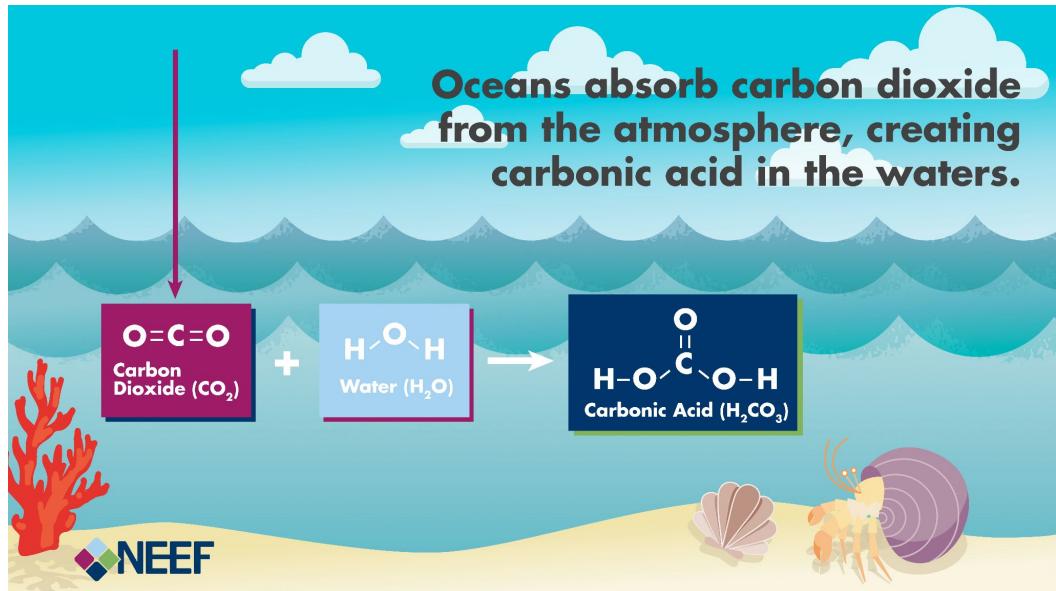
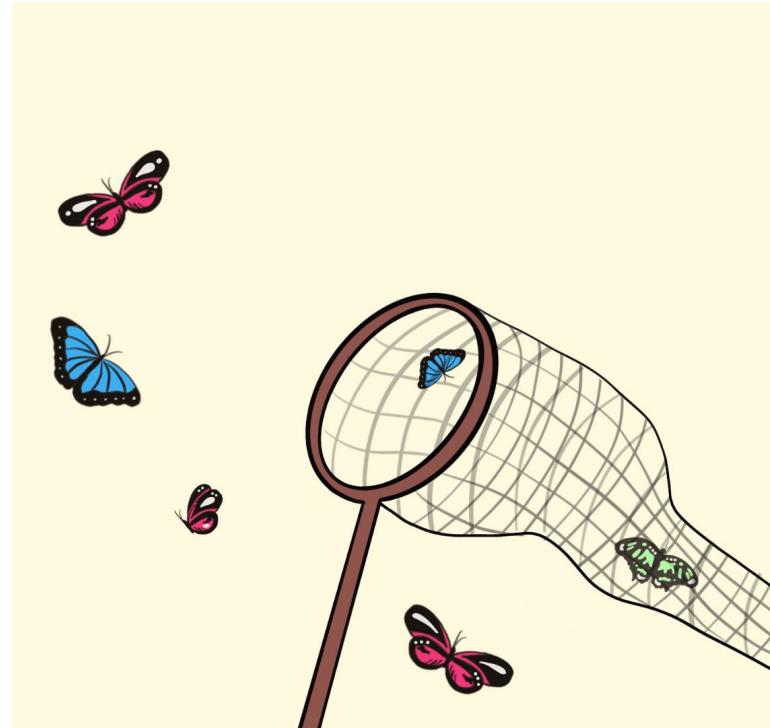


Photo: Jeremy Young



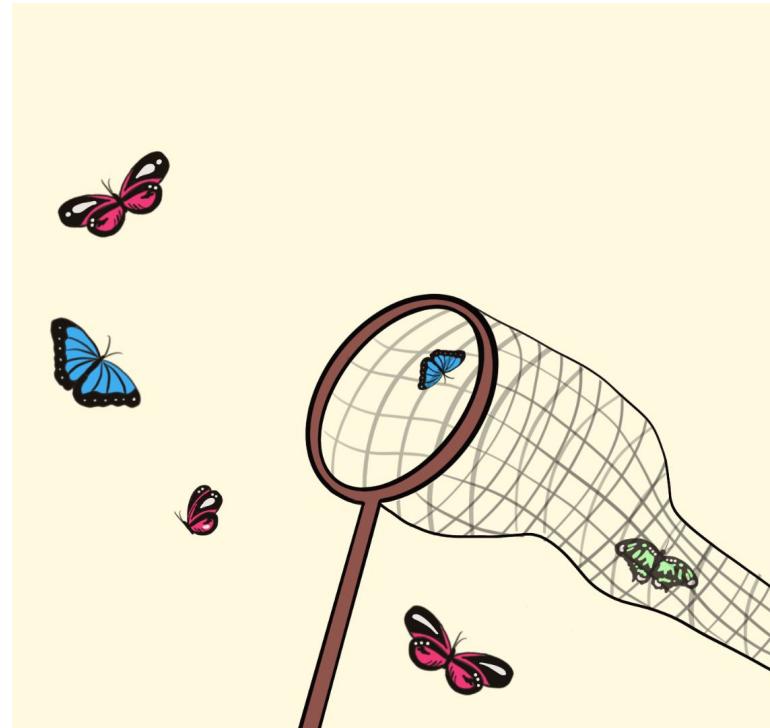
Today's agenda

- Variation in regression
- Hypothesis testing
- Confidence intervals

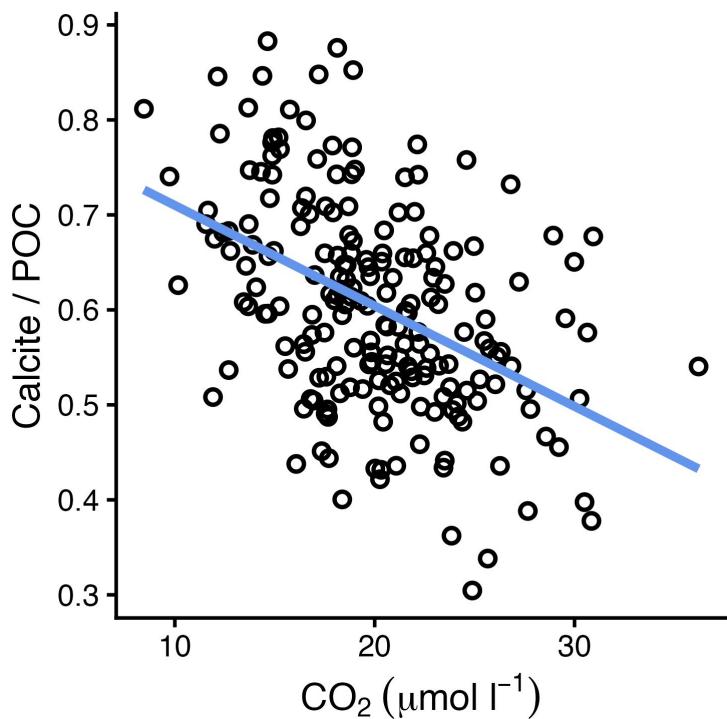


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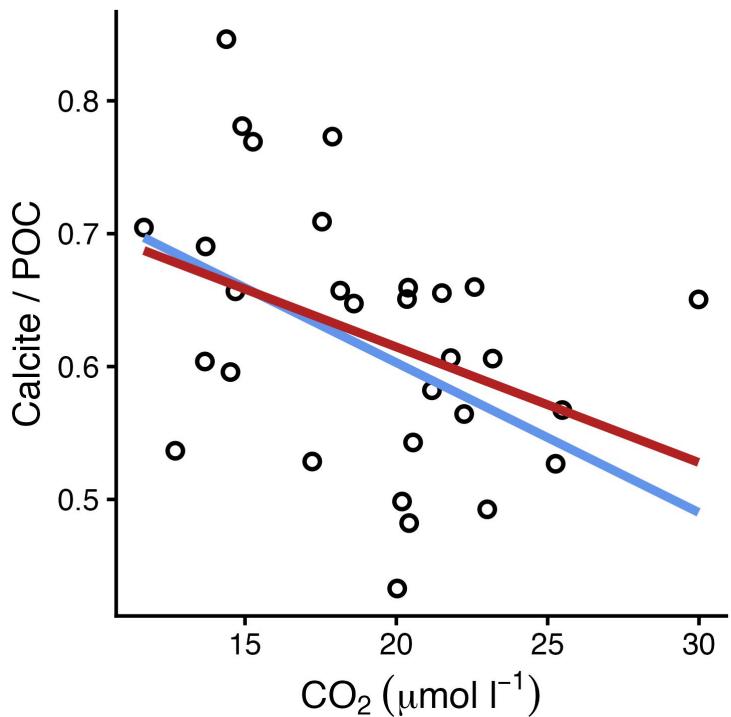
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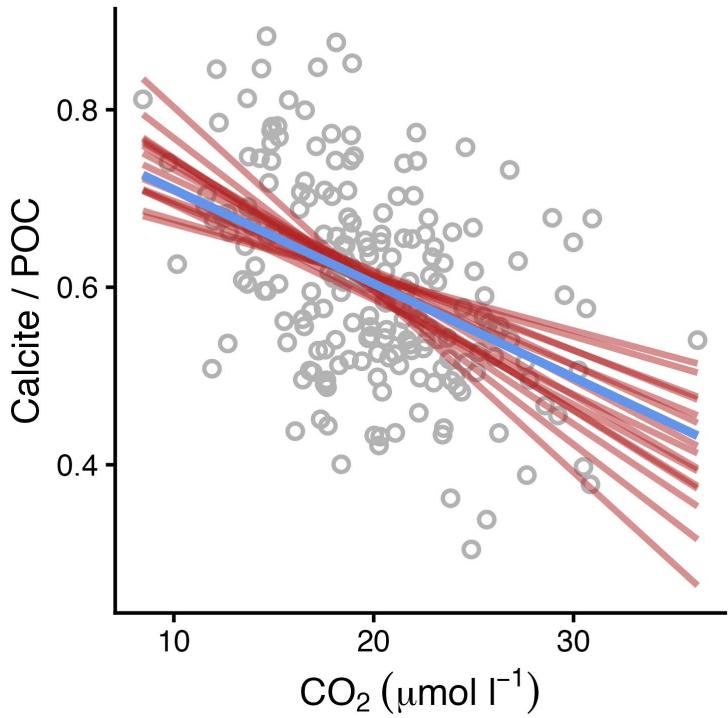
Population-level pattern



Draw a sample



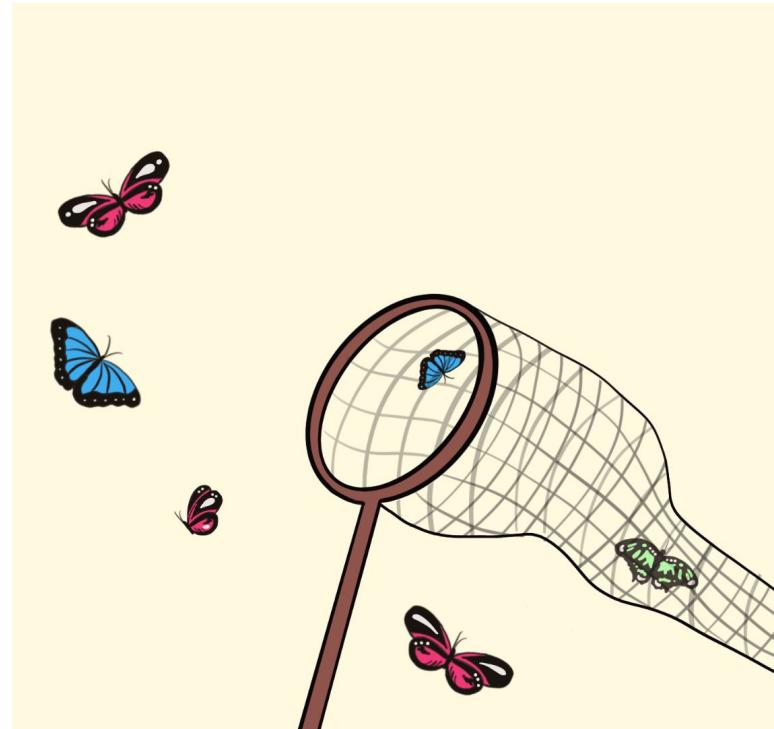
Draw a sample



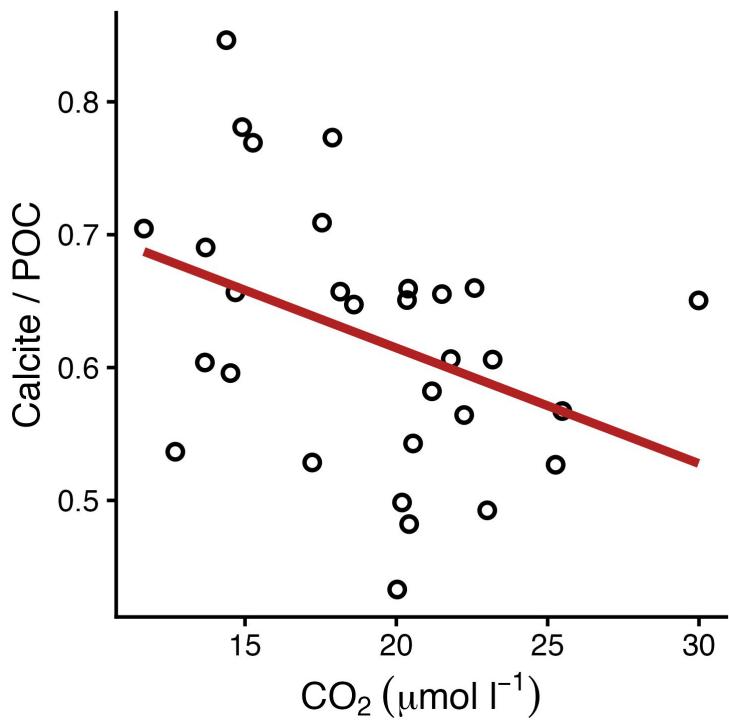
Variation in regression

Today's agenda

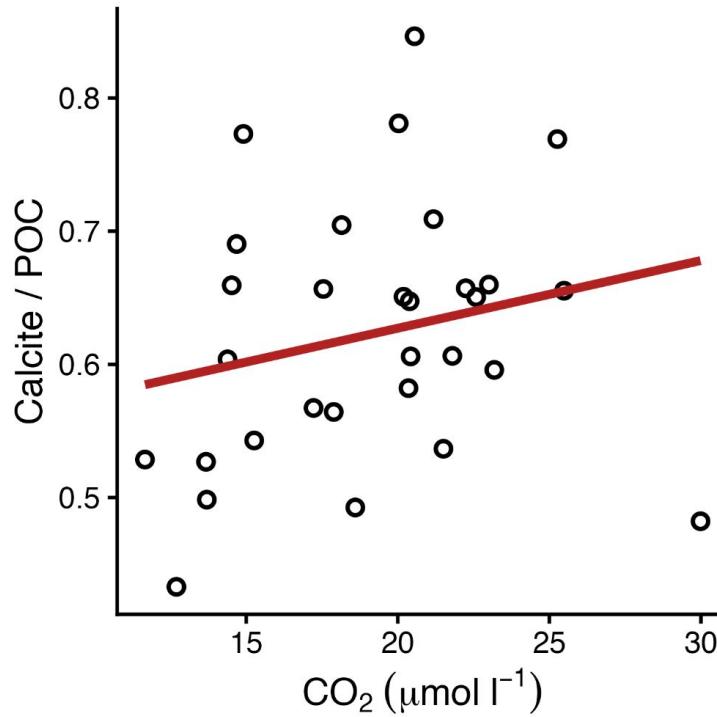
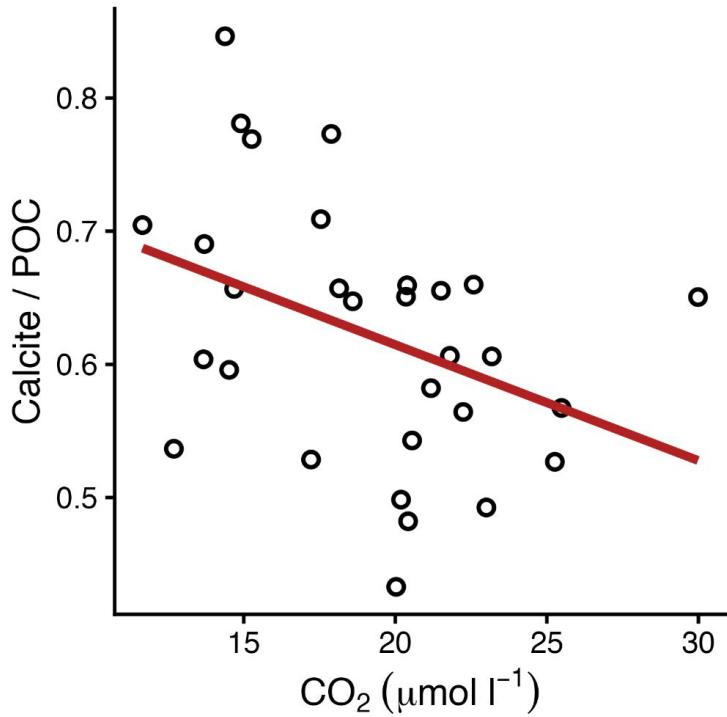
- Variation in regression
- **Hypothesis testing**
- Confidence intervals



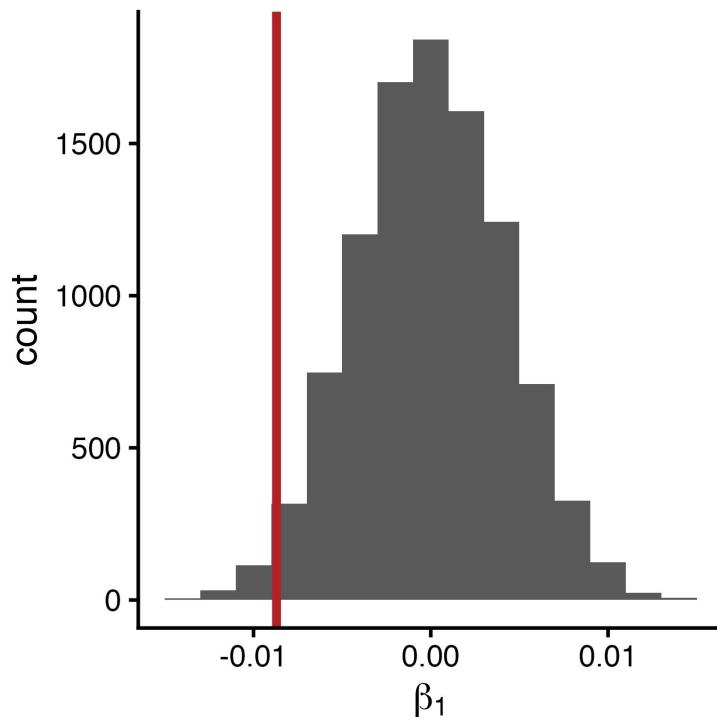
Hypothesis testing



One permutation



Distribution of permutations



Mathematical model

Call:

```
lm(formula = calcite_poc ~ co2_umol_l, data = g_huxleyi_sample)
```

Residuals:

Min	1Q	Median	3Q	Max
-0.18155	-0.06645	0.01227	0.05223	0.18277

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	0.788797	0.077446	10.185	6.41e-11 ***
co2_umol_l	-0.008702	0.003959	-2.198	0.0364 *

Signif. codes:

0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.09167 on 28 degrees of freedom

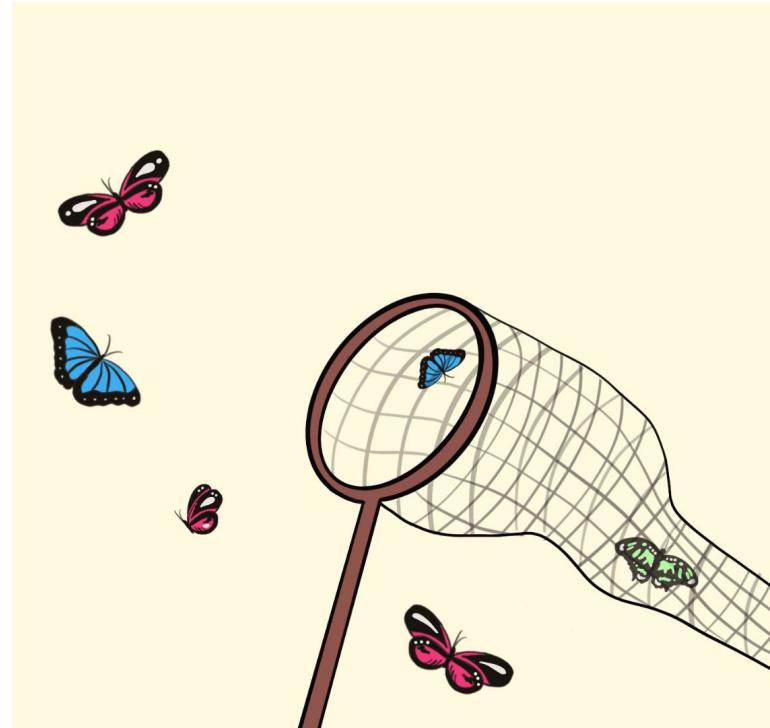
Multiple R-squared: 0.1472, Adjusted R-squared: 0.1167

F-statistic: 4.832 on 1 and 28 DF, p-value: 0.03637

Hypothesis testing

Today's agenda

- Variation in regression
- Hypothesis testing
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Confidence intervals

Coefficient CI

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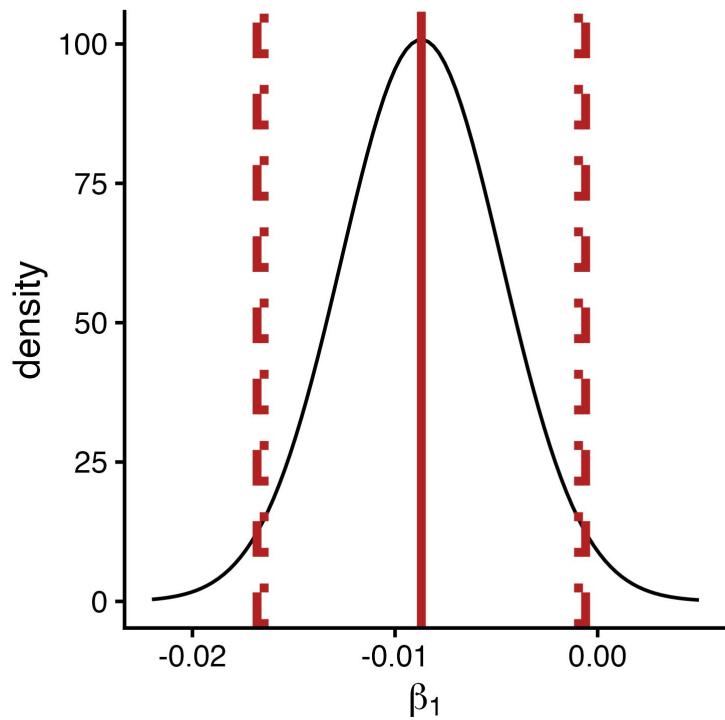
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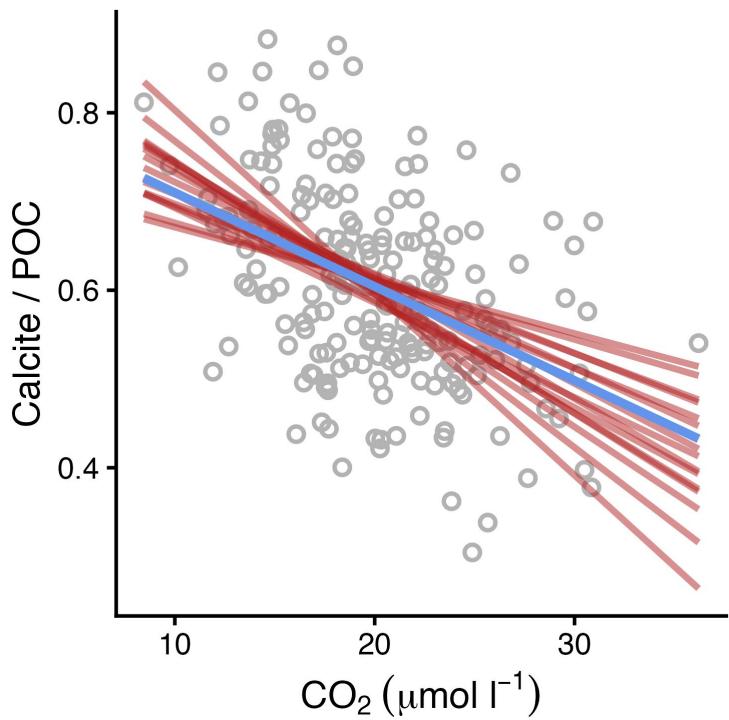
F-statistic: 4.832 on 1 and 28 DF, p-value: 0.03637

Normal is pretty close

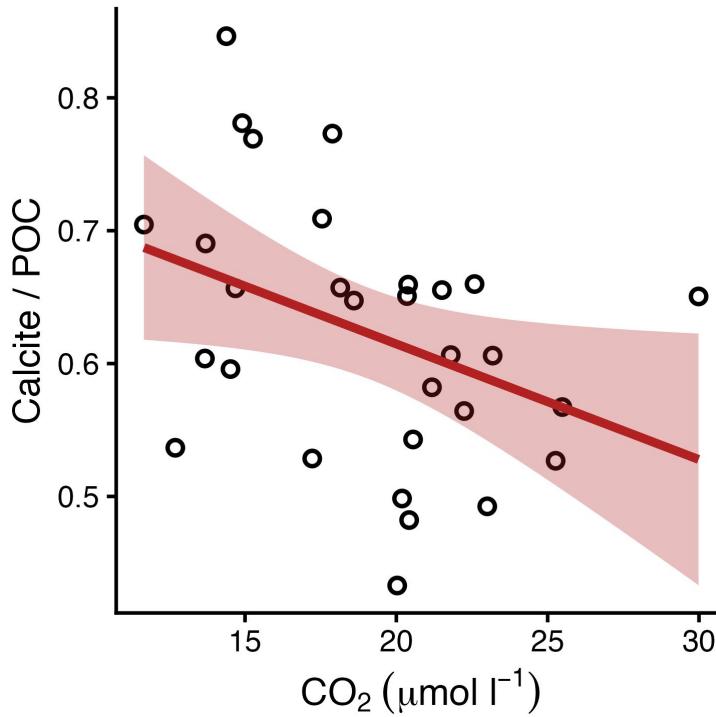
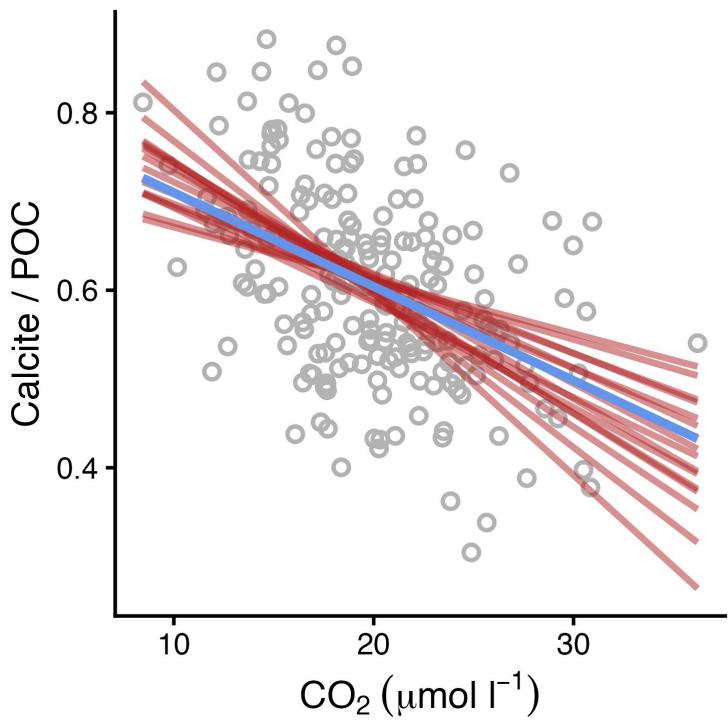


Coefficient CI

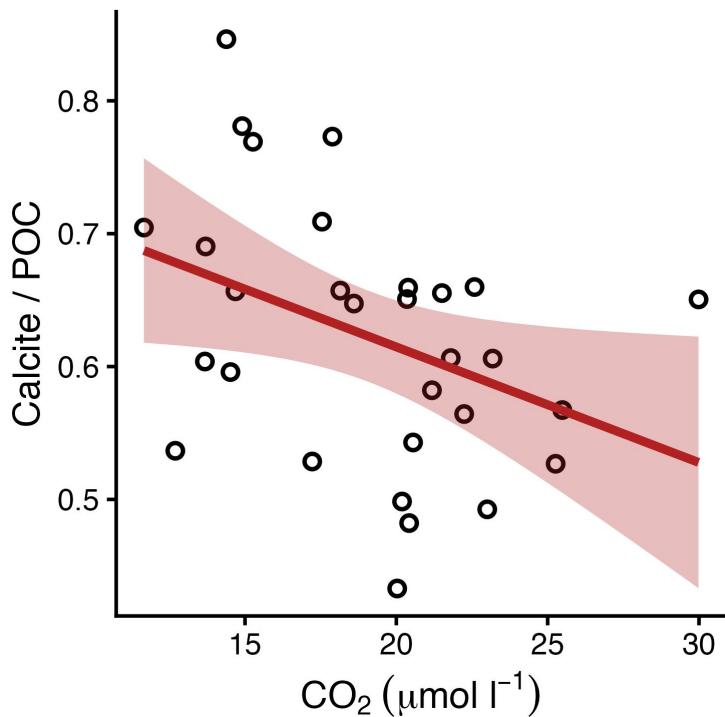
Mean response CI



Mean response CI

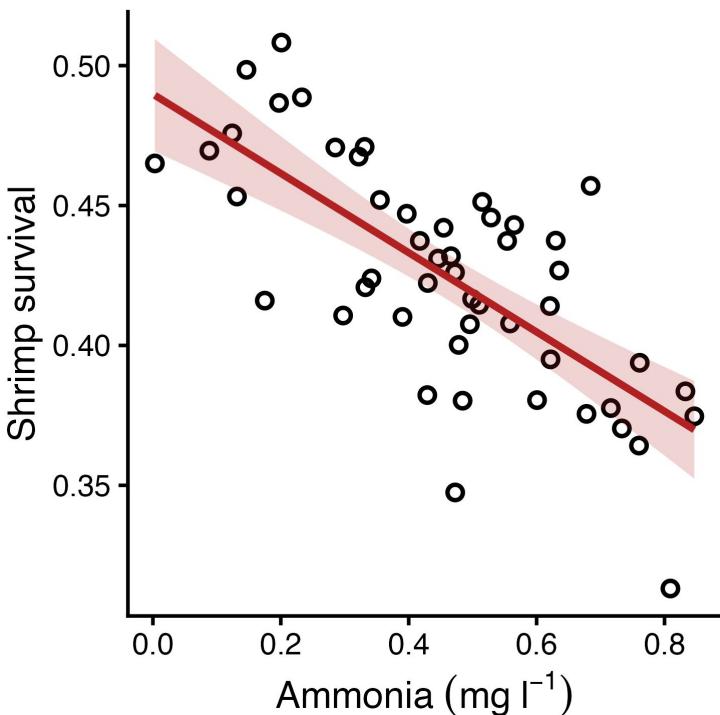


Mean response CI



Confidence intervals

Let's try it



```
> shrimp_aqua_lm <- lm(shrimp_survival ~ ammonia_mg_l, shrimp_aqua)
> summary(shrimp_aqua_lm)
```

Call:

```
lm(formula = shrimp_survival ~ ammonia_mg_l, data = shrimp_aqua)
```

Residuals:

Min	1Q	Median	3Q	Max
-0.075391	-0.017970	0.003363	0.022768	0.064185

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	0.48982	0.01004	48.798	< 2e-16 ***
ammonia_mg_l	-0.14169	0.01990	-7.119	4.83e-09 ***

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.02875 on 48 degrees of freedom

Multiple R-squared: 0.5136, Adjusted R-squared: 0.5035

F-statistic: 50.68 on 1 and 48 DF, p-value: 4.827e-09

```
> confint(shrimp_aqua_lm)
```

	2.5 %	97.5 %
(Intercept)	0.4696378	0.5100018
ammonia_mg_l	-0.1817002	-0.1016706

Let's try it

Confidence intervals

Hypothesis testing

What's H_0 ? H_A ?

What's the p-value?

How do you interpret it?

What interval are you 95% confident contains the population's coefficient for ammonia?

The mean shrimp survival when ammonia levels are 0 mg l^{-1} could fall in what interval?

If you collected a new data point at ammonia = 0, would you expect it to fall inside or outside the previous range?