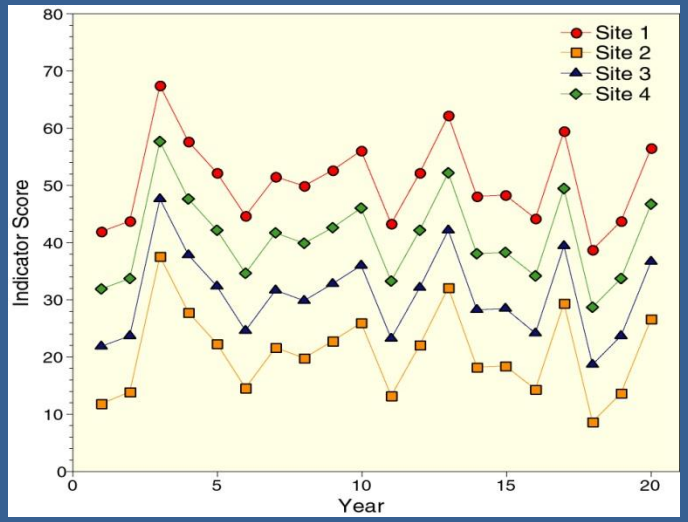

# Variance Decomposition

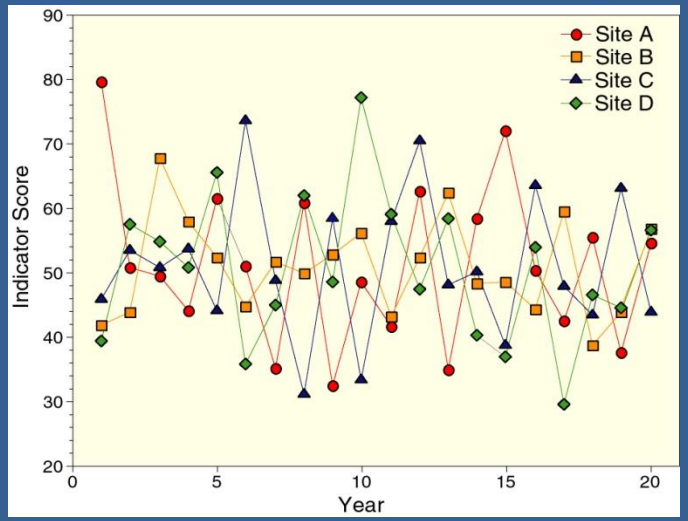
Phil Larsen (Pacific States Marine Fisheries Commission)
and many others

- Conceptual framework
- Summary of datasets
- 2011-2012 CHaMP variance decomposition
  - General summary
  - Illustrative interpretation—what we can learn from variance decomposition

# CHaMP VARIANCE DECOMPOSITION

- Spatial
  - Sites
    - Model
    - Classification
- Temporal
  - Coherent (Synchronous)
  - Interaction
    - Site specific trend
    - Year to year site variation
- Residual
  - The rest
    - Protocol
    - Crew
    - Within index period temporal pattern
    - noise



From Scott Urquhart

# AUGMENTED SERIALLY ALTERNATING

| | TIME PERIOD ( ex: YEARS) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PANEL | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | ... |
| 0 | X | X | X | X | X | X | X | X | X | X | X | X | X | |
| 1 | X | | | | X | | | | X | | | | X | |
| 2 | | X | | | | X | | | | X | | | | |
| 3 | | | X | | | | X | | | | X | | | |
| 4 | | | | X | | | | X | | | | X | | |

# SERIALLY ALTERNATING WITH CONSECUTIVE YEAR REVISITS

| | TIME PERIOD ( ex: YEARS) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PANEL | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | ... |
| 1 | X | X | | | X | X | | | X | X | | | X | |
| 2 | | X | X | | | X | X | | | X | X | | | |
| 3 | | | X | X | | | X | X | | | X | X | | |
| 4 | | | | X | X | | | X | X | | | X | X | |

# CHaMP Why variance decomposition?

- Informs design
  - Status
  - Trend
- Rule: Put effort where variance is greatest
- Estimates noise
  - Natural variation
  - Protocol variation: is the protocol repeatable
  - Crew variation: is the protocol repeatable among crews?
- QA check

# CHaMP 2011-2012 Data pool

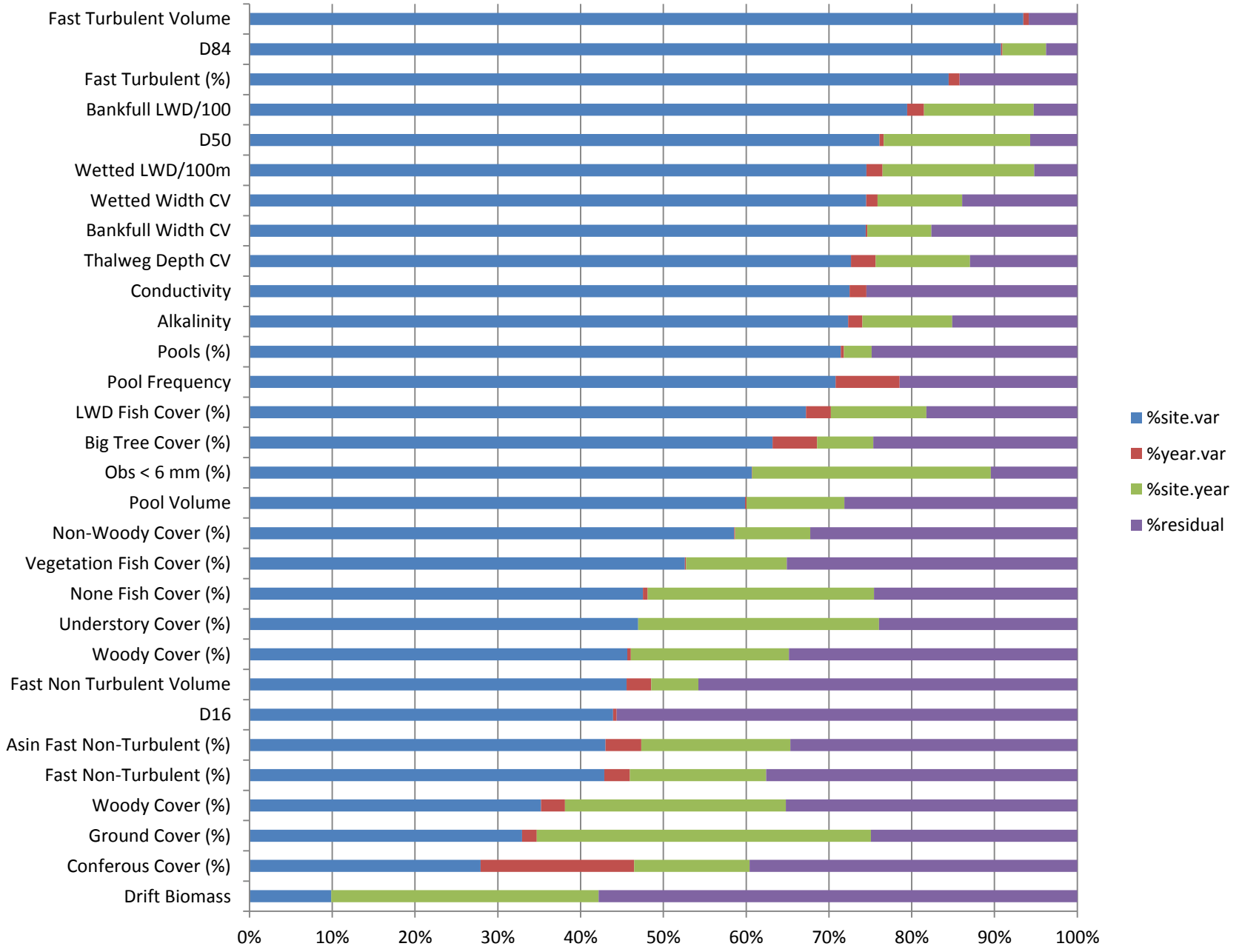
- Annual sites
  - Sampled in 2011 and 2012 (71 sites)
- RP1 and RP2 sites
  - Sampled only in 2011 or 2012 (323 sites)
- QA revisit sites
  - revisits during index window (19 sites)
- Special crew variability sites
  - 2011 crew revisit study (6 sites)
  - 2012 CHaMP-PIBO crew comparison study (3 sites)
- MetricsAndCovariates_CHaMP_FinalWorkshop_20121117.xlsx

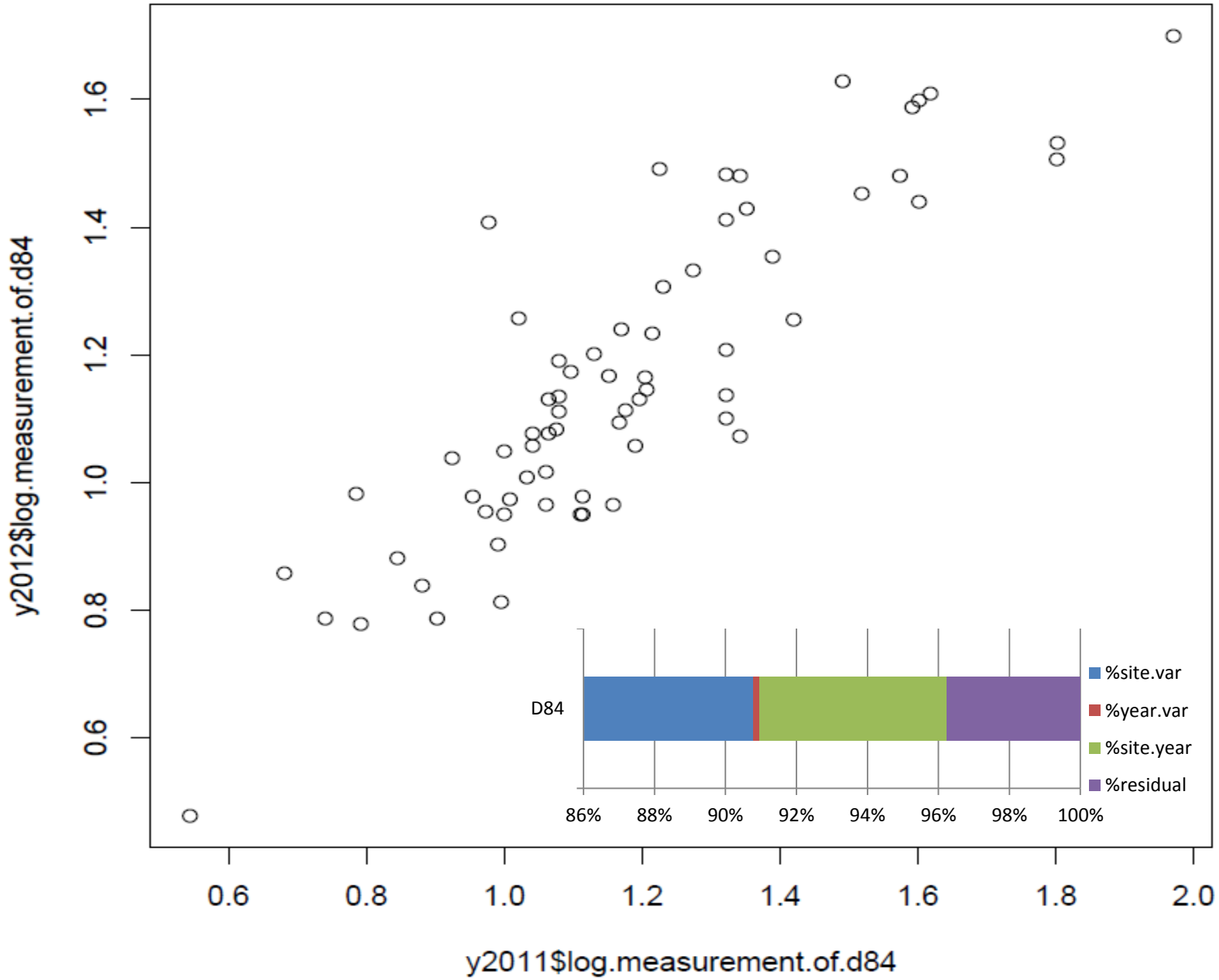

# Conceptual Framework

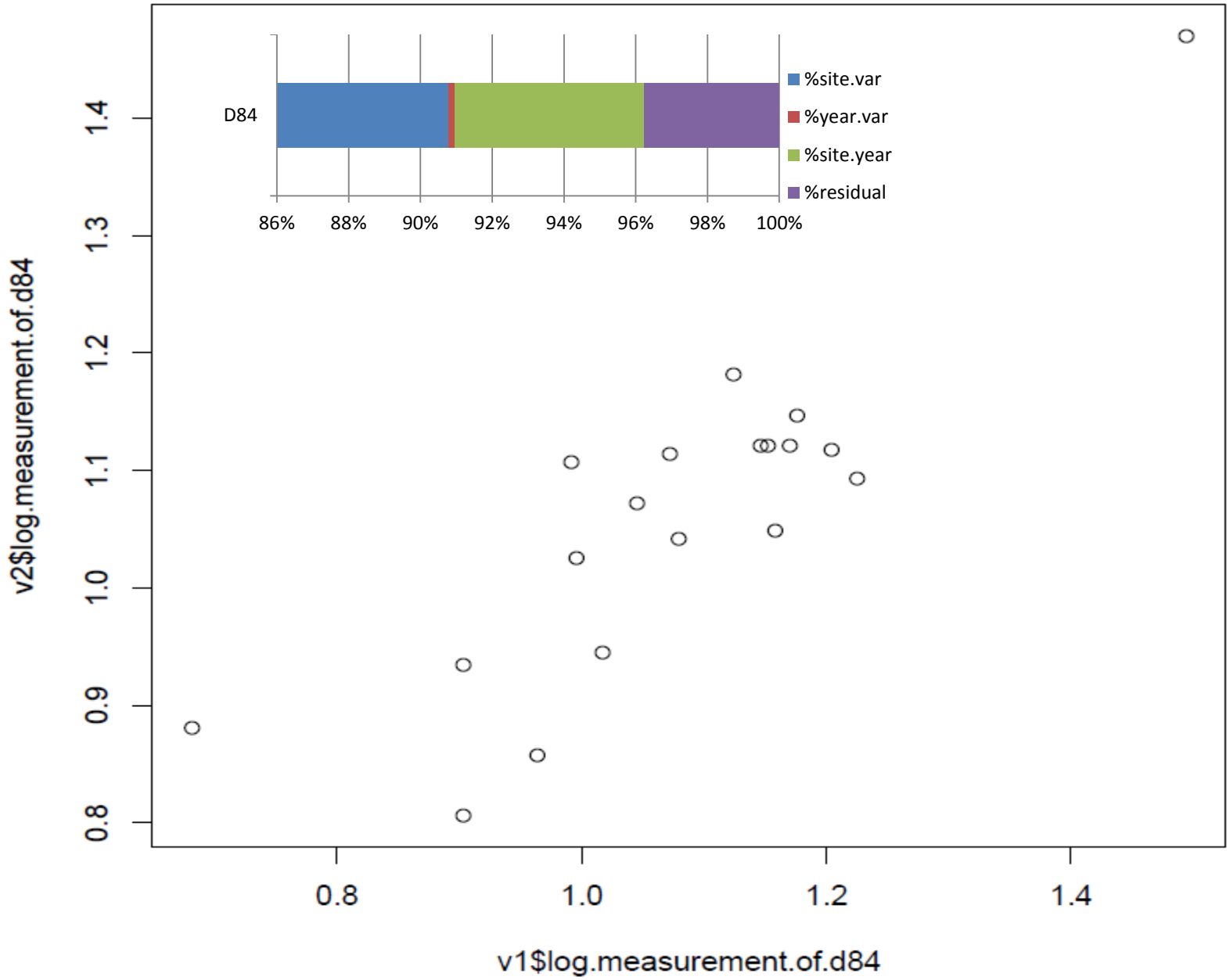
- Spatial
  - Sites
    - Model
    - Classification
- Temporal
  - Coherent (Synchronous)
  - Interaction
    - Site specific trend
    - Year to year site variation
- Residual
  - The rest
    - Protocol
    - Crew
    - Within index period temporal pattern
    - noise

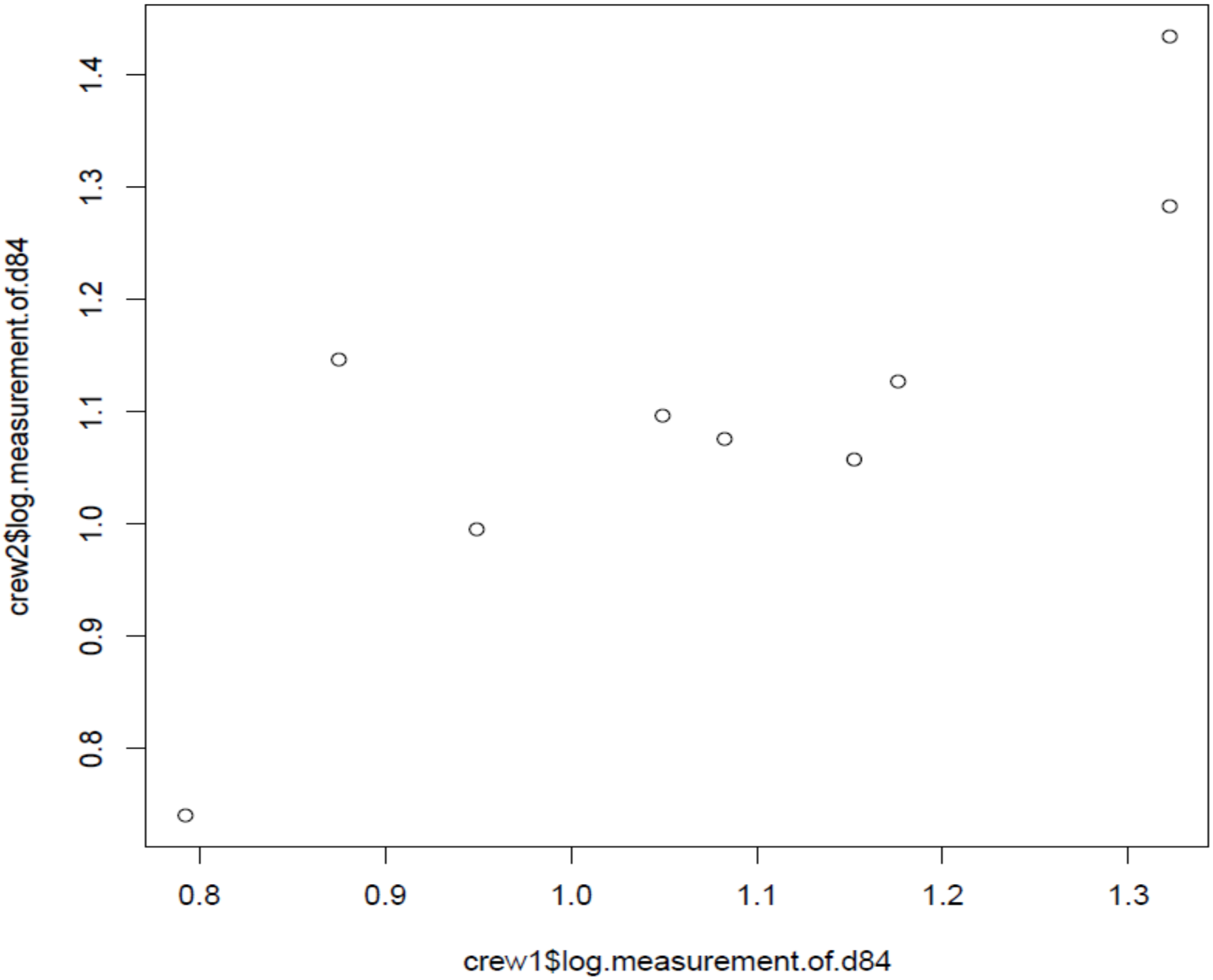
# CHaMP Decomposition model

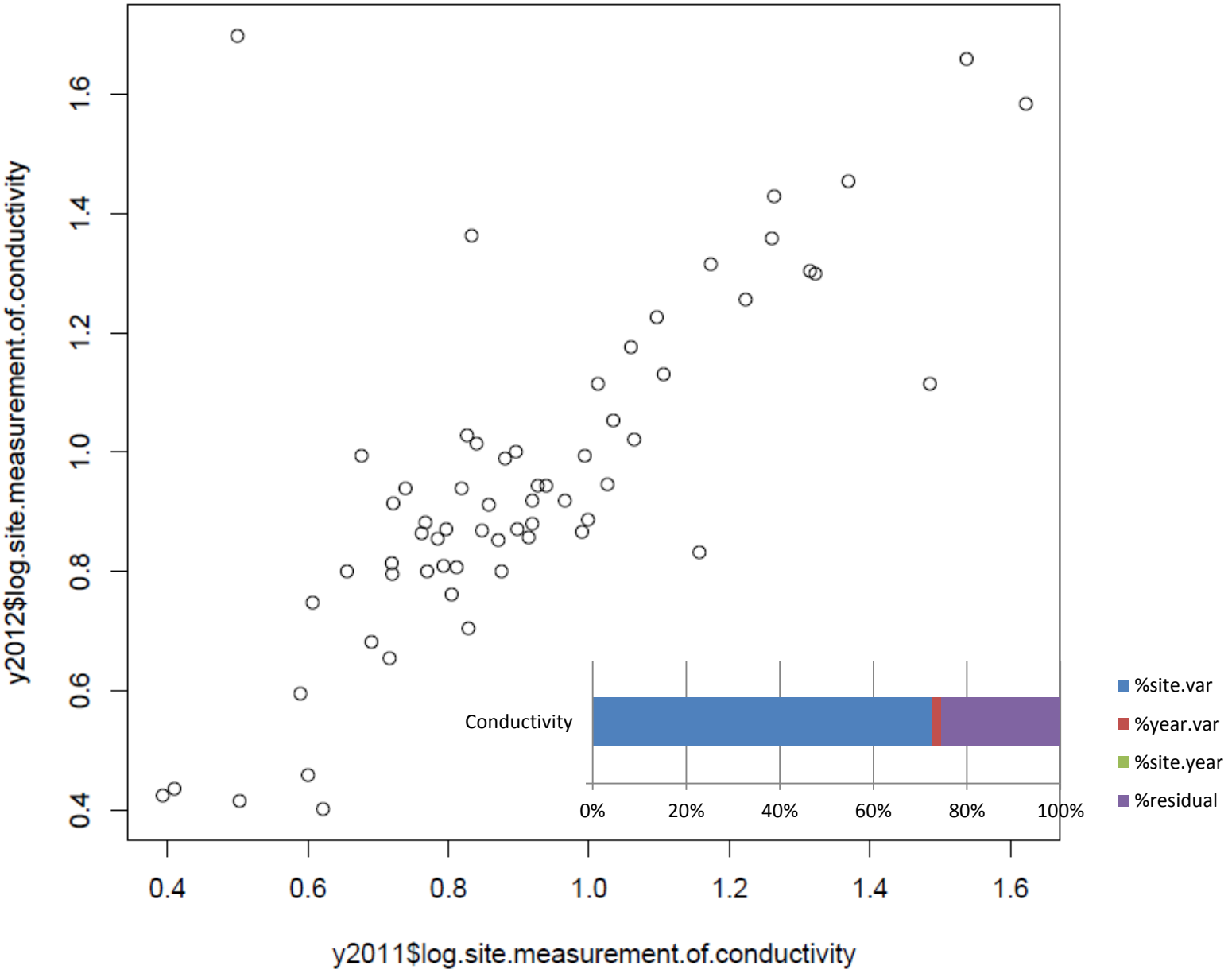
- R library:  lme4
- Function: lmer
- Code
  - lmer(attribute.x~1+(1|(site.id)) + (1|(year))+ (1|(site.id:year)),data=df, REML=T)
- Estimates variances for site, year, interaction, and residual

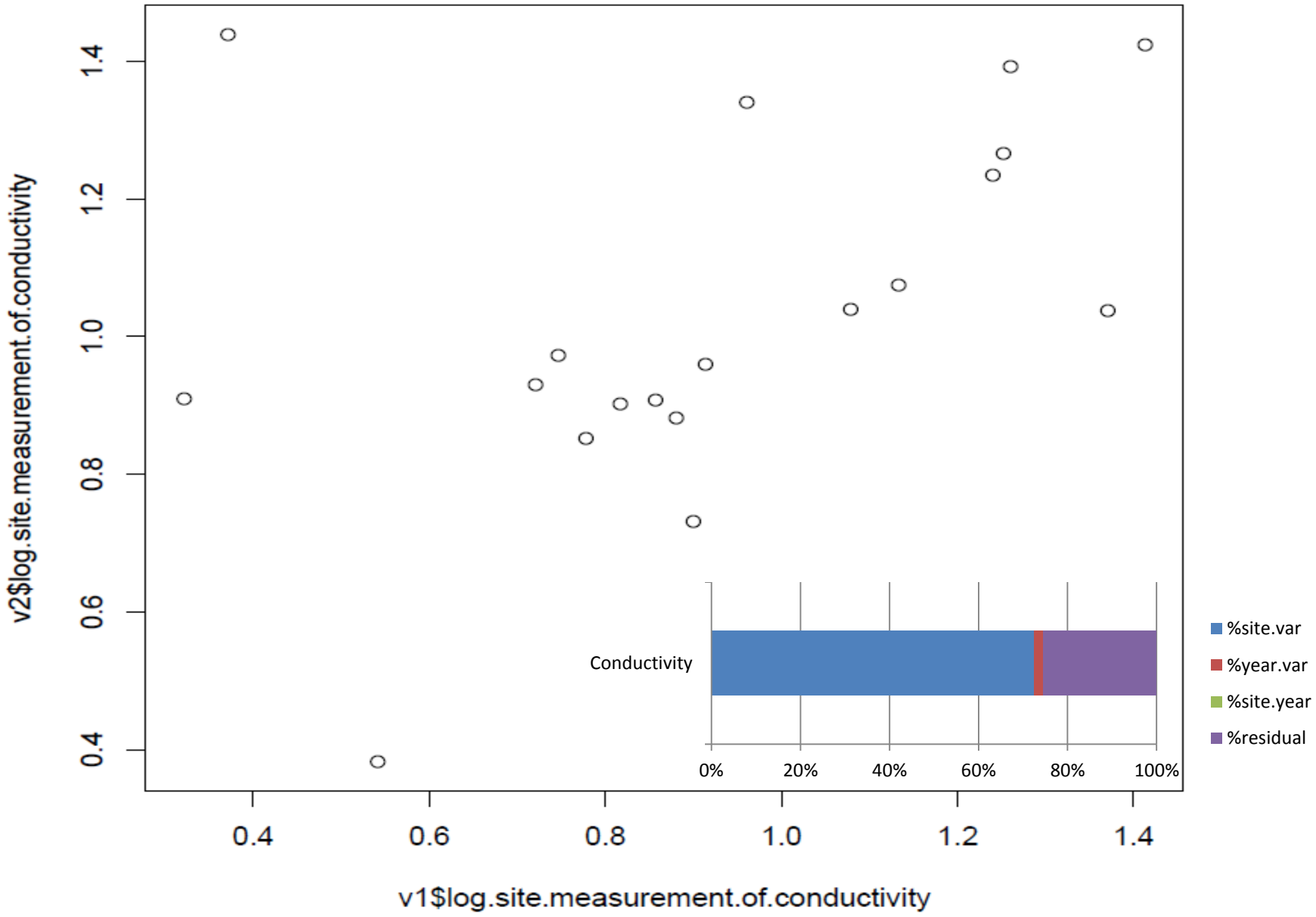

Fast Turbulent Volume
D84
Fast Turbulent (%)
Bankfull LWD/100
D50
Wetted LWD/100m
Wetted Width CV
Bankfull Width CV
Thalweg Depth CV
Conductivity
Alkalinity
Pools (%)
Pool Frequency
LWD Fish Cover (%)
Big Tree Cover (%)
Obs < 6 mm (%)
Pool Volume
Non-Woody Cover (%)
Vegetation Fish Cover (%)
None Fish Cover (%)
Understory Cover (%)
Woody Cover (%)
Fast Non Turbulent Volume
D16
Asin Fast Non-Turbulent (%)
Fast Non-Turbulent (%)
Woody Cover (%)
Ground Cover (%)
Conferous Cover (%)
Drift Biomass
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
%site.var
%year.var
%site.year
%residual

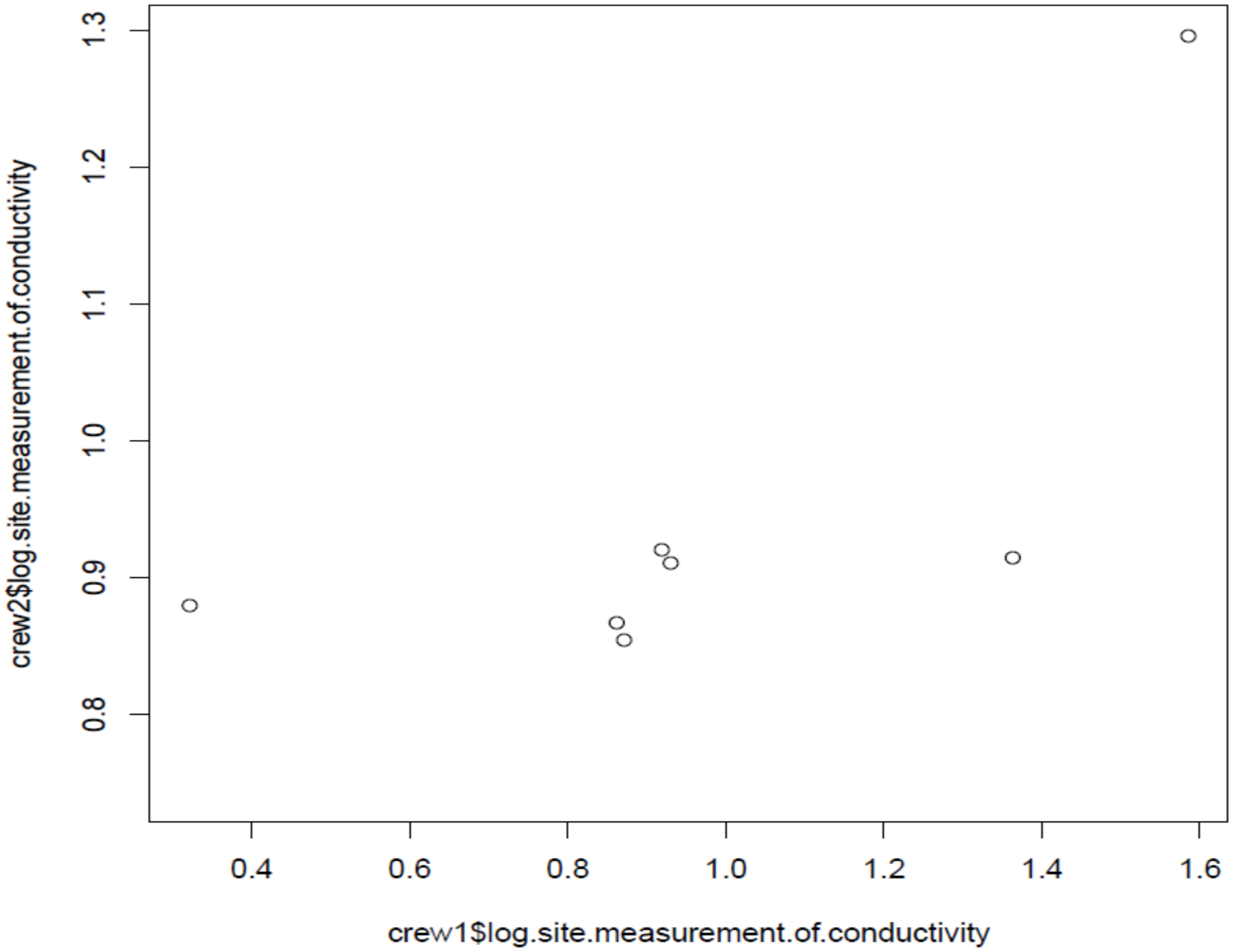

y2012$log.measurement.of.d84
y2011$log.measurement.of.d84
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
D84
%site.var
%year.var
%site.year
%residual
86%
88%
90%
92%
94%
96%
98%
100%

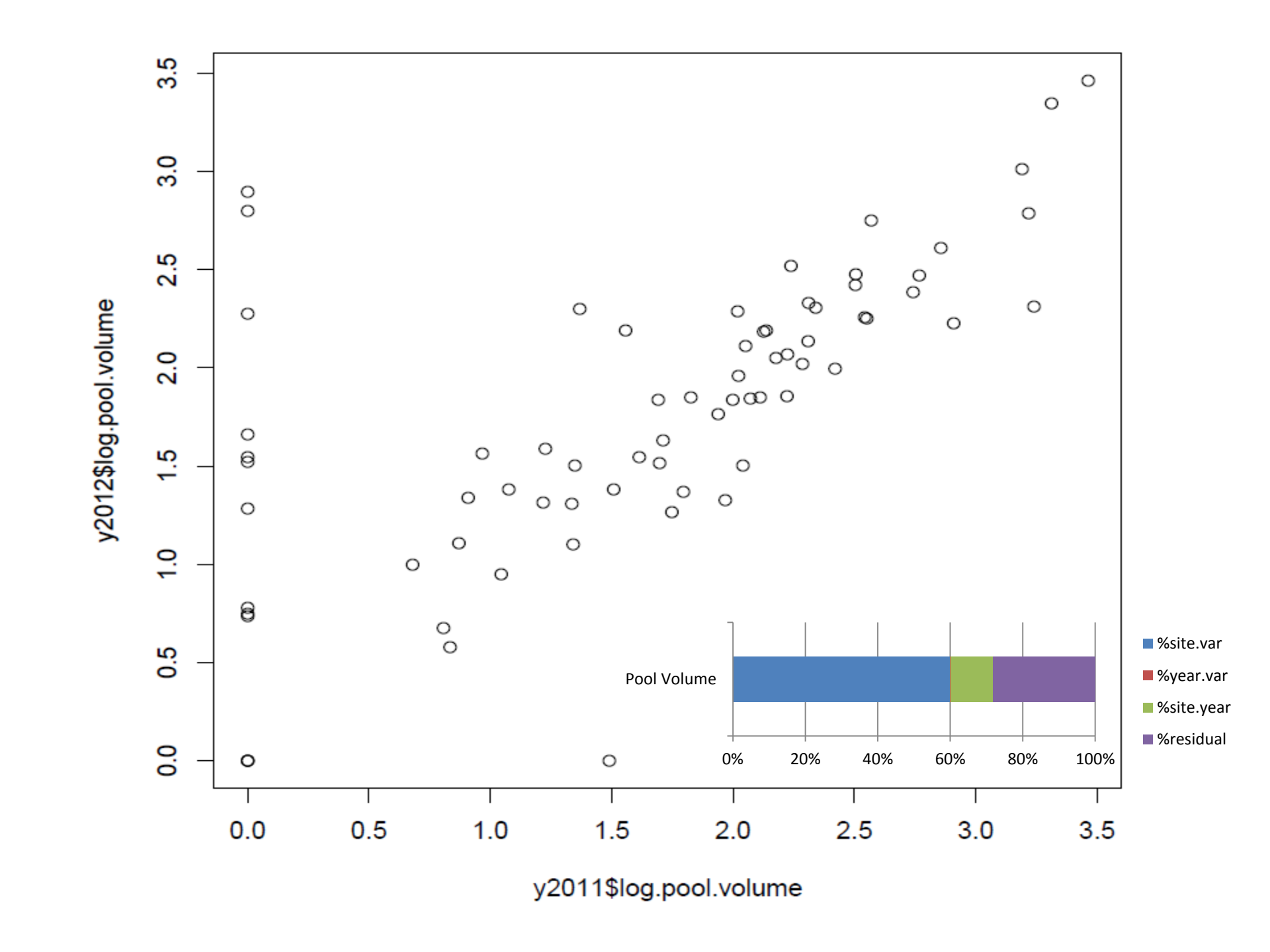

D84
%site.var
%year.var
%site.year
%residual
86%
88%
90%
92%
94%
96%
98%
100%
v2$log.measurement.of.d84
0.8
0.9
1.0
1.1
1.2
1.3
1.4
v1$log.measurement.of.d84
0.8
1.0
1.2
1.4

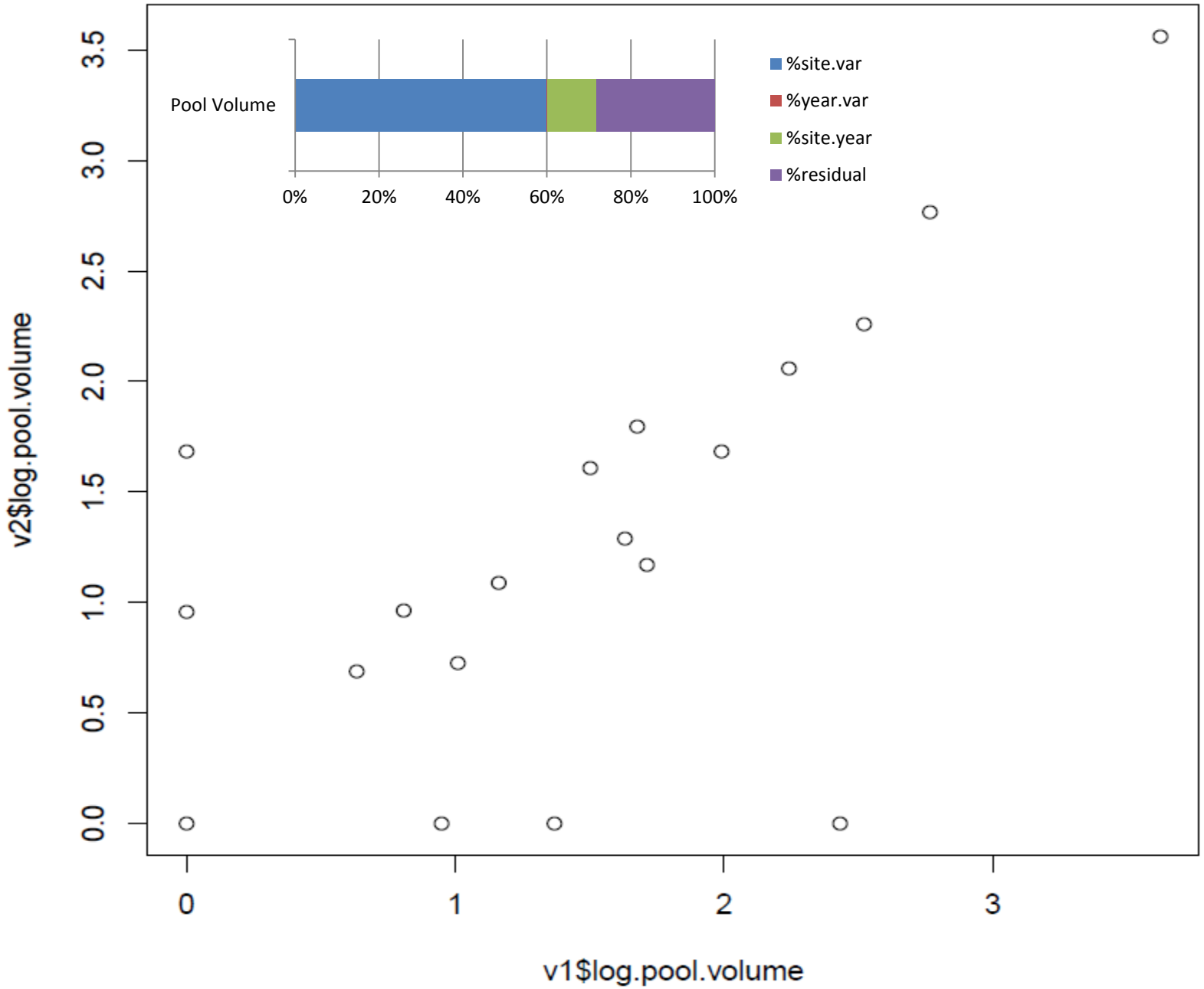

crew2$log.measurement.of.d84
0.8
0.9
1.0
1.1
1.2
1.3
1.4
crew1$log.measurement.of.d84
0.8
0.9
1.0
1.1
1.2
1.3

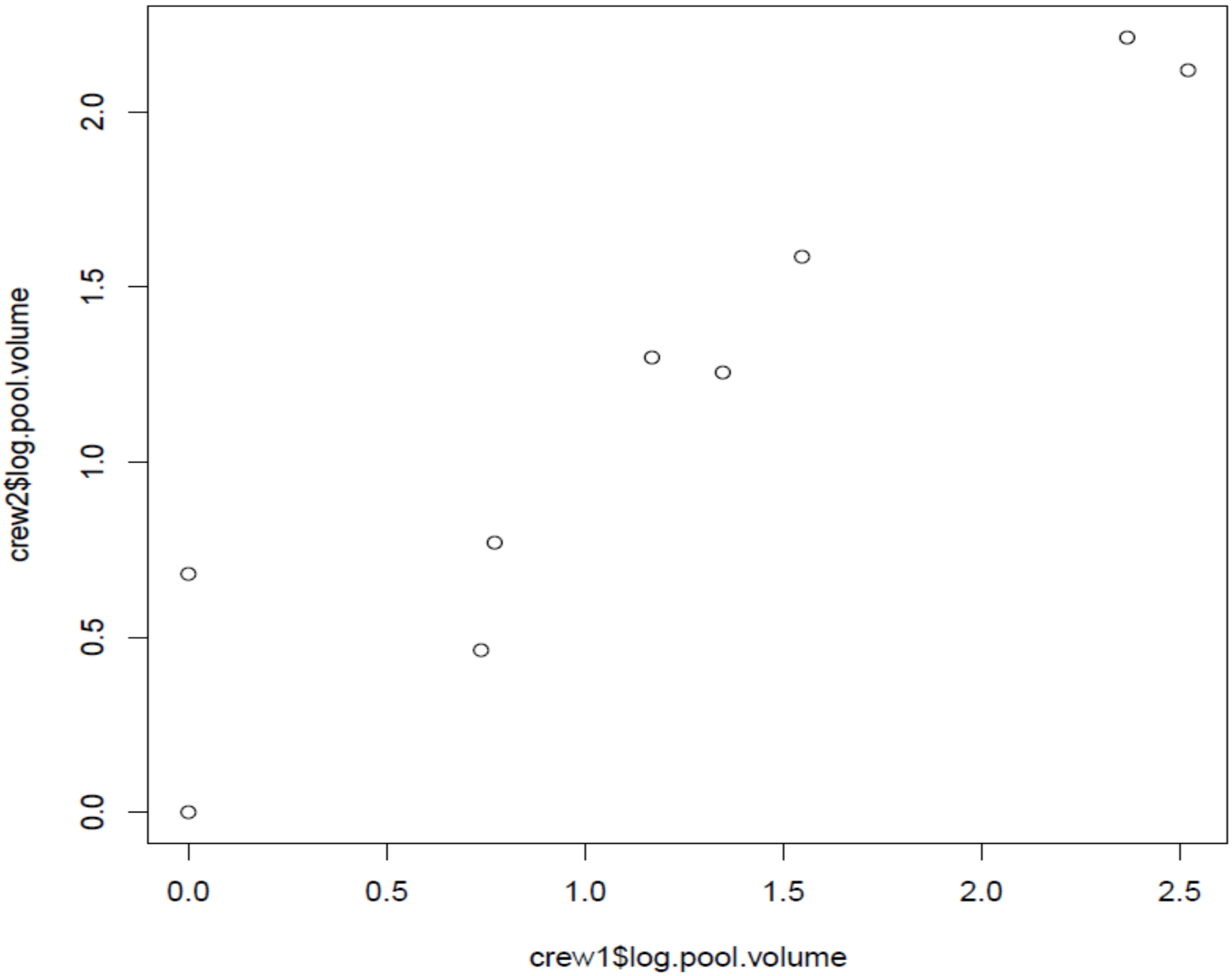

y2012$log.site.measurement.of.conductivity
0.4
0.6
0.8
1.0
1.2
1.4
1.6
y2011$log.site.measurement.of.conductivity
0.4
0.6
0.8
1.0
1.2
1.4
1.6
Conductivity
0%
20%
40%
60%
80%
100%
%site.var
%year.var
%site.year
%residual

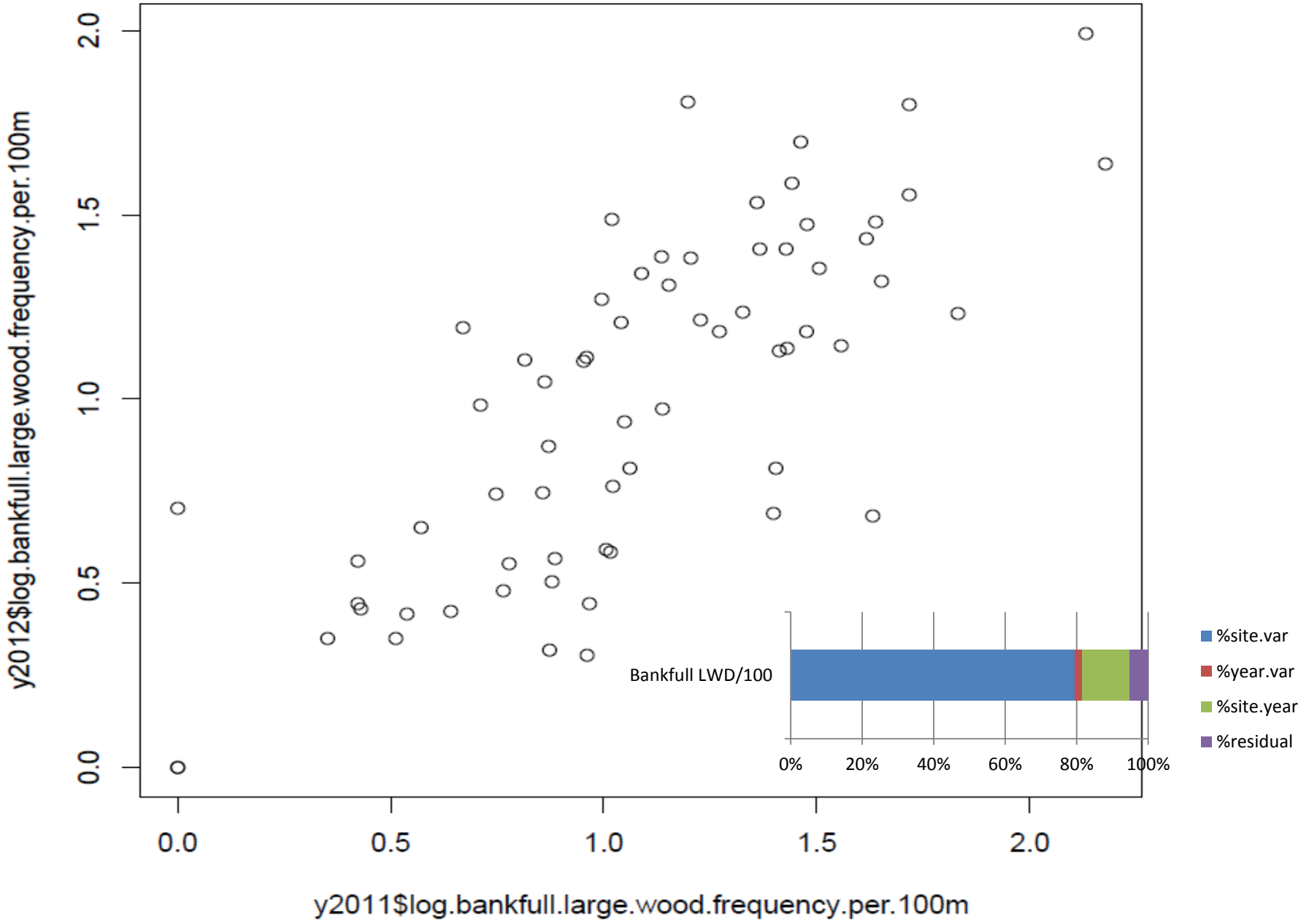

v2$log.site.measurement.of.conductivity
0.4
0.6
0.8
1.0
1.2
1.4
v1$log.site.measurement.of.conductivity
Conductivity
0%
20%
40%
60%
80%
100%
%site.var
%year.var
%site.year
%residual

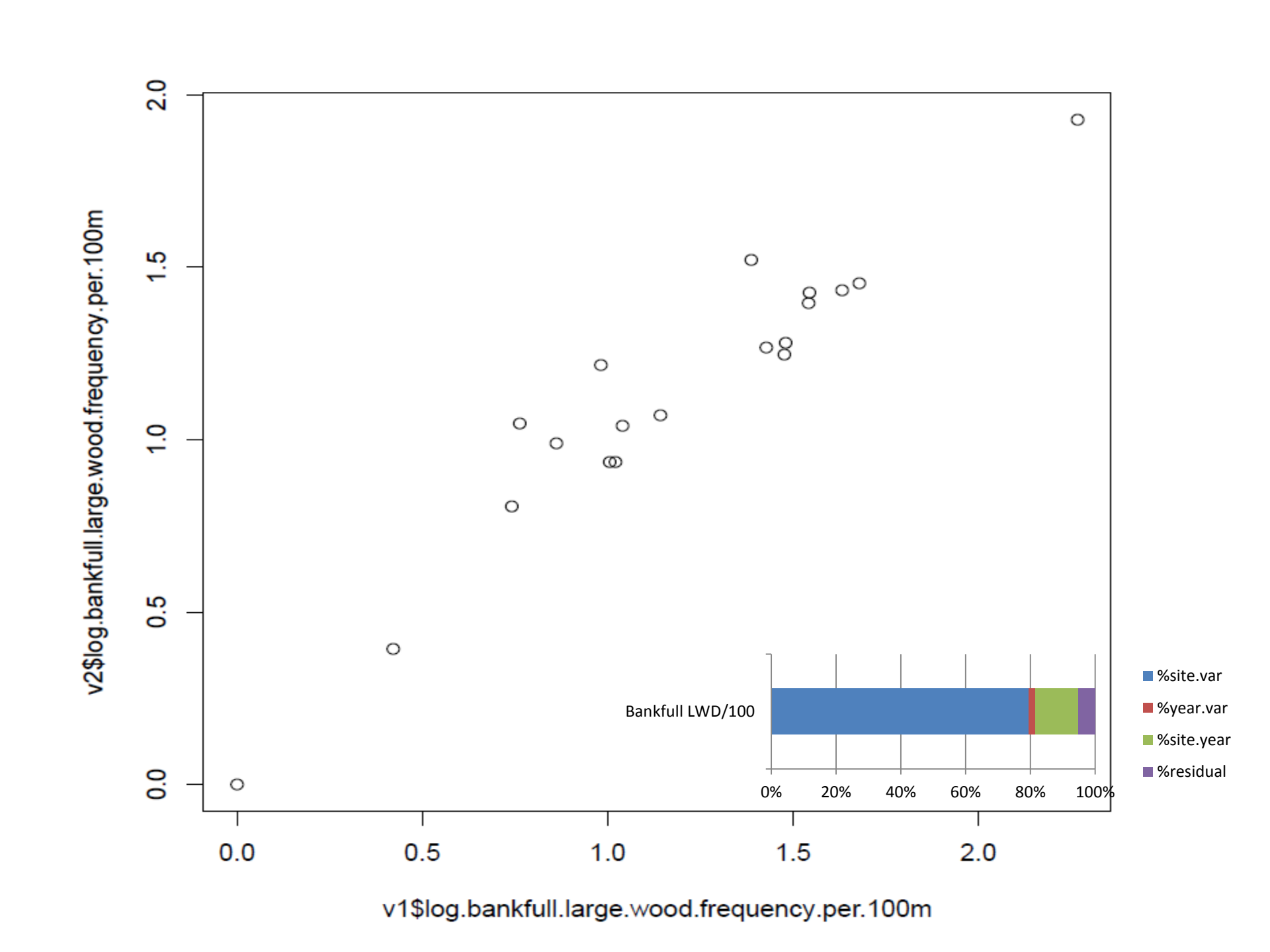

crew2$log.site.measurement.of.conductivity
1.3
1.2
1.1
1.0
0.9
0.8
0.4
0.6
0.8
1.0
1.2
1.4
1.6
crew1$log.site.measurement.of.conductivity

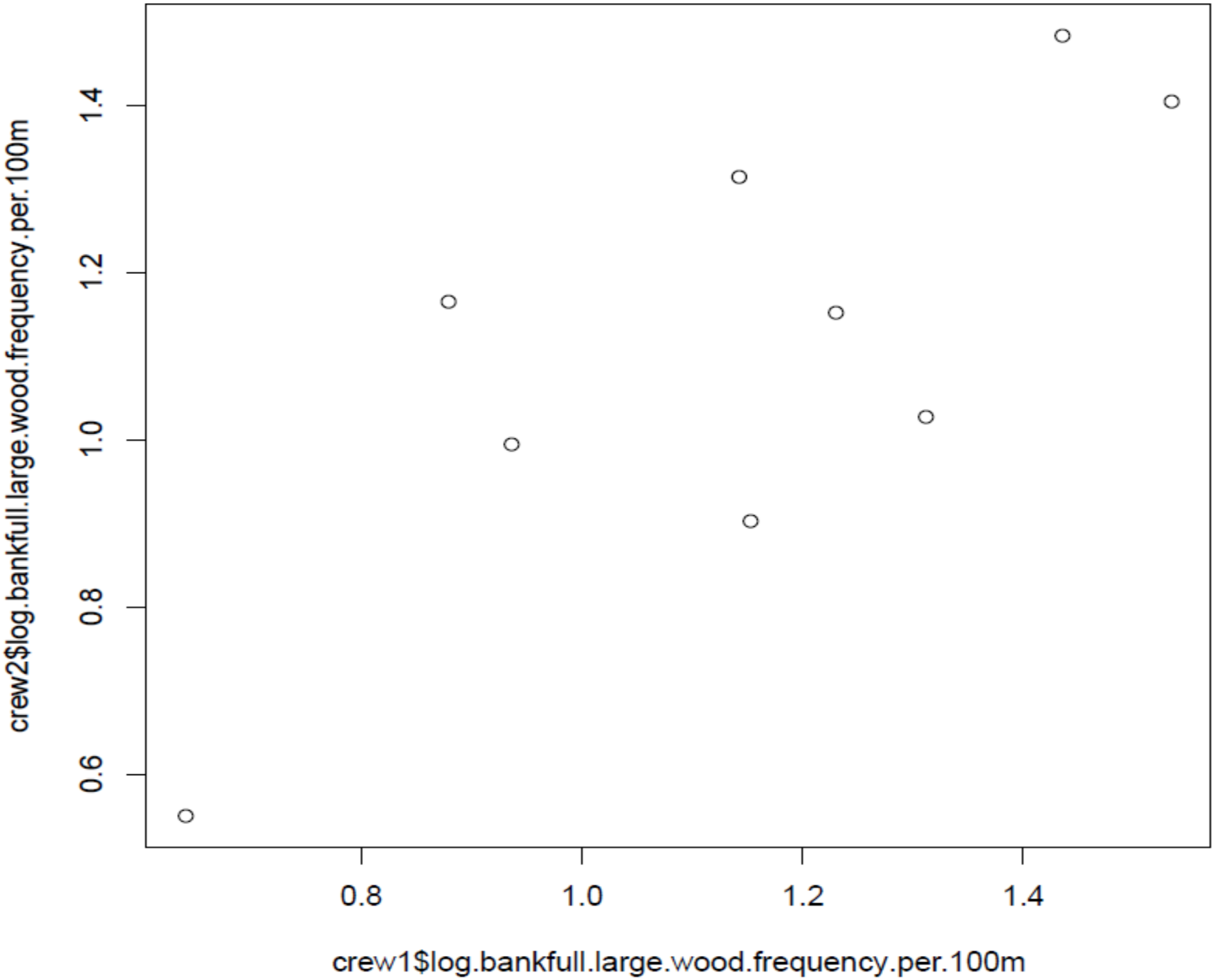

y2012$log.pool.volume
y2011$log.pool.volume
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
Pool Volume
0%
20%
40%
60%
80%
100%
%site.var
%year.var
%site.year
%residual

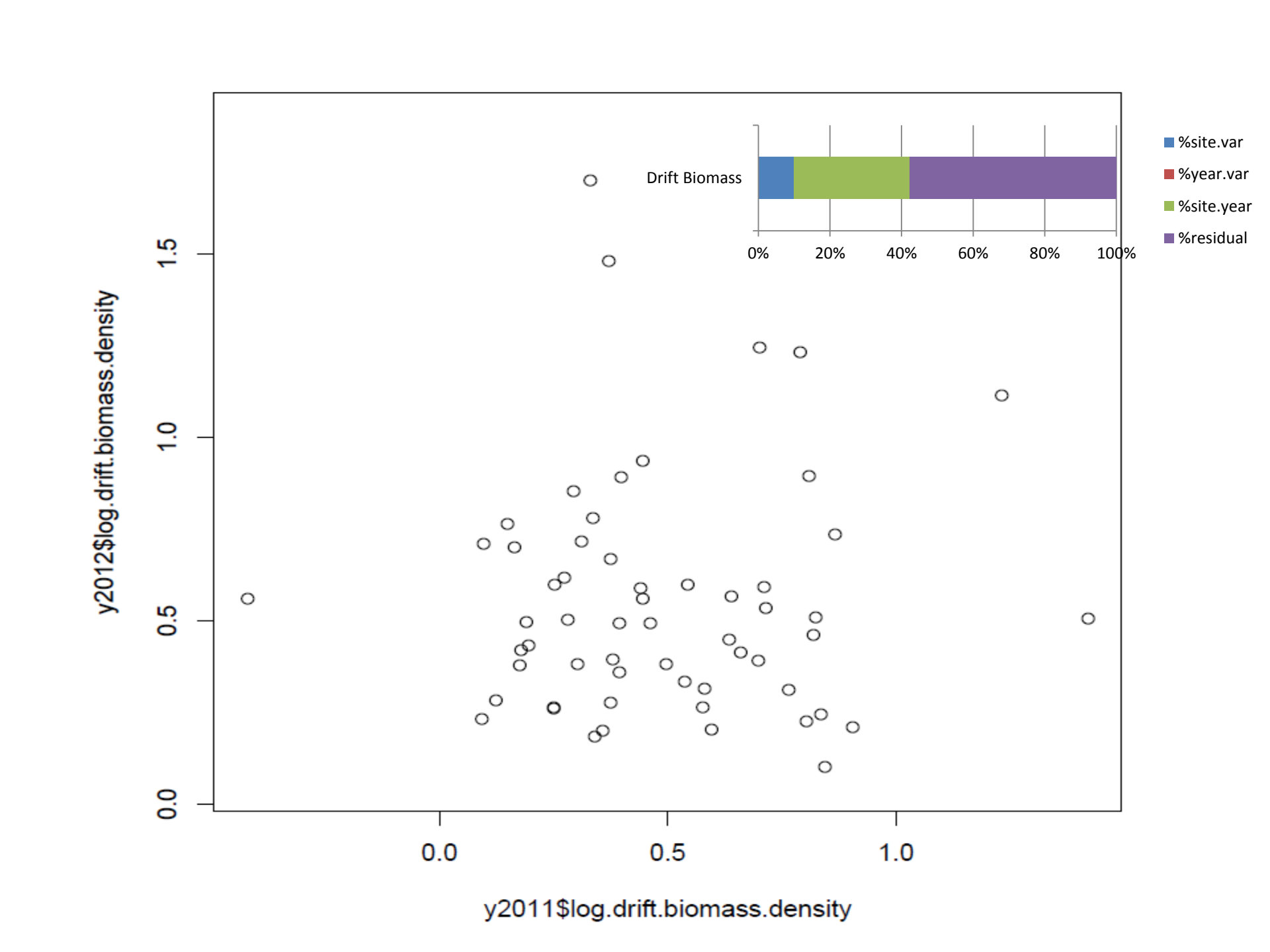

Pool Volume
0%
20%
40%
60%
80%
100%
%site.var
%year.var
%site.year
%residual
v2$log.pool.volume
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
0
1
2
3
v1$log.pool.volume

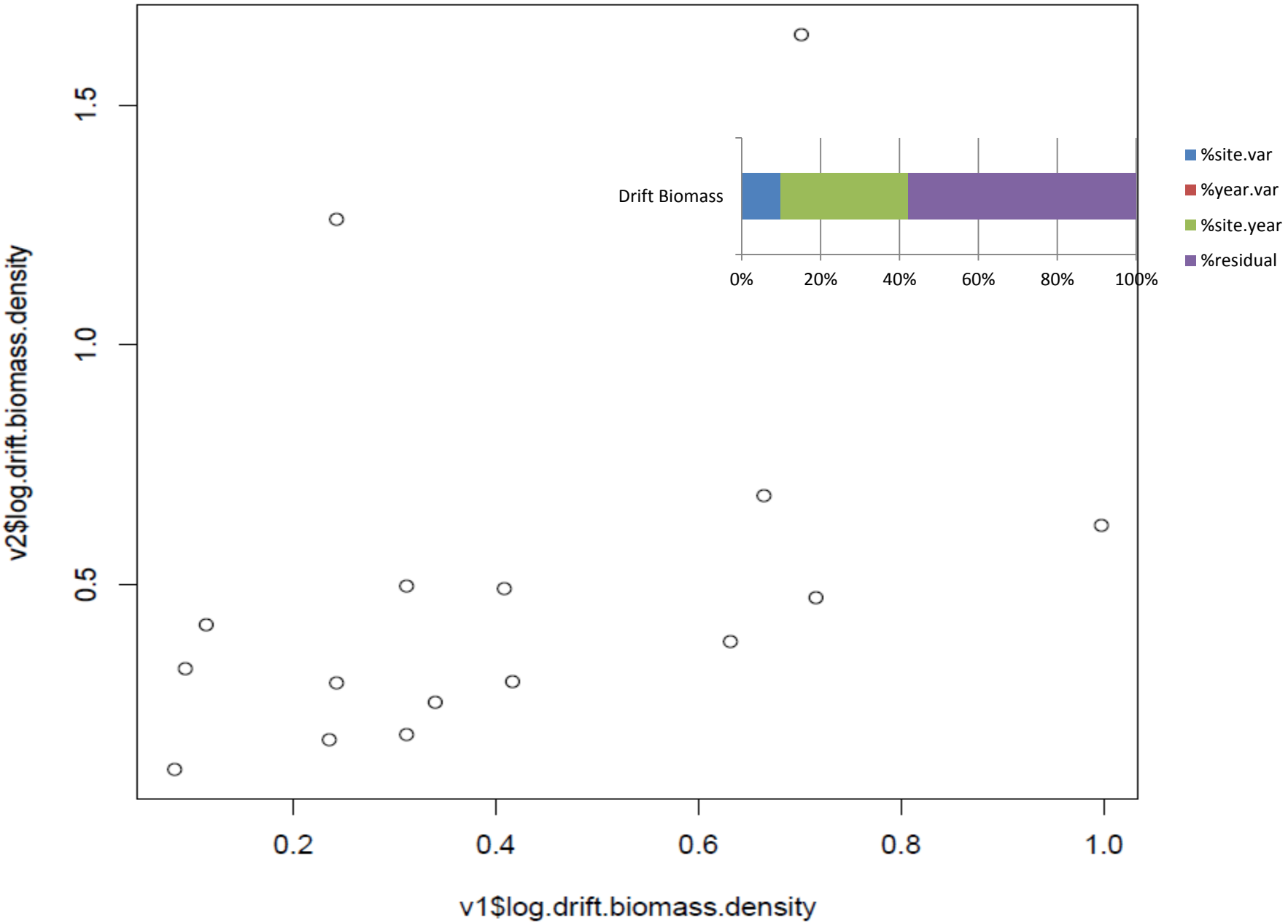

crew2$log.pool.volume
0.0
0.5
1.0
1.5
2.0
crew1$log.pool.volume
0.0
0.5
1.0
1.5
2.0
2.5

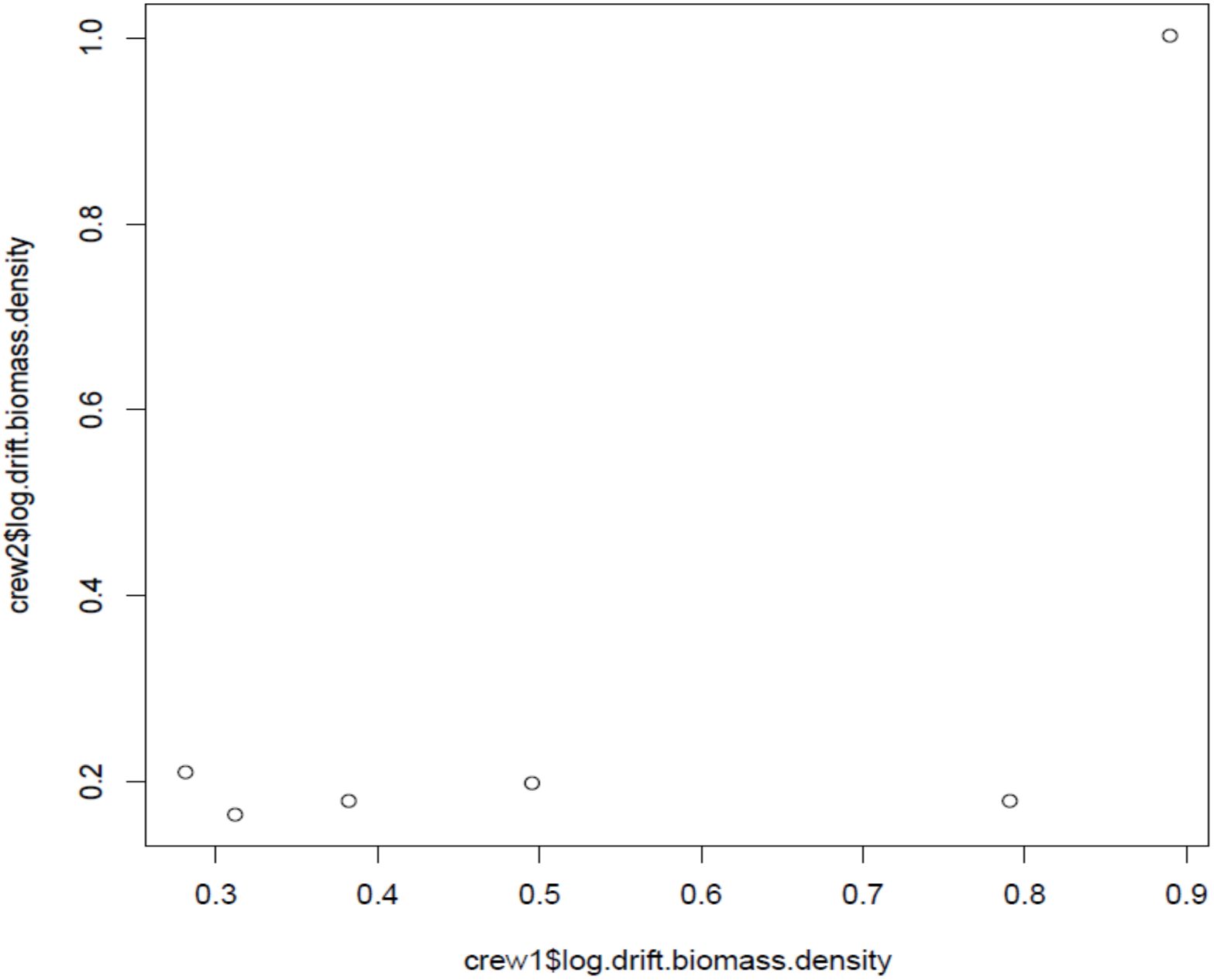

y2012$log.bankfull.large.wood.frequency.per.100m
y2011$log.bankfull.large.wood.frequency.per.100m
0.0
0.5
1.0
1.5
2.0
Bankfull LWD/100
0%
20%
40%
60%
80%
100%
%site.var
%year.var
%site.year
%residual

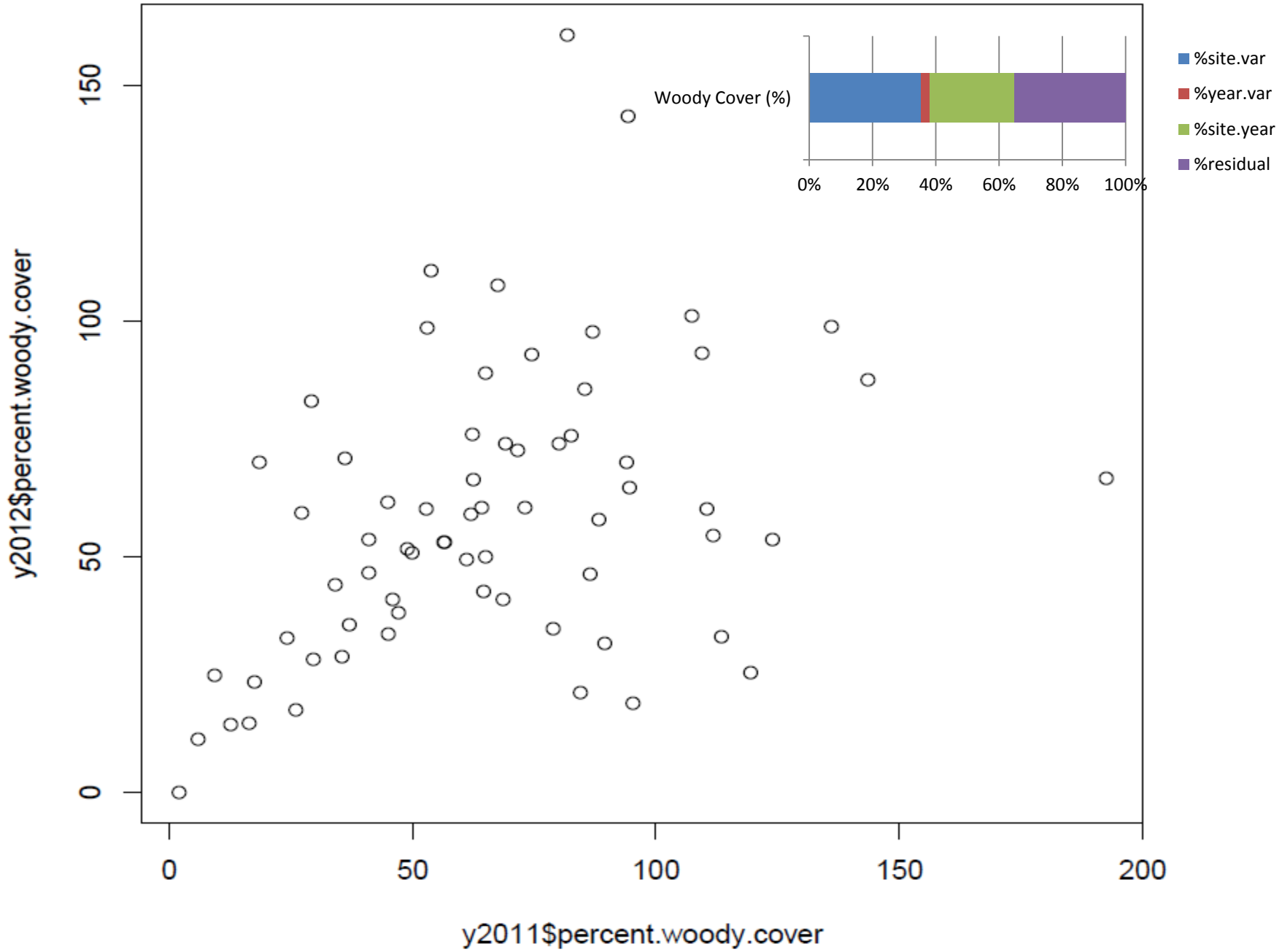

v2$log.bankfull.large.wood.frequency.per.100m
v1$log.bankfull.large.wood.frequency.per.100m
0.0
0.5
1.0
1.5
2.0
Bankfull LWD/100
0%
20%
40%
60%
80%
100%
%site.var
%year.var
%site.year
%residual

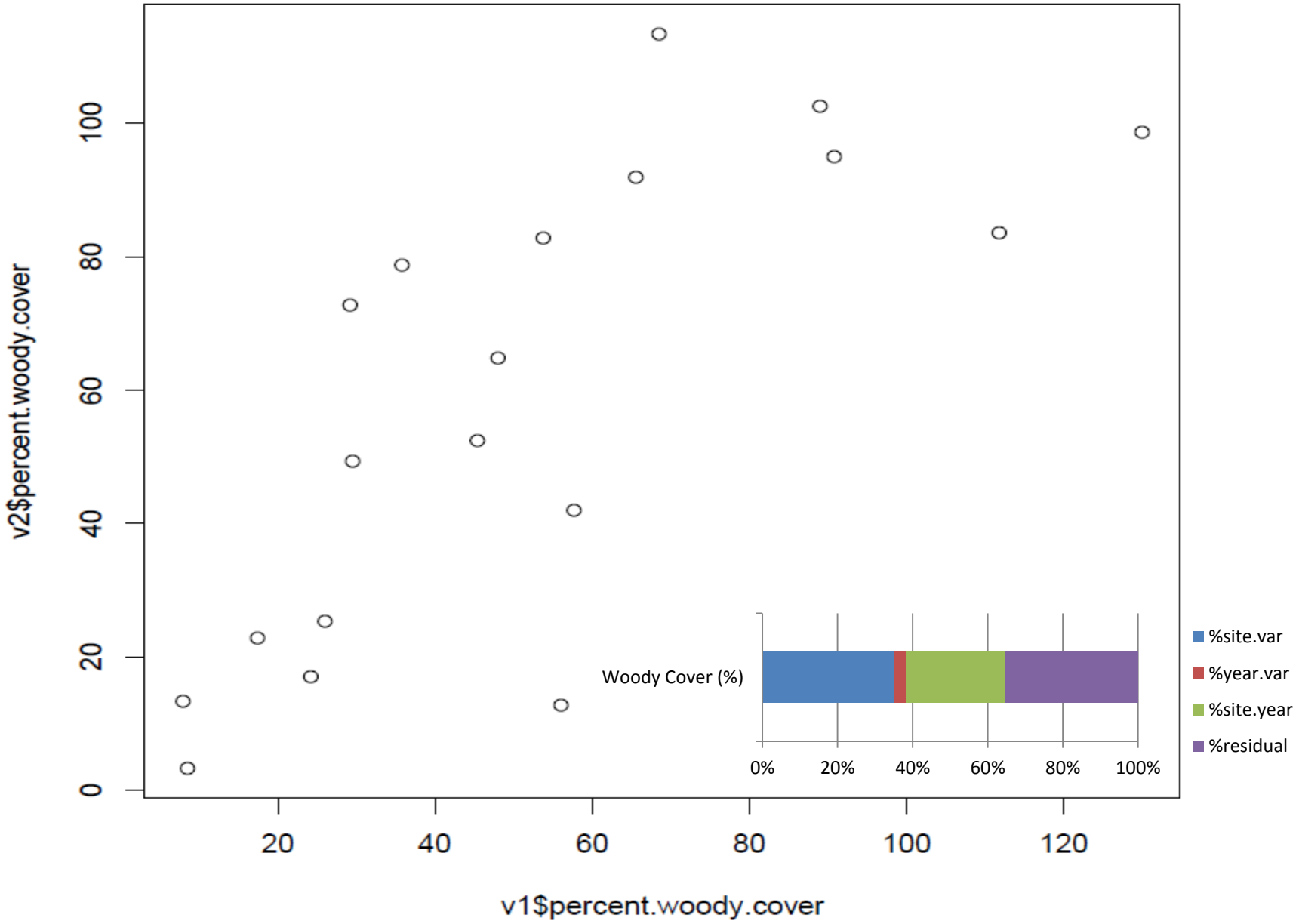

crew2$log.bankfull.large.wood.frequency.per.100m
0.6
0.8
1.0
1.2
1.4
0.8
1.0
1.2
1.4
crew1$log.bankfull.large.wood.frequency.per.100m

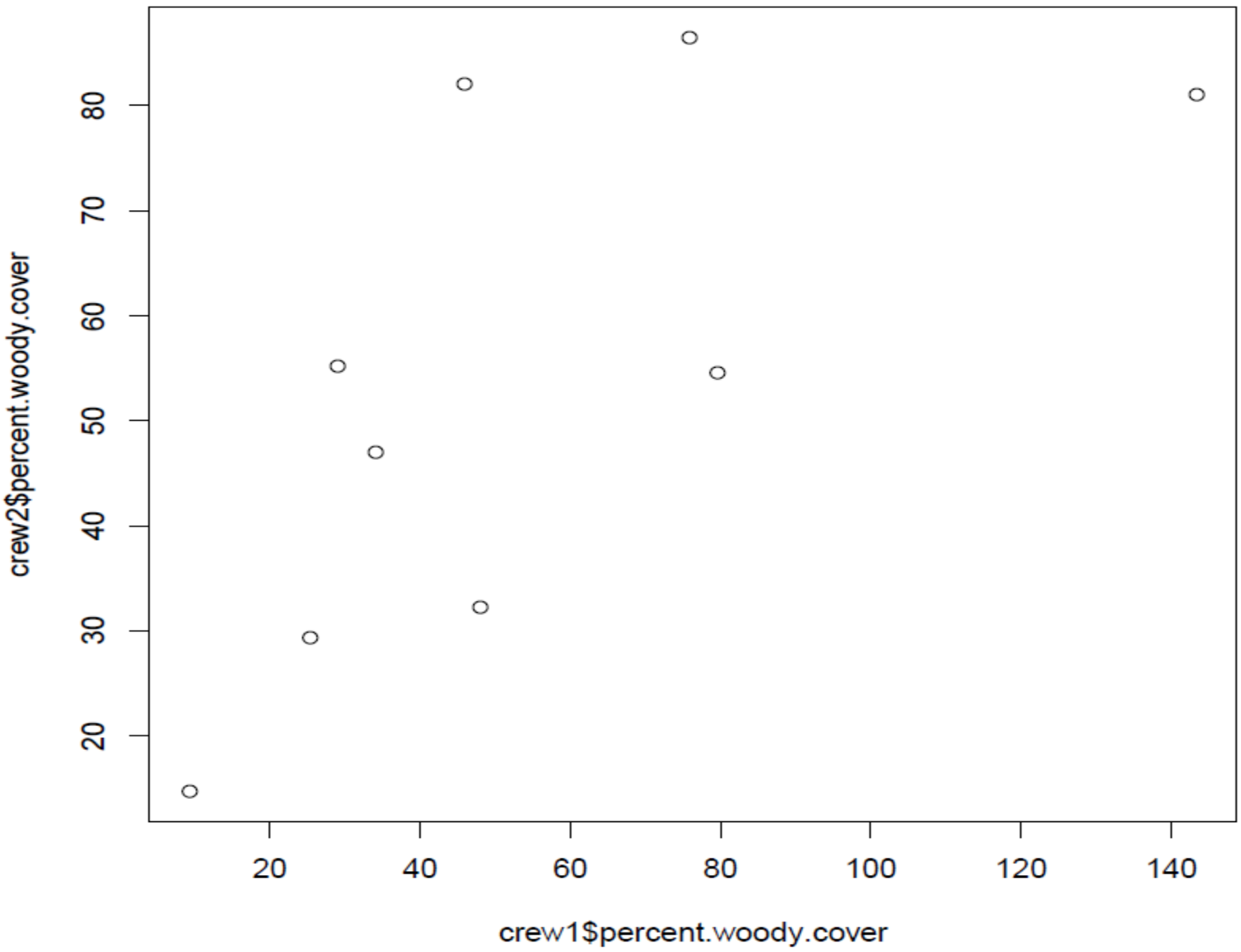

y2012$log.drift.biomass.density
y2011$log.drift.biomass.density
0.0
0.5
1.0
1.5
Drift Biomass
0%
20%
40%
60%
80%
100%
%site.var
%year.var
%site.year
%residual


v2$log.drift.biomass.density
v1$log.drift.biomass.density
0.5
1.0
1.5
0.2
0.4
0.6
0.8
1.0
Drift Biomass
0%
20%
40%
60%
80%
100%
%site.var
%year.var
%site.year
%residual


crew2$log.drift.biomass.density
1.0
0.8
0.6
0.4
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
crew1$log.drift.biomass.density


y2012$percent.woody.cover
y2011$percent.woody.cover
0
50
100
150
200
Woody Cover (%)
0%
20%
40%
60%
80%
100%
%site.var
%year.var
%site.year
%residual


v2$percent.woody.cover
0
20
40
60
80
100
20
40
60
80
100
120
v1$percent.woody.cover
Woody Cover (%)
0%
20%
40%
60%
80%
100%
%site.var
%year.var
%site.year
%residual


crew2$percent.woody.cover
20
30
40
50
60
70
80
20
40
60
80
100
120
140
crew1$percent.woody.cover

# Crew Variance:Survey Residual Variance

## 0 - 0.5

Wetted Width CV
Fast Turbulent Volume
Bankfull Width CV
Pool Volume
Alkalinity
Drift Biomass
Fast Turbulent (%)

## 0.5- : 1.0

Pools (%)
None Fish Cover (%)
Big Tree Cover (%)
Vegetation Fish Cover (%)
D50
D16
Fast Non-Turbulent (%)
Woody Cover (%)
Conferous Cover (%)
LWD Fish Cover (%)

## 1.0 : 1..5

Bankfull LWD/100
Conductivity
Fast Non Turbulent Volume
Woody Cover (%)
Understory Cover (%)
Asin Fast Non-Turbulent (%)
Wetted LWD/100m
Non-Woody Cover (%)
Ground Cover (%)
D84
Pool Frequency
Thalweg Depth CV

## >1.5

Obs < 6 mm (%)

# CHaMP Conclusions

- Variance decomposition is
  - Informative
  - Useful as part of a QA toolbox
  - Sensitive to transformations and outliers
- Some metrics well behaved, some not…
- Incomplete dataset provides preliminary insights