Assessing environmental factors that may influence life history diversity and growth of Puget Sound steelhead smolts.

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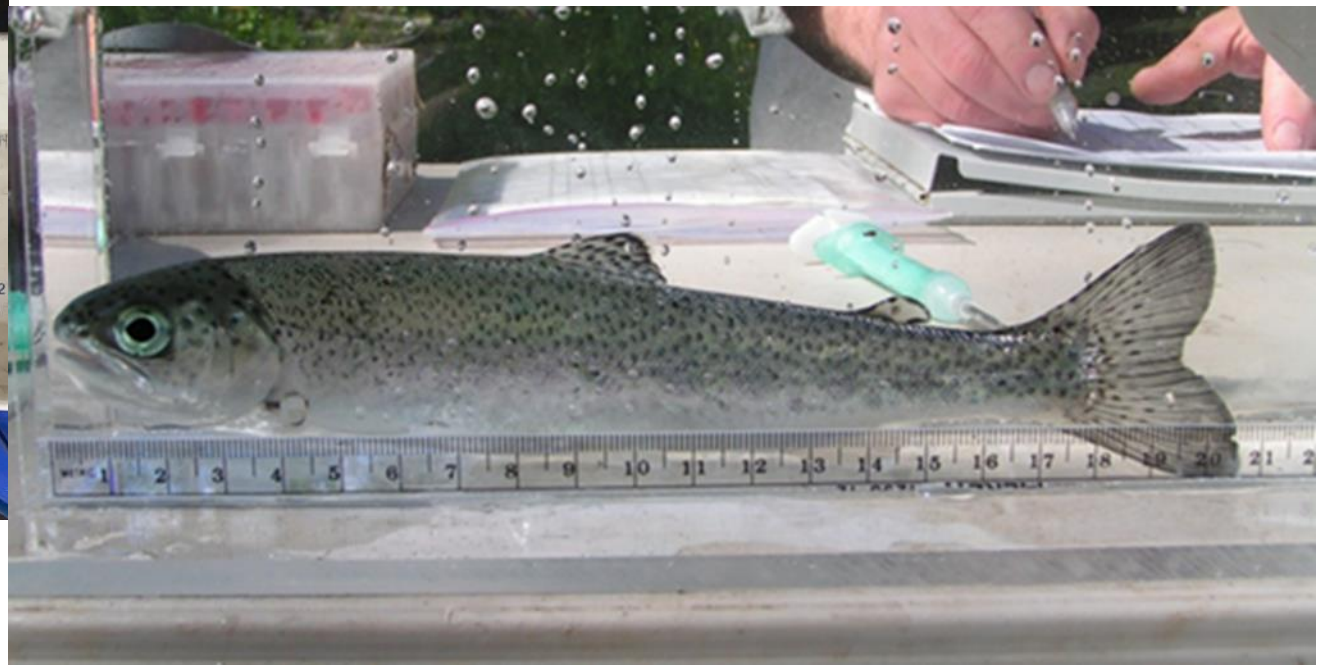
Steelhead smolts tend to have a more diverse life history in their freshwater phase than other Pacific salmonids and this diversity can be expressed regionally among populations within the species.

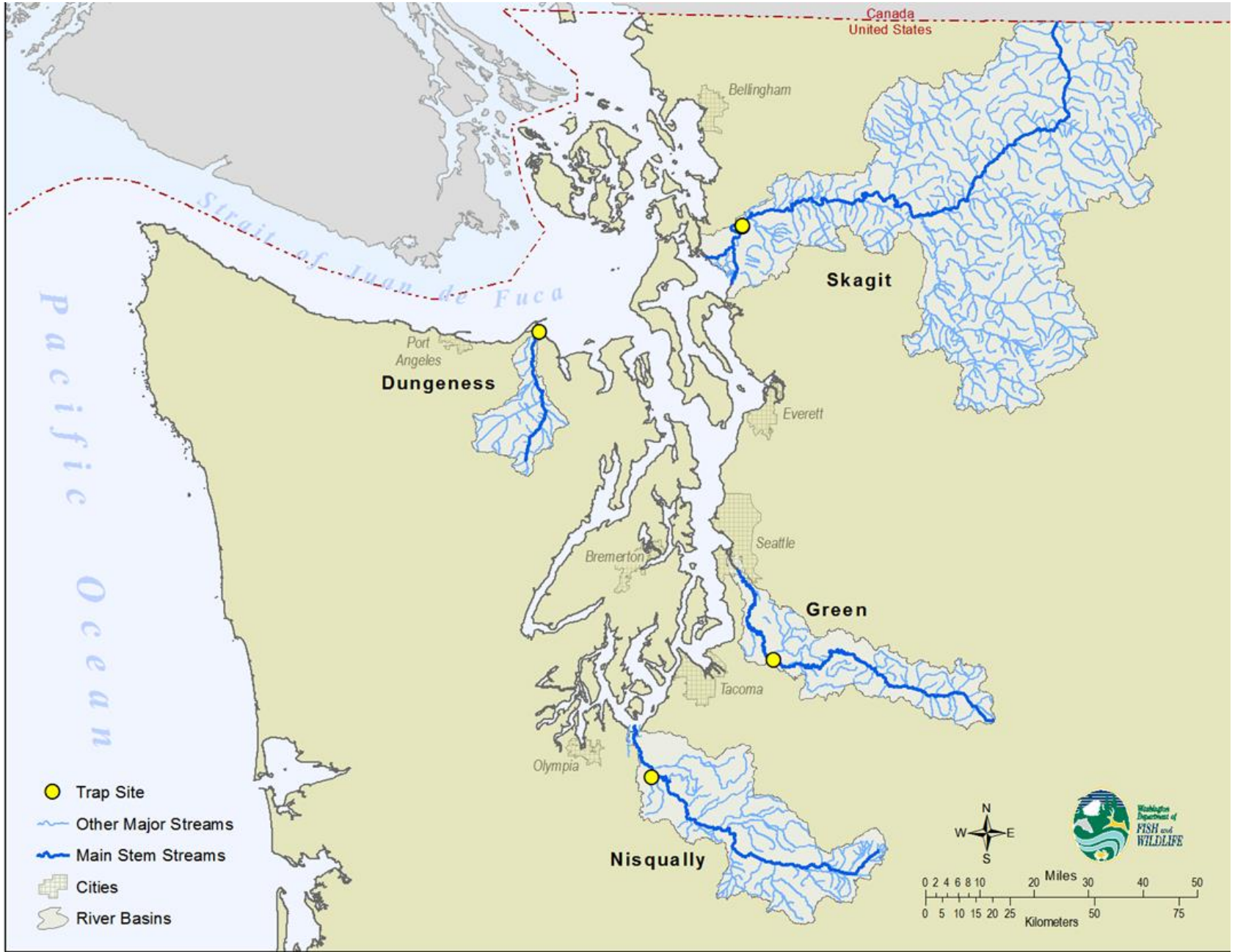
Why do we see such a range of sizes of smolts within Puget Sound?



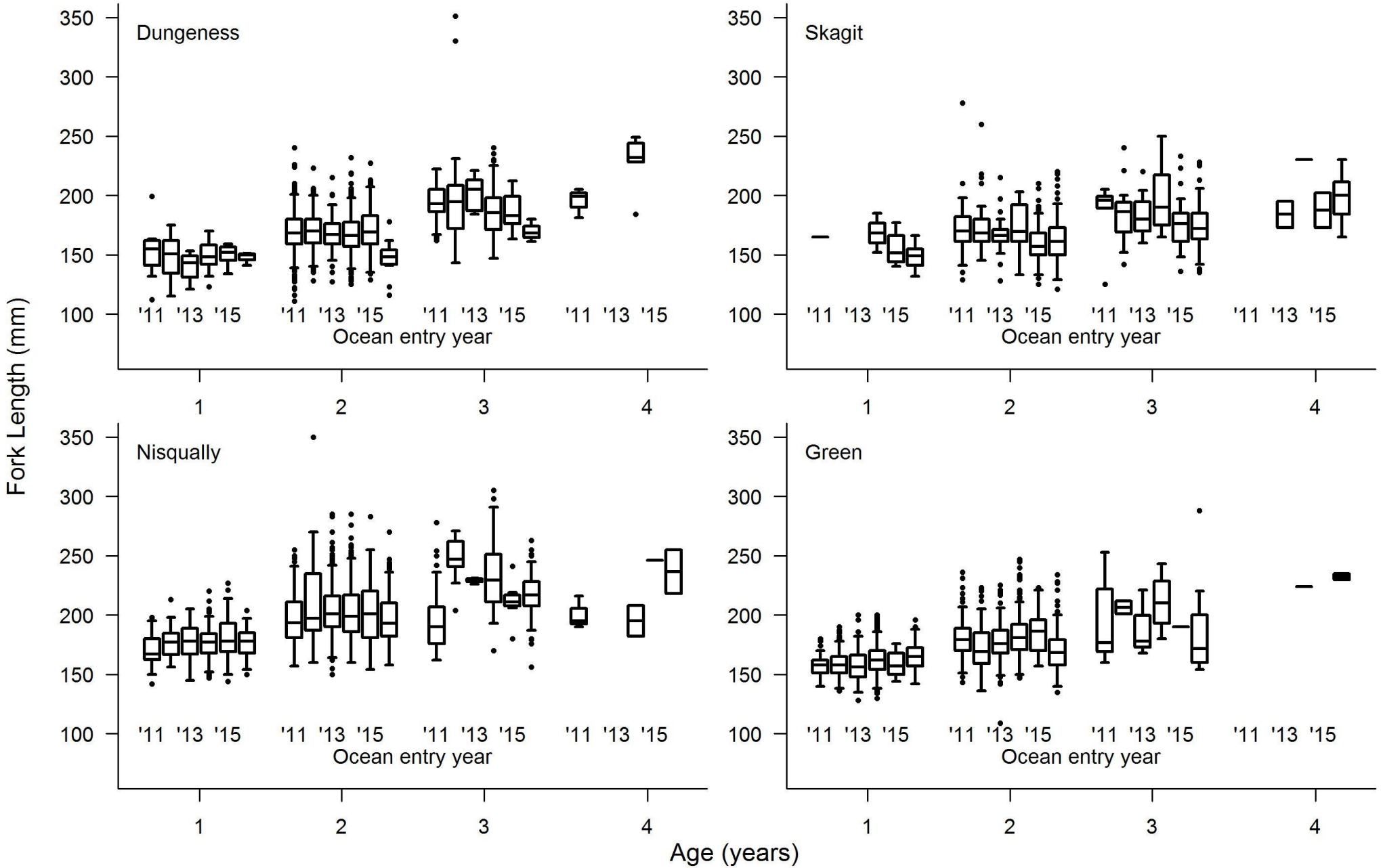

NO
TRESPASSING
PUSH


WILD SALMON
RESEARCH
NO TRESPASSING

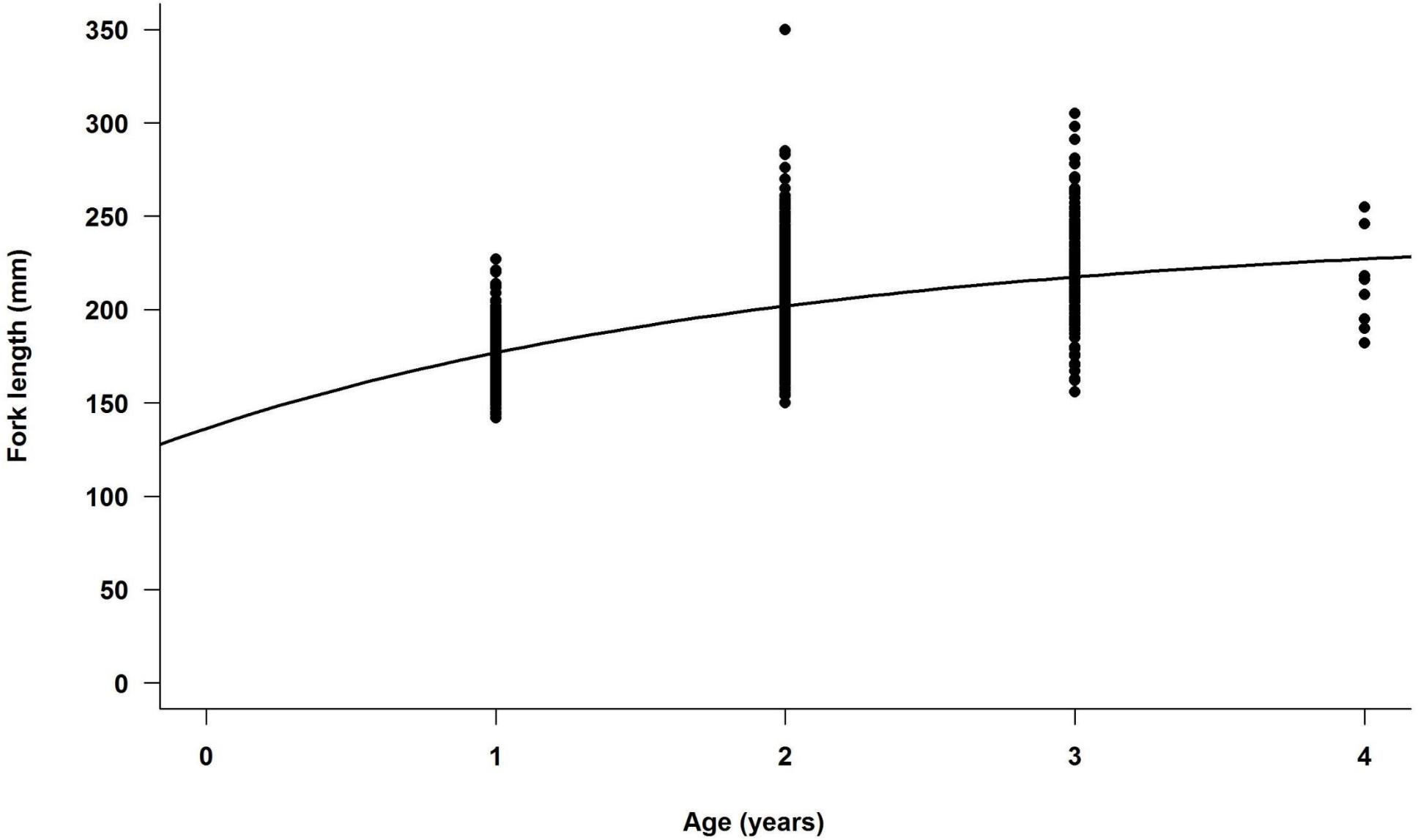
Greater Puget Sound



Length at age (2011 to 2016)



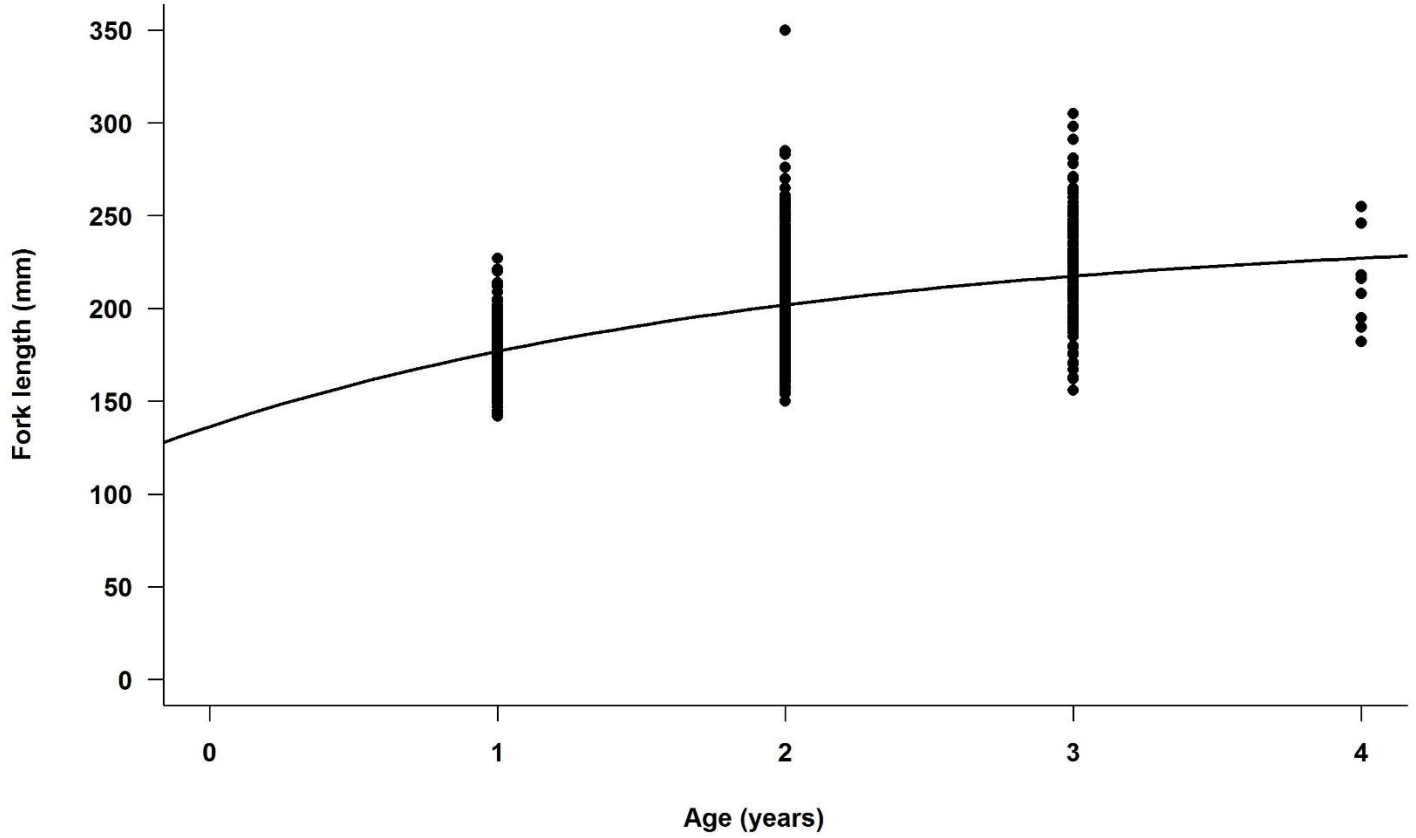
von Bertalanffy growth curve



Length at age-1

Limited this analysis to age-1 smolts

- most growth usually occurs between age-0 and age-1
- convenient way to relate environmental factors
    - single year versus multiple years



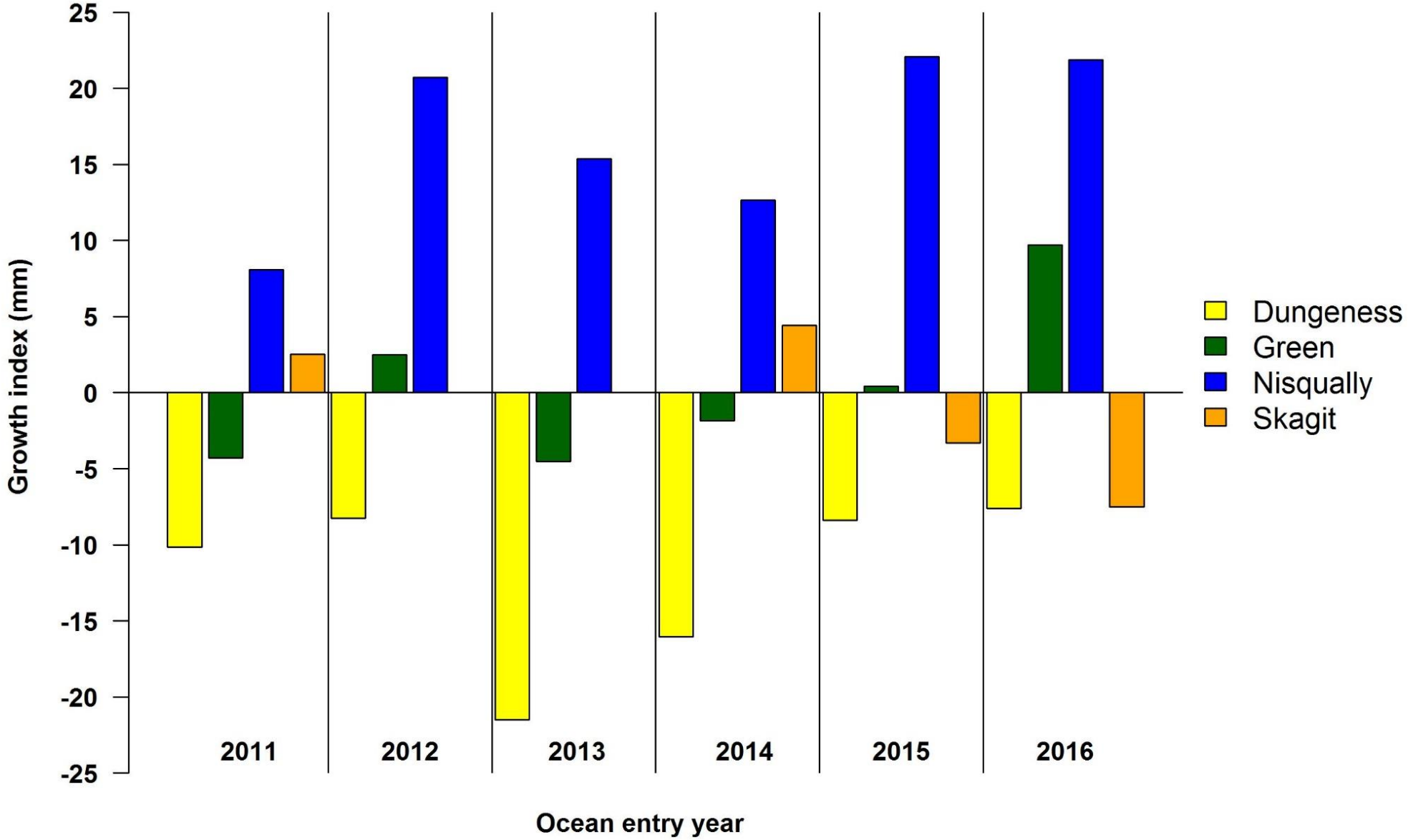
A growth index was used to express the degree to which the growth in a given body of water differs from a regional average.

$$\text{growth index} = \frac{(\overline{\ln}_{2011\text{obs}} - \overline{\ln}_{2011\ \text{PS}}) + \ldots + (\overline{\ln}_{2016\text{obs}} - \overline{\ln}_{2016\ \text{PS}})}{n_{\text{age classes represented}}}$$

Regional average

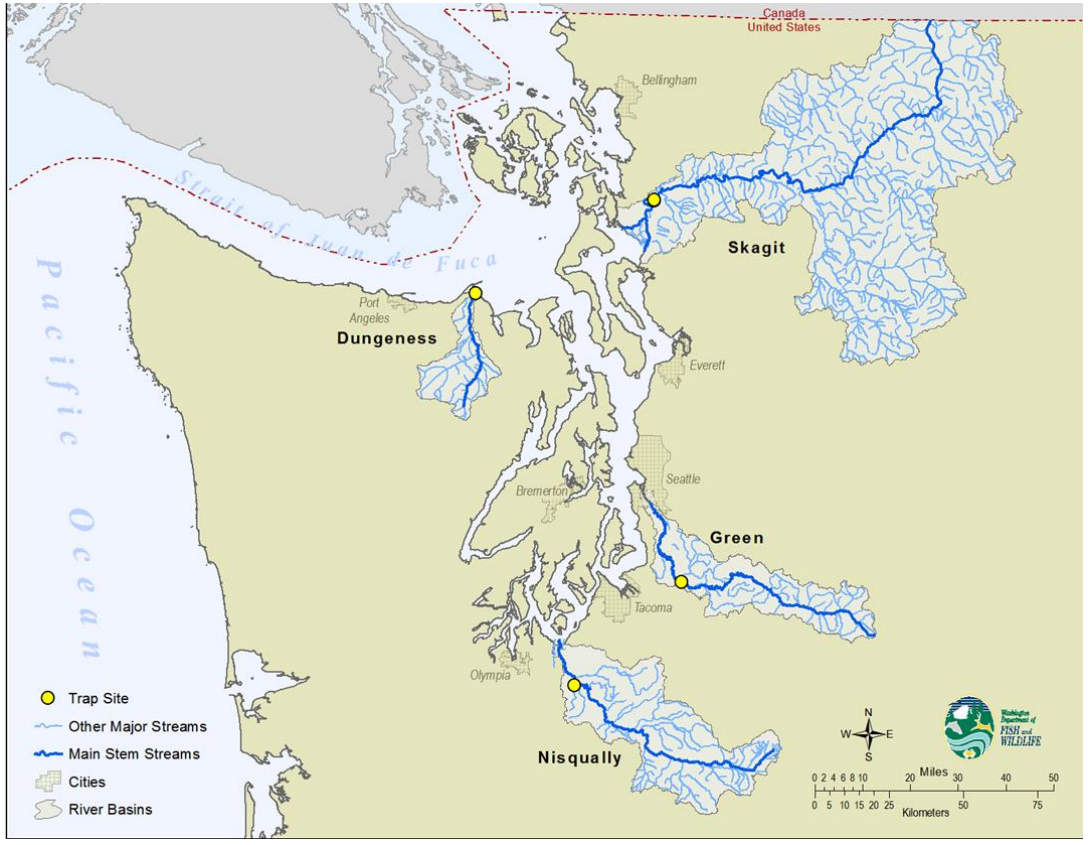
Bacon Creek
Big Beef Creek
Dewatto River
Duckabush River
Finney Creek
Hamma Hamma River
Hanson Creek
Illabbot Creek
Little Quilcene River
Puyallup River
S.F. Skokomish River
Snow Creek
Tahuya River

Growth index



Greater Puget Sound

Dungeness – natural system
Skagit – dammed system, large tributaries
Green – dammed system, tributary poor
Nisqually – dammed system, tributary poor

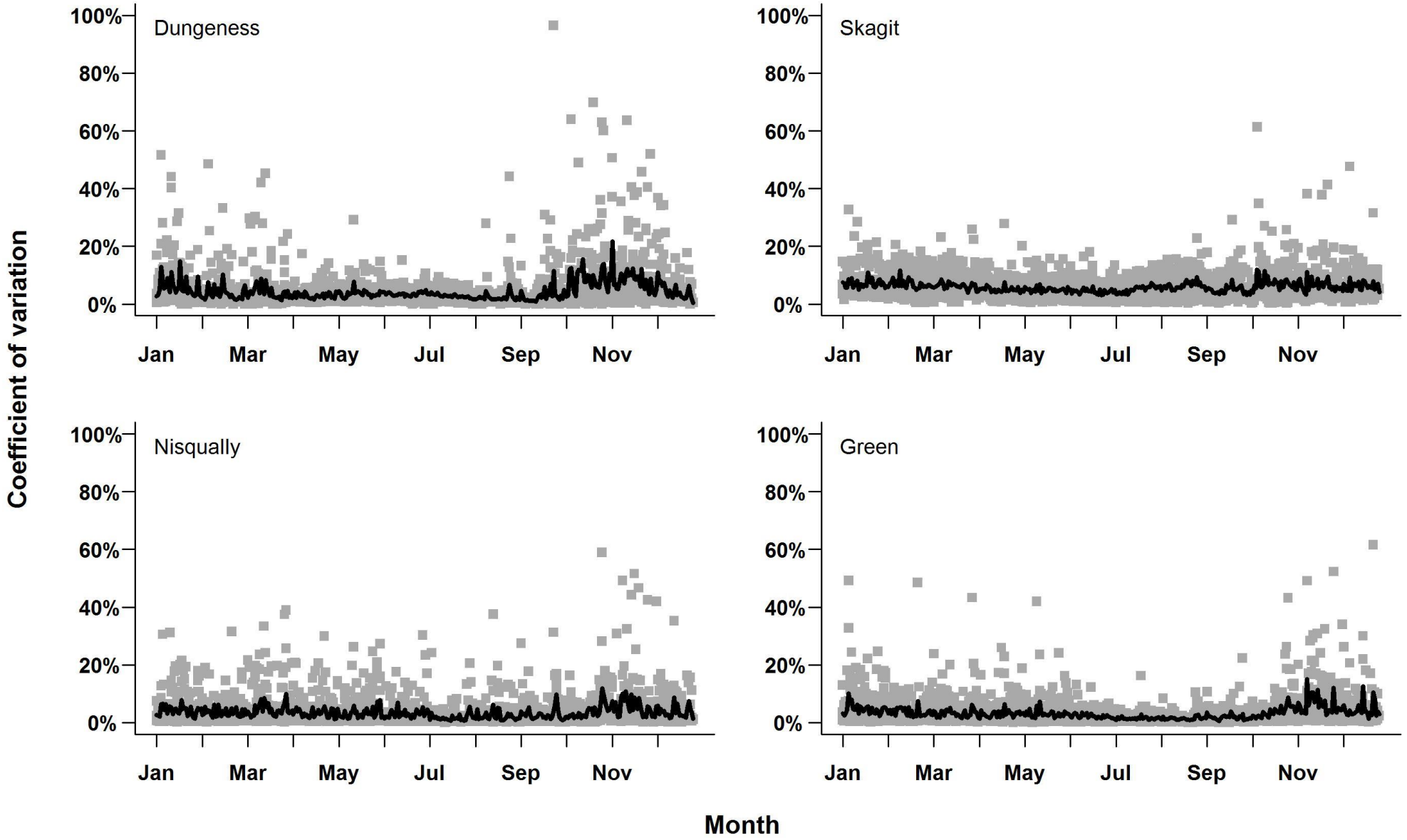


Factors expected to influence growth

Steelhead smolt growth may vary due to abiotic (flow and temperature) and biotic (nutrient availability) differences among rivers we will explore abiotic factors in the following rivers

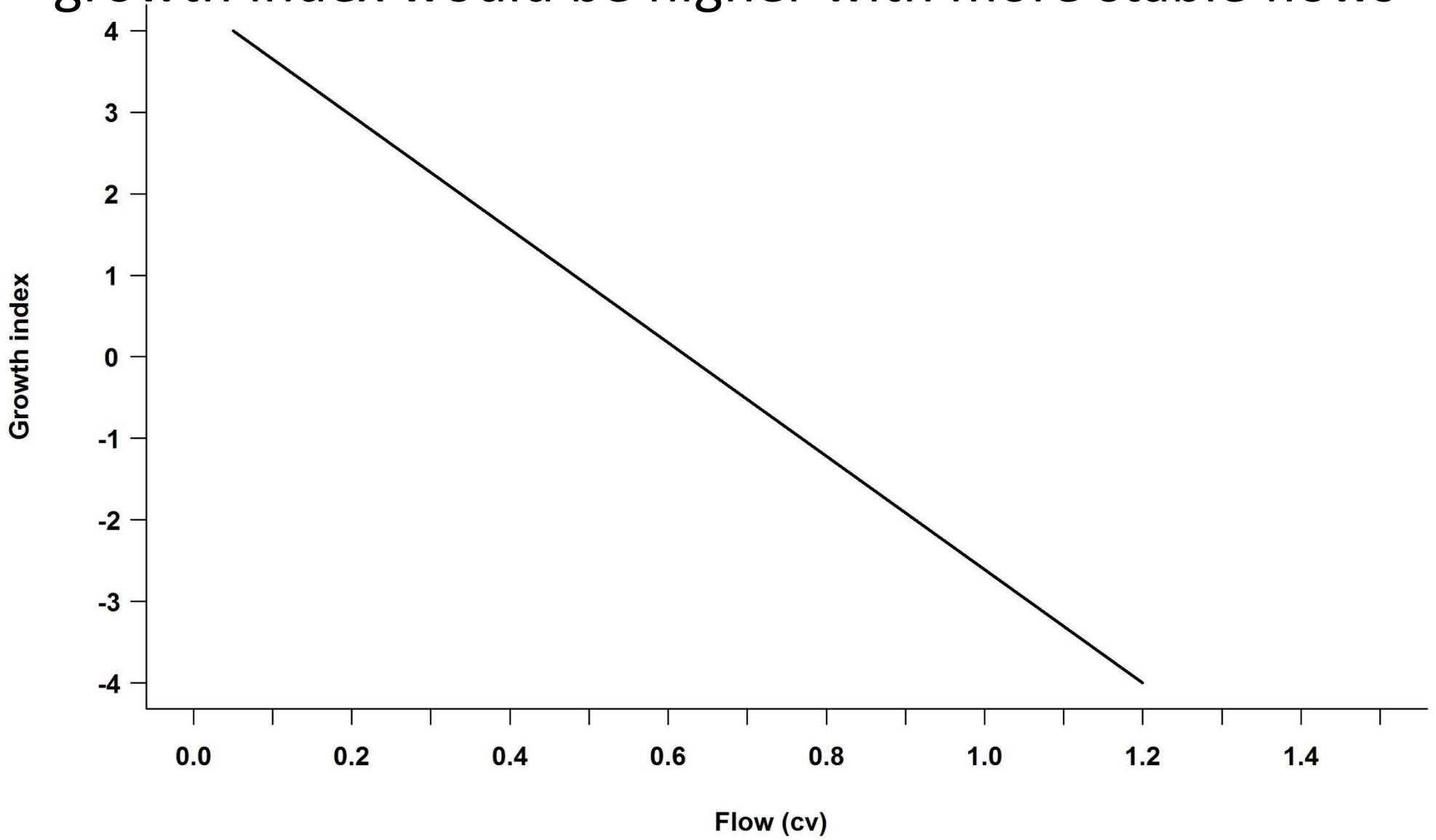
Flow – annual coefficient of variation
Temperature – annual degree days
Nutrients – Pink salmon escapement per drainage area

Flow variability

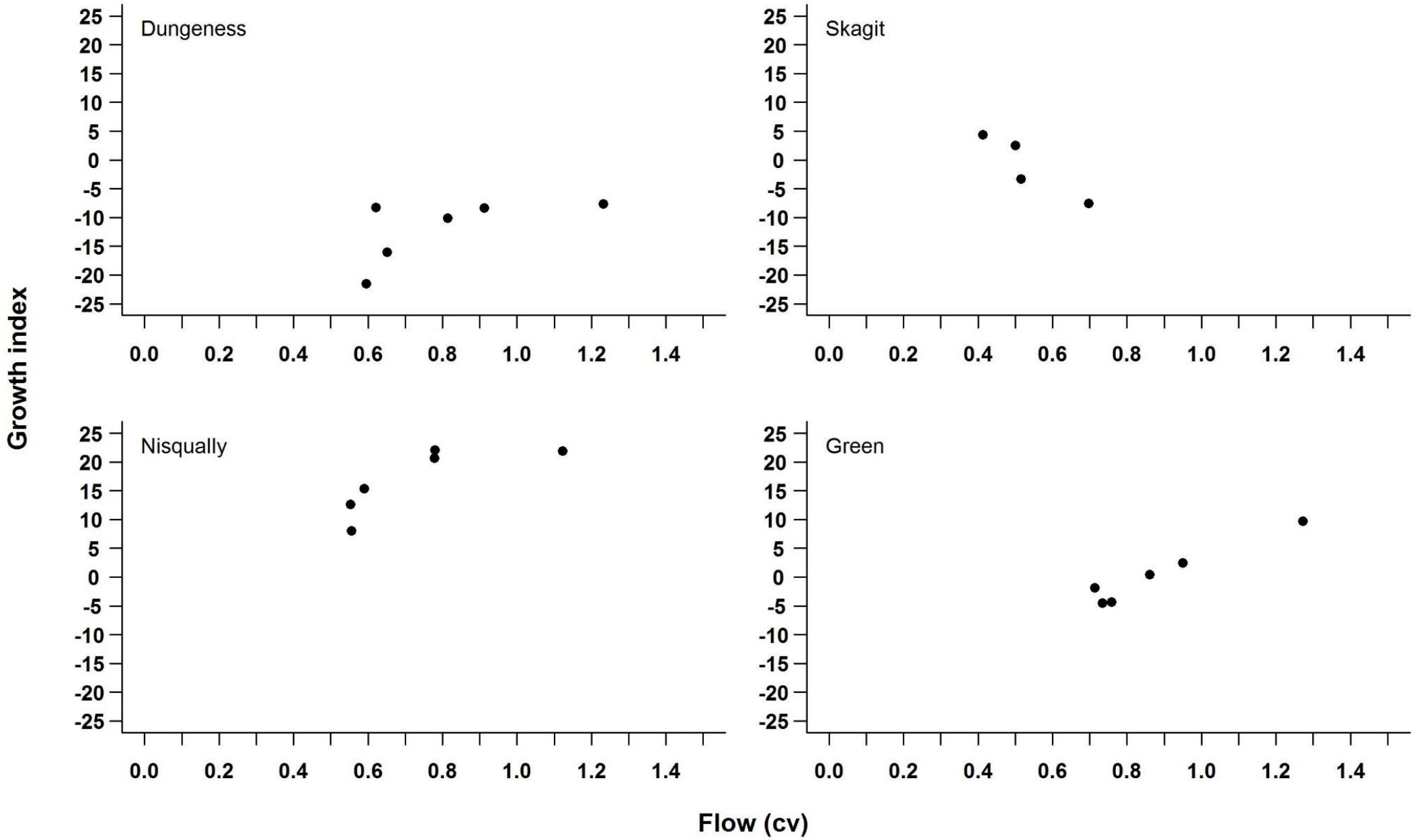


Flow hypothesis

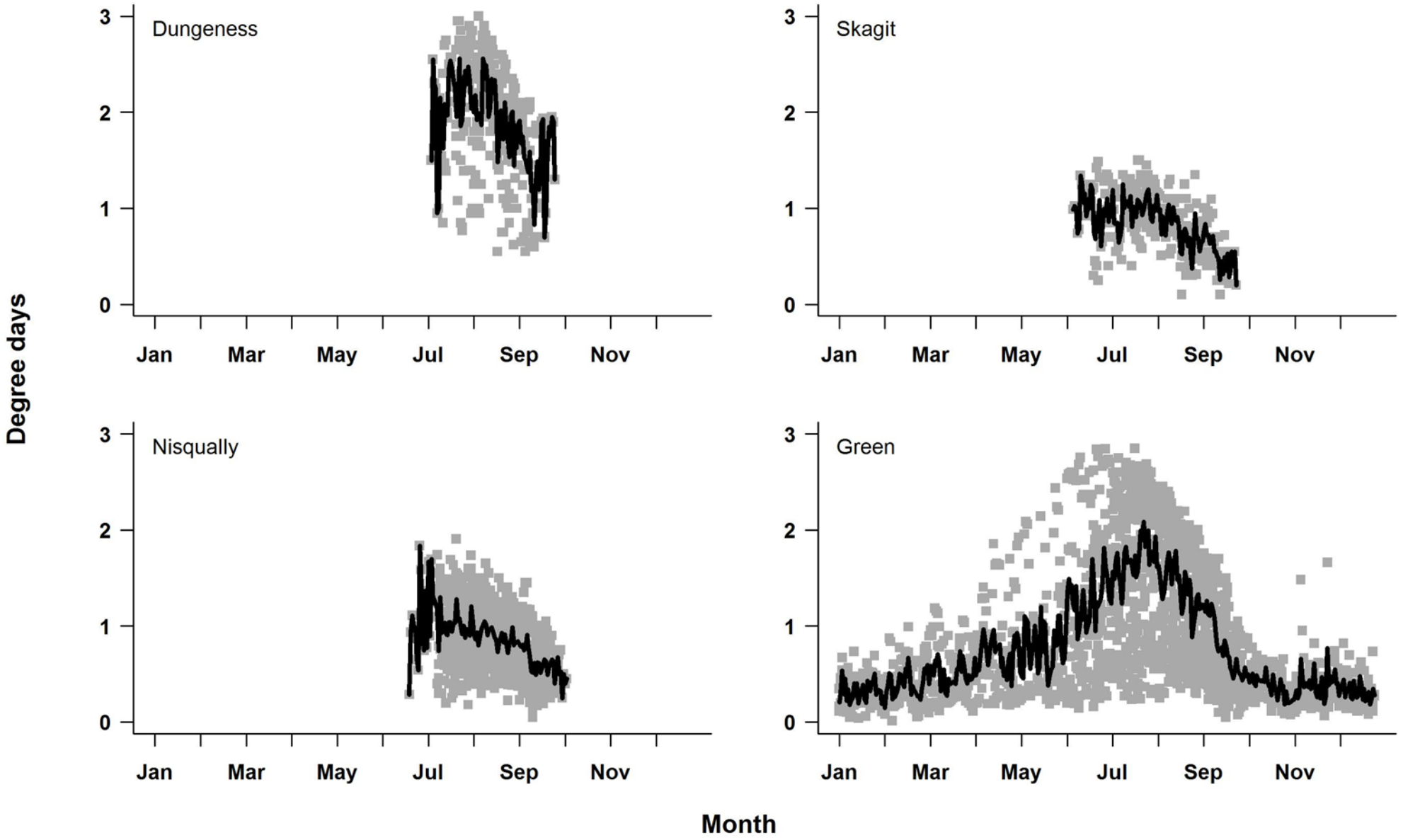
growth index would be higher with more stable flows



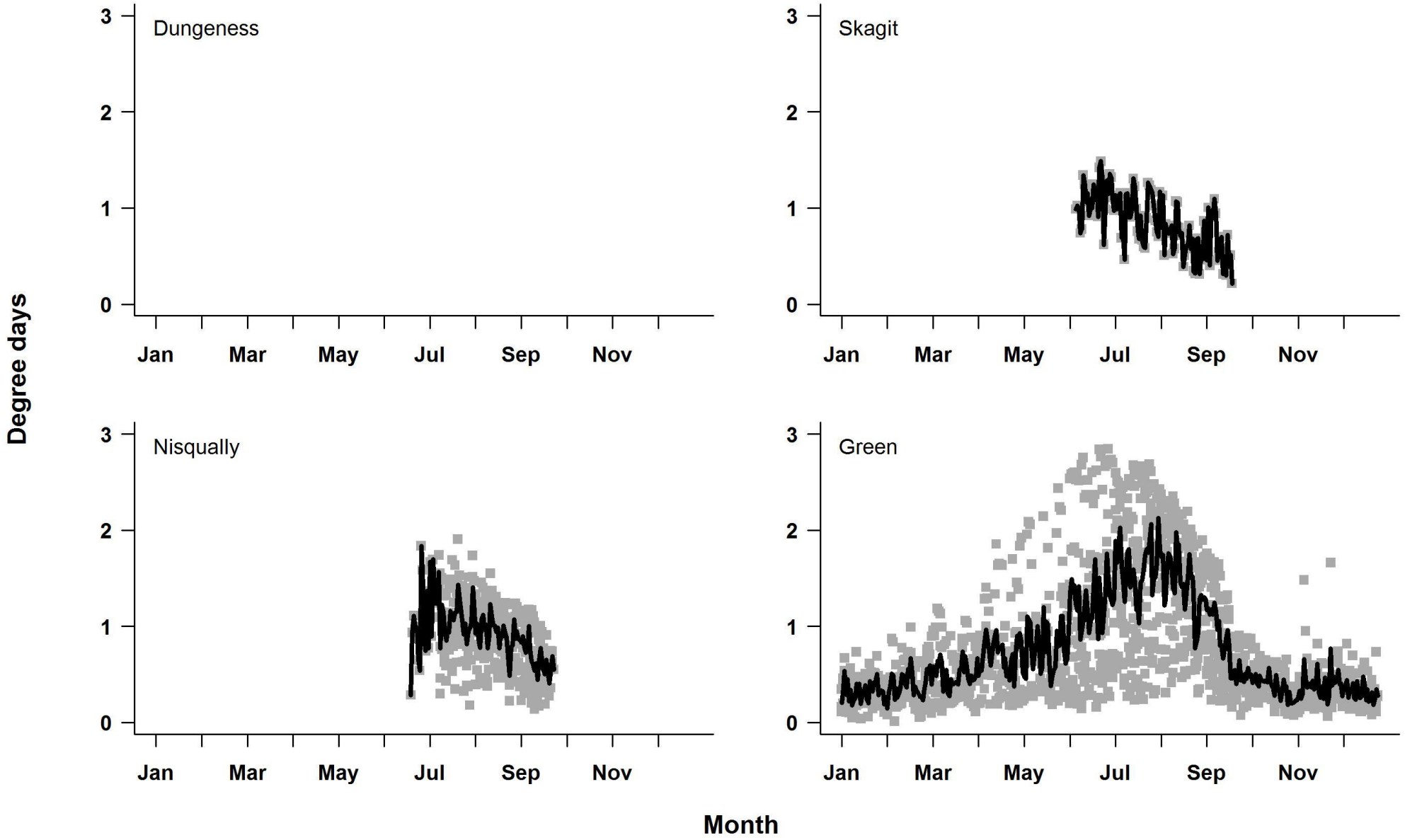
Flow relationship observed



Temperature all available

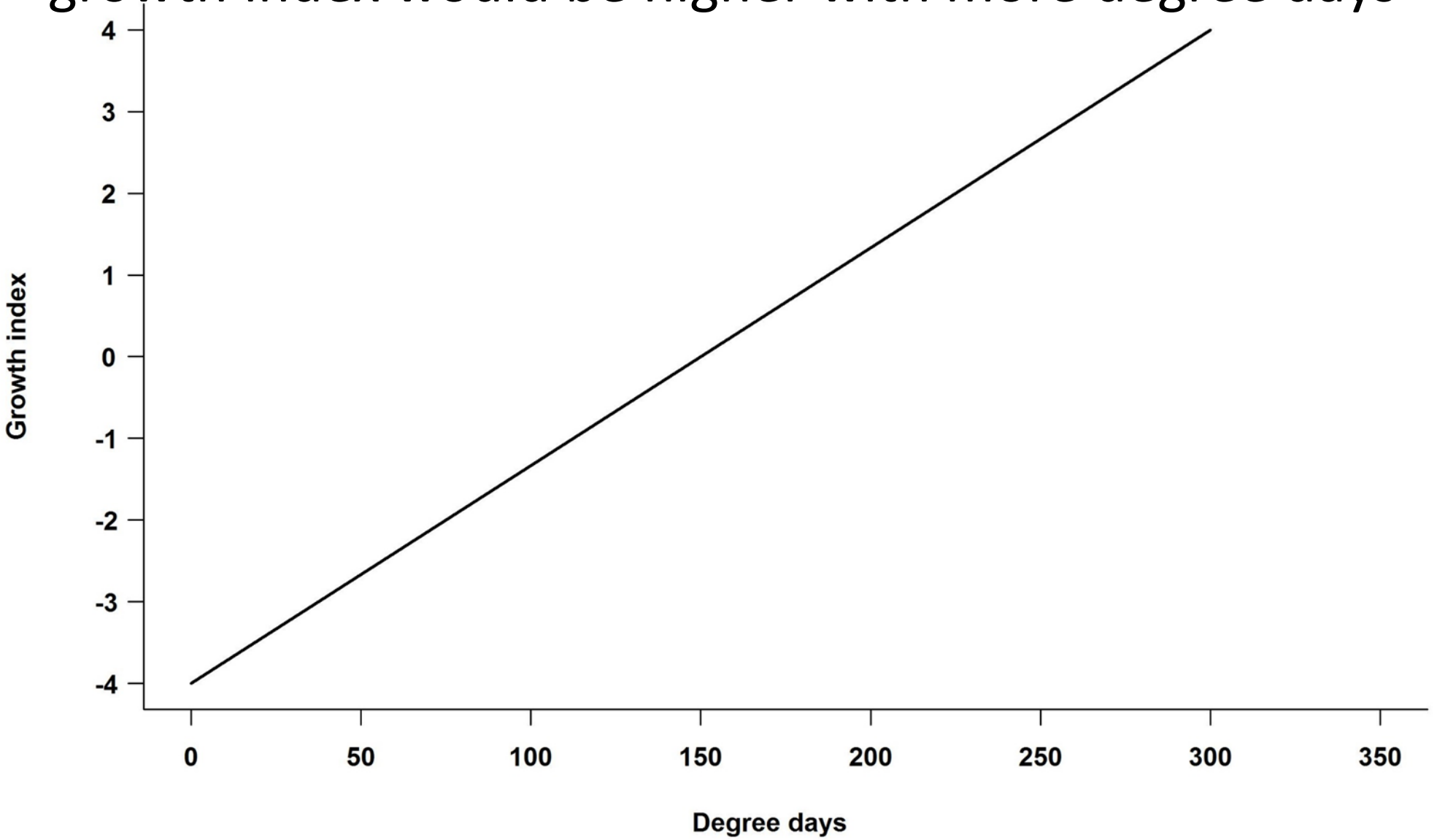


Temperature for brood years 2010 to 2015

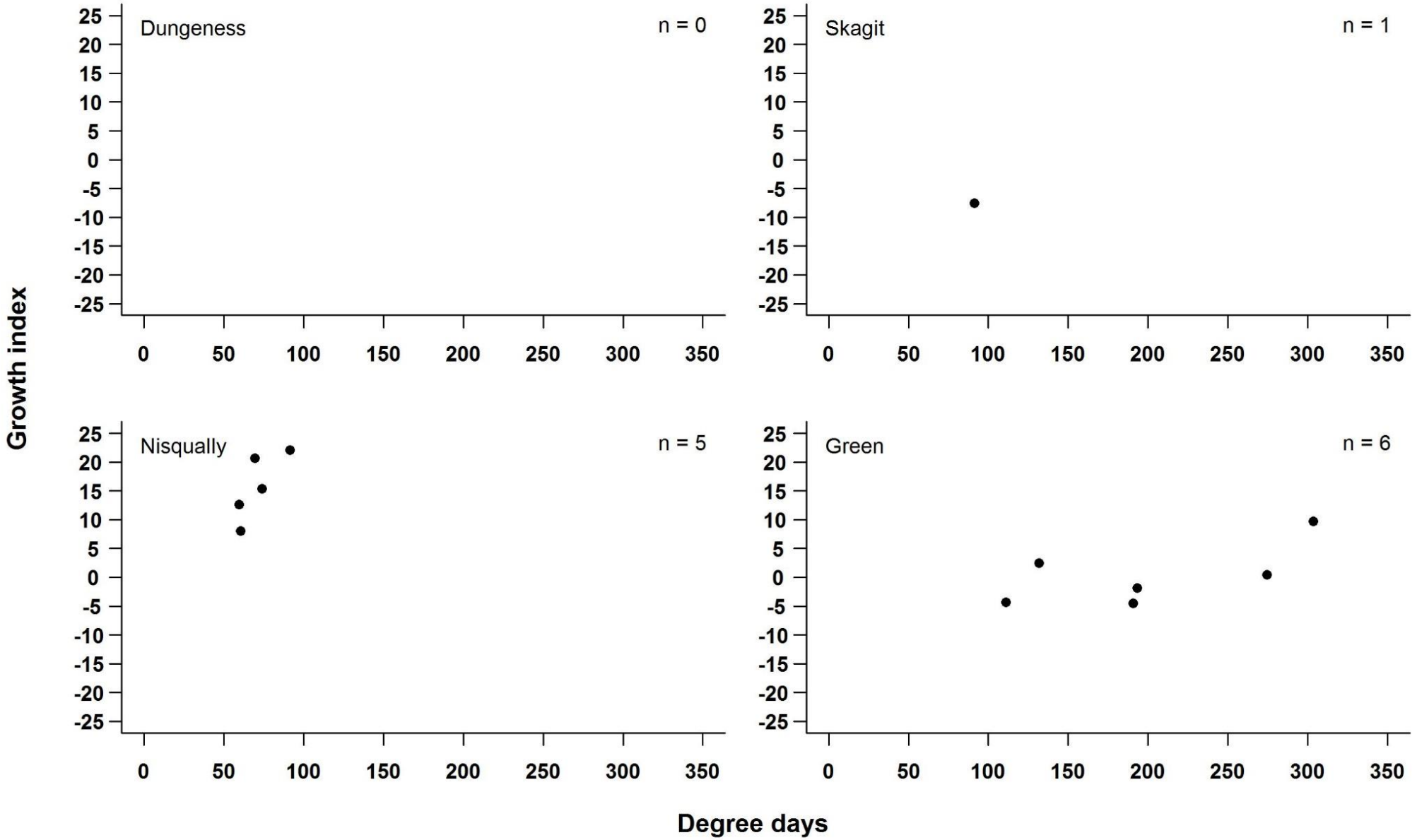


Temperature hypothesis

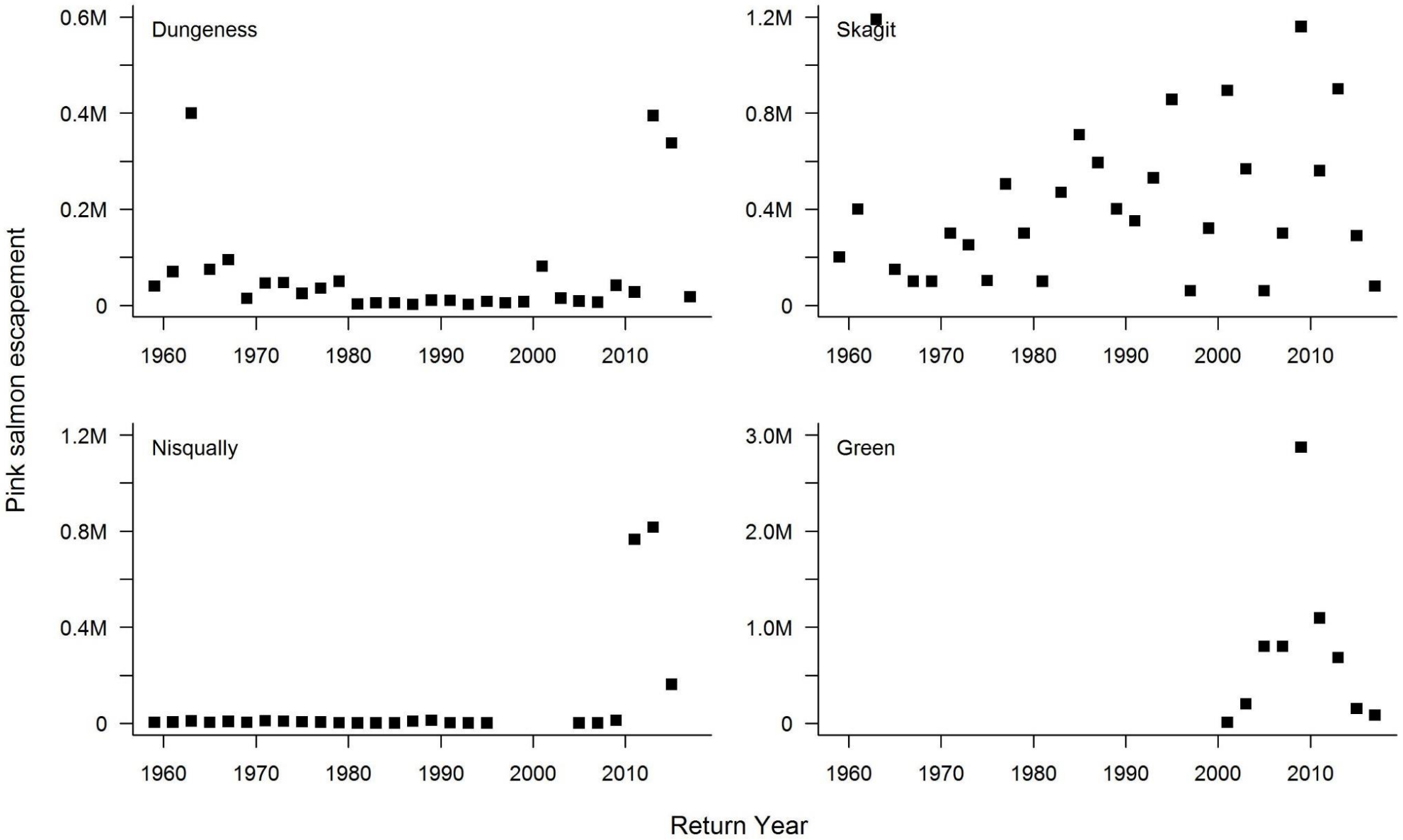
growth index would be higher with more degree days



Temperature relationship observed

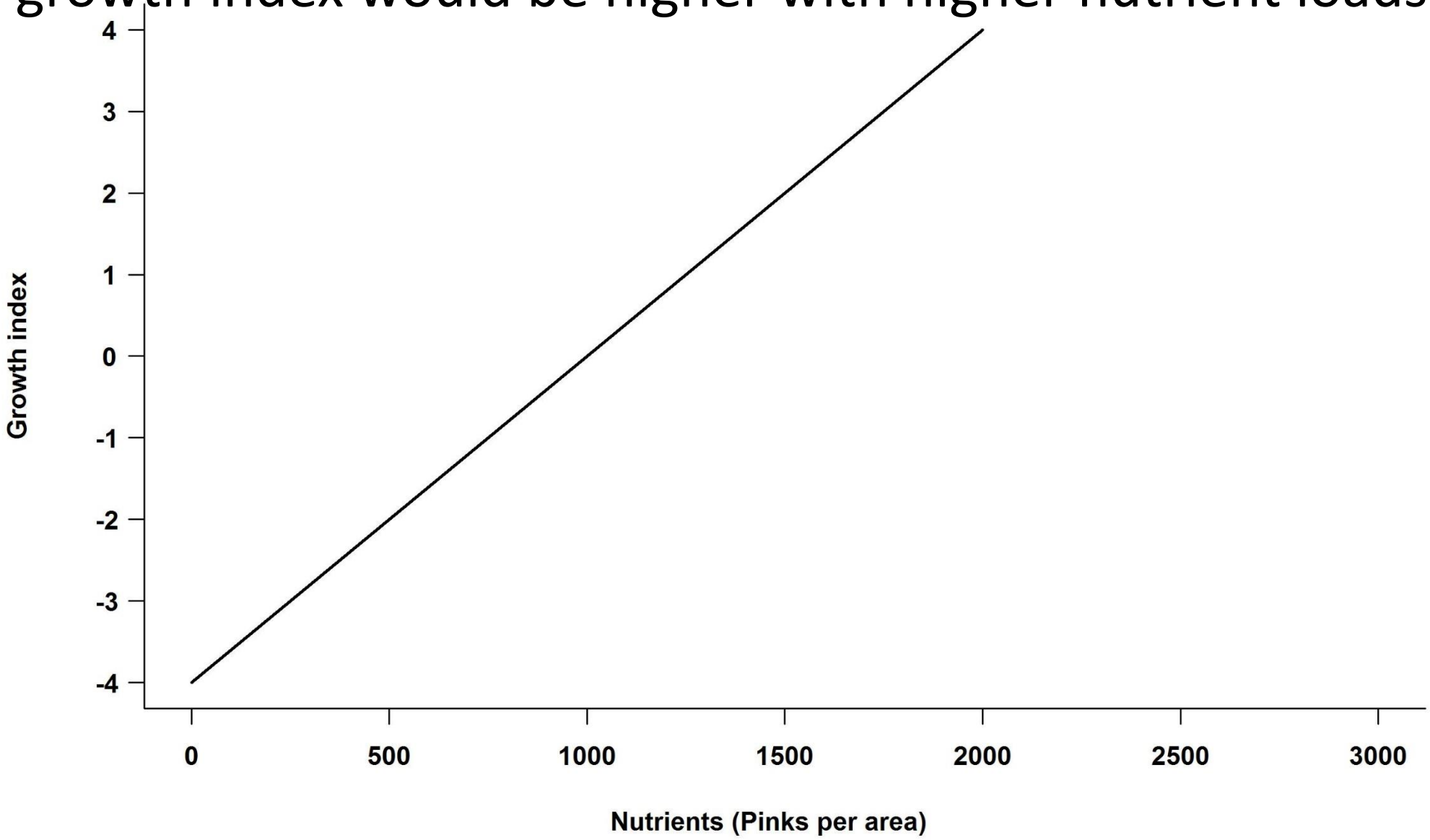


Nutrients

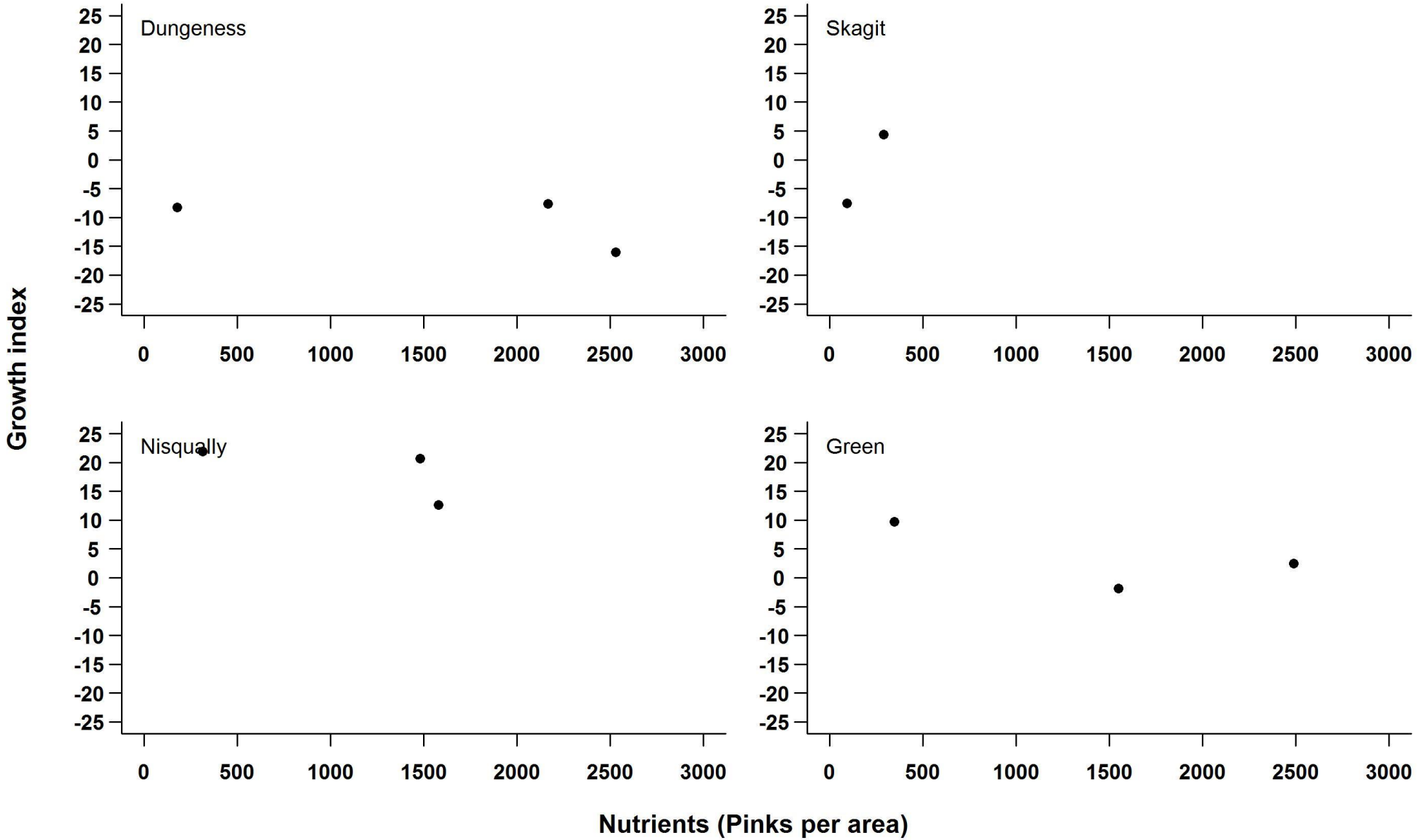

Dungeness
Skagit
Nisqually
Green
0.6M
0.4M
0.2M
0
1.2M
0.8M
0.4M
0
1.2M
0.8M
0.4M
0
3.0M
2.0M
1.0M
0
1960
1970
1980
1990
2000
2010
Pink salmon escapement
Return Year

Nutrients hypothesis

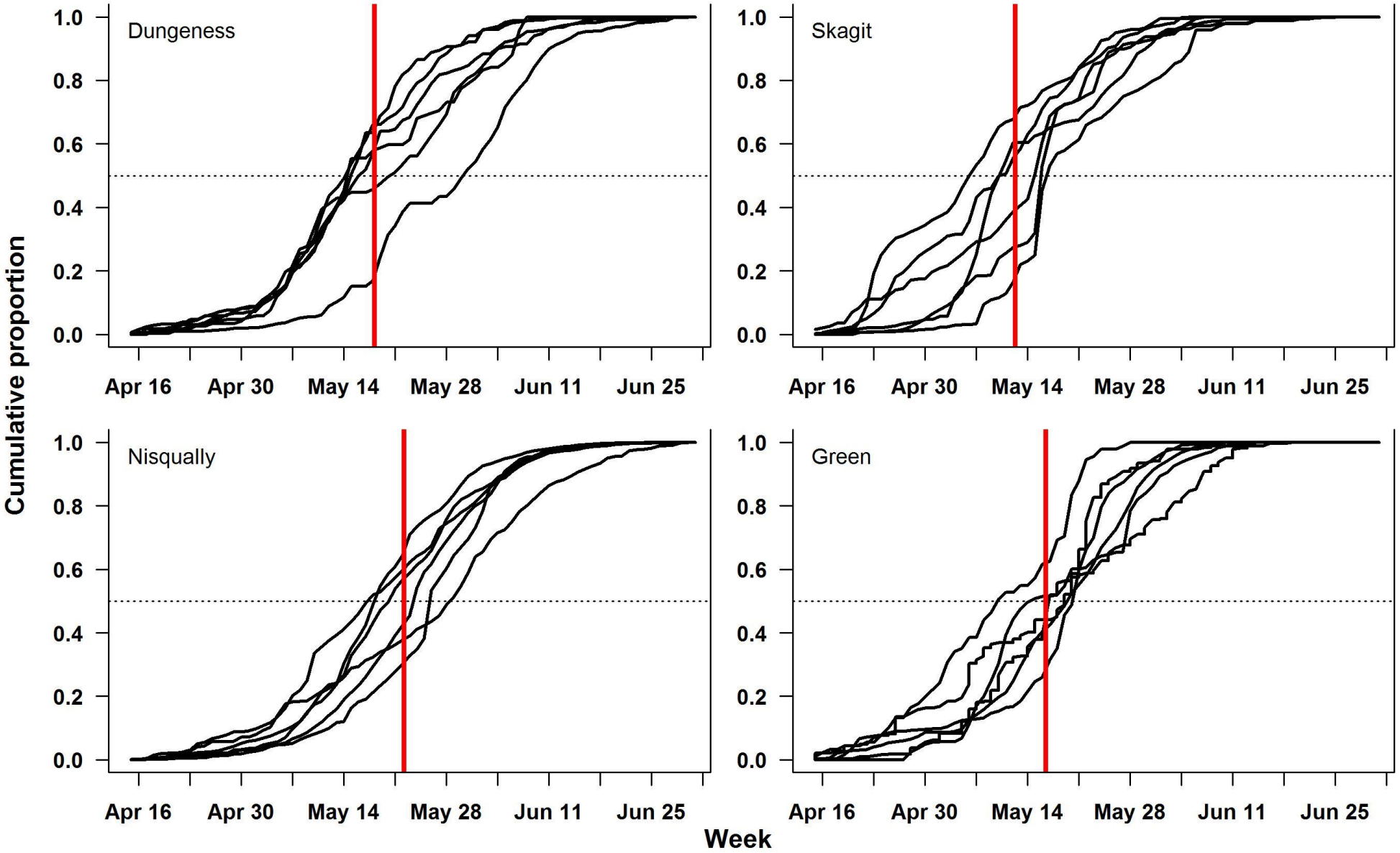
growth index would be higher with higher nutrient loads



Nutrients relationship observed

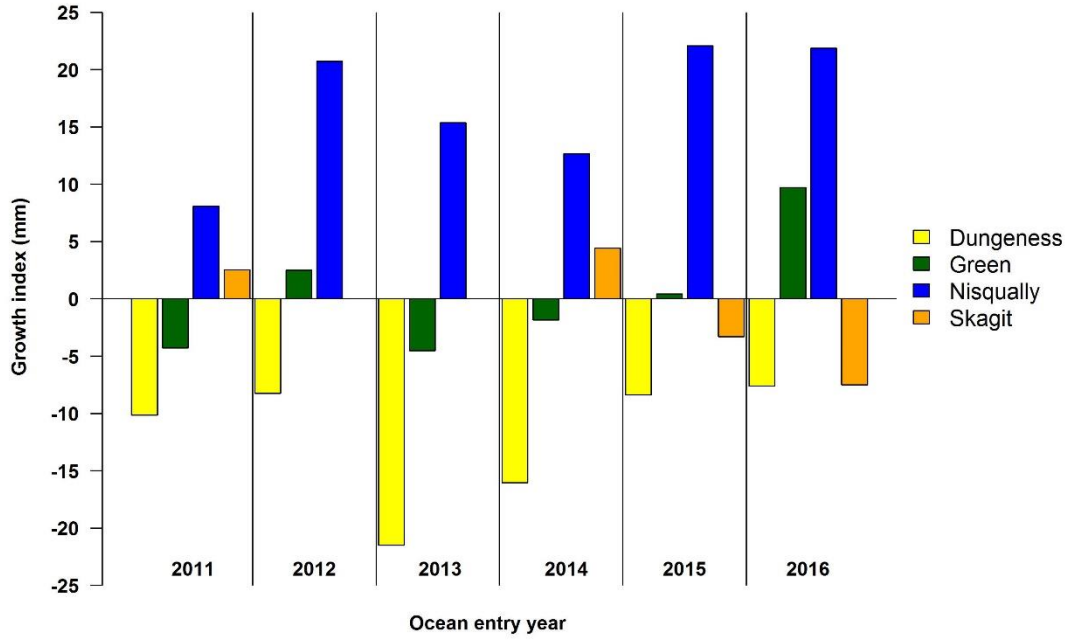


Run timing

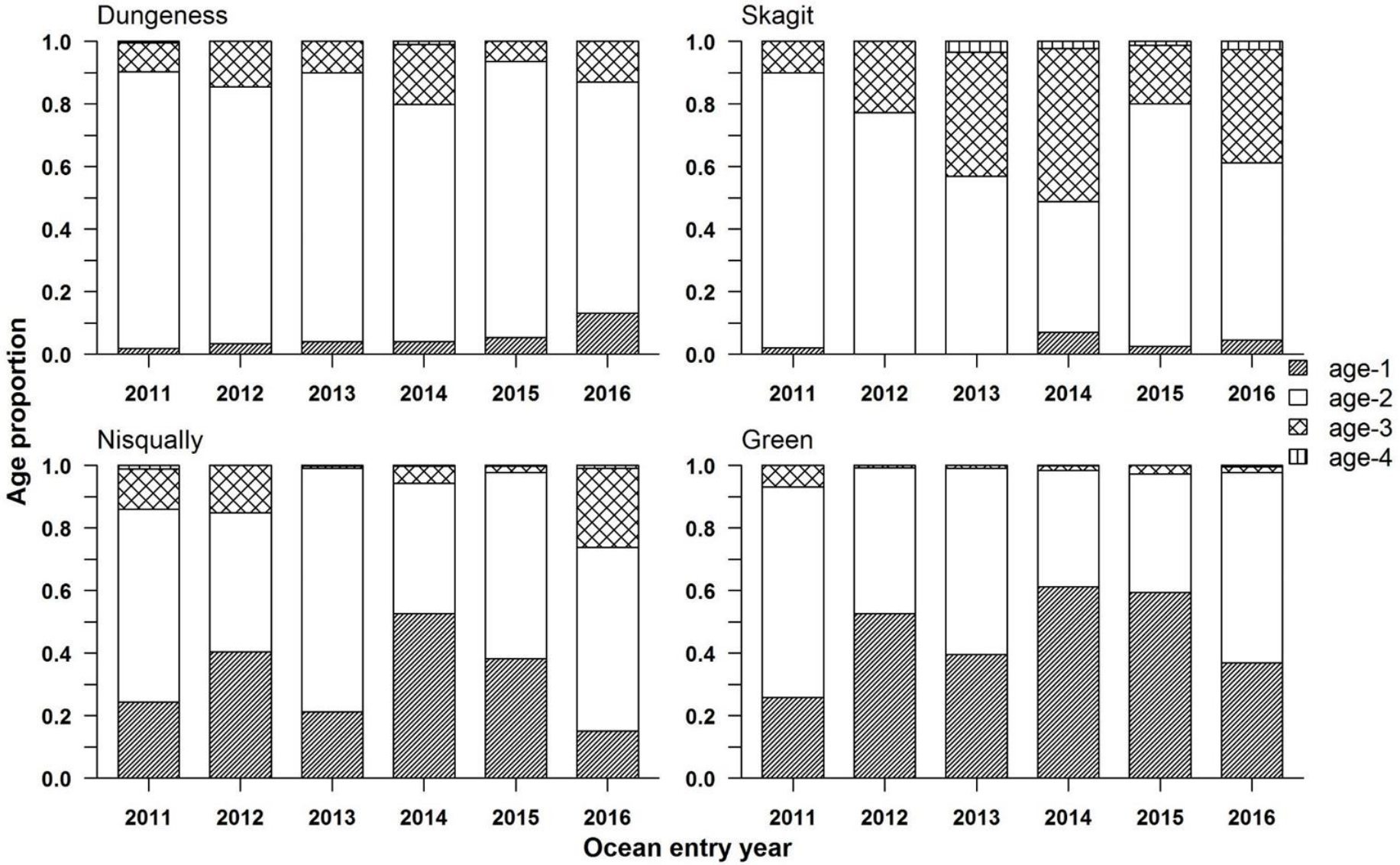

Dungeness
Skagit
Nisqually
Green
Cumulative proportion
1.0
0.8
0.6
0.4
0.2
0.0
Apr 16
Apr 30
May 14
May 28
Jun 11
Jun 25
Week

Run timing

OEY	Site	Median	Site	Median	Days
2011	Dungeness	5/30	Nisqually	5/26	NA
2012	Dungeness	5/13	Nisqually	5/27	14
2013	Dungeness	5/15	Nisqually	5/18	3
2014	Dungeness	5/18	Nisqually	5/17	NA
2015	Dungeness	5/16	Nisqually	5/20	4
2016	Dungeness	5/13	Nisqually	5/22	9



The ecological factors that influence fish growth can be difficult to tease apart but none the less there is an influence.



Conclusions

- von Bertalanffy curve suggests that growth differ by age - not surprising
- Age-1 smolt growth differs by group (river) - interesting
- These river appear to respond to environmental factors differently
  - Skagit River: growth index ~ flow (cv) appears to be negative
  - Dungeness, Nisqually and Green river: growth index ~ flow (cv) appears to be positive - counter intuitive?
- Limited temperature and nutrient data to suggest any relationship at this time
- Rotary screw traps can be size selective

Next steps

- Continue to dig for more temperature data to try to fill out that dataset.

- Include all salmon escapements to fill out nutrient dataset.

- Try to incorporate benthic invertebrate production.

Probably not

Next steps

- Continue to dig for more temperature data to try to fill out that dataset.

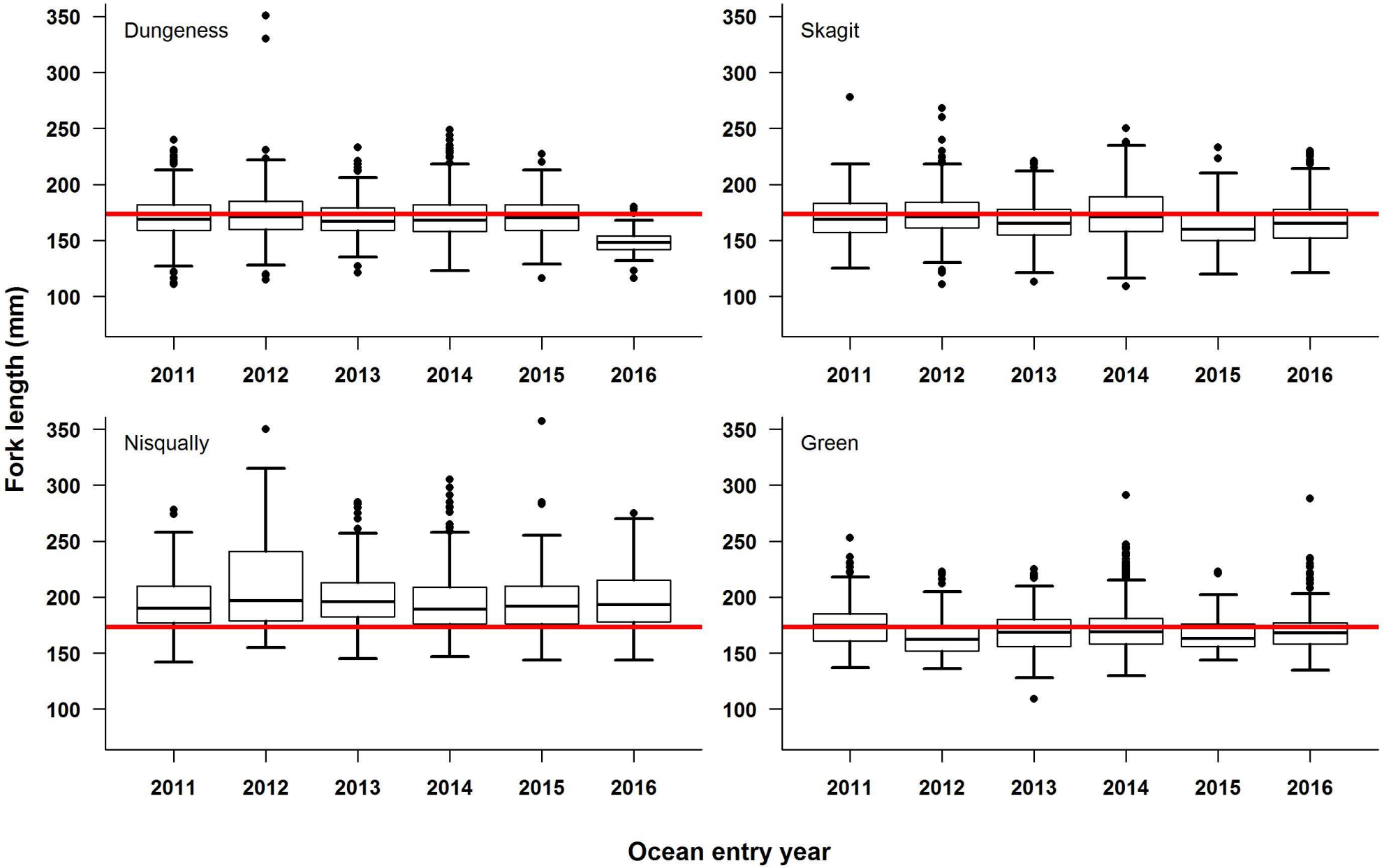
- Include all salmon escapements to fill out nutrient dataset.

- Try to incorporate benthic invertebrate production.

- Build a suite of statistical models to compare and assess these environmental factors possible help explain some of the variability in growth.


Thank you

Size


Dungeness
Skagit
Nisqually
Green
Fork length (mm)
350
300
250
200
150
100
2011
2012
2013
2014
2015
2016
Ocean entry year