

Hatchery Effectiveness Review

# AN EXPLORATORY ANALYSIS INTO SPATIAL PATTERNS OF CORRELATION RELATIVE TO ENHANCEMENT

APPENDIX 2: AREA 08 CHUM SALMON



Photo credit: Eiko Jones

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May 2023



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# Appendix 2

## Area 08 Chum Salmon

Coastland

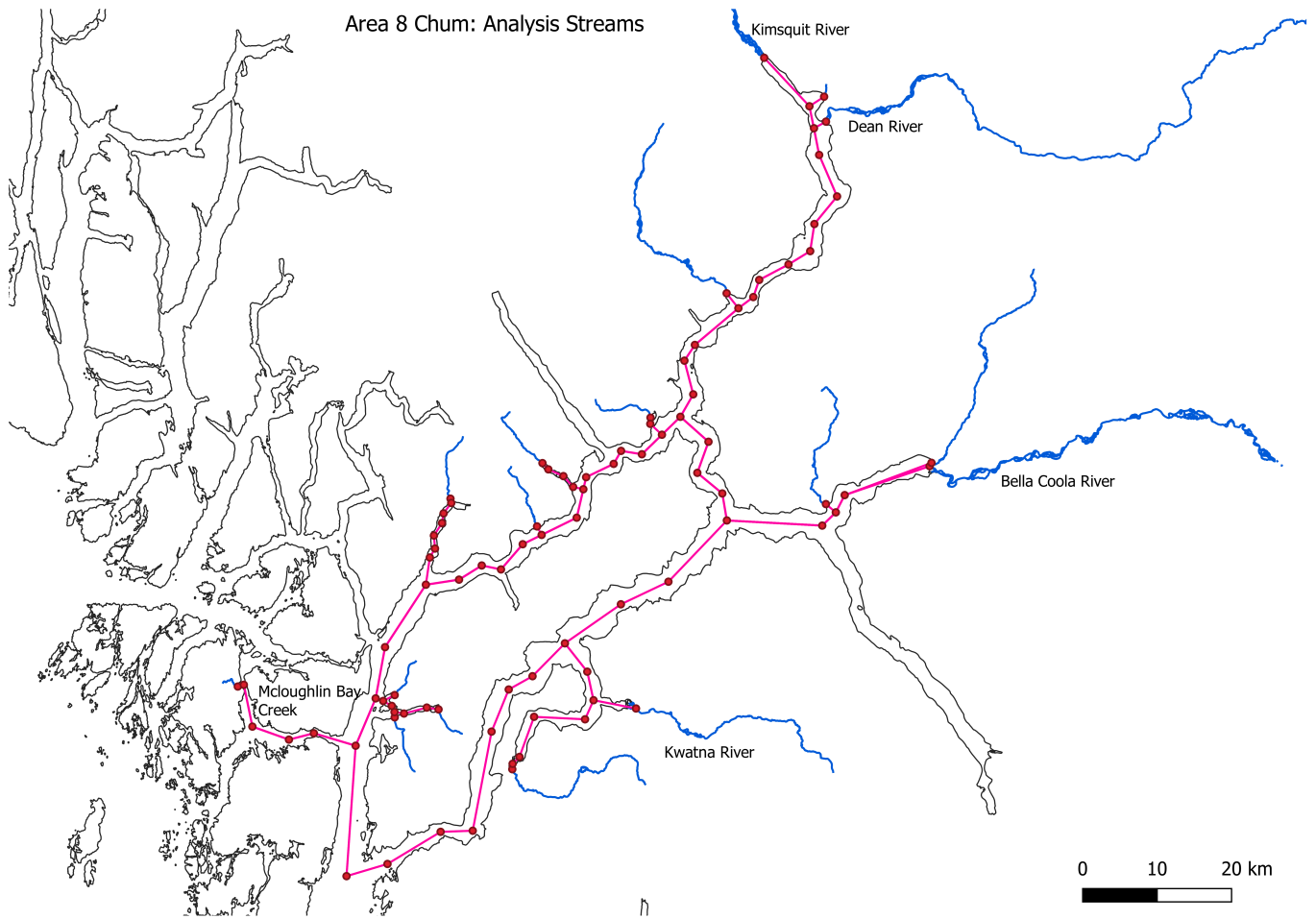
2023-03-07

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# Study area

## Area 8



# Summary figures

## Escapement: Raw and filtered stream list

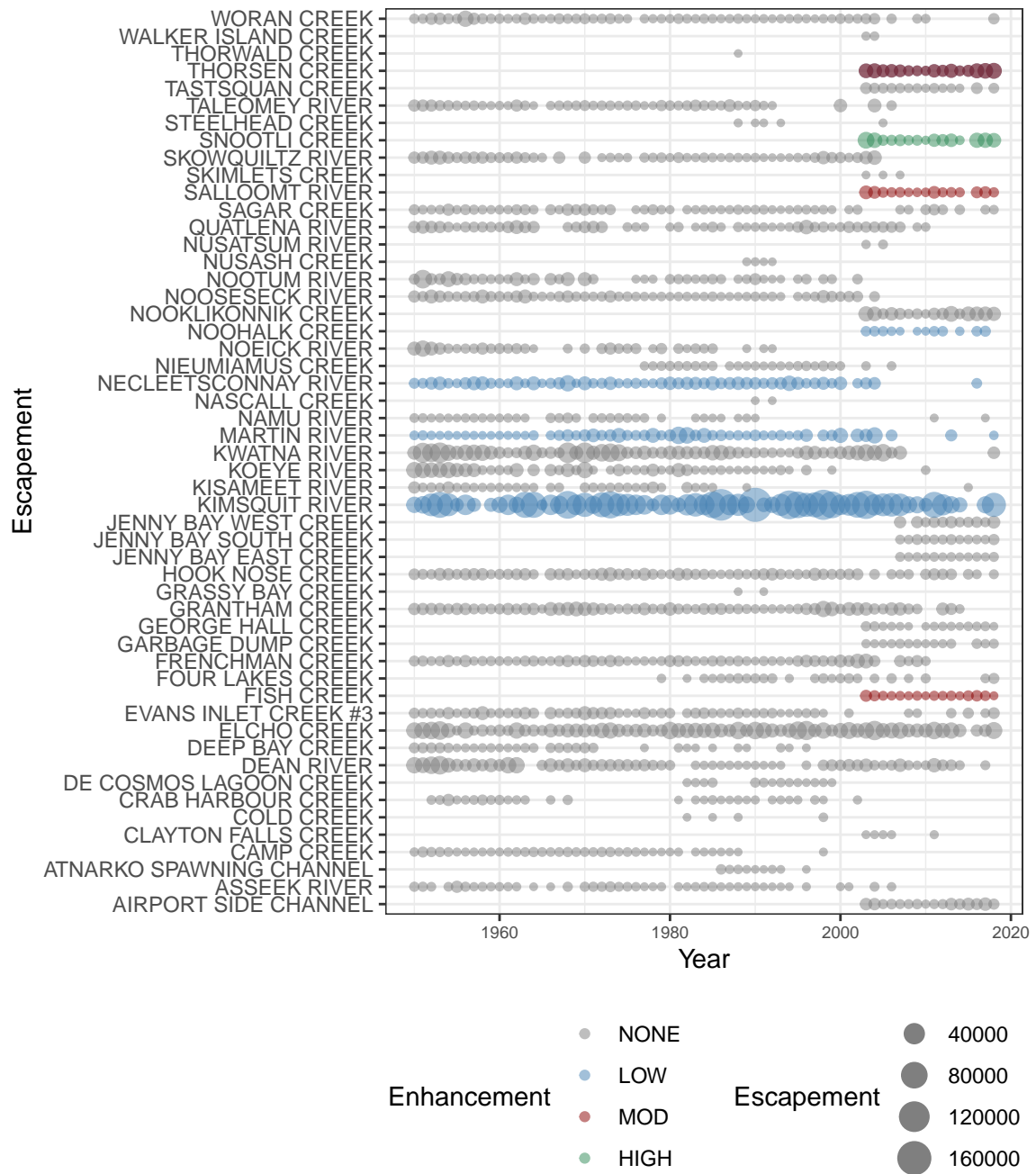


Figure 1: Escapement to area streams by enhancement rank.

## Area 8 Escapement (filtered streams)

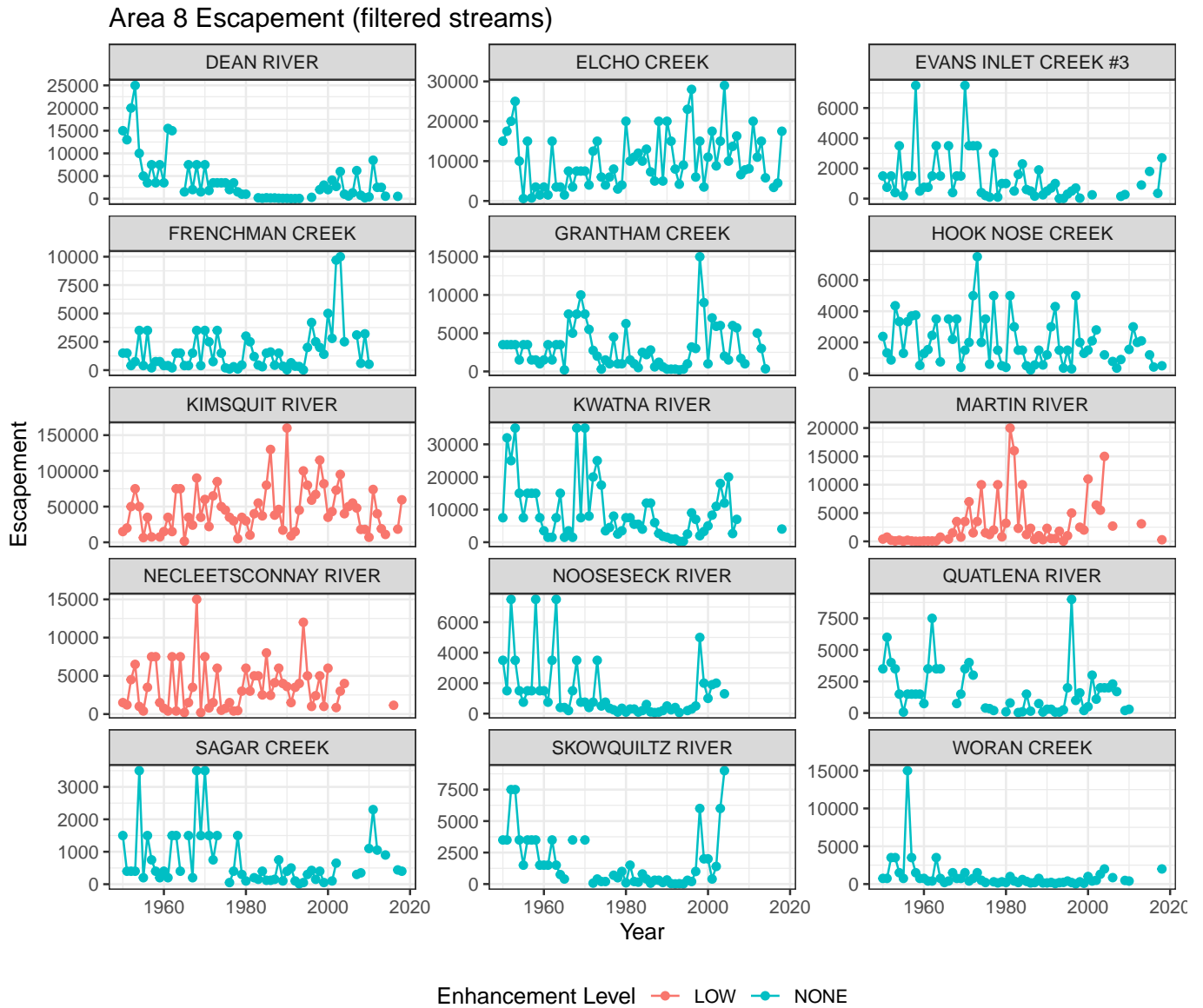


Figure 2: Escapement to filtered streams for Area 8 chum. Colour shows the stream enhancement level from the PSE database.

Table 1: Distance from enhanced systems (Bella Coola and McLaughlin)

| Stream               | Dist. from Bella Coola (km) | Dist. from McLoughlin (km) |
|----------------------|-----------------------------|----------------------------|
| NECLEETSCONNAY RIVER | 0.330                       | 131.240                    |
| NOOSESECK RIVER      | 24.643                      | 170.440                    |
| WORAN CREEK          | 76.866                      | 120.913                    |
| SKOWQUILTZ RIVER     | 94.720                      | 148.313                    |
| ELCHO CREEK          | 103.148                     | 106.639                    |
| KWATNA RIVER         | 105.902                     | 130.621                    |
| FRENCHMAN CREEK      | 107.102                     | 86.179                     |
| QUATLENA RIVER       | 119.732                     | 144.451                    |
| DEAN RIVER           | 131.461                     | 185.054                    |
| GRANTHAM CREEK       | 137.067                     | 190.660                    |
| KIMSQUIT RIVER       | 145.334                     | 198.927                    |
| MARTIN RIVER         | 146.597                     | 33.405                     |
| HOOK NOSE CREEK      | 156.657                     | 42.239                     |
| SAGAR CREEK          | 157.723                     | 43.305                     |
| EVANS INLET CREEK #3 | 166.711                     | 52.293                     |

# Hatchery Releases: Total and by release site

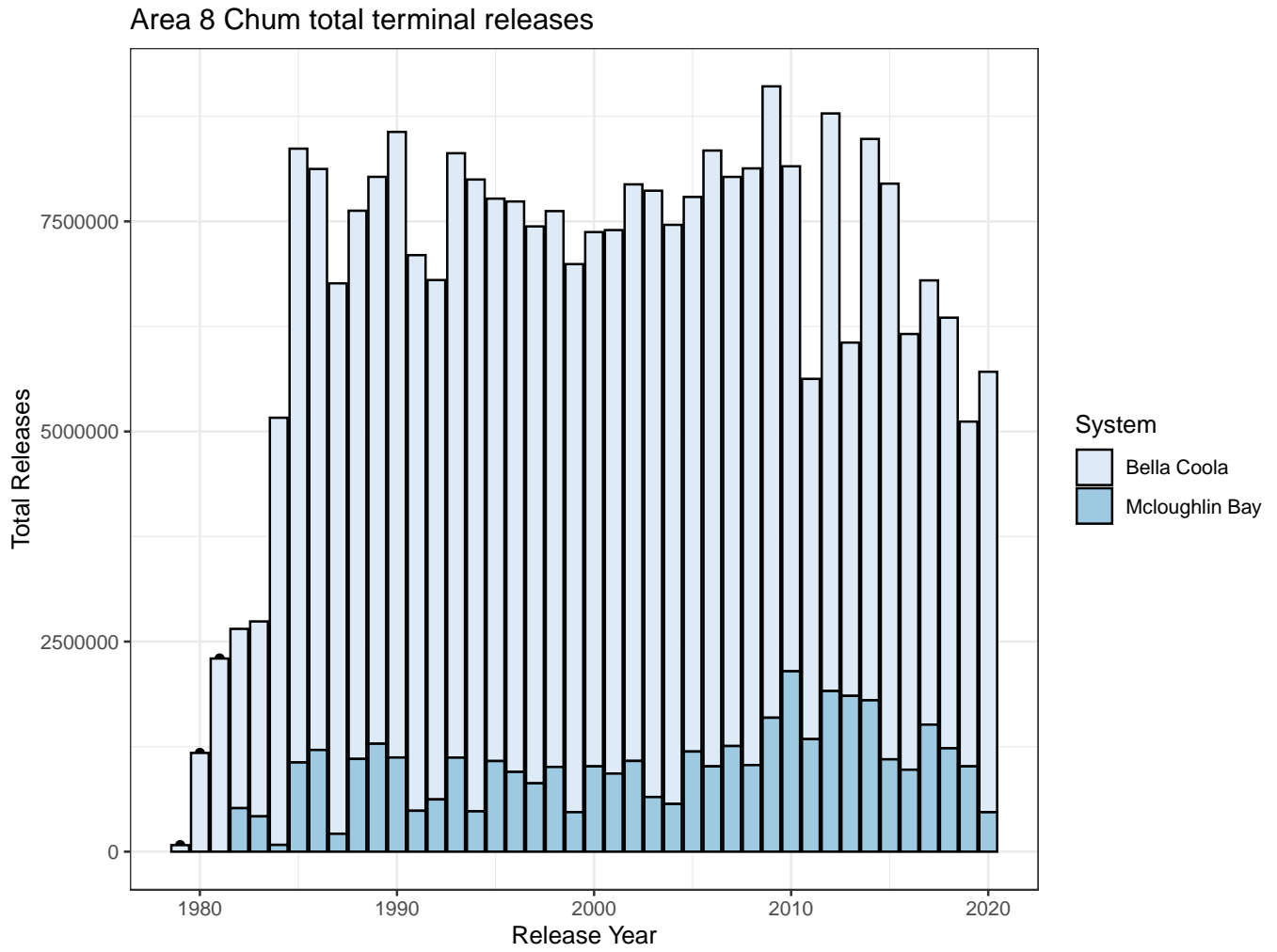


Figure 3: Total releases for Area 8

Chum: BELLA COOLA RIVER-LATE BELLA COOLA-DEAN RIVERS SPILLER-FITZ HUGH-BURKE

Release site:Origin stock

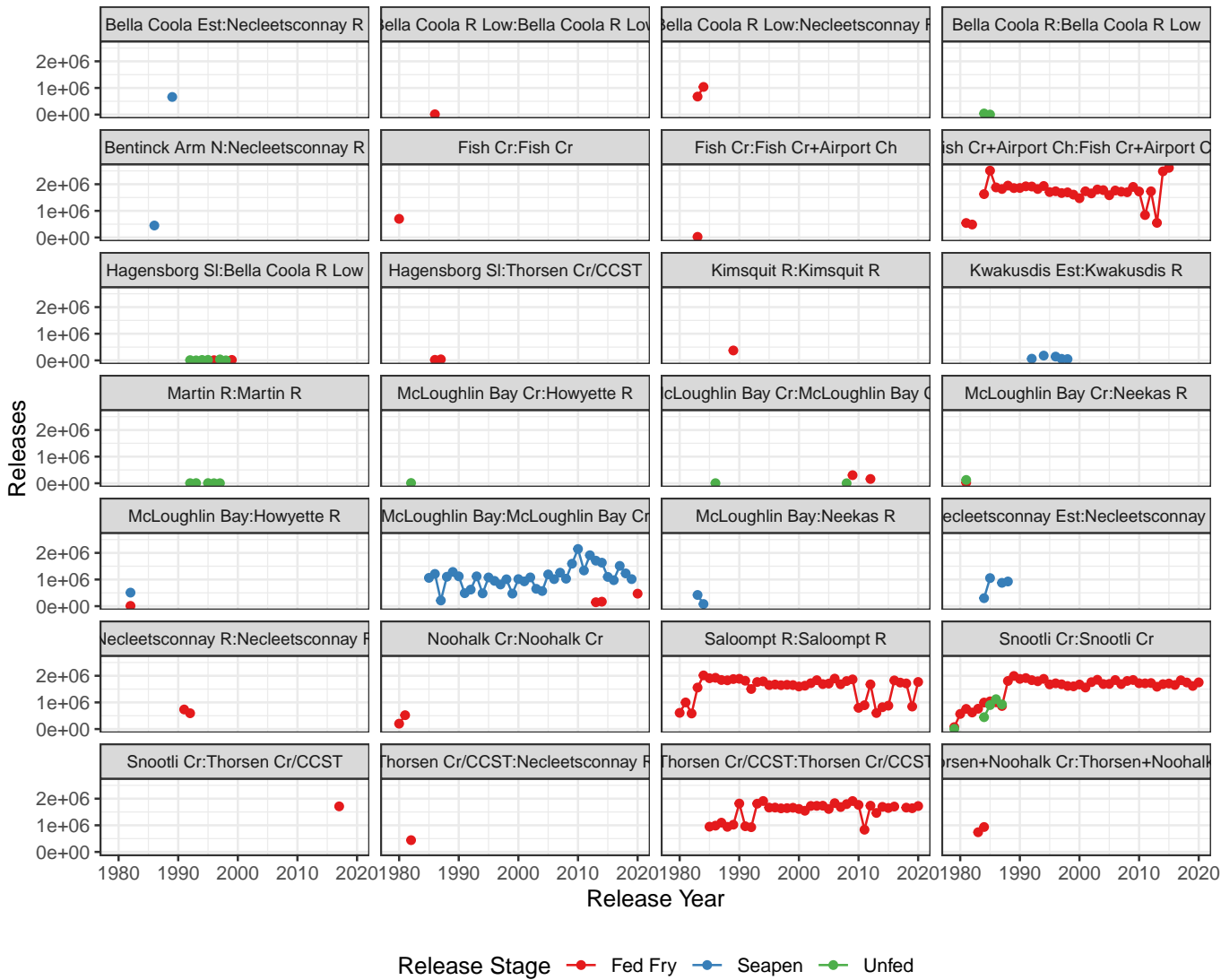


Figure 4: Facet plot of all releases in Area 8



## Metrics

Escapement, logged escapement, Z-scores, Pavg, and moving average

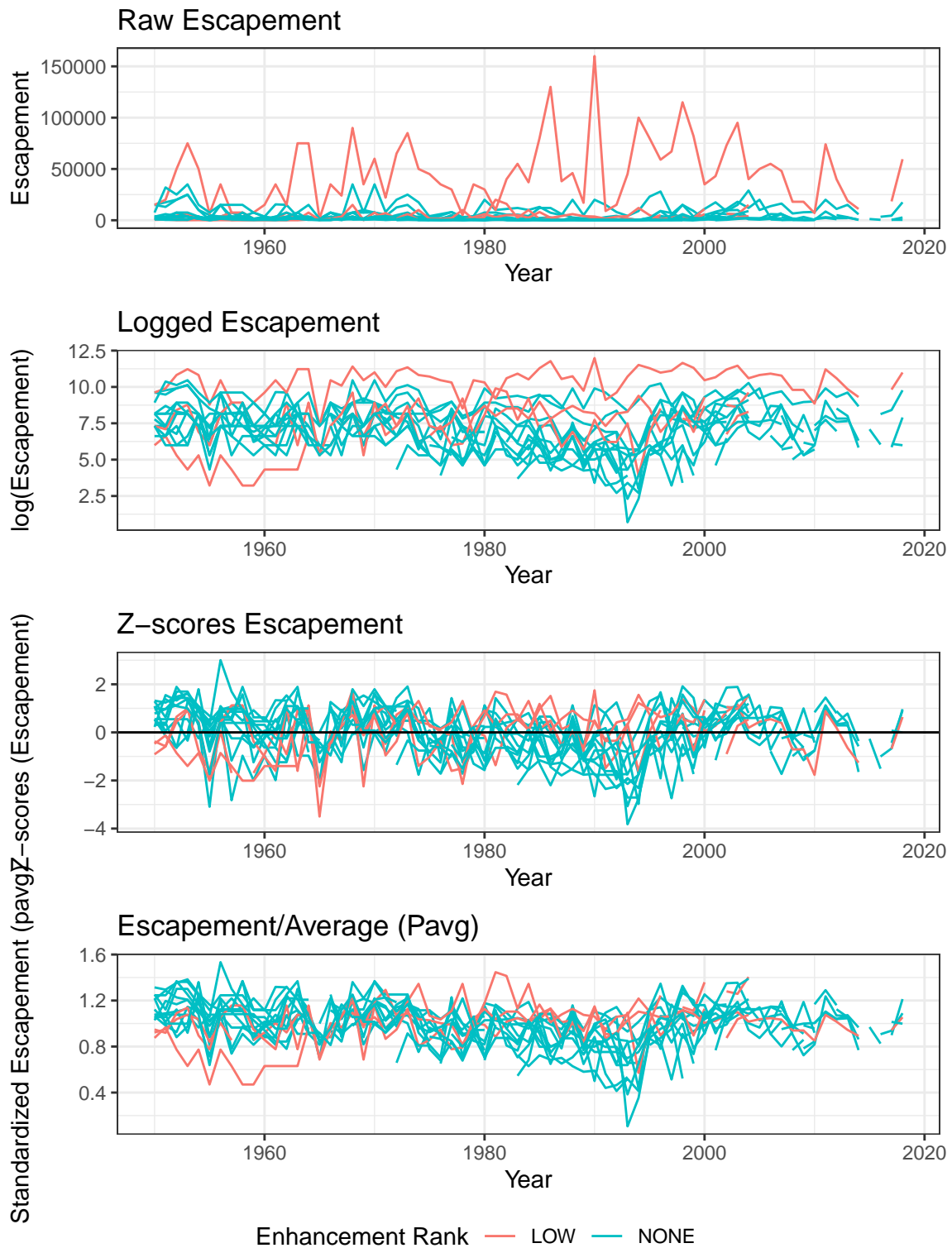


Figure 5: Various plots for escapement and transformations.

Moving average and LOESS fit

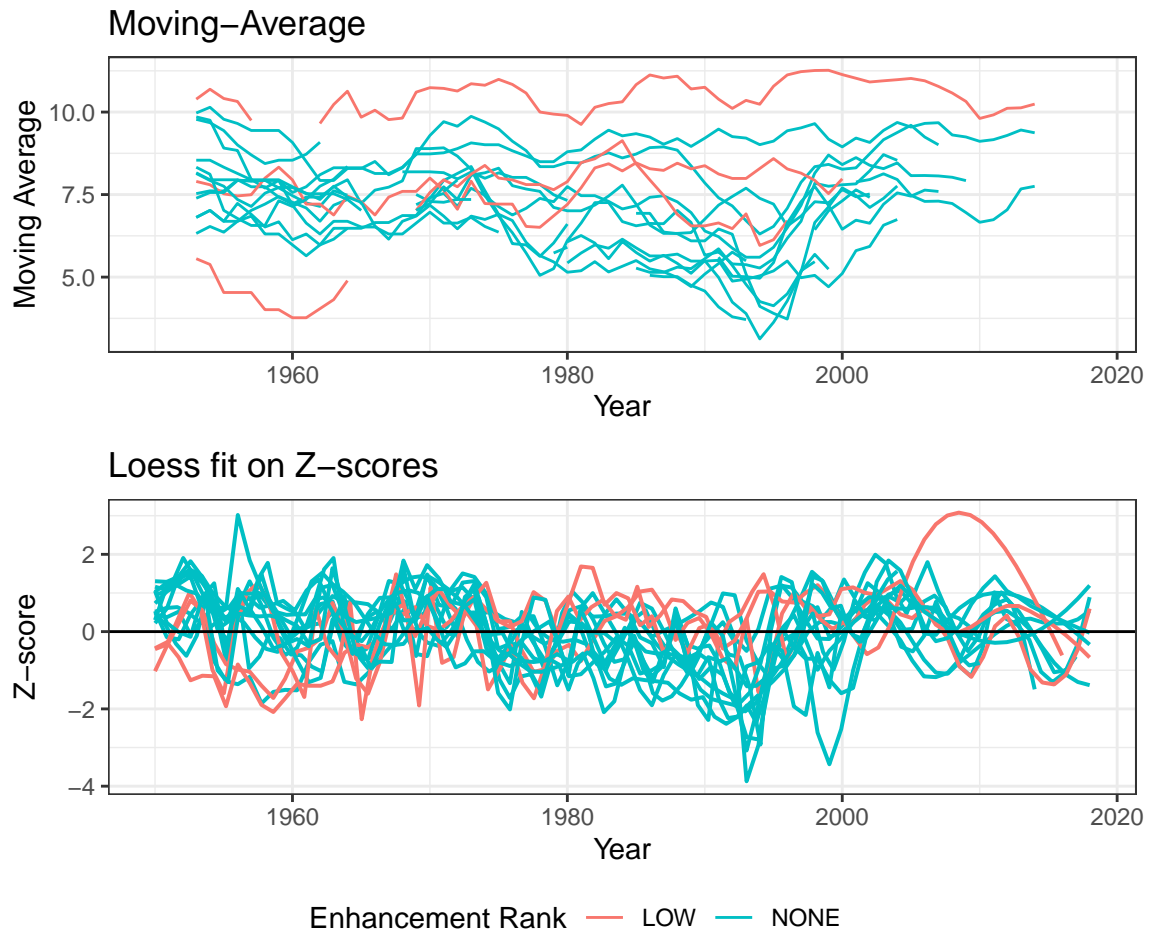


Figure 6: Moving average and LOESS fits on logged escapement by enhancement ranking.

Means trends by enhancement rank

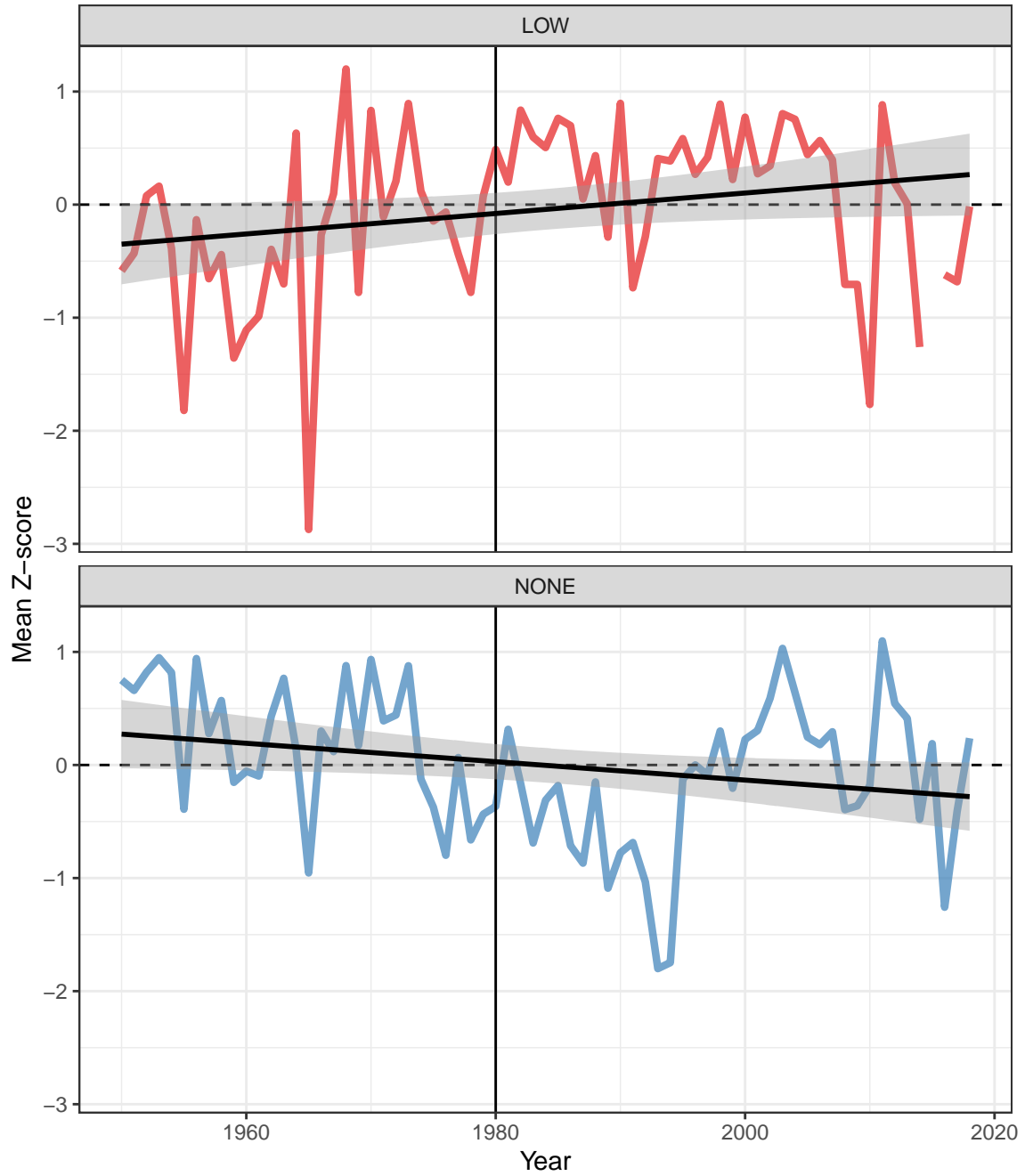


Figure 7: Area 8 chum: Mean Z-score for analysis streams by enhancement rank. Linear regression over all years with SE are shown.

# Recruits per spawner

## Recruits per spawner by system

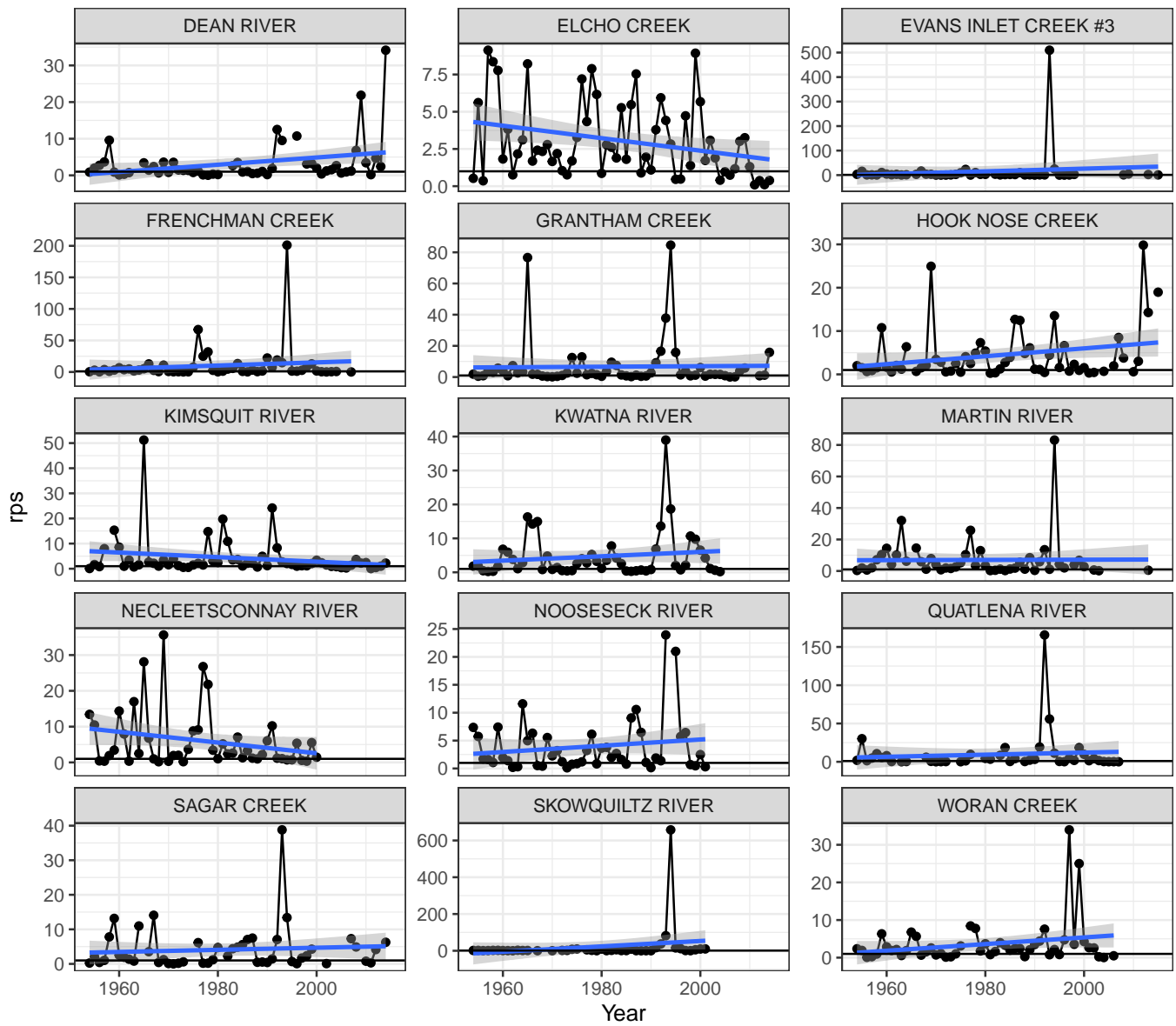


Figure 8: Recruits per spawner by system

Log recruits per spawner by system by period

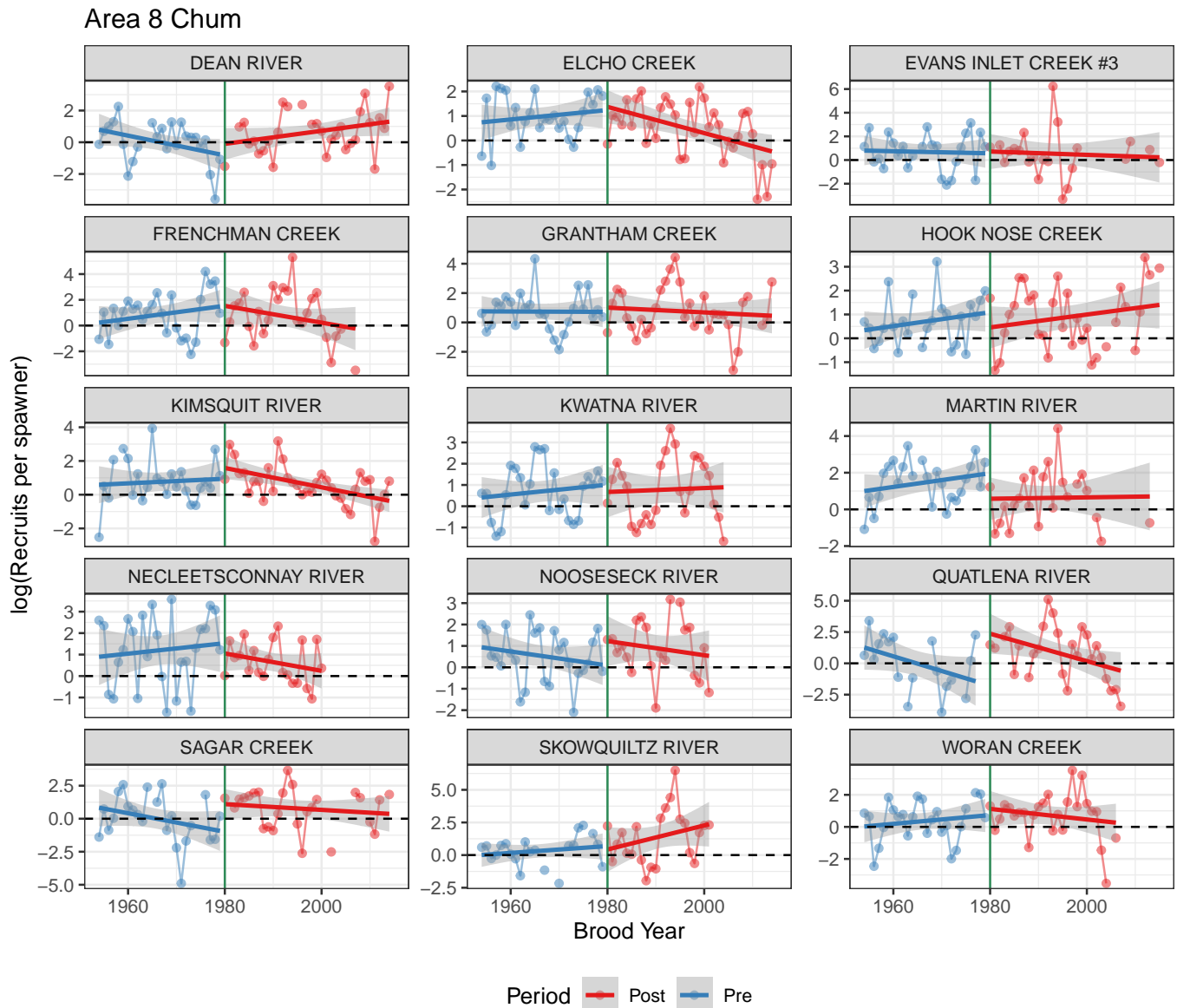


Figure 9: Area 8 chum: log recruits per spawner by system fitted with linear regression for the periods pre- and post-enhancement.

Log RPS comparison before and after enhancement

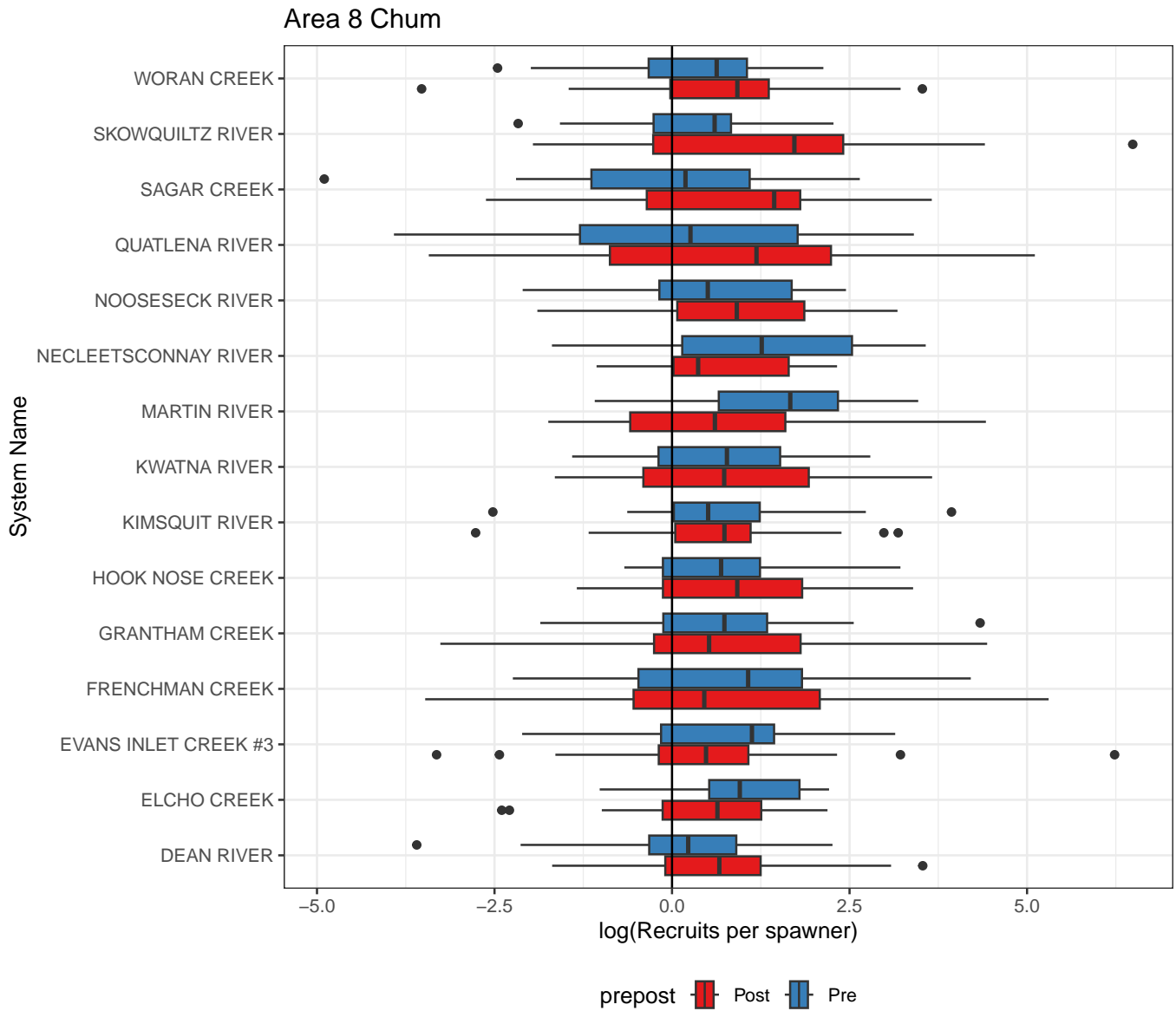


Figure 10: Boxplot of log recruits per spawner by system

# Bubbleplots of metric by inlet

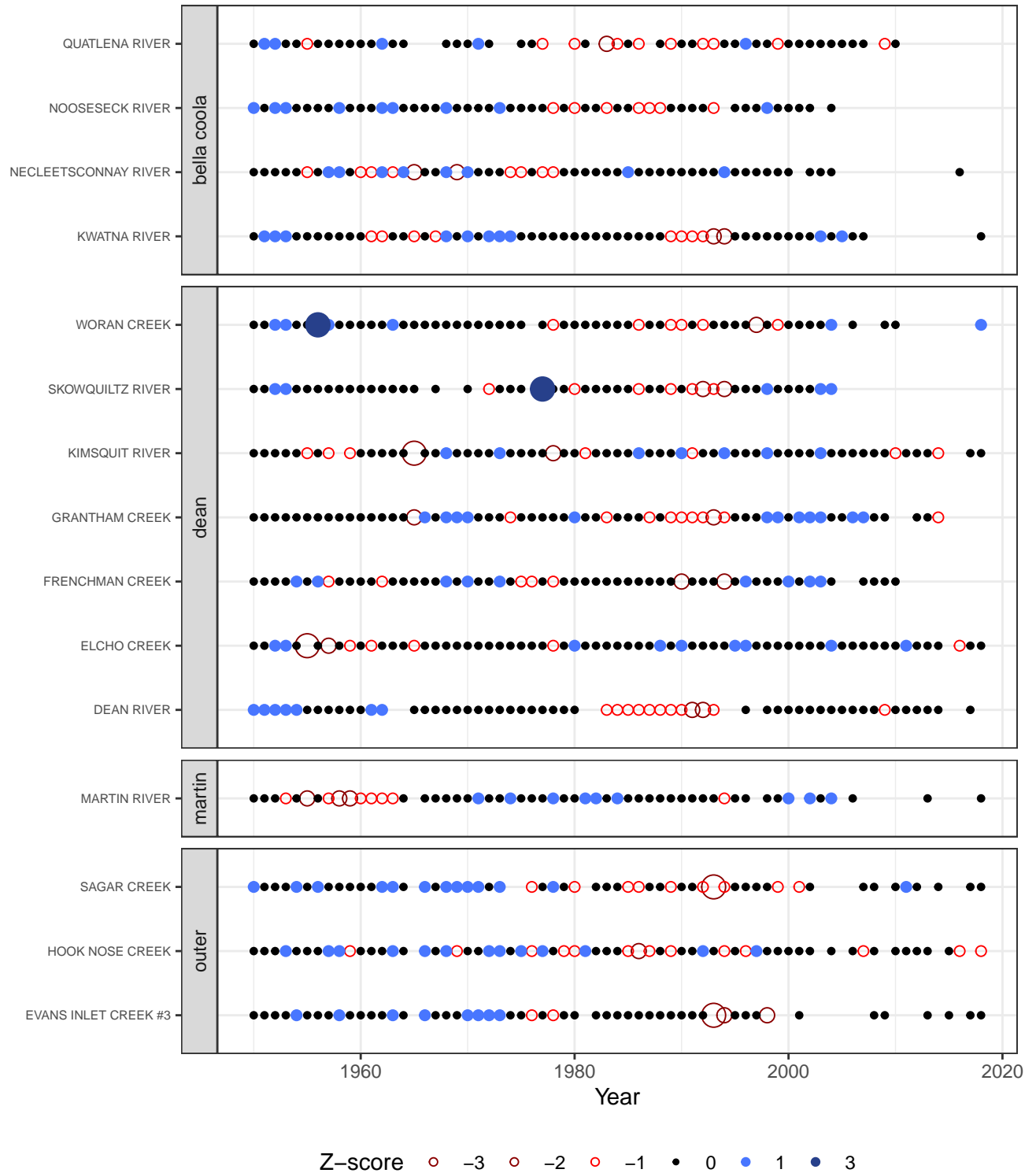


Figure 11: Z-scores of escapement for each system grouped by inlet. Solid blue points indicate positive values and open red circles indicate negative values. The size of the point indicates the magnitude of the metric.

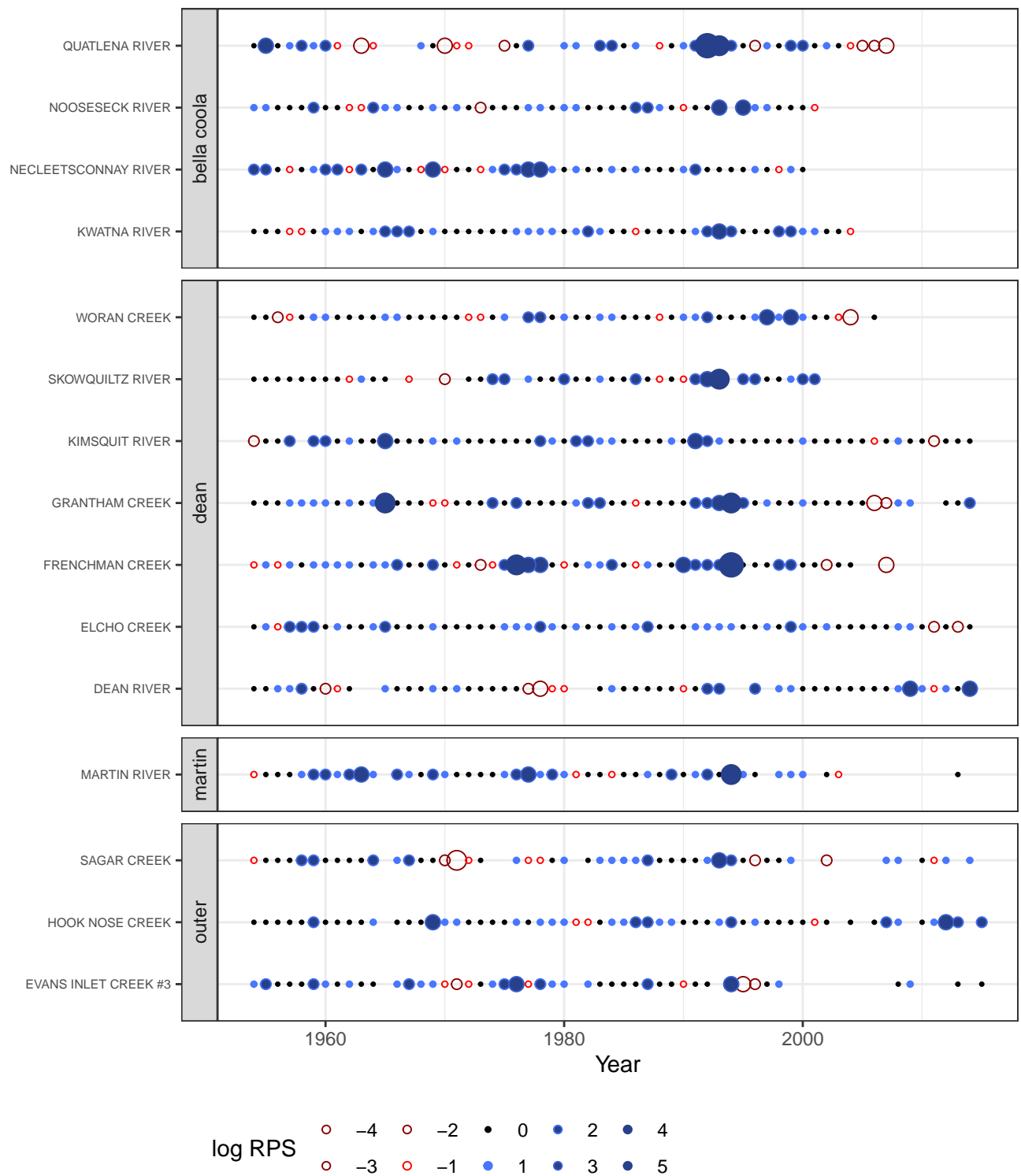


Figure 12: Log(recruits per spawner) for each system grouped by inlet. Solid blue points indicate positive values and open red circles indicate negative values. The size of the point indicates the magnitude of the metric.



# Correlation analyses and Dendrograms

## Cross correlation plots

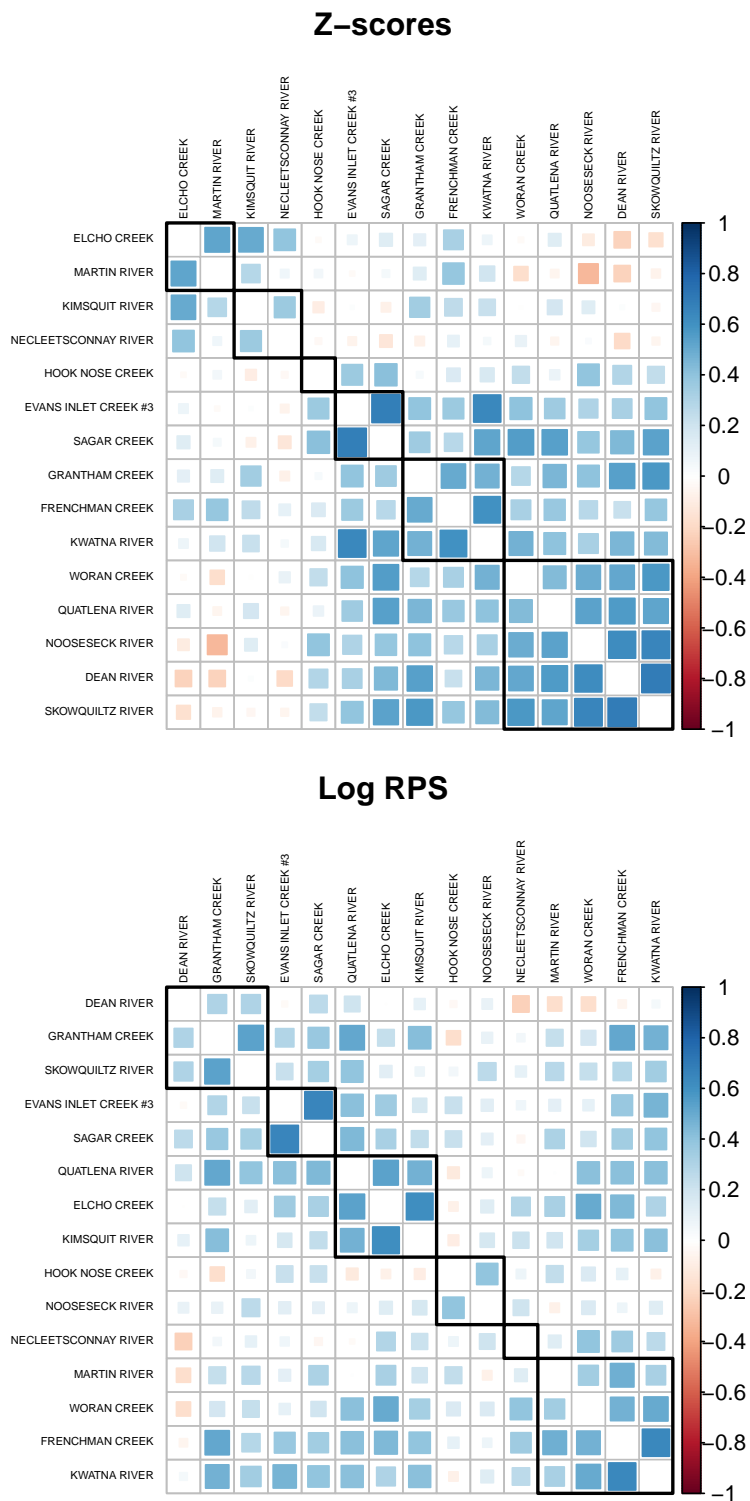


Figure 13: Cross correlation plots to compare metrics.

# Dendrogram clusters analysis

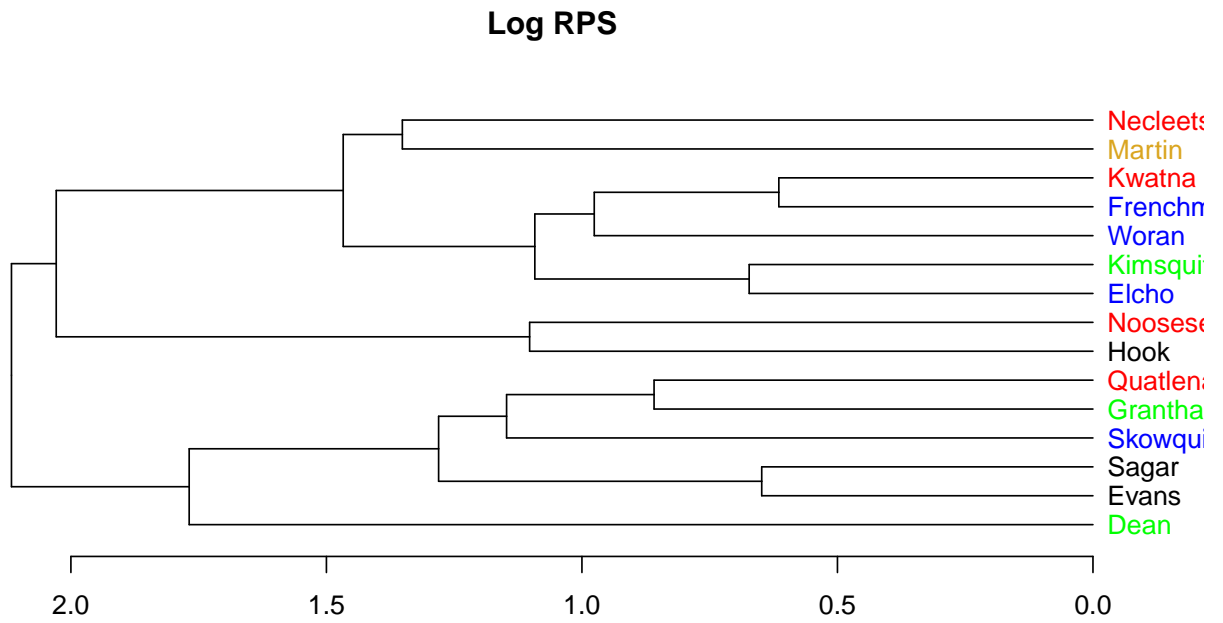
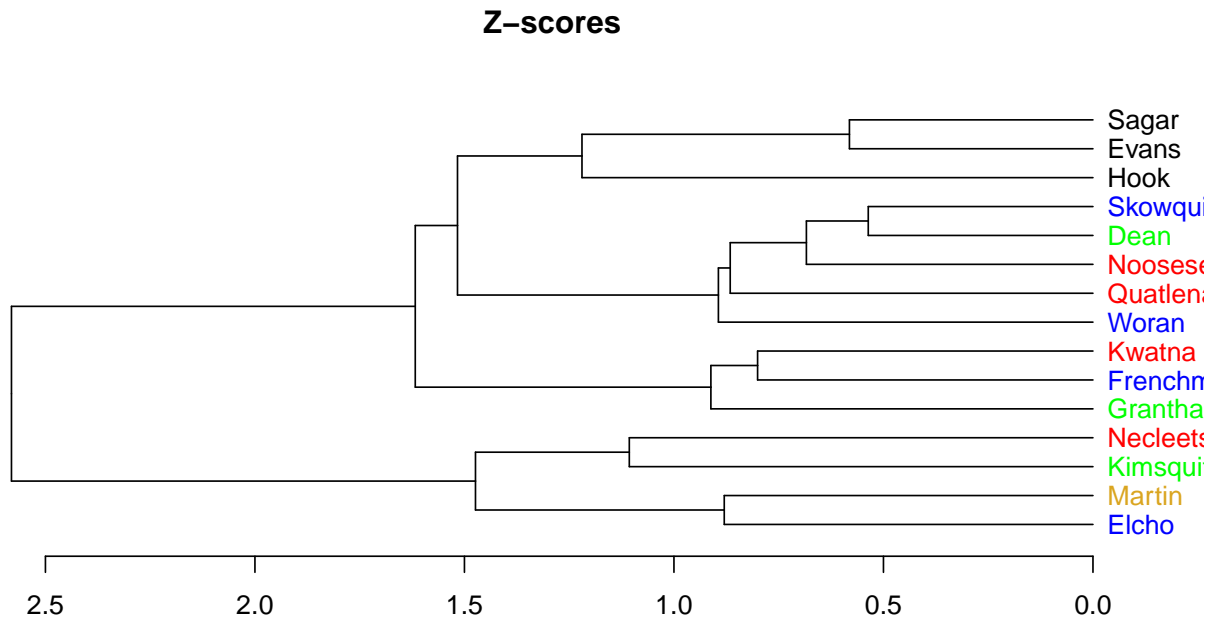


Figure 14: Dendrogram cluster analysis to compare uses of different metrics. Colours represent different subinlets; Bella Coola = red; Dean = blue; Kimsquit = green; Martin = yellow; Sagar = black

# Tanglegrams to compare dendrograms

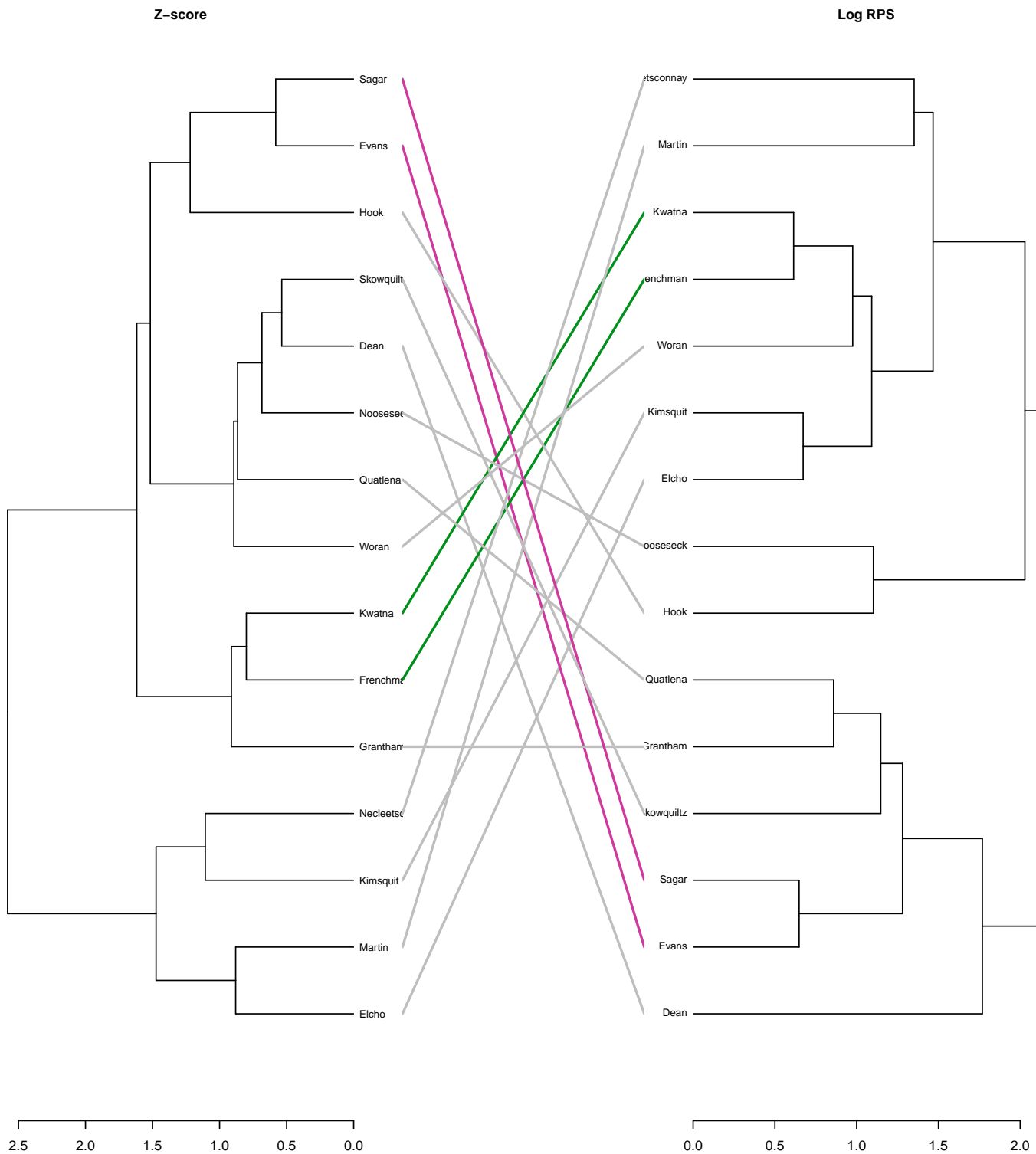


Figure 15: Tanglegram of z-score vs. log RPS

# Pre- and post-1980 correlation analyses

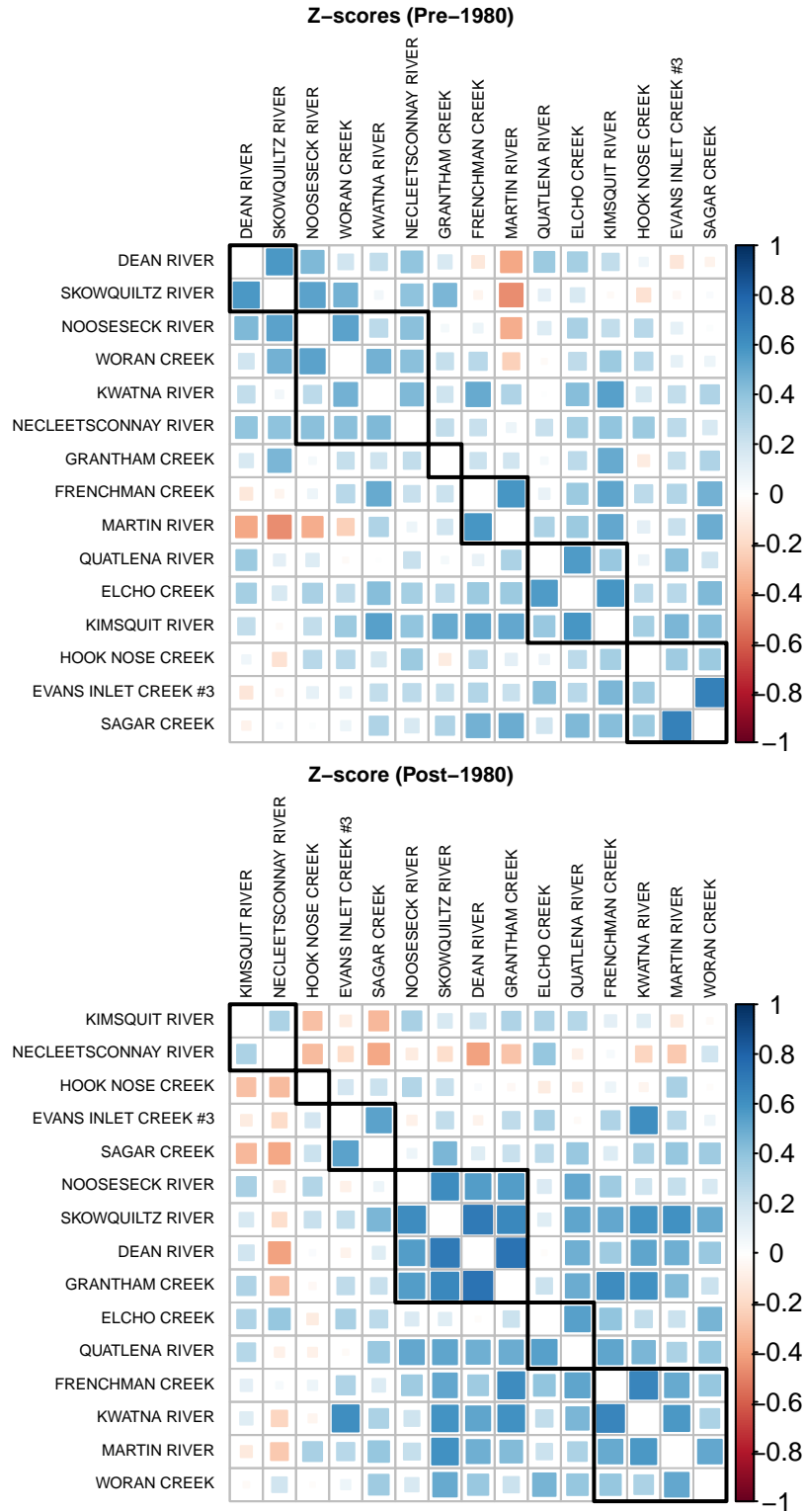


Figure 16: Cross correlation plots of z-scores to compare pre- and post-enhancement.

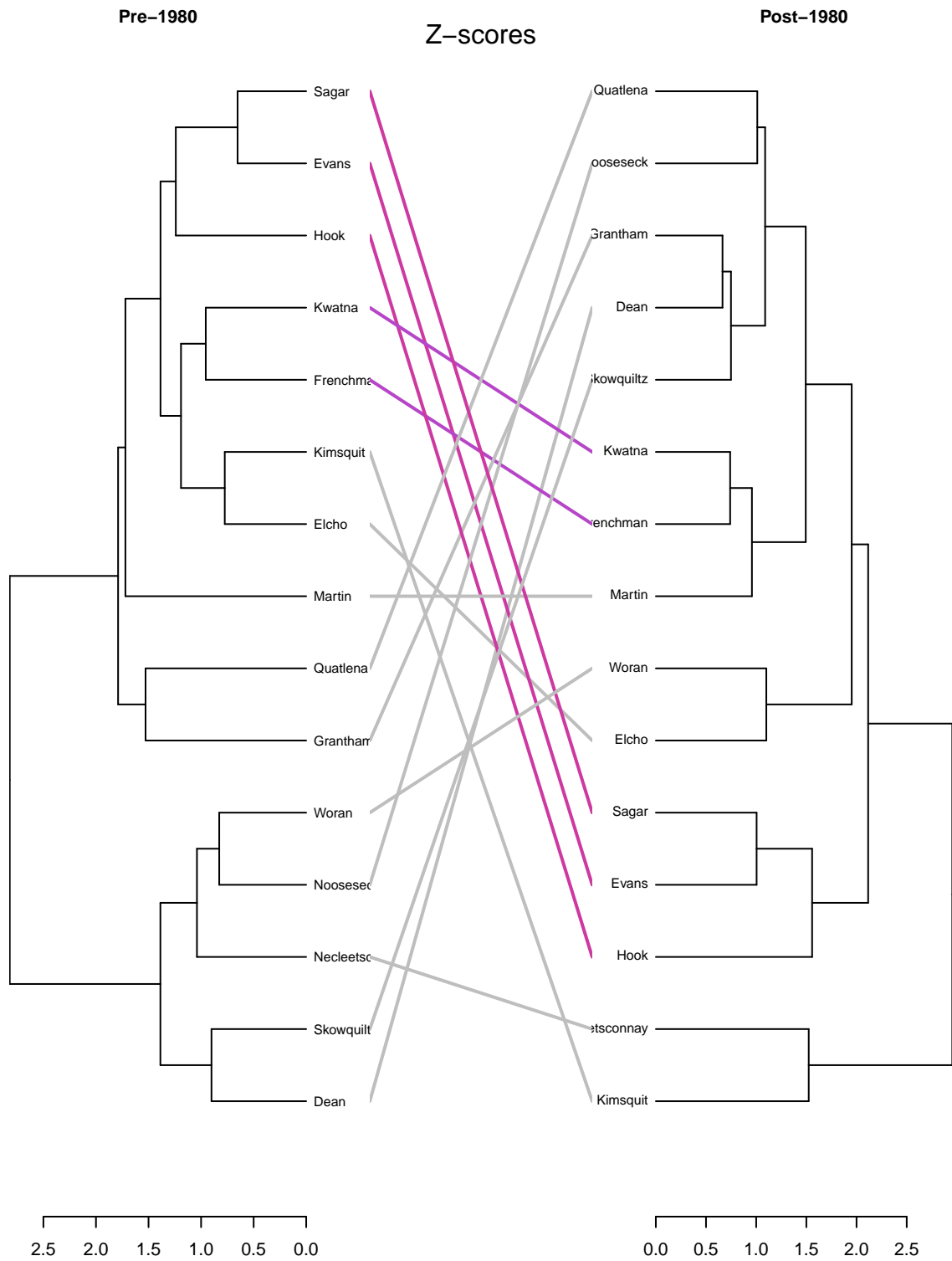


Figure 17: Tanglegram comparing z-scores pre- and post-enhancement (1980)

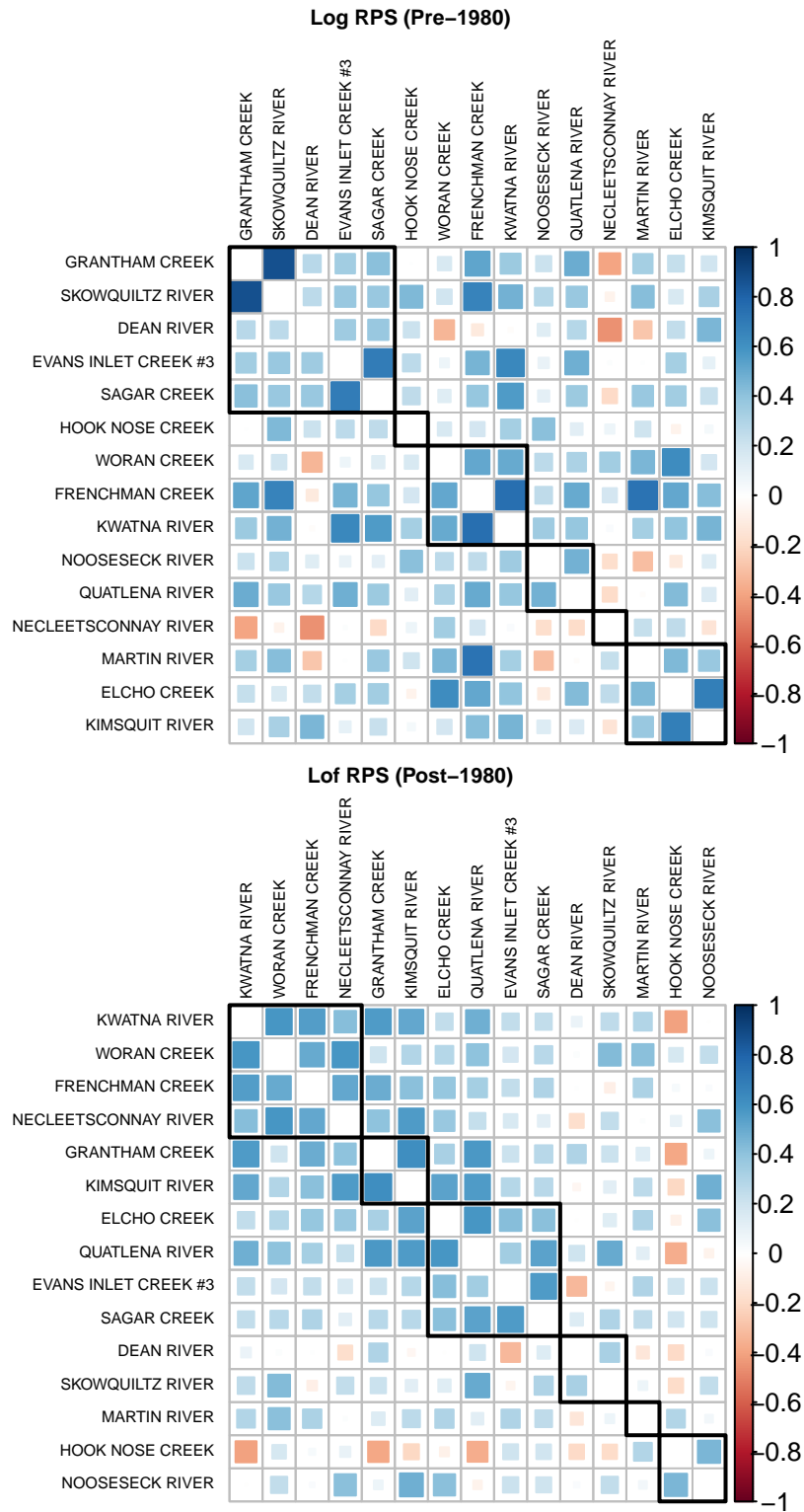


Figure 18: Cross correlation plots of Log RPS to compare pre- and post-enhancement.

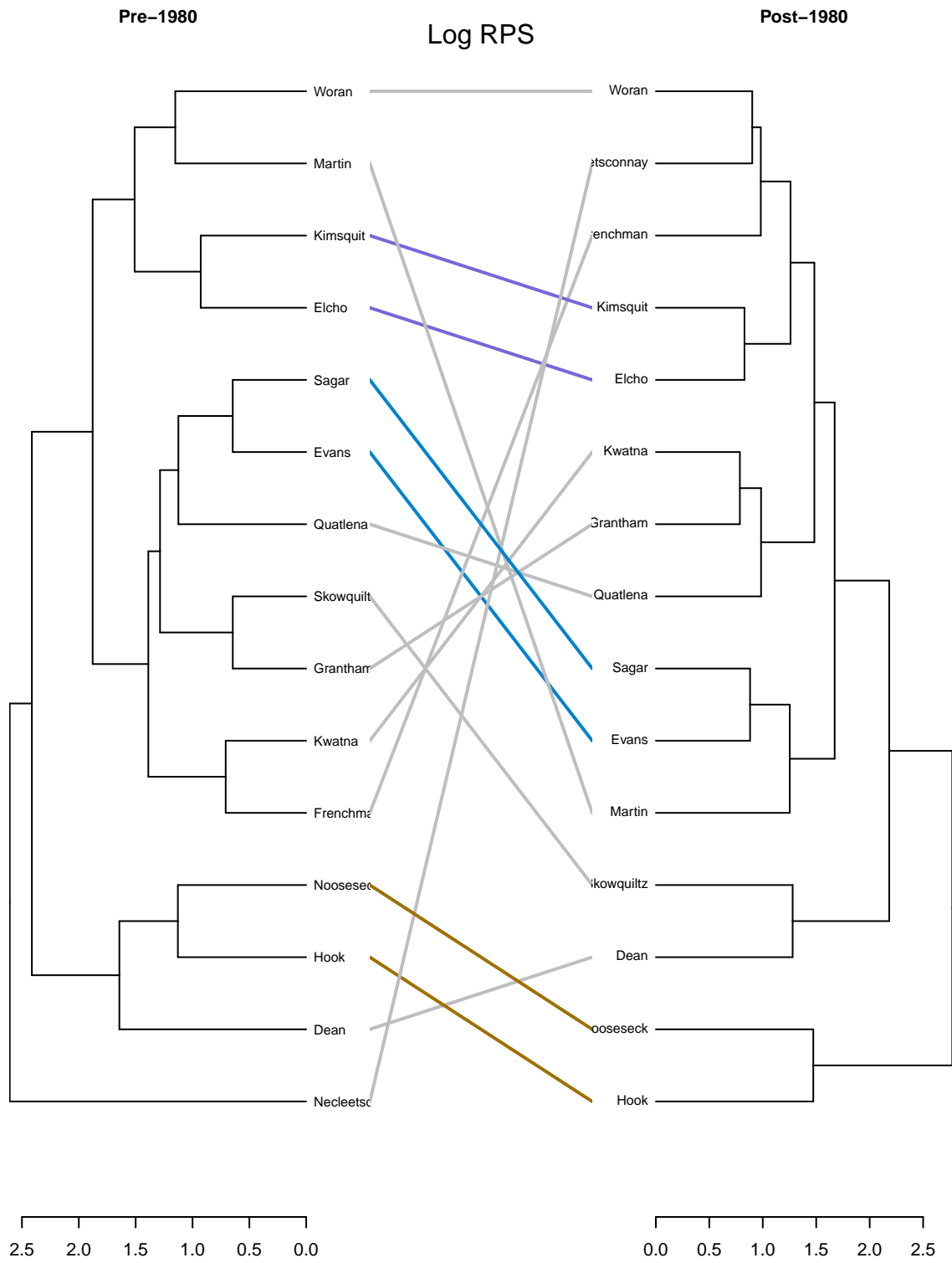


Figure 19: Tanglegram comparing Log RPS pre- and post-enhancement (1980)

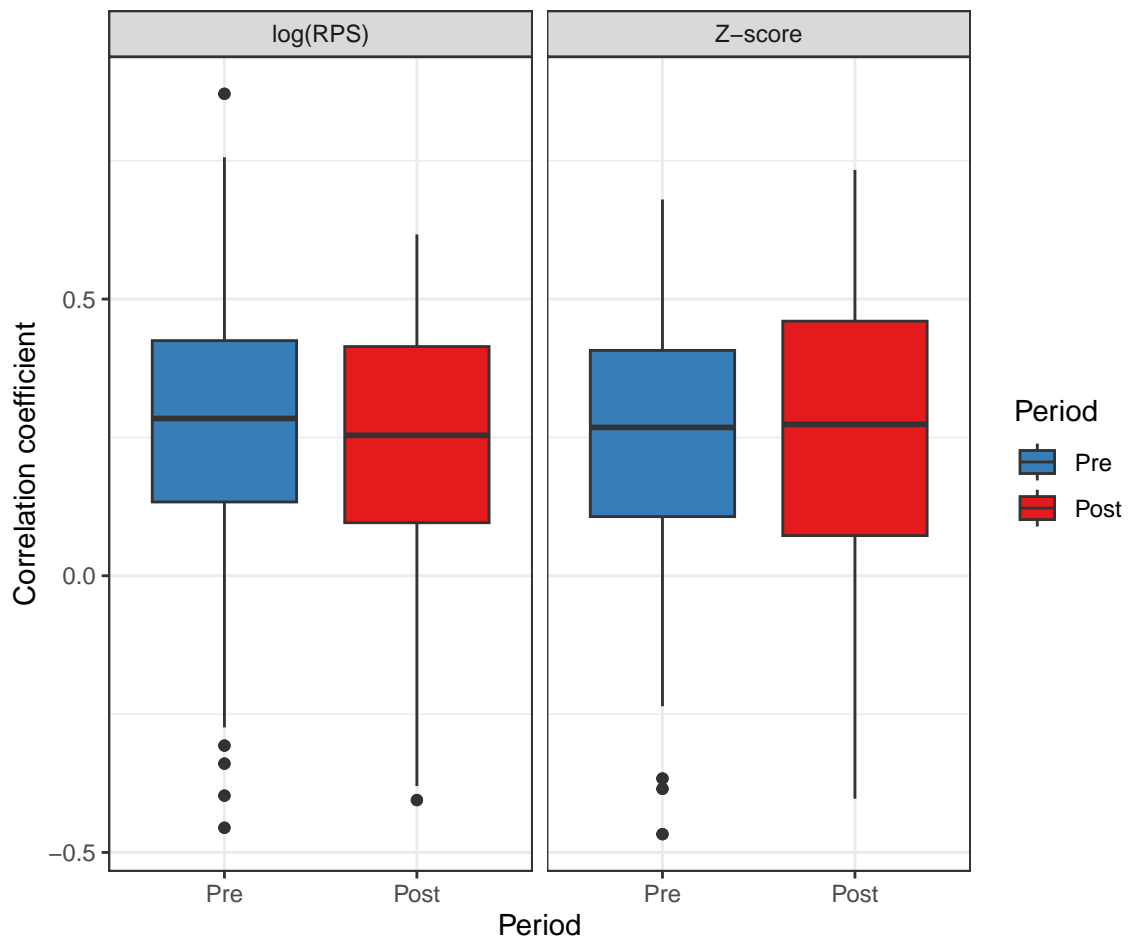


Figure 20: Comparison between correlation coefficients for all pairwise combinations of streams using Z-score and log(RPS) over the pre- and post-1980 periods.



# Pairwise stream to stream correlation versus distance

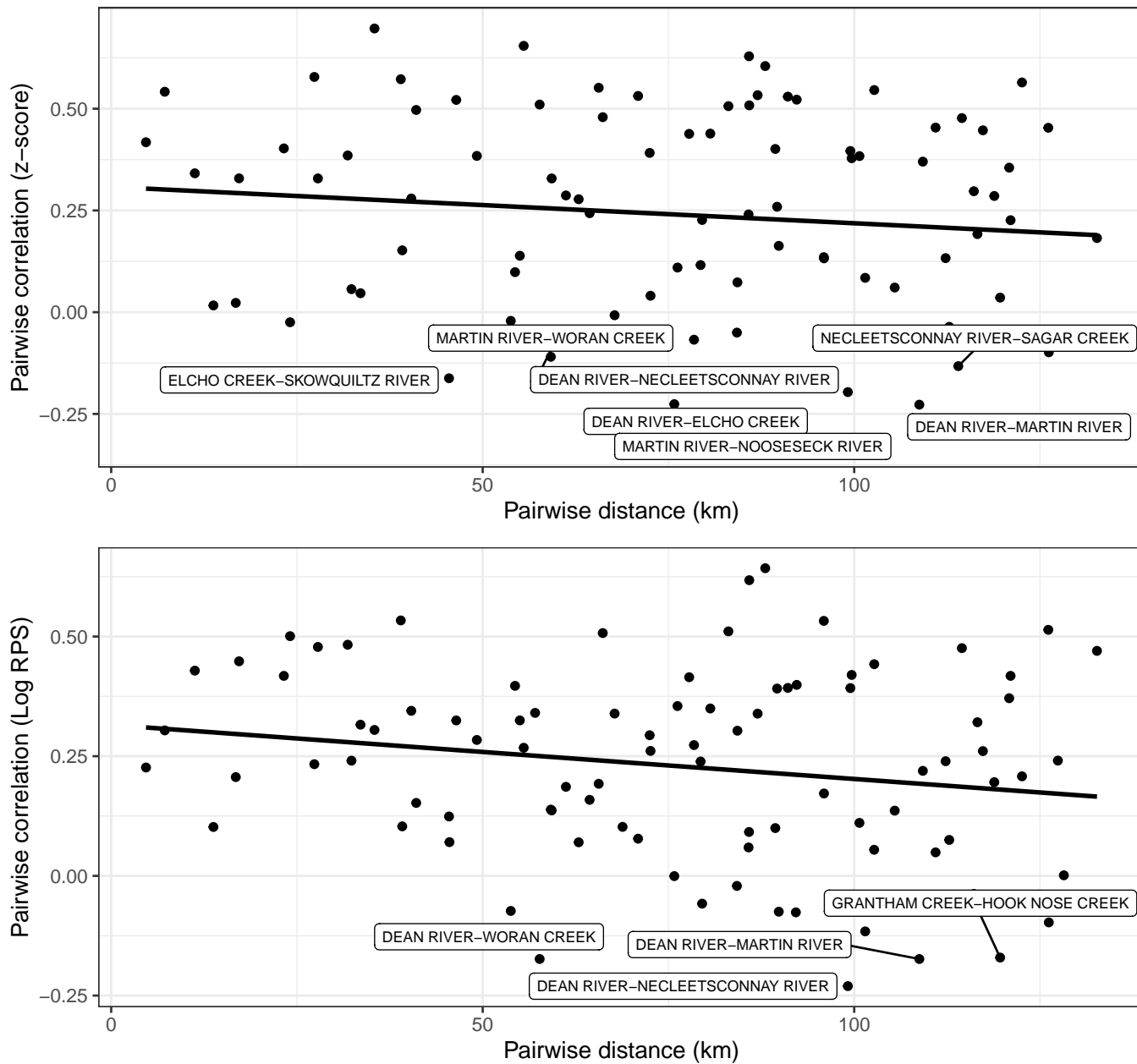


Figure 21: Pairwise stream-stream correlation of Z-score (top) and log(RPS) (bottom) against pairwise distance.

# Dendrogram of pairwise distances

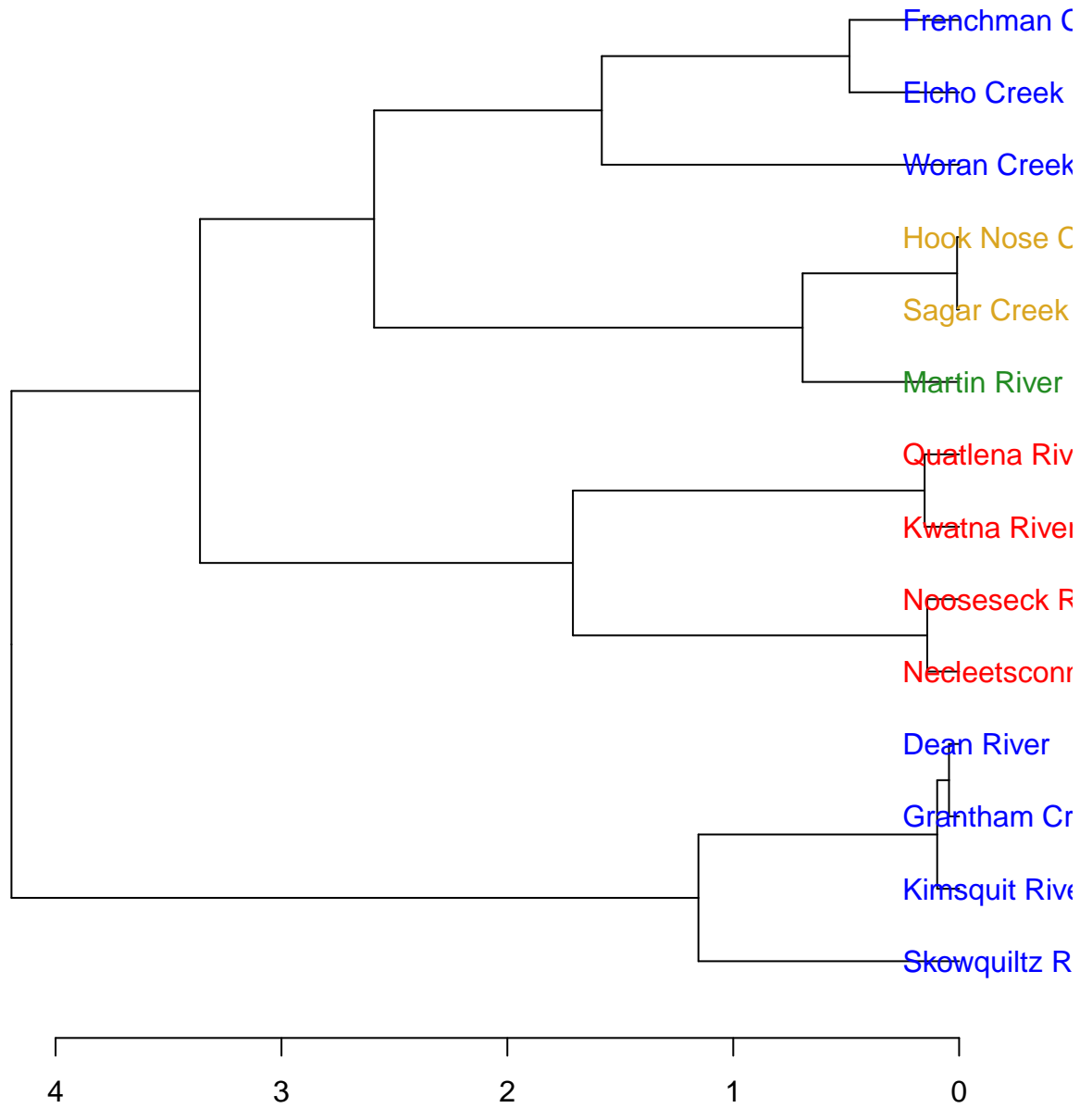


Figure 22: Dendrogram of pairwise distance between river mouths. Red labels - Bella Coola Inlet; Blue - Dean Inlet; Green - Martin Inlet; Yellow - Outer Inlet

### Correlation metrics against distance, pre- and post-1980

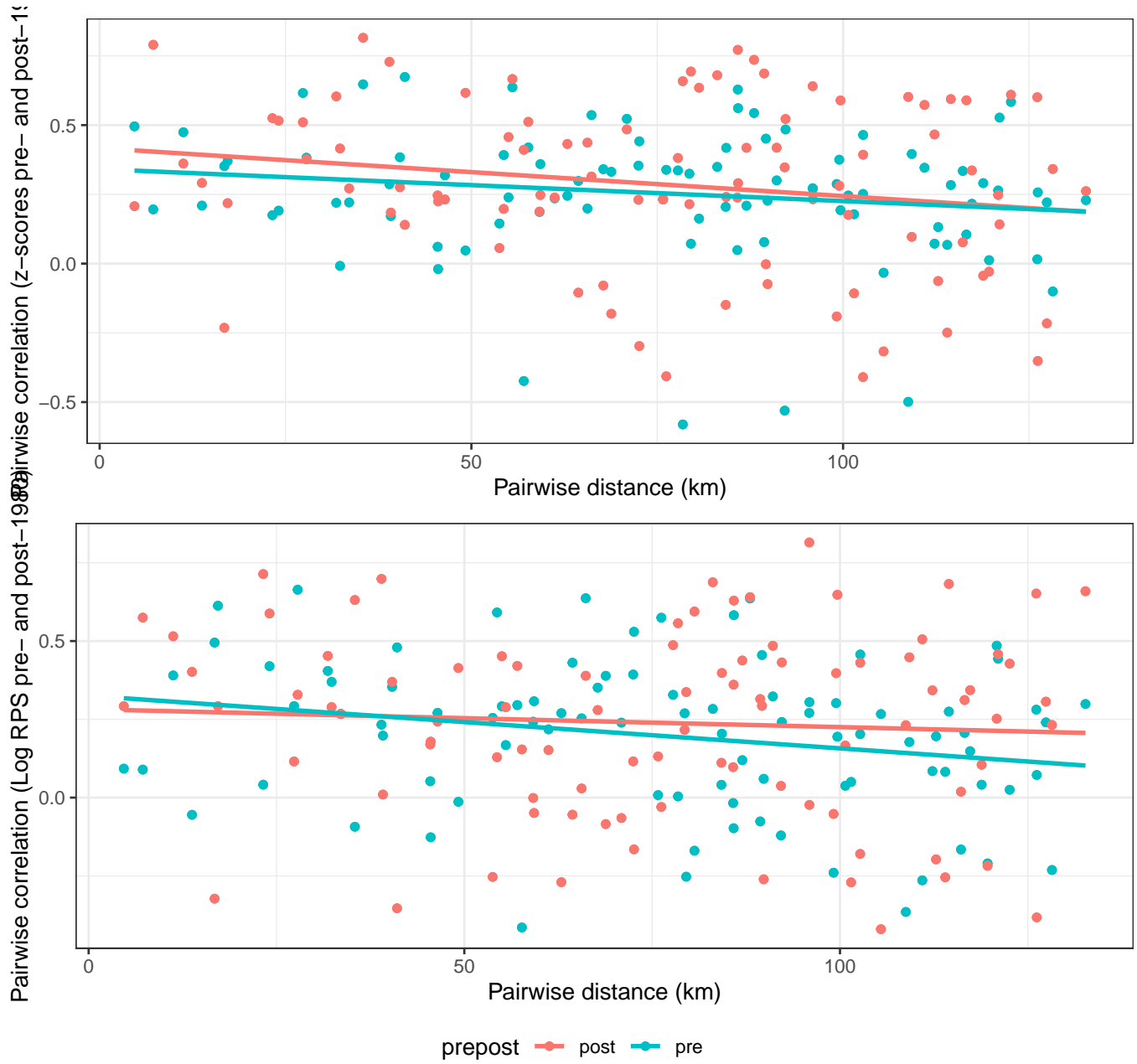


Figure 23: Pairwise stream-stream correlation of Z-score (top) and log(RPS) (bottom) against pairwise distance by period (pre-enhancement and post-enhancement).

## Statistical models

### Candidate Models with AIC scores for log RPS and log escapement

Table 2: Candidate models for log RPS and distance from enhancement (dist), total releases (totrel), and year, with AIC scores.

| Candidate model  | df | AIC      |
|--|----|----------|
| Log RPS ~ Wt. dist. Bella Coola + Wt. dist. McLoughlin + Rel.McLoughlin + Rel.Bella Coola + Year | 7  | 2776.004 |
| Log RPS ~ dist from Bella Coola + dist from McLoughlin   | 4  | 2783.424 |
| Log RPS ~ Wt. dist. from Bella Coola + Wt. dist. from McLoughlin                                 | 4  | 2783.424 |
| Log RPS ~ dist from Bella Coola + dist from McLoughlin + Year                                    | 5  | 2785.416 |
| Log RPS ~ Wt. dist. from Bella Coola + Wt. dist. from McLoughlin + Year                          | 5  | 2785.416 |
| Log RPS ~ dist from Bella Coola + dist from McLoughlin + Year + Subinlet                         | 9  | 2790.437 |
| Log RPS ~ Wt. dist. from Bella Coola + Wt. dist. from McLoughlin + Year + Subinlet               | 9  | 2790.437 |

Table 3: Candidate models for log escapement and distance from enhancement (dist), total releases (totrel), and year, with AIC scores.

| Candidate model  | df | AIC      |
|--|----|----------|
| Log escapement ~ dist from Bella Coola + dist from McLoughlin + Year + Subinlet                    | 9  | 3019.123 |
| Log escapement ~ Wt. dist. from Bella Coola + Wt. dist. from McLoughlin + Year + Subinlet          | 9  | 3019.123 |
| Log escapement ~ Wt.dist.BellaCoola + Wt.dist.McLoughlin + Rel.Bella Coola + Rel.McLoughlin + Year | 7  | 3045.062 |
| Log escapement ~ Wt. dist. from Bella Coola + Wt. dist. from McLoughlin                            | 4  | 3059.479 |
| Log escapement ~ dist from Bella Coola + dist from McLoughlin                                      | 4  | 3059.479 |
| Log escapement ~ dist from Bella Coola + dist from McLoughlin + Year                               | 5  | 3060.954 |
| Log escapement ~ Wt. dist. from Bella Coola + Wt. dist. from McLoughlin + Year                     | 5  | 3060.954 |

### Effects plots for top model: $\log(\text{RPS})$

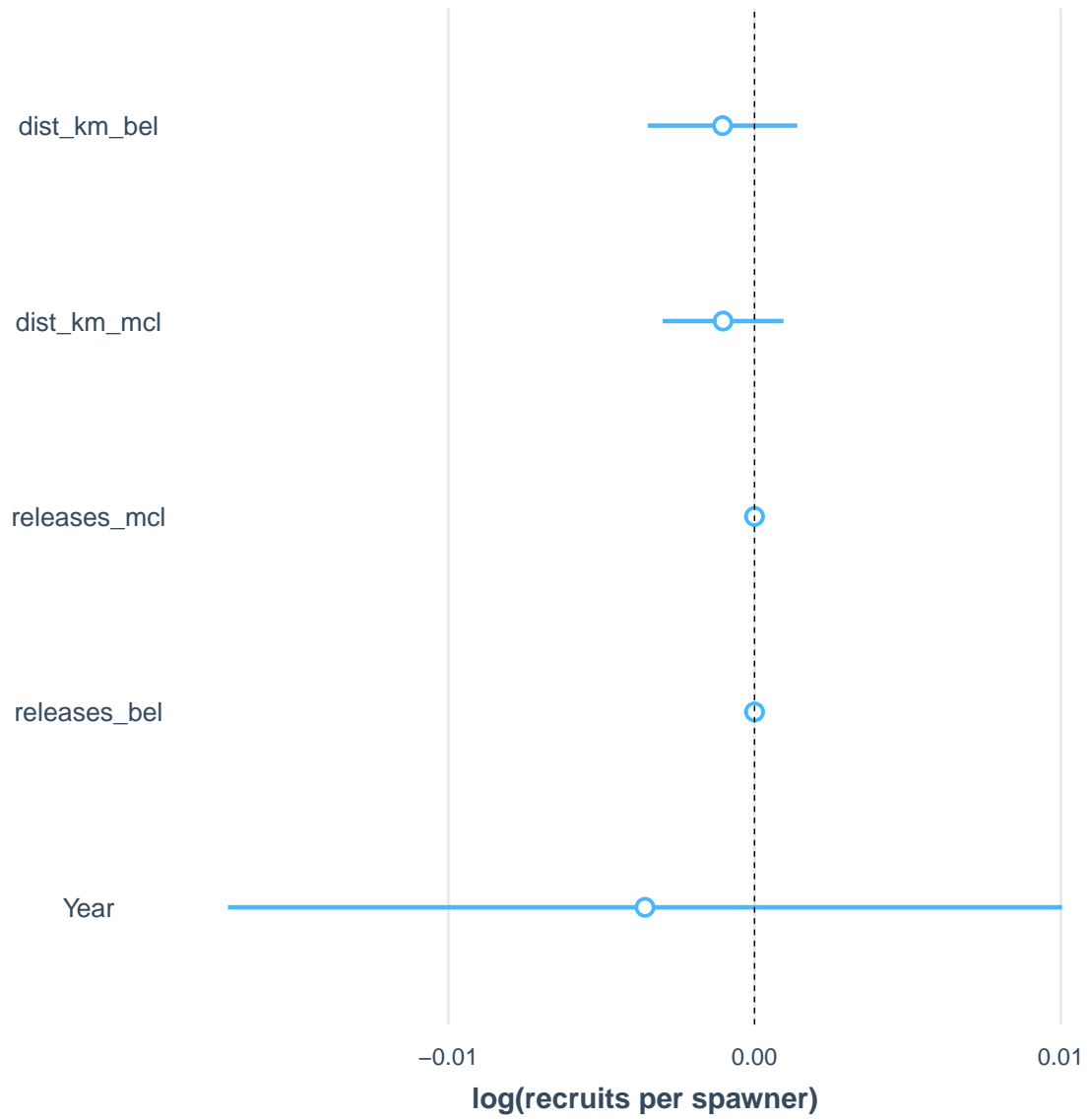


Figure 24: Plot of effects included in the most parsimonious model for  $\log(\text{RPS})$ .

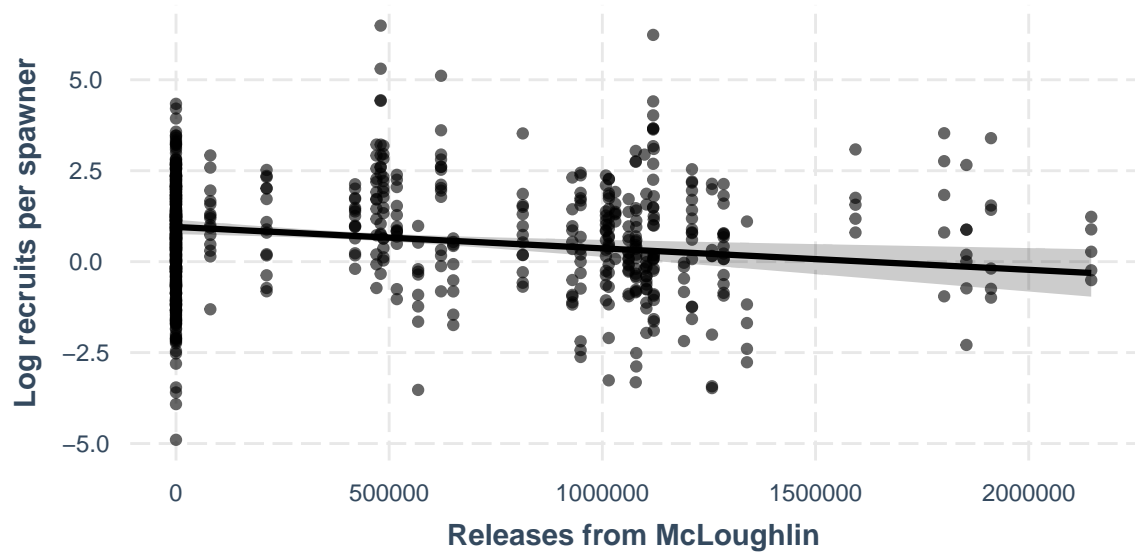
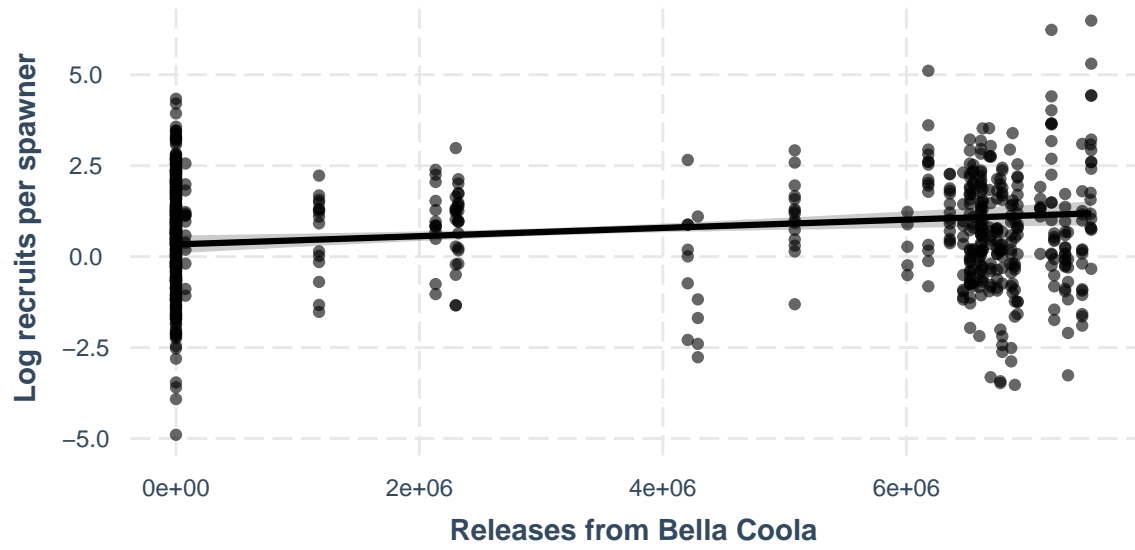


Figure 25: Effects plots of recruits per spawner by releases from Bella Coola (top) and releases from McLoughlin Creek (bottom).

### Effects plots for top model: log(escapement)

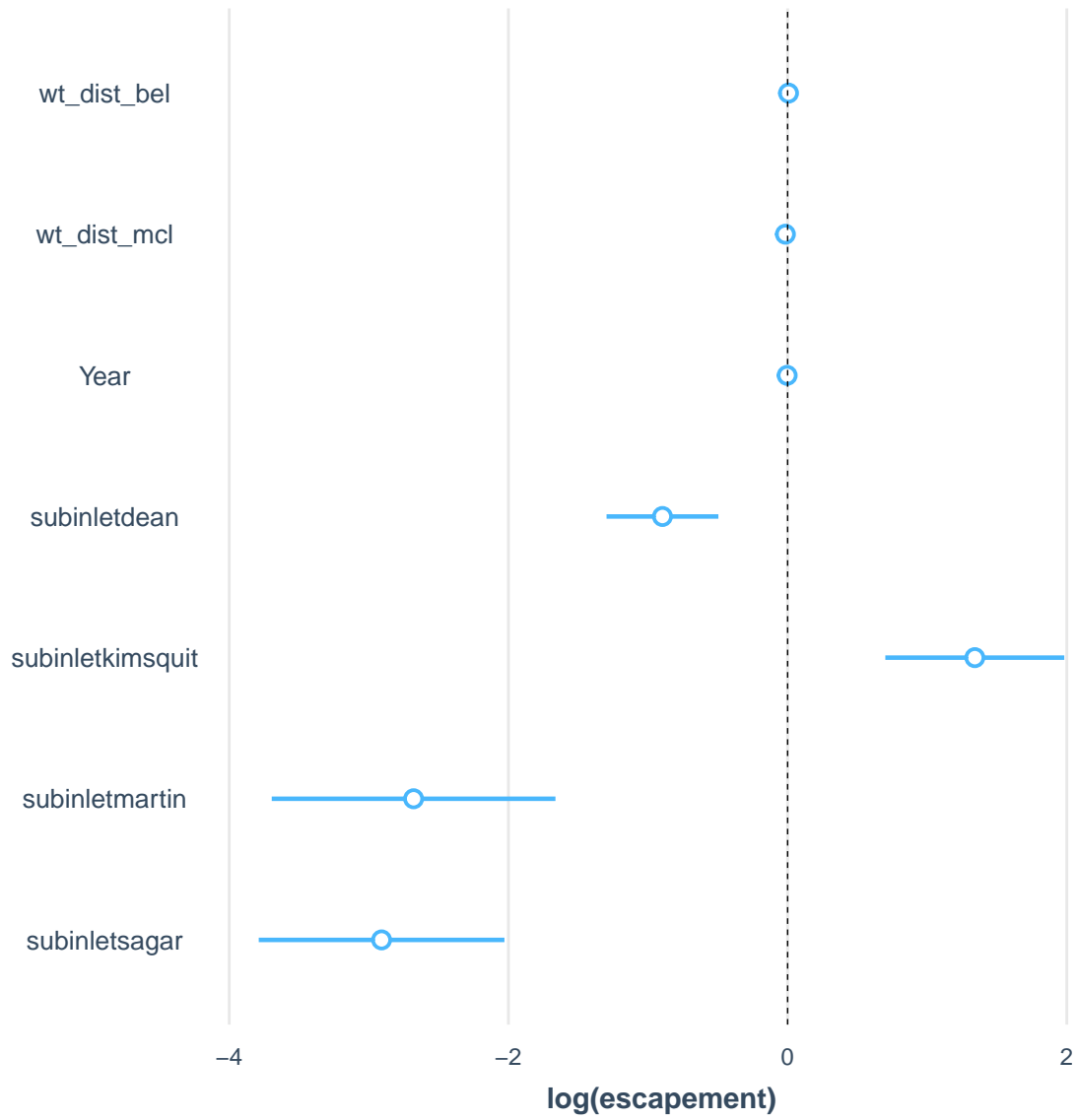


Figure 26: Plot of effects included in the most parsimonious model for log(escapement).

