Applying the Bayesian approach in assessment of red king crab (*Paralithodes camtschaticus*) and northern shrimp (*Pandalus borealis*) stocks in the Barents Sea

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Introduction

Bayesian's theorem has been applied in fishery biology since 1990s. At present these models are widely used to describe the status of stocks and in forecasting.
The estimates of the stock status made by this method have been supported by CCAMLR, FAO, NAFO, NEAFC, ICES.

Goal

to review the possibility of using this method for assessing the population dynamics and TAC of northern shrimp and red king crab in the Barents Sea

Methods

The Bayesian approach was used to construct a posterior model parameters distributions

$$p(\theta \mid data) \propto p(data \mid \theta)\, p(\theta)$$

$p(\theta \mid data)$ **is the posterior probability distributions ? of parameters?,**

$p(data \mid \theta)$ **is the likelihood function of difference between s urvey indices and absolute biomass,**

$p(\theta)$ **is the estimated or assumed prior probability distribution of unobservable parameters (catchability coefficients, MSY, carrying capacity, etc.).**

Methods

State equations

Production model for red king crab and shrimp stocks

$$B_{t+1} = B_t - C_t - V_t + \lambda MSY \frac{B_t}{K}\left(1 - \left(\frac{B_t}{K}\right)^{m-1}\right)$$

Cohort model Catch Survey Analysis (CSA) for red king crab

$$R_{t+1} = PR_t * molt * G_{PR,R} * e^{-m} * e^{a}$$

$$P_{t+1} = ((P_t + R_t + PR_t * molt * G_{PR,P}) * e^{-m} - C_t * e^{(y-1)*m}) * e^{b}$$

Cohort model Length-Based Analysis (LBA) for red king crab

$$N_{l+1,t+1} = \sum_{l'=1}^{l'=l+1}\left\{[P_{l',l+1}(N_{l',t} + O_{l',t})e^{-M_t} - C_{l',t}e^{(y-1)M_t}]m_{l',t} * e^{nl}\right\} + R_{l+1,t+1}$$

$$O_{l+1,t+1} = [(N_{l+1,t} + O_{l+1,t})e^{-M_t} - C_{l+1,t}e^{(y-1)M_t}](1 - m_{l+1,t}) * e^{ol}$$

Shrimp
input data

Russian trawl survey data,
Norwegian trawl survey data,
Ecosystem trawl survey data

Fishery data

Area-swept method
(observed abundance by year)

Russian and Norwegian CPUE, total catch

Consumption by cod
(AFWG)

Crab
input data

Trawl survey data

Area-swept method
(observed abundance by length, sex, shell condition, year)

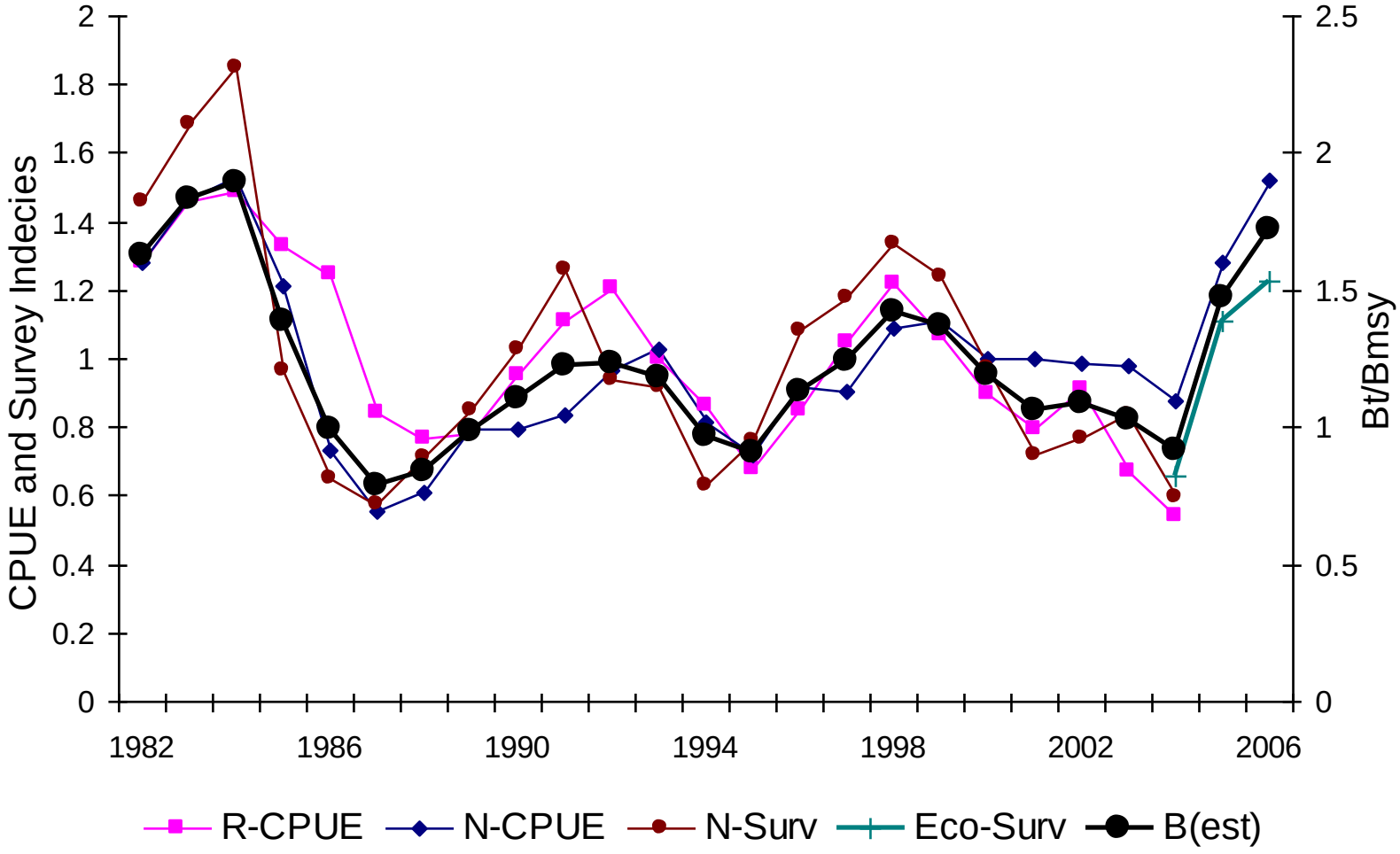
Fishery data

Catch in numbers
(by length, shell condition, year)

Tagging data
(length increment per moult, moulting probability)

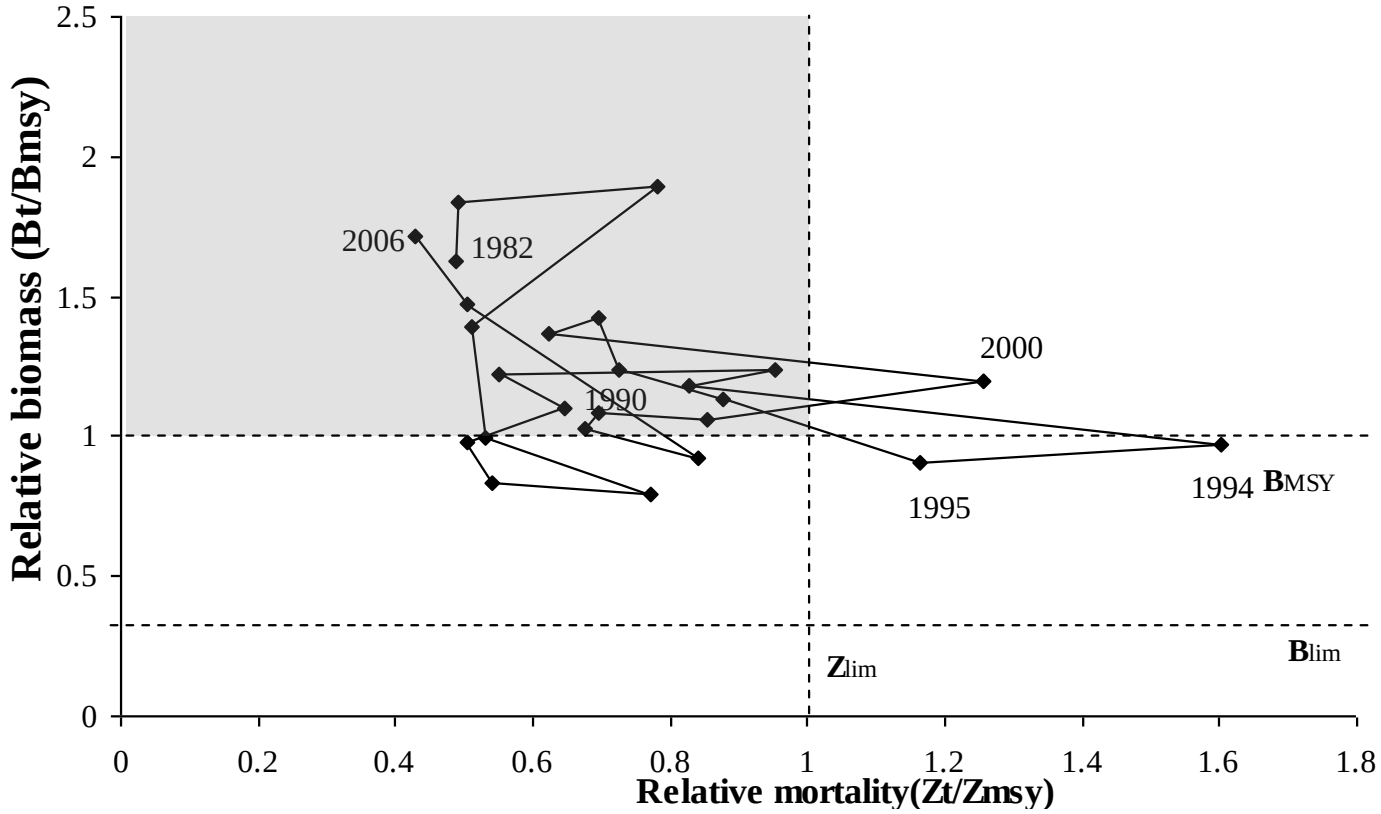
Results for shrimp

Comparison of observed and model estimated values: CPUE and survey stock biomass indices

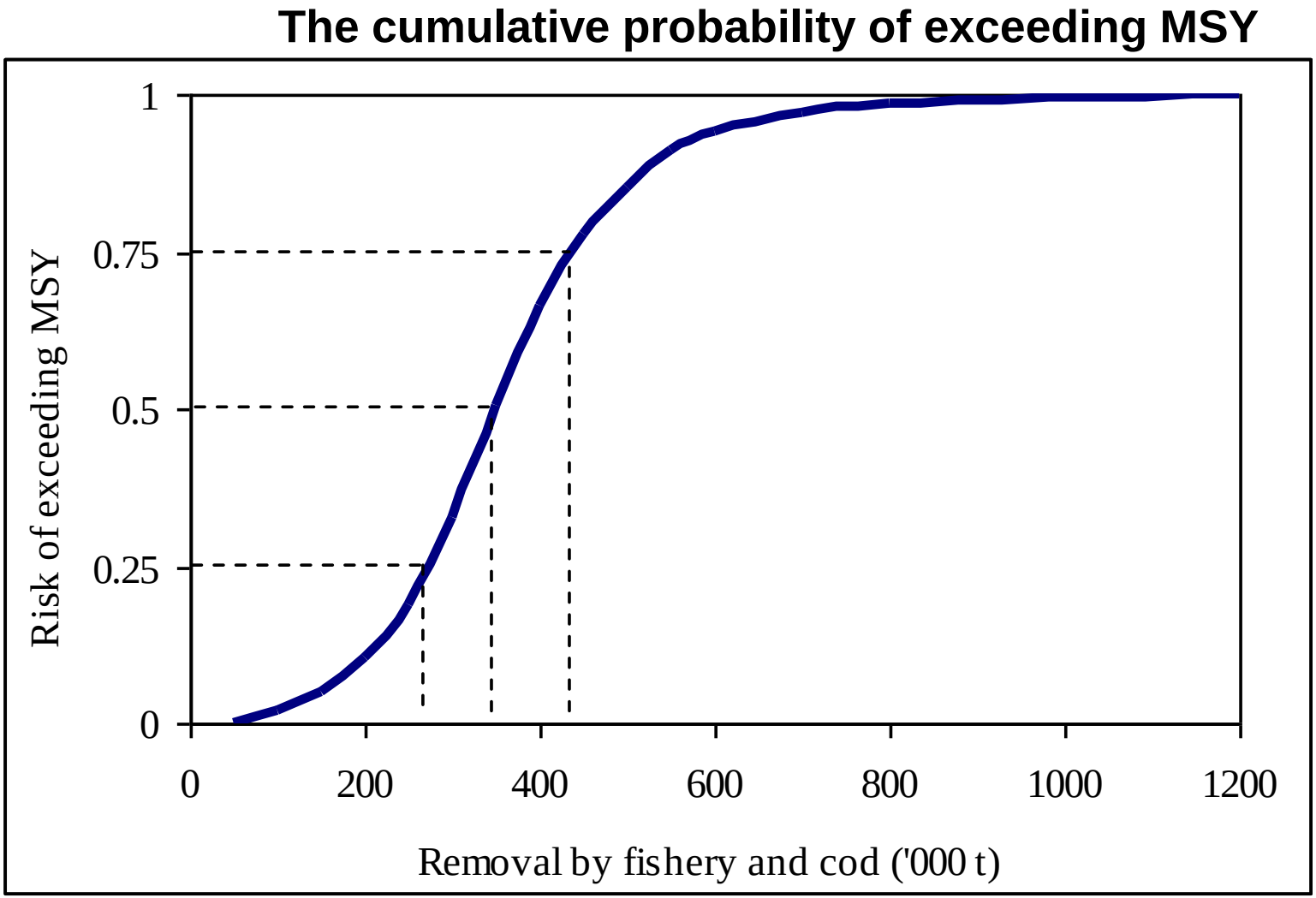


Results for shrimp

Dynamics of northern shrimp stock in the Barents Sea by management zone applying the precautionary approach for 1982-2005 (dark area – safe zone)

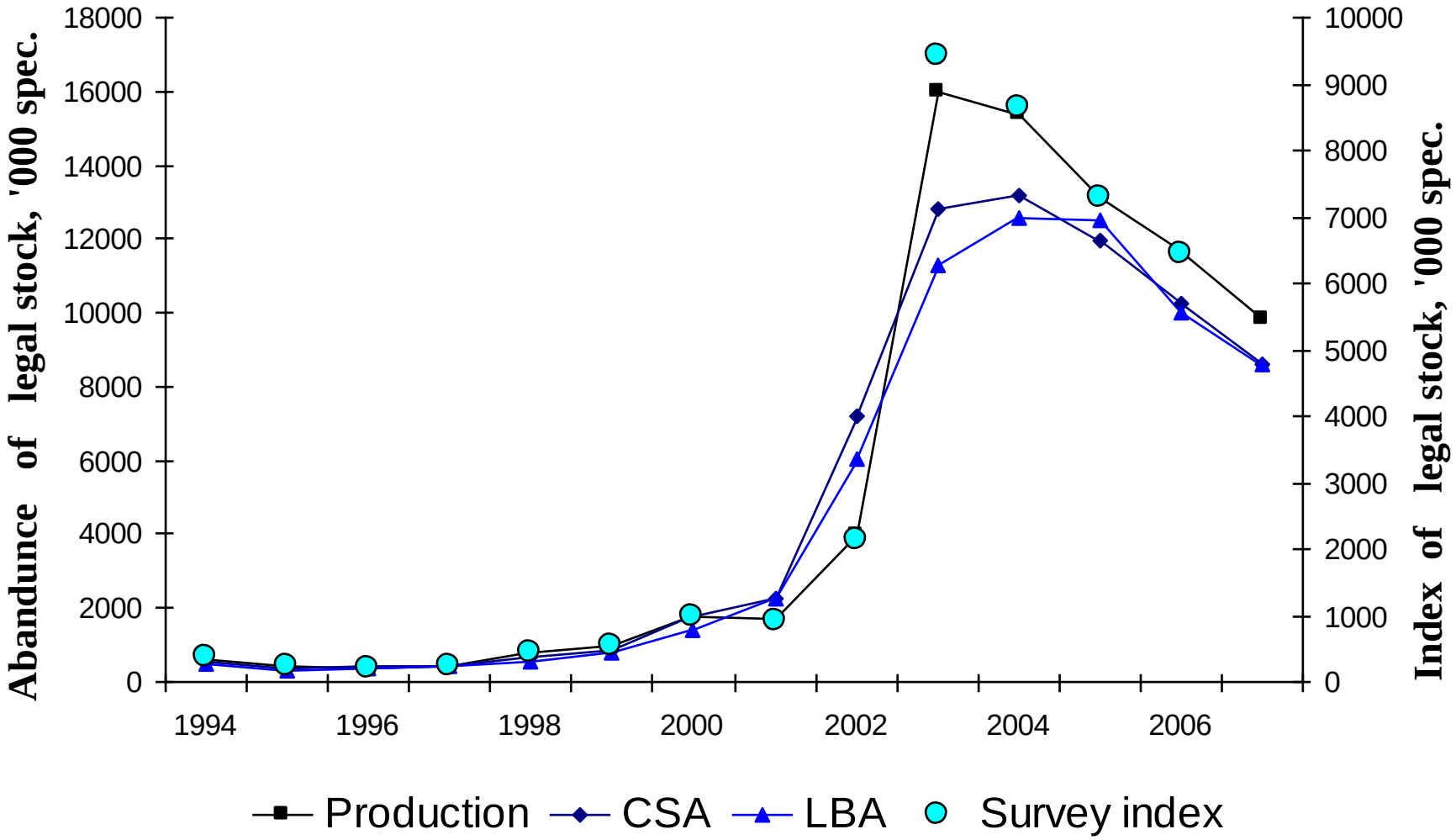


Results for shrimp



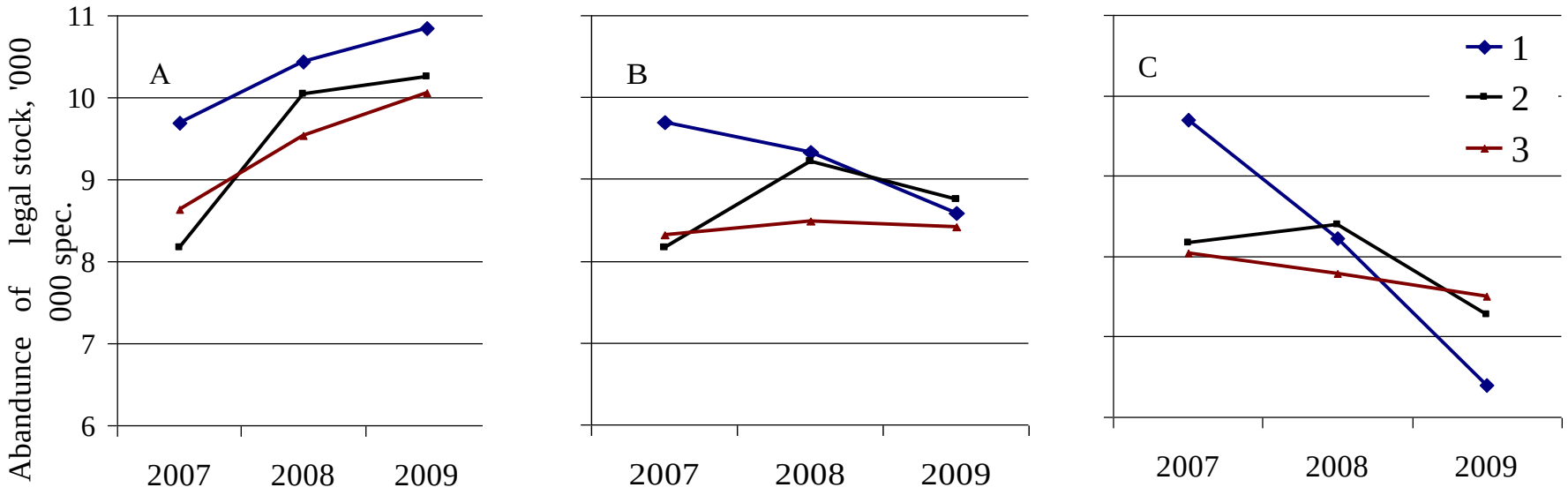
Results for red king crab

Fitted (lines) and observed survey index (circles) of legal stock using production, CSA, LBA models in REZ of the Barents Sea



Results for red king crab

Forcasted legal stock with annual catch of 2 million (A), 3 million (B) and 4 million (C) in 2007-2009 according to production (1), CSA (2) and LBA (3) models



Conclusions

The Bayesian approach can be used for estimating the population dynamics of northern shrimp and red king crab in the Barents Sea and Spitsbergen area.

The dynamics of the Barents Sea red king crab population parameters is extremely unstable. But the presence of strong year-classes make it possible to forecast the stock dynamics and develop appropriate management strategies.