FROM REPRODUCTION TO RECRUITMENT IN NORTH-EAST ARCTIC COD

by

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Introduction

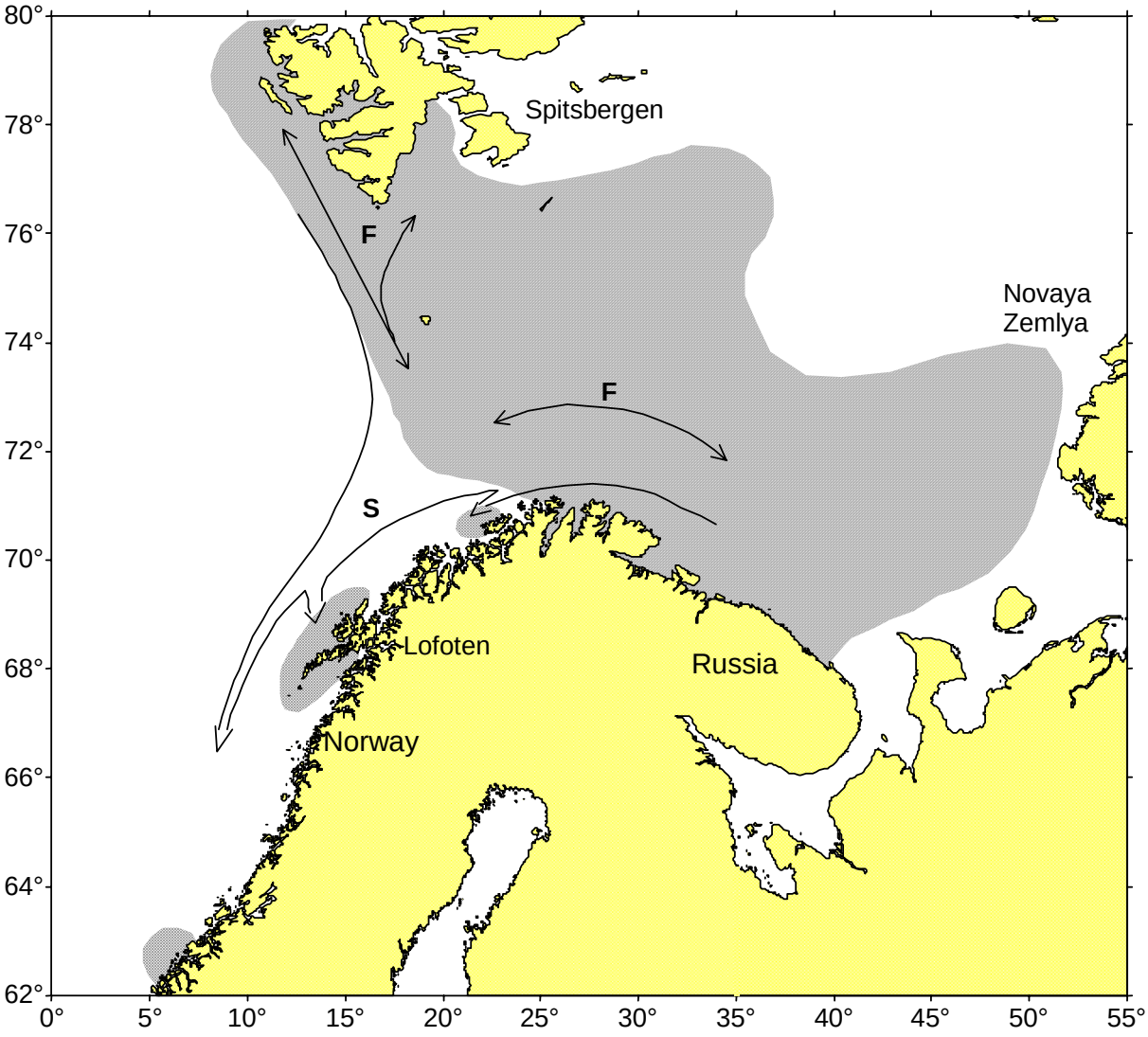
Most current fisheries management models do not include biological detail for processes occuring between spawning and recruitment. This means that temporal trends present in biological or environmental factors can and have been ignored.

The temporal and spatial trends in stock reproductive potential (SRP) have been largely ignored, however, variation in SRP can have a fundemental influence on recruitment. However, there are many processes occurring between spawning and recruitment that are not influenced by the parental stock.

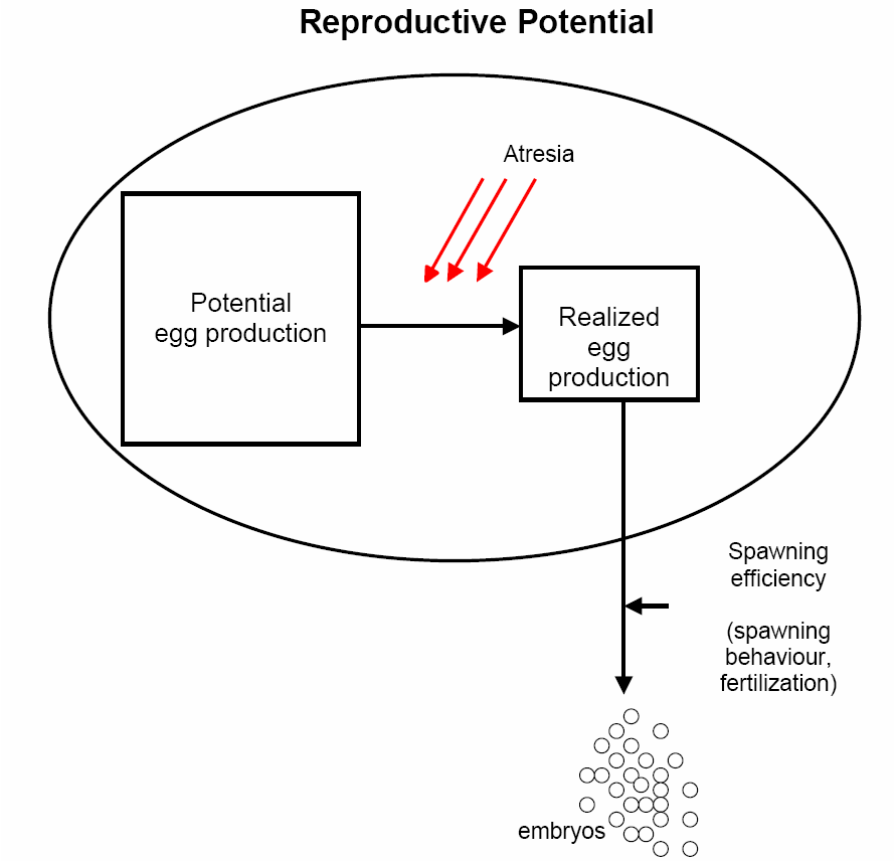
Materials and methods

North-east Arctic cod biomass/abundunce estimates, obtained by analytical methods (VPA, XSA) and trawl-acoustic surveys, were used (ICES CM 2003/ACFM:22). Portion of mature fish were taken from the Arctic Fisheries Working Group report, whereas sex composition from Norwegian database. Individual fecundity was calculated using C.T. Marshall and co-authors method (submitted). Potential fecundity was calculated for each year, taking into account length-age composition and mean length/weight.

Spawning and feeding grounds



Stock Reproductive Potential (SRP)



The transition from potential to realized egg abundance is a critical stage in the evolution of year-class strength of NA cod (connected with atresia, influenced by condition of spawners).

Furthermore, the signal in year-class strength undergoes substantial modification between the egg and larval stages. Thus, the signal in year-class strength of NA cod is determined in the earliest life history stages (Sundby et al., 1989; Mukhina, Marshall & Yaragina, 2003) before young fish settlement.

Stock Reproductive Potential (SRP)

Spawning Stock Biomass (SSB)

· number of mature fish at age
· mean weight of mature fish at age

Stock Reproductive Potential (SRP)

Female
· proportion mature at age
· non-annual maturation of adults
· egg production (fecundity at length, age)
· viable eggs (fertilization, hatching success)
· sex ratio
· body size at age
· other factors
  – spawning duration
  – egg size, larval size
  – egg nutrient and lipid content
  – time to starvation
  – larval activity
  – first feeding success
  – compensatory growth

Maternal reproductive experience
– Condition factor
– Length

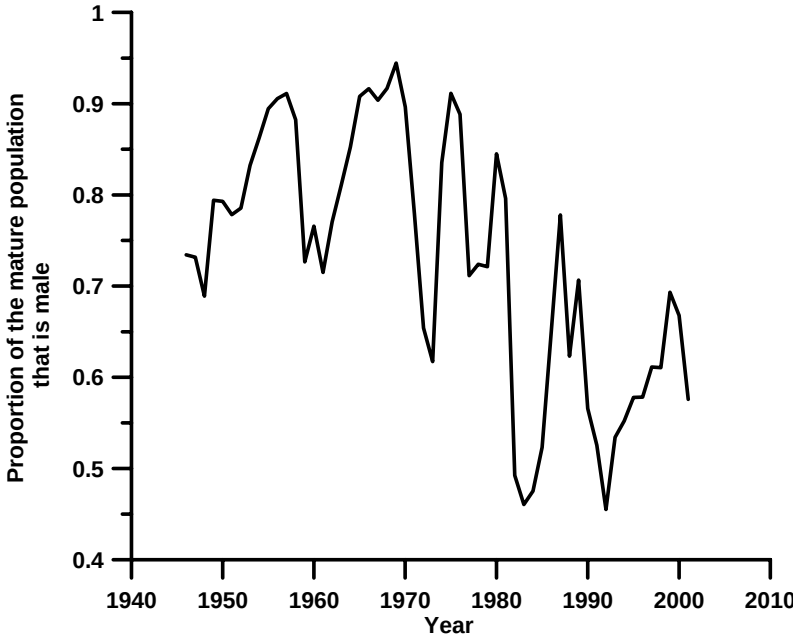
Male
· proportion mature at age
· non-annual maturation of adults
· testes weight
· sperm motility
· effect of male on larval fitness and early life survival
· sperm density
· fertilization rates, pairedmatings, in vivo sperm competition

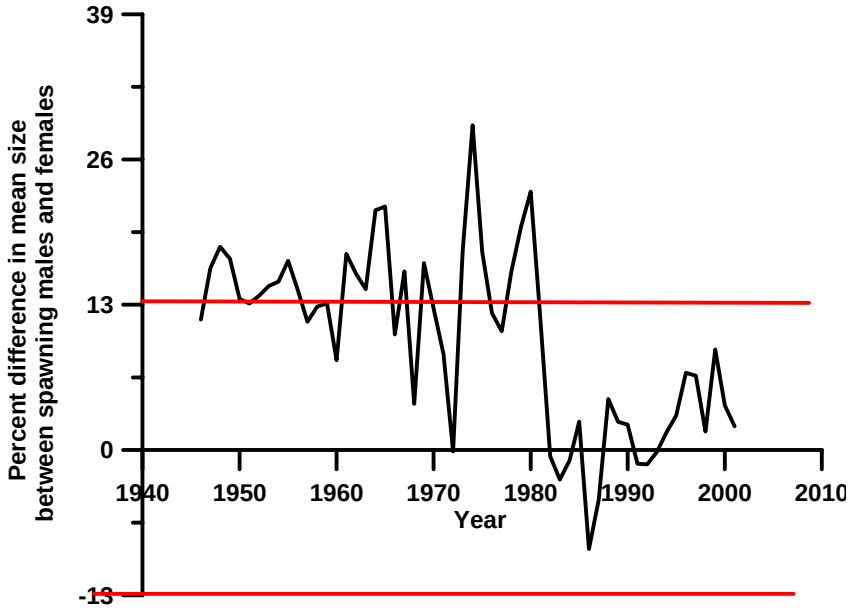
Paternal reproductive experience
– Condition factor
– Length

Other factors
Stock-specific values
Water temperature interaction/effects
Maternal-paternal interactions

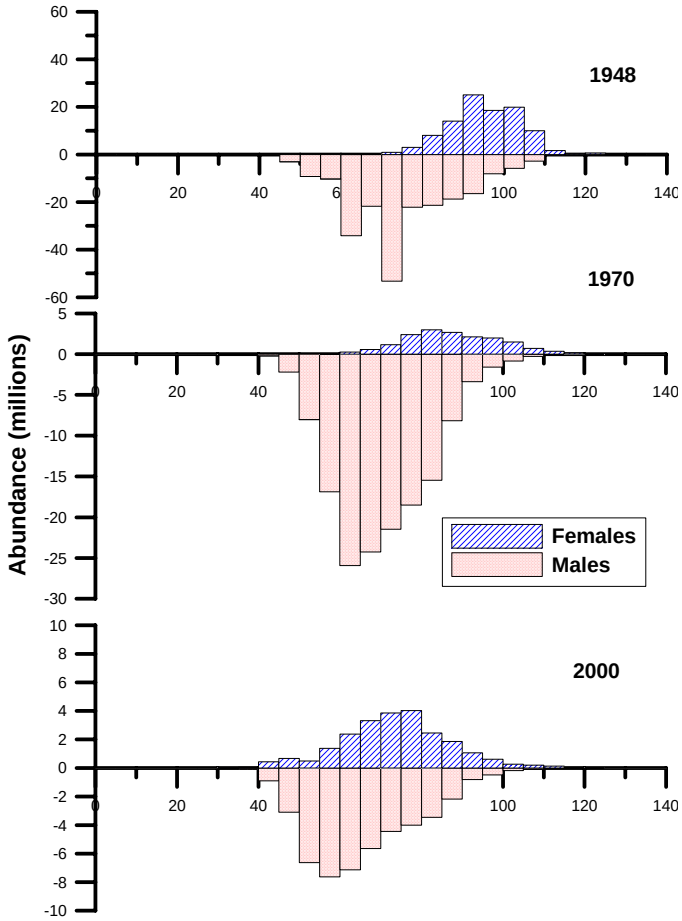
From: Trippel 1999

Males



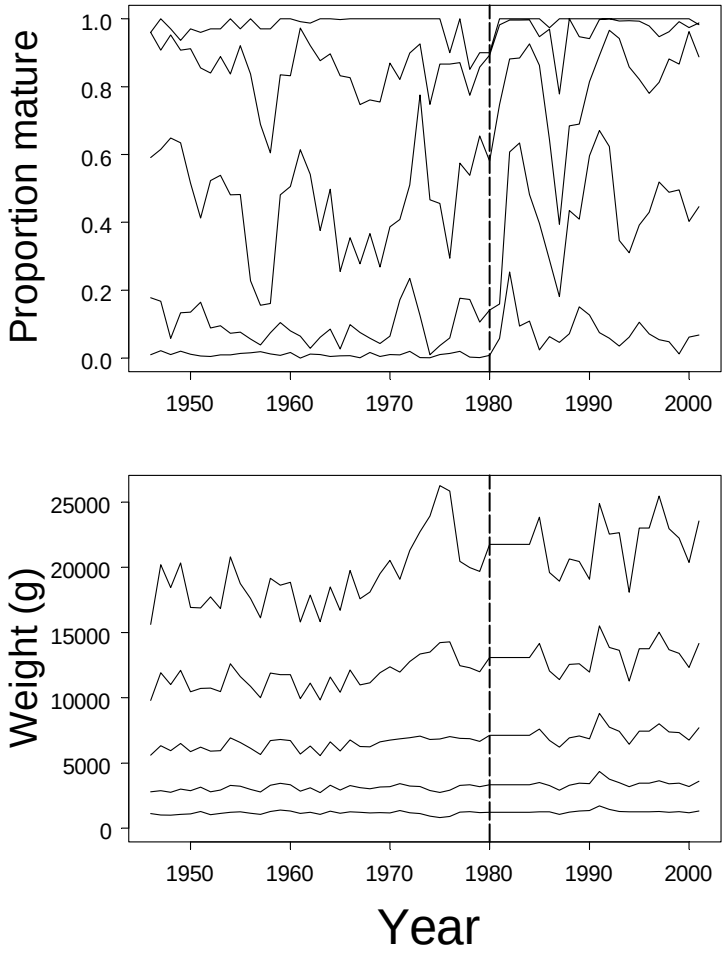


Should be worry about the male part of the population?
Figures to the left show fairly substantial changes in the sex ratio of the mature part of the population and illustrate fairly major changes in the relationship between mean size of mature males and females. Could this have an influence on reproductive success? Do we know enough about fertilisation success and maternal and paternal effects on survivorship in early life history stages?

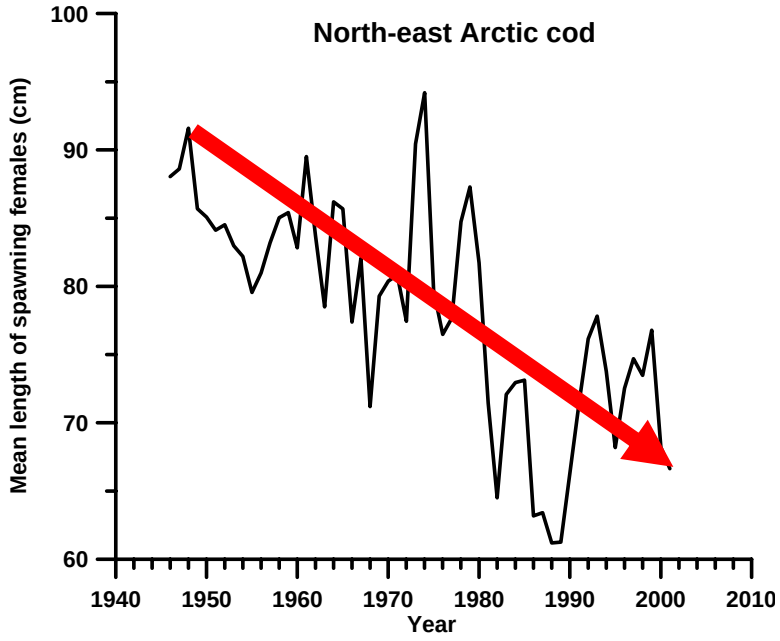


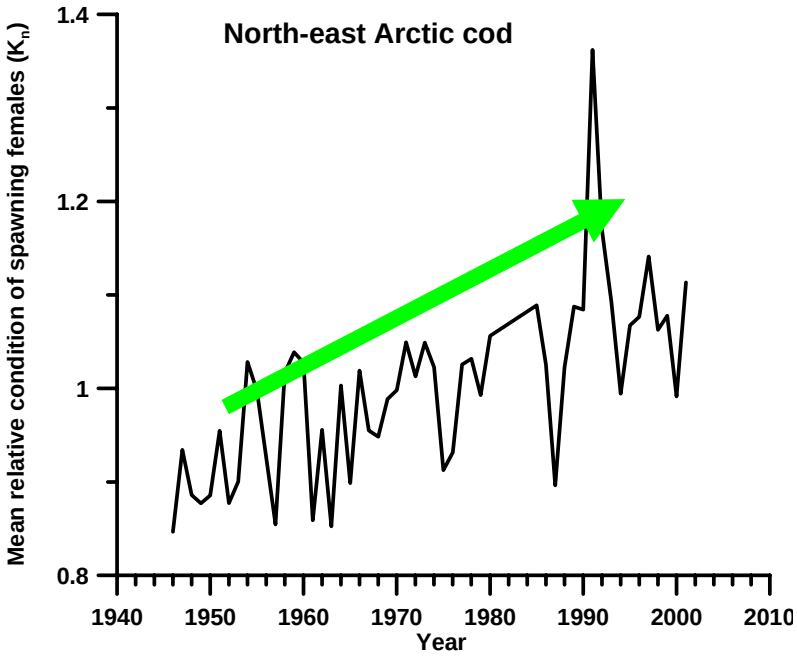
The figure above illustrates the changes in length frequency that have occurred in this stock. At present mature males and females are more similar in length

Females

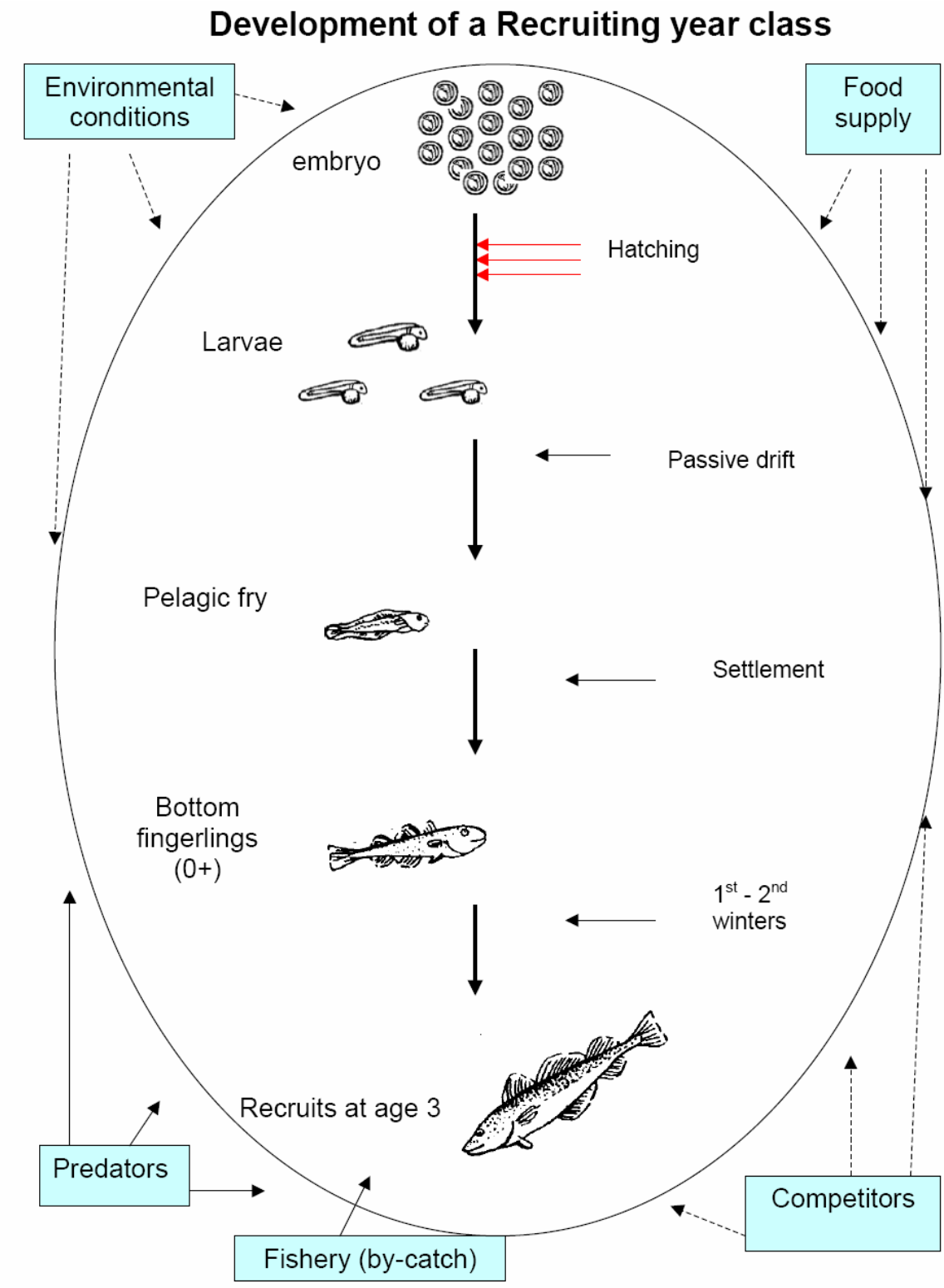


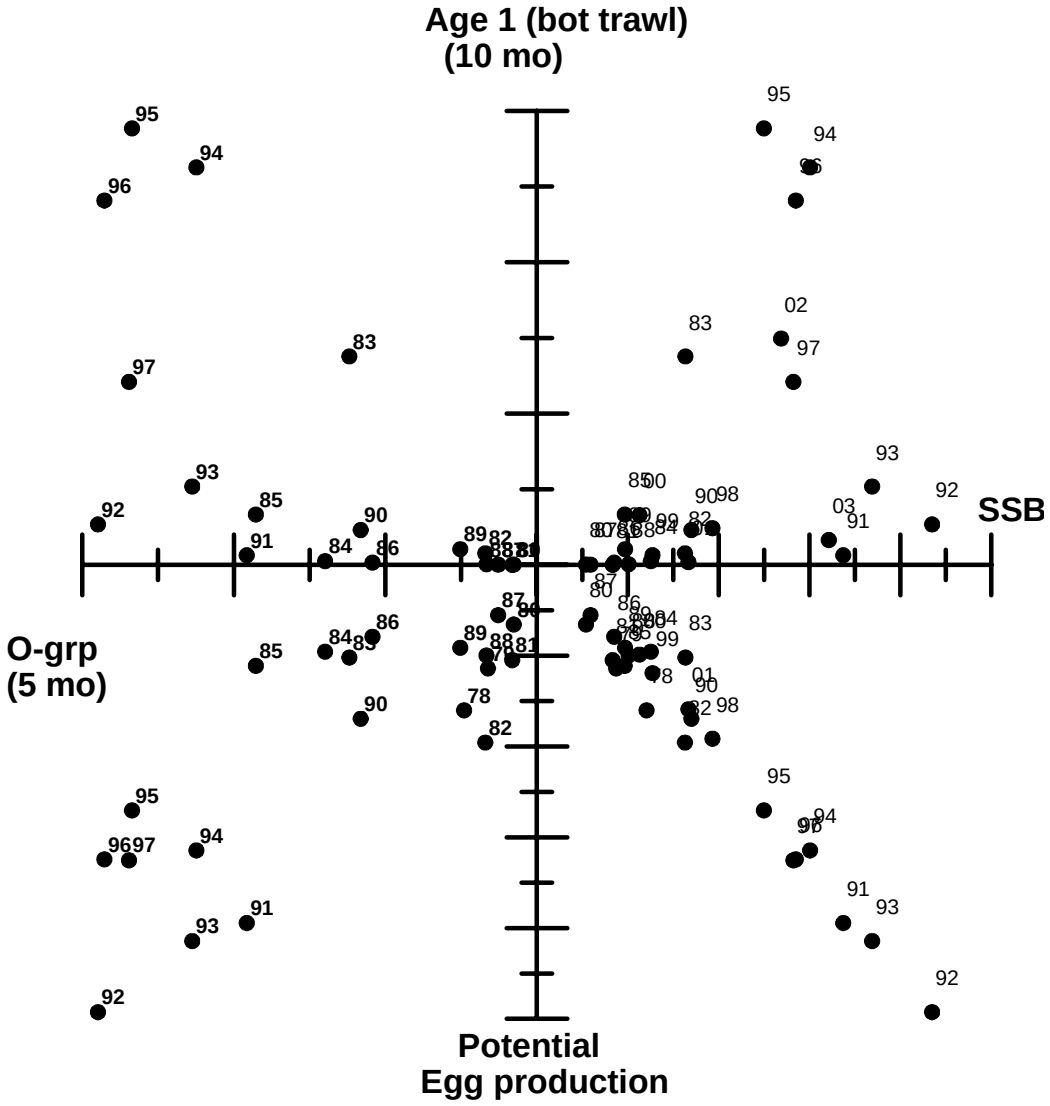
Interannual variation in maturity ogive and mean weights at length: verical line separates pre and post 1980.





In general there has been a decline in mean length of mature females over time, however there has been a corresponding increase in mean condition . The consequence is an apparent 'compensatory' response in the egg production per unit SSB (see bottom right panel below).


Development of a Recruiting year class
Environmental conditions
Food supply
embryo
Hatching
Larvae
Passive drift
Pelagic fry
Settlement
Bottom fingerlings (0+)
1st - 2nd winters
Recruits at age 3
Predators
Competitors
Fishery (by-catch)

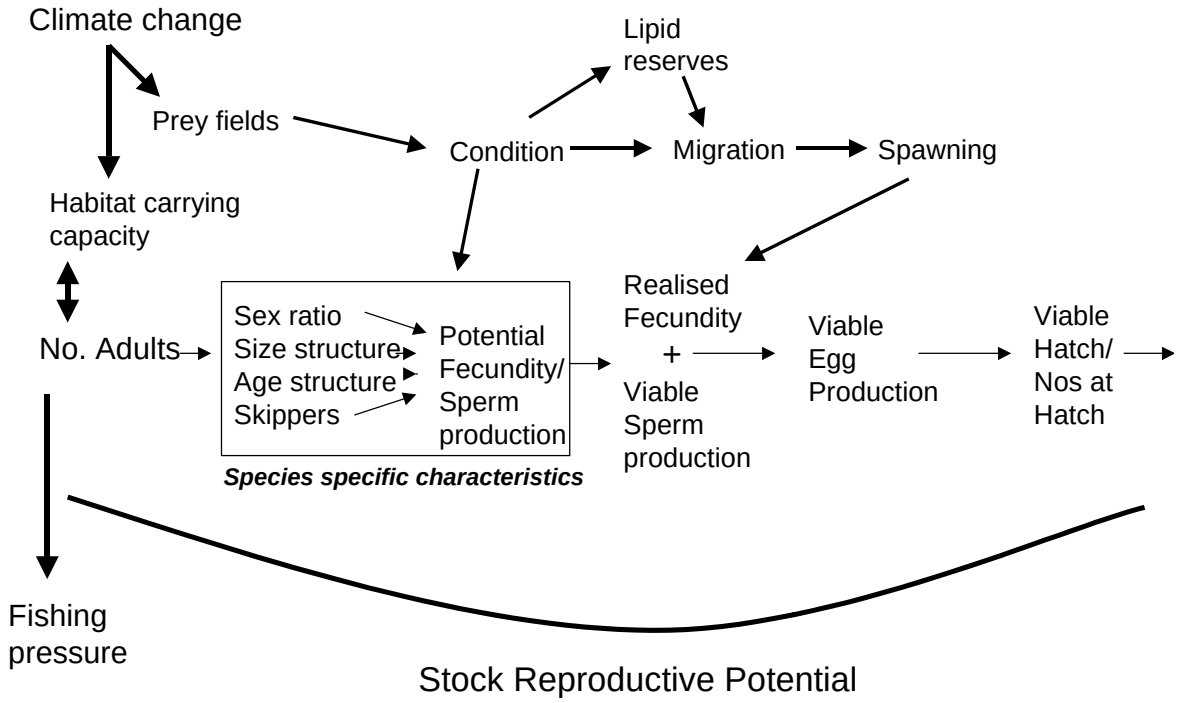


Life-history model or Paulik diagram for North-east Arctic cod. The SSB data are from the VPA, egg production data calculated from relationships determined by Marshall et al. (submitted) and O and 1 group abundances from surveys.

Some variability is generated in the transition from adult population to eggs, however, very large variability is generated through subsequent life-history stages which ultimately results in the classical stock and recruitment relationship by three years old.

These diagrams/models rely on being able to estimate the abundance of individuals at the transition boundaries e.g. metamorphosis, settlement, I year old etc.

The challenge for stock to recruitment studies



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