BEHIND THE DECLINE OF ALASKA SNOW CRAB – EXPLORING CLIMATE CHANGE FACTORS & POLICY OPTIONS

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ABSTRACT

This study provides a comprehensive investigation, employing both quantitative and qualitative approaches, of the substantial decline in the Alaska snow crab population. Our analysis examines the interplay between climate change factors and the stock of Alaska snow crab, utilizing OLS regression and Best Unbiased Estimators to construct their correlation. Our findings indicate a pressing need for the provision of disaster relief for Alaska snow crab farmers and the enhancement of long-term risk management frameworks in the fishing industry. Our objective is to offer valuable insights to stakeholders concerned with Alaska's local ecosystem and economy.

INTRODUCTION

Background

In 2022, for the first time in state history, Alaska fisheries officials announced the shutdown of the snow crab harvest

Billions of Alaska snow crabs have disappeared in the past two years, and local fishers are estimated to lose millions of dollars

Alaska snow crab is a vital element of Alaska's economy and a global source of seafood

Motivation

Crab farmers are advocating for comprehensive explanations and viable solutions to ensure economic resilience

Several assumptions were made, yet the reason behind this vast collapse remains unclear

We are interested in exploring the climate-caused theory

DATA

Response variable (Y)

Annual Alaska snow crab's landing stock (SCS) - NOAA Fisheries

Explanatory variables (X_i)

X_1: Annual sea surface temperatures of the Bering Sea (SST) - NOAA's Coral Reef Watch Program

X_2: Annual precipitation for the Alaska region (PRCP) - NOAA's National Centers for Environmental Information

X_3: Annual sea ice index (SII) - National Snow and Ice Data Center

X_4: Annual breakup dates for Yukon River (YUK) - NOAA's National Weather Service

X_5: Annual breakup dates for Tanana River (TAN) - NOAA's National Weather Service

X_6: Natural disaster events (DIS) - NOAA's National Weather Service

METHODOLOGY

Ordinary Least Squares (OLS) regression

> White's test for heteroscedasticity

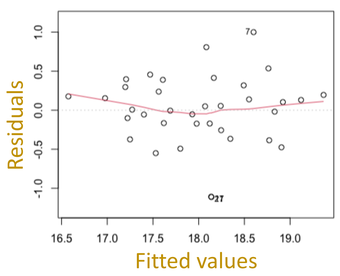
> Durbin-Watson test for autocorrelation

> Newey-West Robust Covariance Matrix Estimator to address autocorrelation

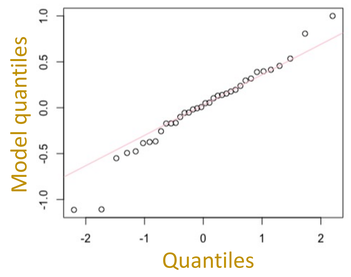
> Normal probability plot to assess the errors are normally distributed

EMPIRICAL RESULTS

homoscedasticity



normality of errors



Regression Results Using lg(SCS) as Criterion with Autocorrelation Correction

Predictor	*b*	*Adjusted b* 95% CI [LL, UL]	*p value*
(Intercept)	25.43***	[18.57, 32.29]	<.001
→ SST	-0.52***	[-0.66, -0.39]	<.001
PRCP	0.00*	[-0.00, 0.00]	.013
→ SII	0.66***	[0.46, 0.86]	<.001
YUK	-0.08**	[-0.12, -0.03]	.002
TAN	-0.04**	[-0.06, -0.01]	.002
DIS_SII	-0.03	[-0.05, 0.00]	.069

Note. b represents unstandardized regression weights. *LL* and *UL* indicate the lower and upper limits of a confidence interval.
* indicates $p < .05$ ** indicates $p < .01$ *** indicates p<.001

SST & SII are good indicators of SCS

one-unit increase in SST is correlated with a 0.52% decrease in SCS

Through: reproductive cycle, timing of egg hatching, growth of snow crab larvae/juveniles, metabolism, abundance of their prey species, habitat area

> one-unit increase in SII is correlated with a 0.66% increase in SCS

Through: Alexandrium catenella reduction, zooplankton growth, timing and strength of ocean currents

Incorporate the best unbiased estimates to our **MODEL**:

$$\ln SCS_t = 25.43 - 0.52\,SST_t + 0.66\,SII_t - 0.08\,YUK_t - 0.04\,TAN_t - 0.03\,DIS\_SII_t$$

$$(3.76)^{***}\ (0.13)^{***}\quad (0.15)^{***}\quad (0.02)^{**}\quad (0.02)^{**}\quad (0.02)$$

$$R^2 = 0.69^{**},\quad \text{Adjusted } R^2 = 0.63^{**}$$

Policy implications

Grant/relief program

> provide financial assistance and other forms of quick support to the affected crab farmers – short-term goal

- clarify the eligibility
- stakeholder analysis & engagement
- identify diverse funding sources
- review, monitor & evaluate

Framework improvement

> new framework is necessary due to shortcomings of the existing framework in providing financial support to snow crab farmers and implementing effective policies for sustainable resource management – long-term prosperity

- comprehensive assessment of the current state of the crab industry
- obtain wide-scale involvement
- prioritize solutions that address the primary concern
- job training and education programs
- biological research programs
- clear communication and continuous monitoring
- regular framework review and modification

CONCLUSION

This research examines the interactions between climate change factors and the supply system of Alaska snow crab and identifies sea surface temperature and sea ice index are pivotal factors that influence the snow crab stock.

Accordingly, we reveal their correlation and constructed an economic model.

Grant program and revised framework are recommended under this context.