Evaluation of maximum long-term yield for Northeast Arctic cod

Y. A. Kovalev (PINRO)

B. Bogstad (IMR)

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Aim of study

- To evaluate maximum long-term yield of Northeast Arctic (NEA) cod in a single-species context
- First sub-project in the joint Russian-Norwegian research program: “Optimal long-term harvest in the Barents Sea ecosystem”

Background

- Previous studies of long-term yield of NEA cod have been made using models with very simplistic population biology
- Time series of weight and maturity at age were revised in 2001, and more biological knowledge should be utilized in such studies
- JRNC harvest control rule (F=0.40 above B_{pa} max 10% annual change in TAC) found to be precautionary, but important also to search for rules giving maximum long-term yield

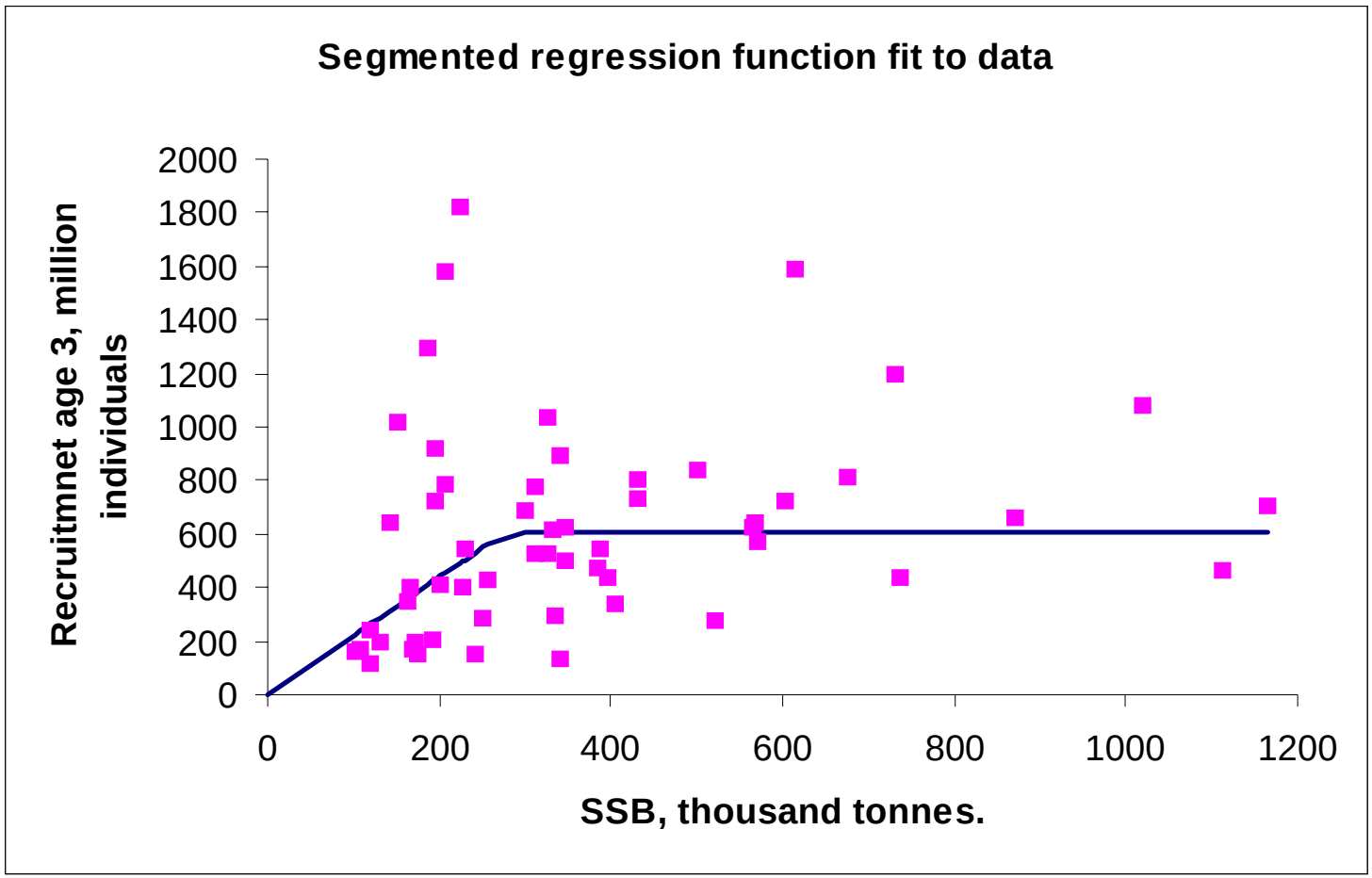
Method

- Stochastic long-term simulations are made using the computer program PROST
- Runs are made for a 100-year period, and the mean yield etc. for the last 80 years of the period is calculated
- Age groups 3-13+ used, as in current assessment
- Assessment error ignored

Population sub-models

- Recruitment
- Growth
- Maturation
- Natural mortality/cannibalism
- Fishing pattern

Stock-recruitment for NEA cod



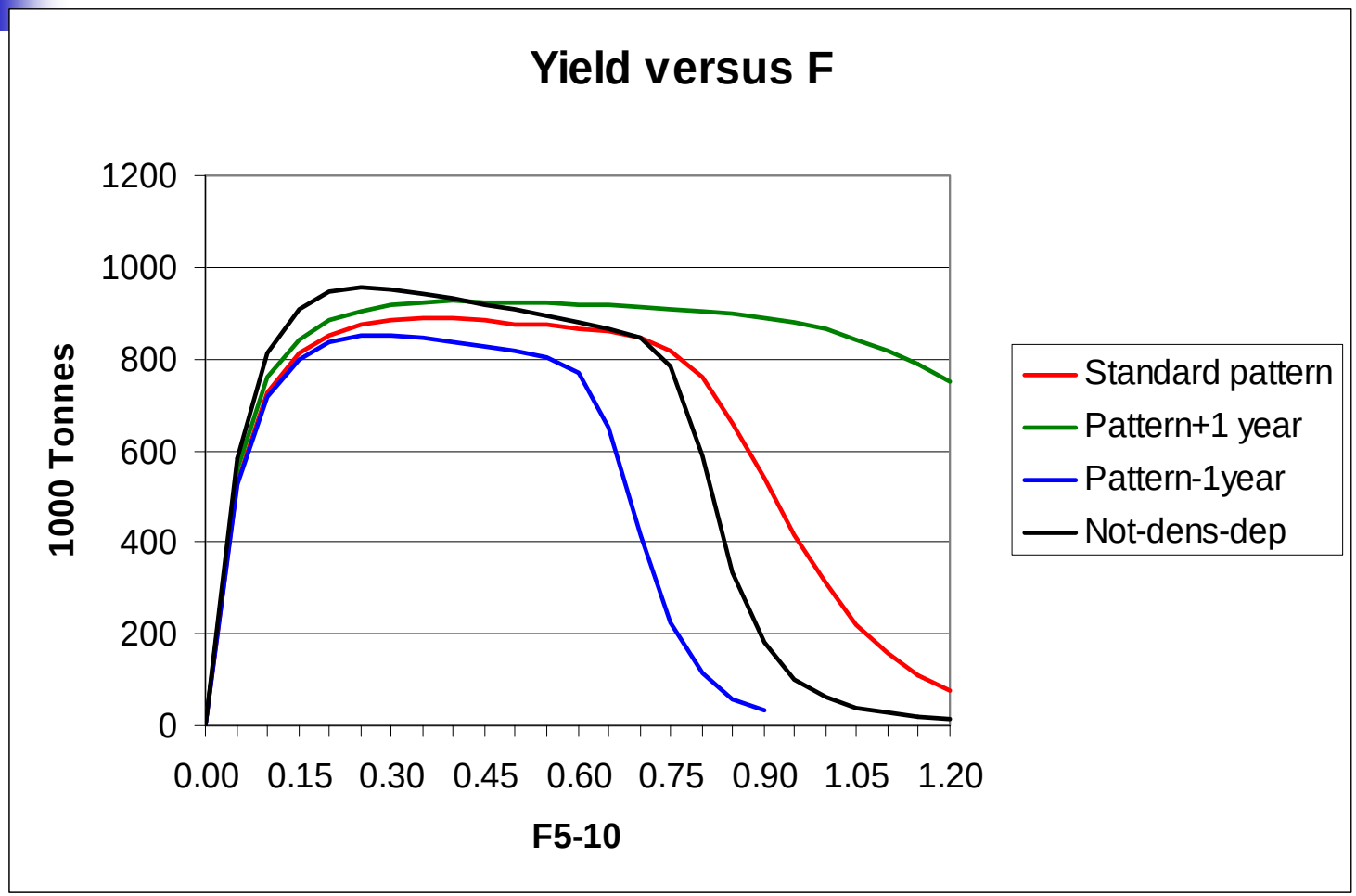
Population models

- Cyclic term and stochastic term added to segmented regression recruitment function
- Density-dependent weight at age in stock for age 6-9
- Weight at age in catch and maturity a function of weight at age in stock
- Cannibalism on age 3-4 a function of predator (large cod) abundance or of SSB 3 year previously

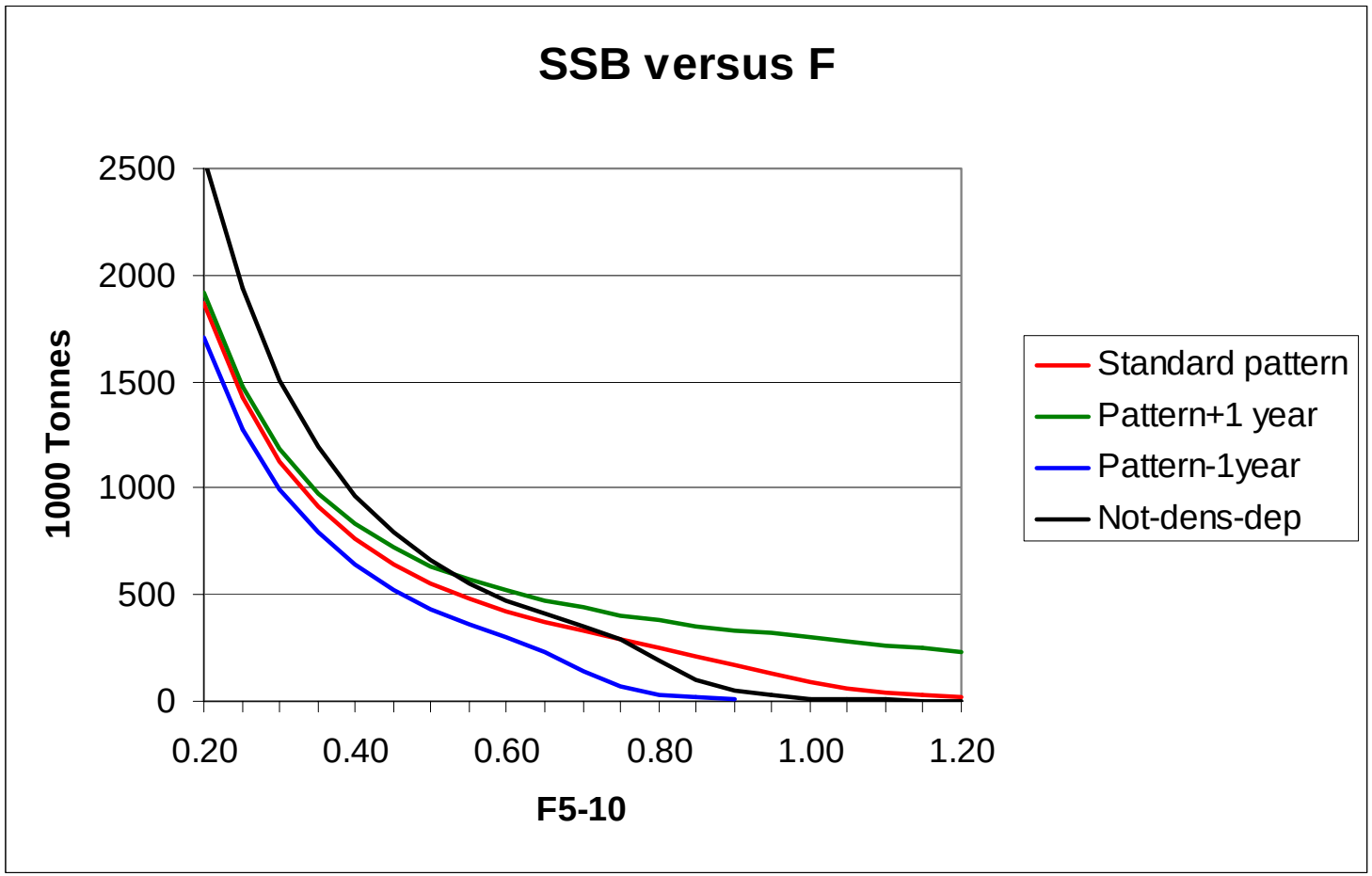
Harvest control rule/fishing pattern

- Will only show results of fixed F rules
- Fishing pattern as present or shifted one age group up or downwards

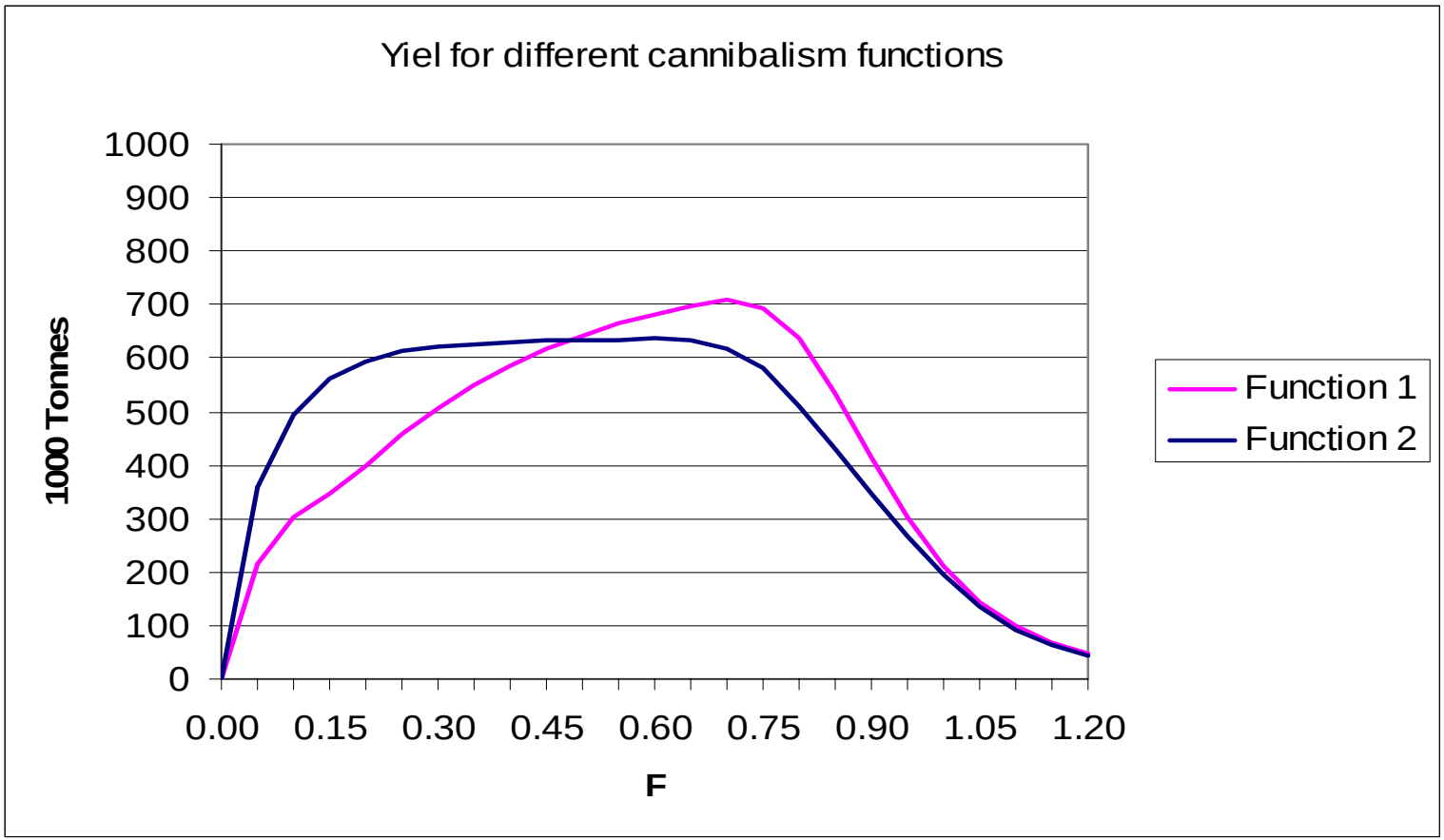
Yield – changing selection pattern and density-dependence



SSB- changing selection pattern and density-dependence



Yield for different cannibalism functions



Conclusions

- Method/framework for studying maximum LTY for NEA cod has been established
- Maximum LTY around 900 000 tonnes for F in range 0.2-0.4
- Including cannibalism *may* change this result
- LTY drops significantly above F=0.7
- Results for F below 0.2 extrapolations (higher stock sizes than historically observed) and thus not reliable

Choice of strategies

- The fishing mortality used in the current management strategy (F=0.40) seems to give long-term yield close to maximum
- Should stick to this strategy for some years, to get observations of how the stock behaves when exploited at F values around 0.40
- Further work: How to find compromise between precautionary rules, maximum yield and stability?

Further work

- Add more biological knowledge
- Improve time series of data (discards , cannibalism before 1984 etc.)
- Try different functional forms for biological processes
- Include assessment uncertainty
- Extend to multispecies models
- Effect of climate changes
- Genetic effects