The response of Hornaday River Arctic charr (*Salvelinus alpinus*) to climate-induced environmental variation

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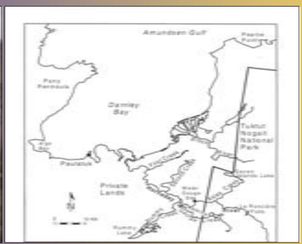
Arctic charr (*Salvelinus alpinus*) are routinely monitored for stock status in the north because of their importance in subsistence fisheries. Monitoring has yielded long-term data sets useable for understanding the pattern of biological variation in the stock and its connection to environmental variation [1]. Here 15 years of mean **length** (mm), **weight** (g) and **age** data from the Hornaday river (69˚21' N, 124˚4' W) near Paulatuk are used to investigate linkages between Arctic charr population characteristics and regional environmental variation as represented by **air and sea surface temperature, precipitation, degree days and the Arctic Oscillation Index.**

Materials and methods

Study Area



Environmental data

Internet Archives data

General circulation model interpolation of historical weather observation (e.g. air temperature and precipitation from University of Delaware, Arctic Oscillation Index from NOAA)

Biological data

- Obtained from DFO Canada monitoring programs on the Hornaday conducted July to September: 1979,1981 and 1990 to 2003.
- Mean age-specific biological measures transformed to remove influence of trends.

Analysis

Trends-adjusted biological data were used to select multiple regression models that best explained observed variation in the Arctic char biological data. Standardized regression coefficients used to rank variables in terms of importance as explanatory variables.

Results

Age	Length	Weight
5	**SSST(+)**	**PAU (+)**
	r^2 = 0.596	r^2 = 0.585
6	**SUD (-), PJULAUG (+)**	**PAU (+)**
	r^2 = 0.605	r^2 = 0.594
7	**PJULAUG(+), SUD (-)**	**PAU (+)**
	r^2 = 0.633	r^2 = 0.371
8	**PJULAUG (+)**	**PAU (+)**
	r^2 = 0.794	r^2 = 0.534

Table 1. "Best" models with explanatory variables listed in order of importance. All coefficients are significant (P<0.05). SSST= summer sea surface temperature (°C), SUD=summer degree days>2.57°C [2], PJULAUG=July+August precipitation (mm), PAU=August precipitation (mm). Signs in parentheses (+,-) define the direction of correlation between explanatory and dependant variables. Positive correlation with precipitation relates to the impacts of increased freshwater flows on nutrient exports to nearshore marine areas [1]. Negative correlation with degree days results from the effect of temperature increases on total degree days and metabolic costs. As temperature increases, metabolic costs increase with the effect of reducing realized increments in length (i.e. avg. length increments are below the trend), probably as a result of ration limitations restricting the scope for growth [3].

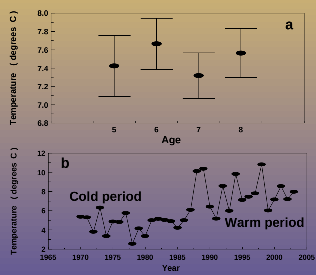


Fig.1. (a) Estimated optimum growth temperature for each age-class based on field data, and **(b)** summer air temperature for Hornaday area 1970-2003.

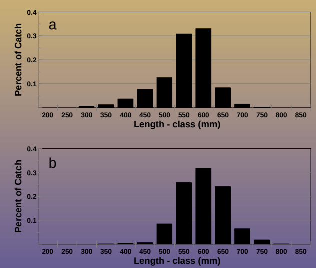


Fig. 2 Age 6 to 8 length-frequency distributions for the **(a)** cold period 1979, 1981 and **(b)** warm period 2000 to 2003. Means and variances differ significantly (P<0.05).

	Cold period	Warm period
S	0.404±0.036	0.425±0.042
Air temp.	3.75 °C	7.73 °C

Table 2. Mean ± std. deviation of survival (S) estimates from Hornaday Arctic Charr catch curves and corresponding mean air temperatures for the cold (1979,1981) and warm periods (2000-2003).

Conclusions

[1] Inter-annual variation
Driven by local environmental variation
precipitation (ages ≥ 6)
temperature (ages ≤ 7)

[2] Cold and warm period differences
↑Size-at-age as temperatures ↑

[3] Growth best in 7.3 to 7.7ºC range
If metabolic cost ↑ > available ration ↑
then
scope for growth ↓ with climate change

References

[1] **Power, M. et al. 2000.** Environmental influences on an exploited anadromous Arctic charr stock in Labrador. J. Fish Biology 57:82-98.
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