

Update Report

Period 3/1/2013 - 2/28/2014

Project E/I-20 - NMFS Population Dynamics Sea Grant Graduate Fellowship An evaluation of the stock assessment method for eastern Bering Sea snow crab incorporating spatial heterogeneity in fishing pressure, recruitment processes and distribution of spawning biomass. Andre Punt in support of Cody Szuwalski

STUDENTS SUPPORTED

Szuwalski, Cody, szuwalsk@uw.edu, University of Washington, SAFS, status cont, field of study Population dynamics, advisor Andre Punt, degree type PhD, degree date 2014-06-01, degree completed this period No

Student Project Title An evaluation of the stock assessment method for eastern Bering Sea snow crab incorporating spatial heterogeneity in fishing pressure, recruitment processes and distribution of spawning biomass

Involvement with Sea Grant This Period Graduate fellow

Post-Graduation Plans stock assessment scientist (NOAA, hopefully)

CONFERENCES / PRESENTATIONS

Program on Climate Change, public/profession presentation, 50 attendees, 2013-09-13

Center for International Experts review of snow crab assessment, public/profession presentation, 5 attendees, 2014-01-15

World Conference on Stock Assessment Methods, public/profession presentation, 400 attendees, 2013-07-15

PICES Annual Meeting, Nanaimo, BC, public/profession presentation, 1000 attendees, 2013-10-16

ADDITIONAL METRICS

K-12 Students Reached	Acres of degraded ecosystems restored as a result of Sea Grant activities
Curricula Developed	Resource Managers who use Ecosystem-Based Approaches to Management
Volunteer Hours	HACCP - Number of people with new certifications
Cumulative Clean Marina Program - certifications	

PATENTS AND ECONOMIC BENEFITS

No Benefits Reported This Period

TOOLS, TECH, AND INFORMATION SERVICES

No Tools, Tech, or Information Services Reported This Period

HAZARD RESILIENCE IN COASTAL COMMUNITIES

No Communities Reported This Period

ADDITIONAL MEASURES

Safe and sustainable seafood

Number of stakeholders modifying practices

Actual (3/1/2013 - 2/28/2014)

Anticipated (3/1/2014 - 2/28/2015)

Number of fishers using new techniques

Actual (3/1/2013 - 2/28/2014)

Anticipated (3/1/2014 - 2/28/2015)

Sustainable Coastal Development

Actual (3/1/2013 - 2/28/2014)

Anticipated (3/1/2014 - 2/28/2015)

Coastal Ecosystems

Actual (3/1/2013 - 2/28/2014)

Anticipated (3/1/2014 - 2/28/2015)

PARTNERS

Partner Name Alaska Department of Fish and Game (AK DFG)

Partner Name National Marine Fisheries Service (US DOC)

Partner Name NOAA Fisheries

IMPACTS AND ACCOMPLISHMENTS

Title A Washington Sea Grant fellow seeks a better way to assess a spatially dynamic, commercially important crab species

Type accomplishment

Description Relevance The Eastern Bering Sea snow crab is a commercially important stock that was declared overfished in 1991; reasons for the decline are still unclear. Its population is spatially structured by migration over its lifetime, but current stock assessments ignore this structure and lack key pieces of information required for effective management. An assessment model that takes account of the crabs’ movement patterns could better capture their population dynamics and improve management capacity. Response A Washington Sea Grant-supported fellow developed a spatially explicit assessment method that tracks the movements of male crabs among four quadrants of the Bering Sea. Results There was insufficient data to verify the accuracy of the new assessment method’s estimates of movement, recruitment, fishing mortality, and other quantities used to manage the fishery. However, the method did support development of an operating model that could be used to test the ability of current methods to estimate trends in abundance and fishing pressure in a spatially structured population. This model test showed that it was necessary to know the

share of a target sample the survey technique actually caught and counted in order to reliably capture the dynamics of the population.

Recap Washington Sea Grant-supported research develops a spatially structured method for assessing Bering Sea snow crab population and tests the ability of current methods to assess this spatially dynamic species.

Comments Primary Focus Area LME (SSSS) State Goals Support conservation and sustainable use of living marine resources through effective and responsible approaches, tools, models and information for harvesting wild and cultured stocks and preserving protected species (SSSS Supply).

Related Partners Alaska Department of Fish and Game (AK DFG), National Marine Fisheries Service (US DOC)

PUBLICATIONS

Title Can an aggregate assessment capture the dynamics of a spatially-structured stock? Snow crab in the eastern Bering Sea as a case study

Type Reprints from Peer-Reviewed Journals, Books, Proceedings and Other Documents
Publication Year 2014 Uploaded File [SpatialSC_proof_v1.pdf](#) URL none

Abstract The snow crab population in the eastern Bering Sea is panmictic, but it is spatially structured by inferred ontogenetic migrations, and fishing pressure is often spatially restricted by sea ice extent. This spatial structure is ignored when stock assessments are conducted. A spatial assessment was developed for snow crab to estimate spatially-explicit trends in recruitment, fishing mortality and rates of movement. Confounding with other processes prevented accurate estimation of movement parameters, but reasonably good fits to the data were nevertheless achieved. The fitted spatial population dynamics model was used to simulate data sets to test the ability of a non-spatially structured (aggregate) assessment method to estimate trends in abundance and fishing pressure in the presence of spatial structure. The aggregate assessment method performed well if survey selectivity was well known, but was unable to reliably capture the dynamics of the population without data on survey selectivity. Additional data on movement from tagging studies or winter surveys would be useful to improve the understanding of the influence of spatial structure on snow crab in the eastern Bering Sea.

Citation Szuwalski, C.S. and Punt, A.E. (in review) Can an aggregate assessment capture the dynamics of a spatially structure population? Snow crab in the eastern Bering Sea as a case study. Fisheries Research.

Copyright Restrictions + Other Notes this is in review and the file I attempted to provide was an initial proof, not for distribution. however, the file would not upload, I will pass it along some other way.

Journal Title Fisheries Research

OTHER DOCUMENTS

| No Documents Reported This Period |

LEVERAGED FUNDS

| No Leveraged Funds Reported This Period |

UPDATE NARRATIVE

| Uploaded File [Szuealski_8427_update_....5.pdf](#) |

An evaluation of the stock assessment method for eastern Bering Sea snow crab incorporating spatial heterogeneity in fishing pressure, recruitment process and distribution of spawning biomass.

Cody Szuwalski and Andre Punt
Narrative for project E/I-20
Population Dynamics SeaGrant Graduate Fellowship

Activities:

Related to the project

A spatially explicit assessment method was developed in Auto-Differentiating Model Builder (ADBM) that divided the Bering Sea into 4 areas and tracked male crab by length, maturity state and area. Estimates of recruitment, fishing mortality and movement by area were produced, but the assessment method did not converge (based on a non-positive definite Hessian). Consequently, it is not possible to assert that our estimates reflect reality, but the spatial assessment method was used to develop an operating model to test the ability of non-spatial models to capture the dynamics of a spatially-structured population. The final results of this analysis are now in review at Fisheries Research and were presented to a variety of audiences, including, the Center for International Experts review panel for the snow crab assessment, a general audience at my dissertation defense and assessment scientists at the World Conference on Stock Assessment Methods in Boston, MA. A chapter in a book focused on management strategy evaluation is under development incorporating the work completed under this grant. My dissertation was completed, defended and submitted in February and this grant allowed me to complete a portion of it.

Unrelated to the project

During this reporting period, I authored or co-authored several publications not directly related to this proposal. First, I was part of a working group that produced a simulation framework for Stock Synthesis 3 and are in the process of publishing 3 papers: “Data quality and performance of stock assessment methods”, “Time-varying natural mortality in fisheries stock assessment models: Identifying a default approach”, and “Looking in the rearview mirror: reflections on bias and retrospective patterns from a fisheries assessment simulation study”. I wrote “Examining assumptions about recruitment: a meta-analysis of recruitment dynamics for worldwide fisheries” and it is under final review. “Predictability of worldwide marine fisheries” was written using the same dataset as “Examining assumptions...” and will be submitted soon. Finally, “An Evaluation of Stock-Recruitment Proxies and Environmental change Points for Implementing the US Sustainable Fisheries Act” is currently in review.

I presented some of these works at the UW quantitative seminar, the World Conference on Stock Assessment Methods, the Program on Climate Change (a UW summer institute) and the PICES Annual Meeting. In summer of 2013, I was awarded the UW School of Aquatic and Fishery Science Faculty Merit Award, which would not have been possible without the help of SeaGrant.

Participants:

I have had the opportunity to engage (and draw data from) individuals in relation to this project from industry (the Bering Sea Fisheries Research Foundation), academia (UW), federal government (NOAA, NMFS) and state government (ADFG) during this reporting period.

Results:

The abstract from the now submitted paper describing the results of this project is as follows:

The snow crab population in the eastern Bering Sea is panmictic, but it is spatially structured by inferred ontogenetic migrations, and fishing pressure is often spatially restricted by sea ice extent. This spatial

structure is ignored when stock assessments are conducted. A spatial assessment was developed for snow crab to estimate spatially-explicit trends in recruitment, fishing mortality and rates of movement. Confounding with other processes prevented accurate estimation of movement parameters, but reasonably good fits to the data were nevertheless achieved. The fitted spatial population dynamics model was used to simulate data sets to test the ability of a non-spatially structured (aggregate) assessment method to estimate trends in abundance and fishing pressure in the presence of spatial structure. The aggregate assessment method performed well if survey selectivity was well known, but was unable to reliably capture the dynamics of the population without data on survey selectivity. Additional data on movement from tagging studies or winter surveys would be useful to improve the understanding of the influence of spatial structure on snow crab in the eastern Bering Sea.

This paper shows that the current assessment is capable of assessing the stock, but points out that there are key pieces of information missing required by the management strategy. A draft is enclosed.

Challenges and changes in direction:

Difficulty of estimating movement rates with the available data necessitated a small change in direction from a full-feedback management strategy evaluation (which would require specifying movement accurately) to an evaluation of the estimation ability of the current assessment method when the population is spatially structured.