

## **Age based stock assessment methods**

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# My background

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- 1992: PhD in Biological Oceanography
  - Some mathematical and statistical courses, limited understanding of stock assessment
- 1994-present: Teacher at the University of Akureyri, Iceland
  - Principal task: Teaching the fundamentals of stock assessment
- 1996-present: Marine Research Institute, Reykjavik
  - Stock assessment, advice, PR
- 1998-2007: ICES ACFM member
  - Reviewer of central European stock assessment work (Nothern Shelf, North Sea)
- 2004-2006: ICES stock assessment courses
  - Age based, 3x1 week courses (in association with Dankert Skagen)
- 2006-present
  - UN – Fisheries Training Program (in association with Jeppe Kolding)
    - 2 x 2 weeks assessment course in data poor, species rich situation (South Pacific).
    - Assessment course for the Caribbean pending

## Tentative plan for the next 5 days: Part 1

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- Day 1: Thursday

- Lectures:

- Age based measurements: patterns observed
    - The basic equations
    - Signal in the measurements

- Laboratory

- Signals in the measurements

- Day 2: Friday

- Lecture

- The building blocks of an assessment model

- Laboratory

- Building an assessment model from scratch

- Lecture (if time permits)

- Introduction to a population simulator

## Tentative plan for the next 5 days: Part 2

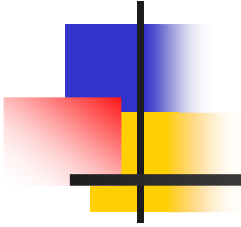
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- Day 3: Monday
  - Lecture
    - Diagnostics and estimates of uncertainty
  - Laboratory
    - Model misspecifications
- Day 4: Tuesday
  - Lecture
    - Some variation in model fitting and the VPA
    - Predictions, short and long term, HCR
  - Laboratory
    - Some further exploration on age based models
- Day 5: Wednesday
  - Yet to be finalized, depends on needs and wishes

## My approach

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- I hear - I forget
- I see - I remember
- I do - I understand



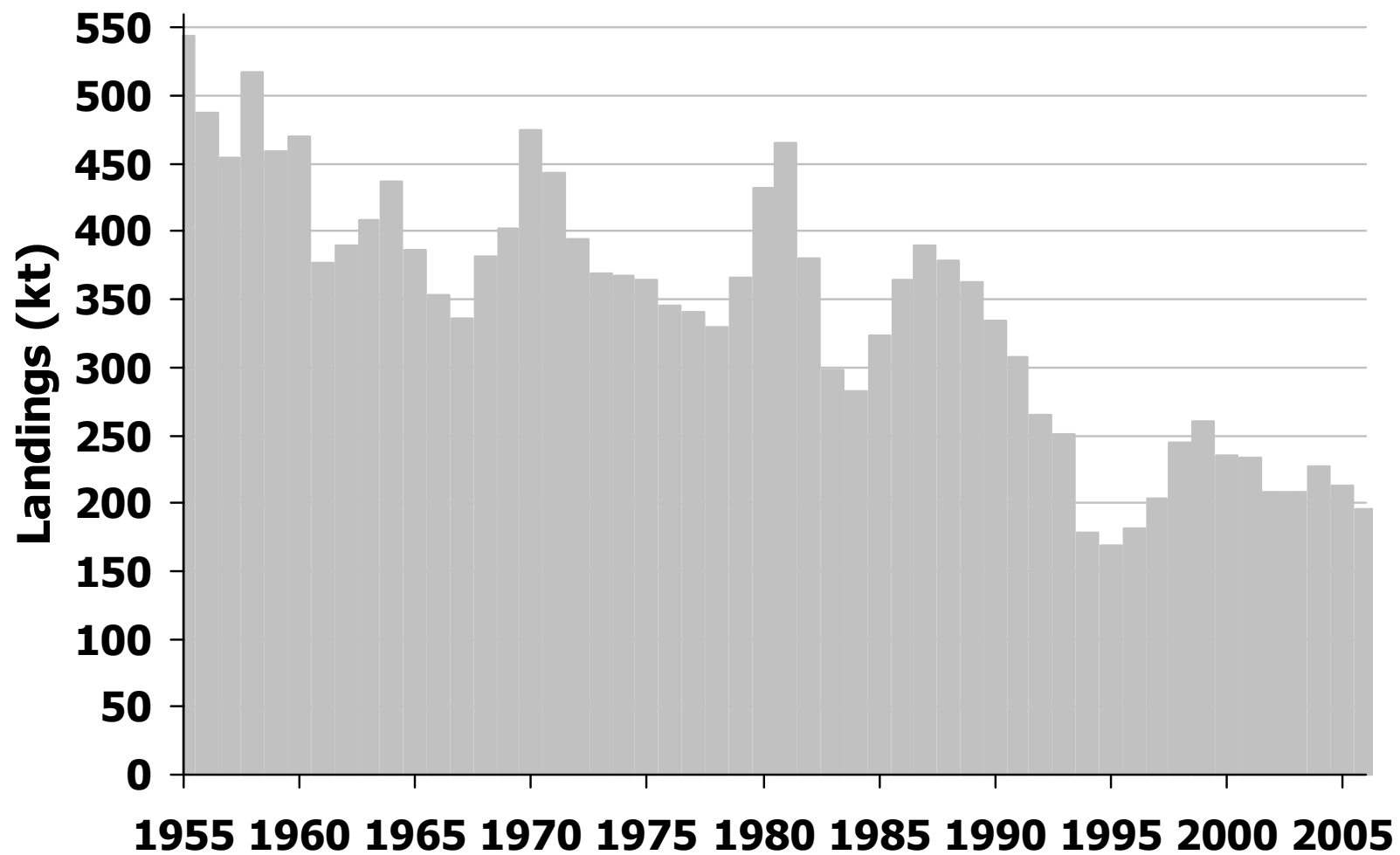
# **The patterns in the age based measurements**

**Subtitle: Why do fisheries biologist always think in year classes?**

## Measurements: The basis for any stock assessment

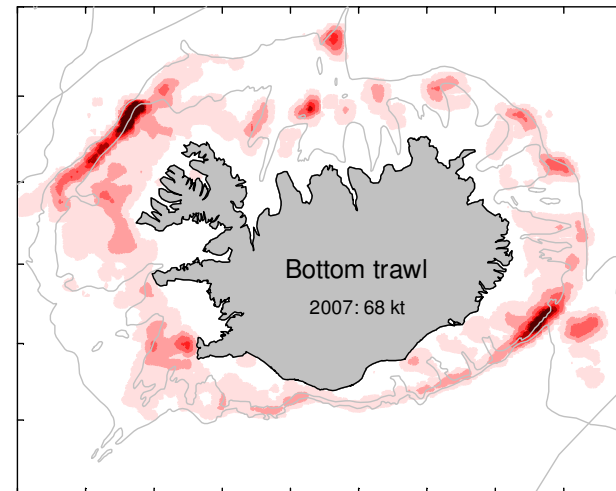
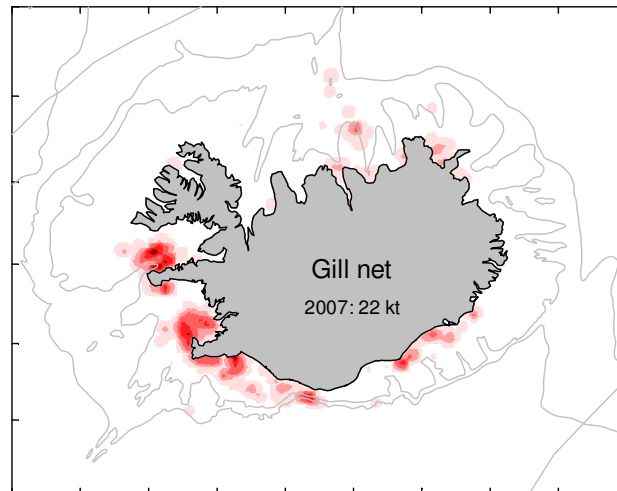
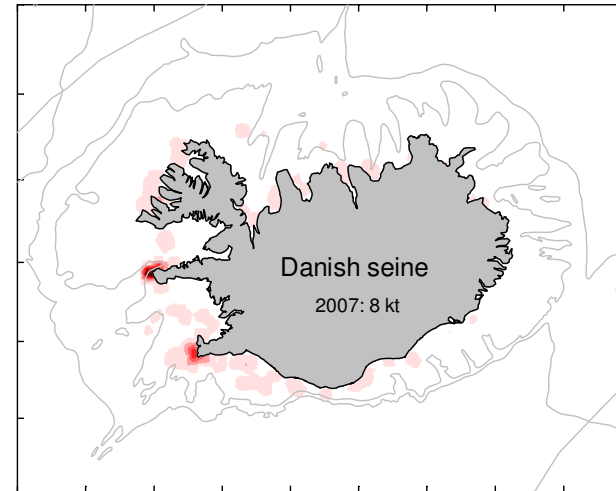
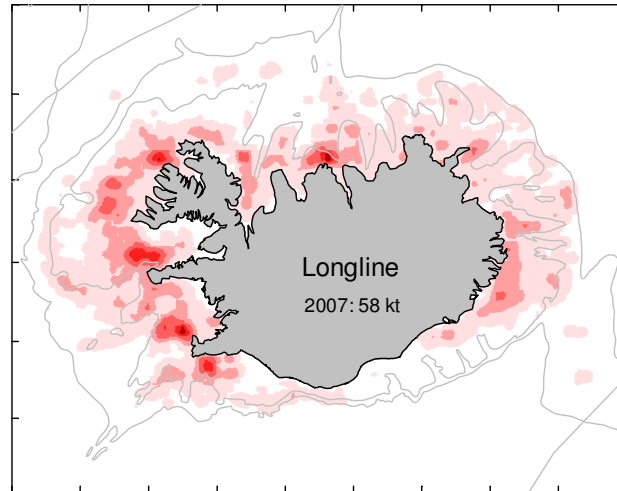
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- Measurements of commercial catch composition
  - Total catch
    - Landings
    - Discards
  - Catch composition
    - Size (length)
    - Age
  - Catch curve of a year class
- Independent measurements (surveys)
  - Total indices
  - Survey size composition
    - Length based indices
    - Age based indices
  - Survey “catch” curve of a year class
- Correlation among commercial data and scientific surveys

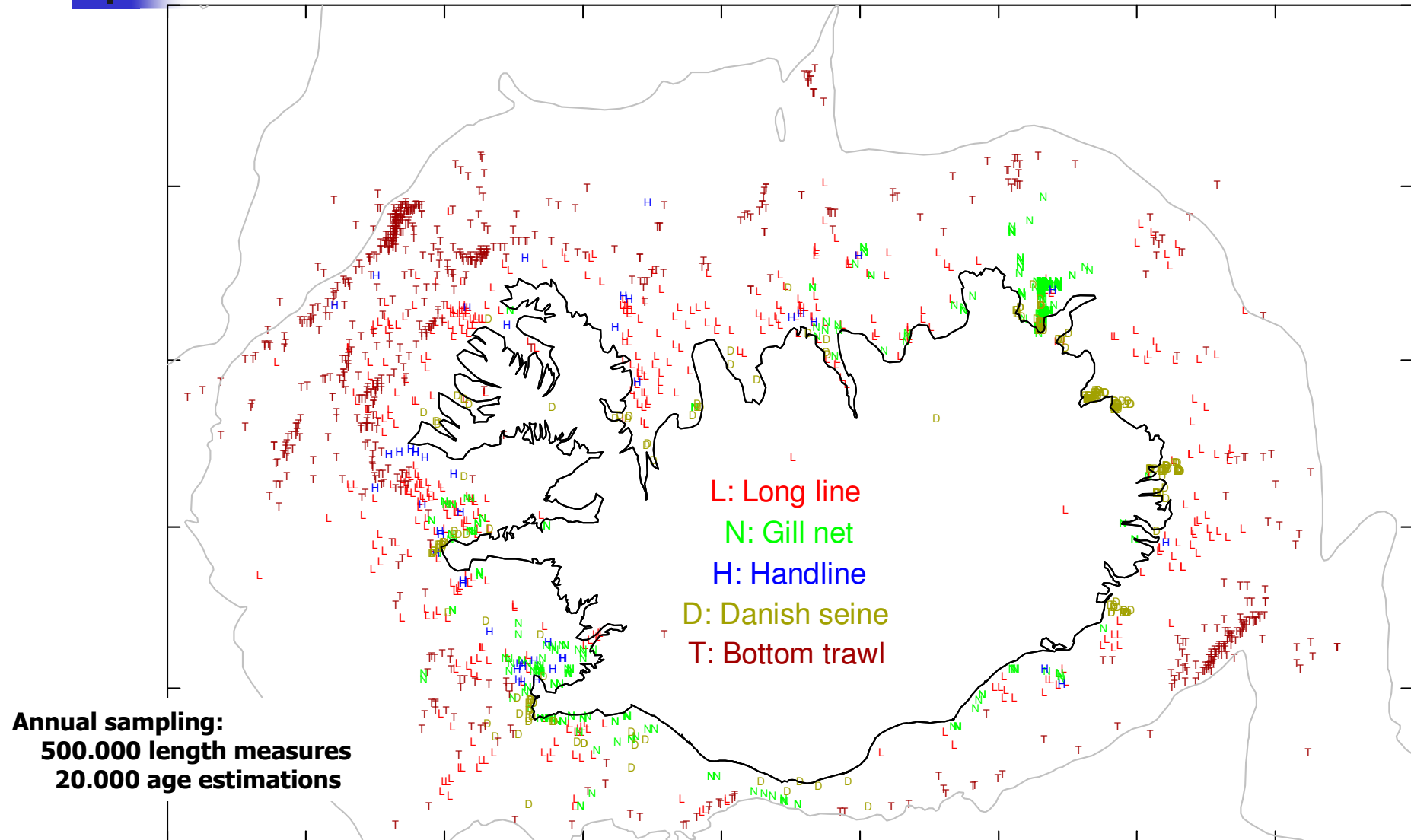




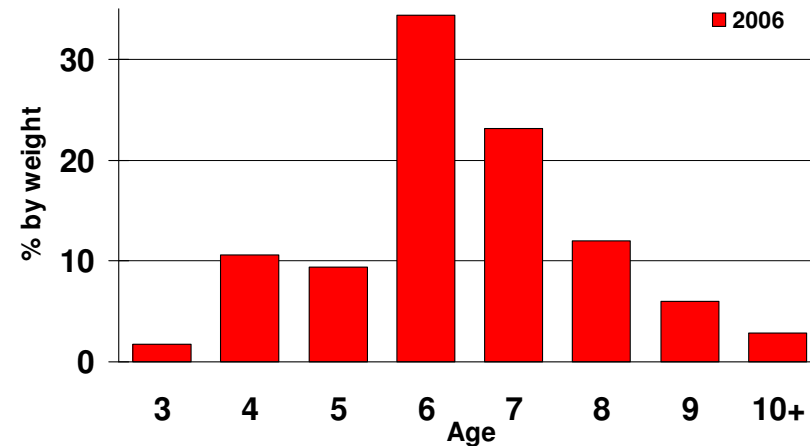
## Catches are taken by different gear and in different location



## Sampling of catches need to reflect the actual fisheries



**Catch composition in 2006:**  
**Annual landings is known.**  
**By sampling the catch**  
**composition (length and age)**  
**one can split the annual**  
**landings into landings by age**  
**groups.**

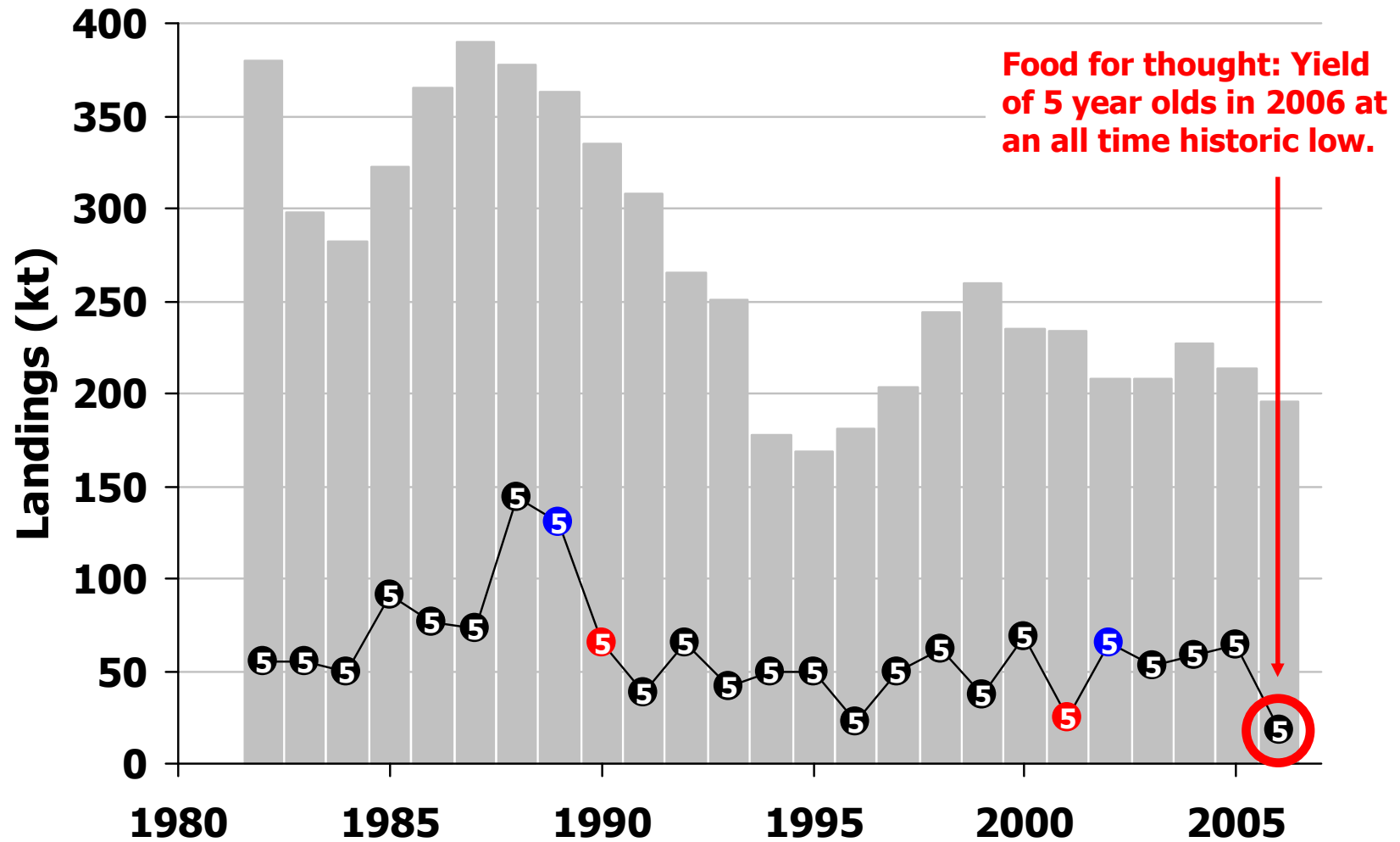


[illegible]

## Total yield and the yield of 5 year olds

5 year old fish: 65-75 cm long

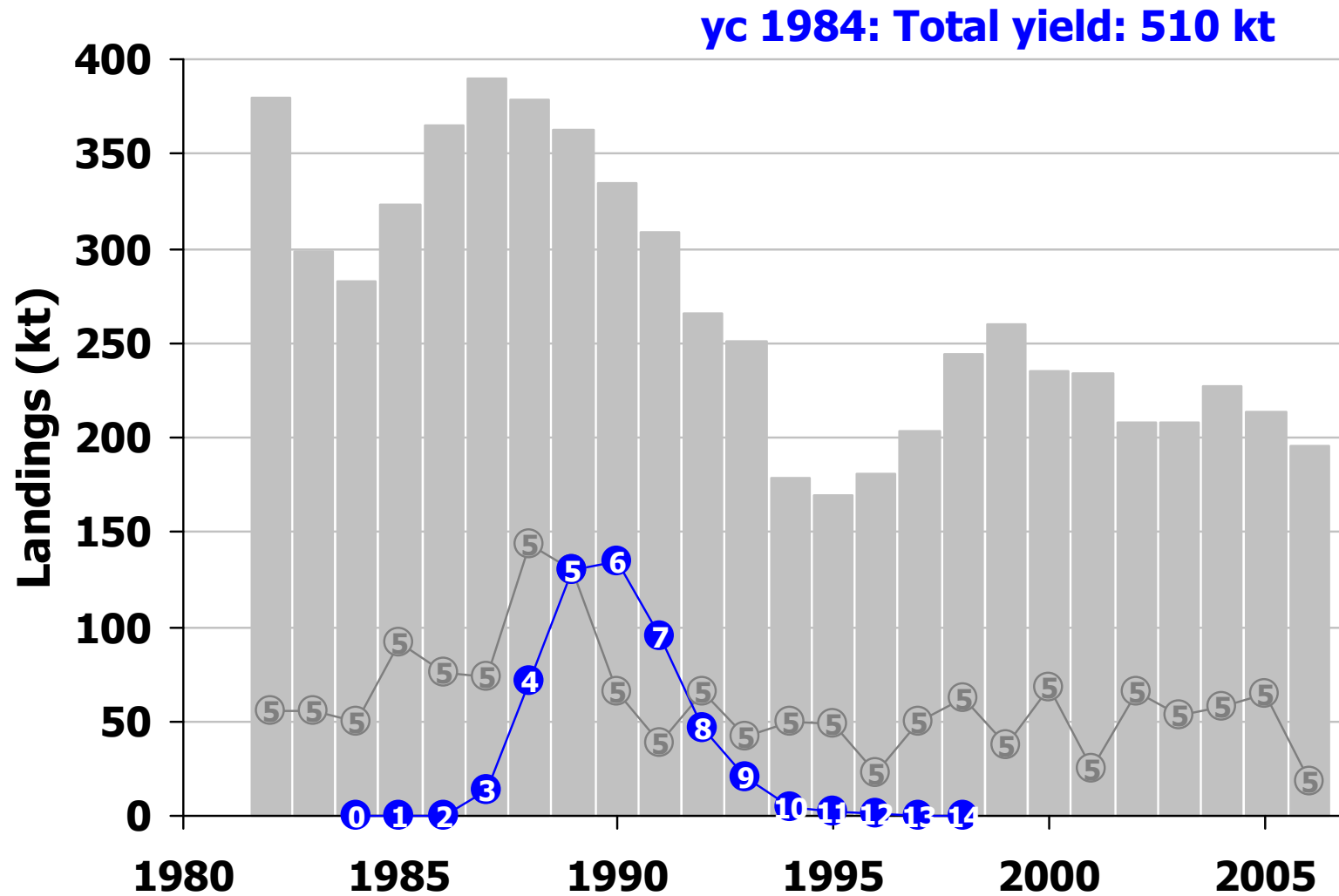
Interannual changes in catch of 5 year olds much greater than changes in total landings



Here the catch of the **1984** cohort is highlighted.

[illegible]

## The yield of the 1984 year class

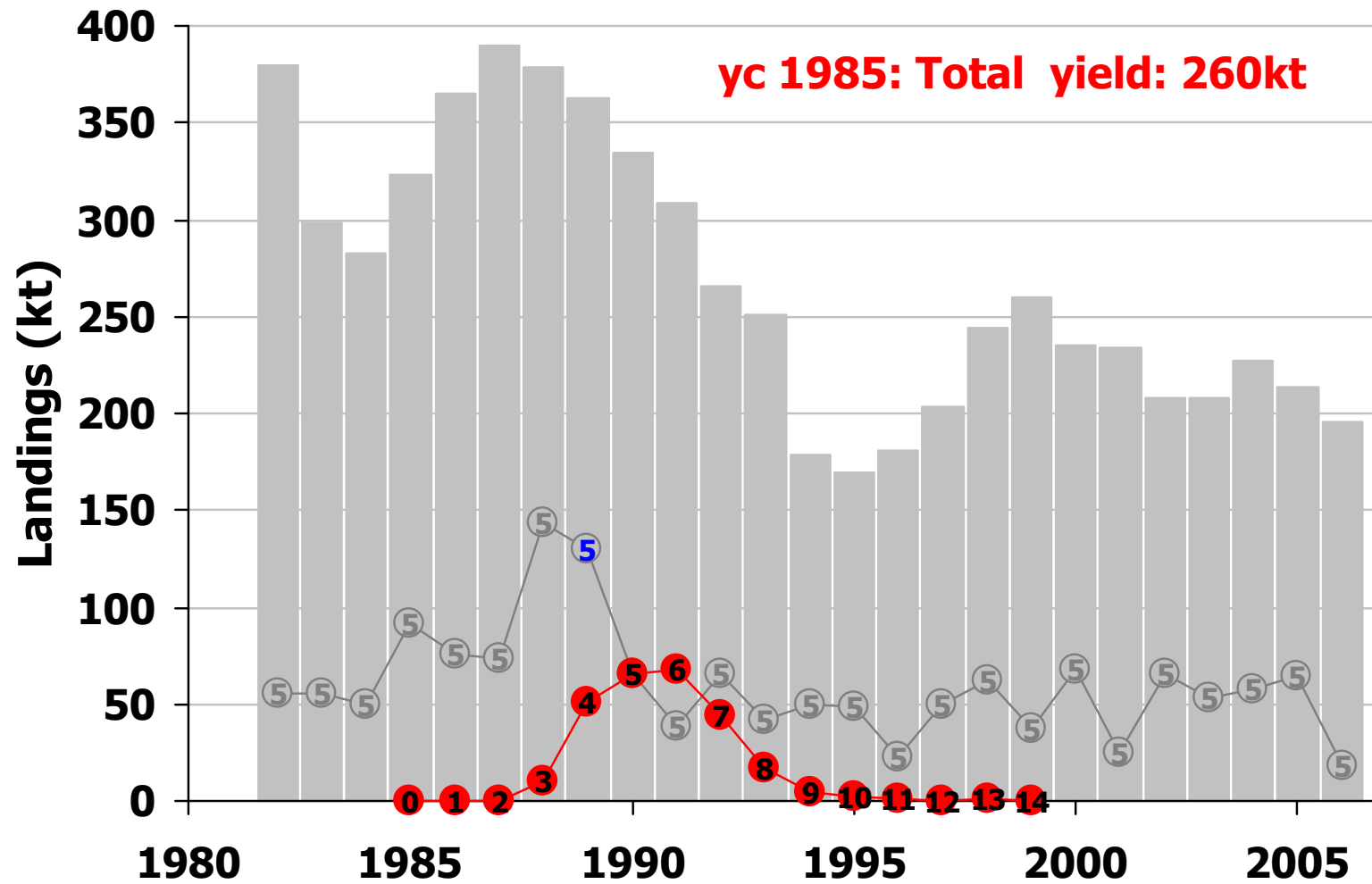


**Note that for any particular age group the yield of the 1984 is always higher than in the adjacent 1985 cohort**

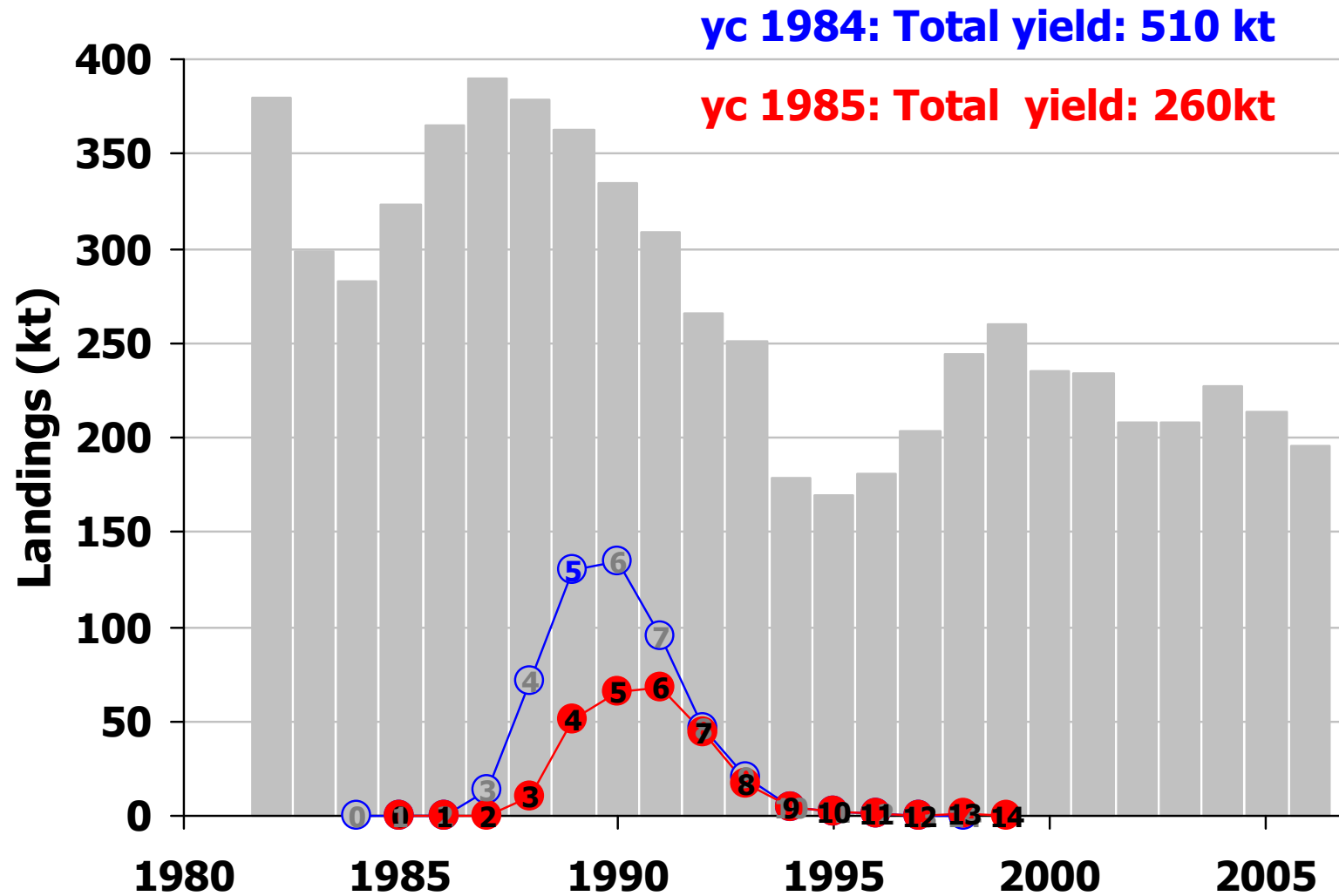
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## The yield of the 1985 year class

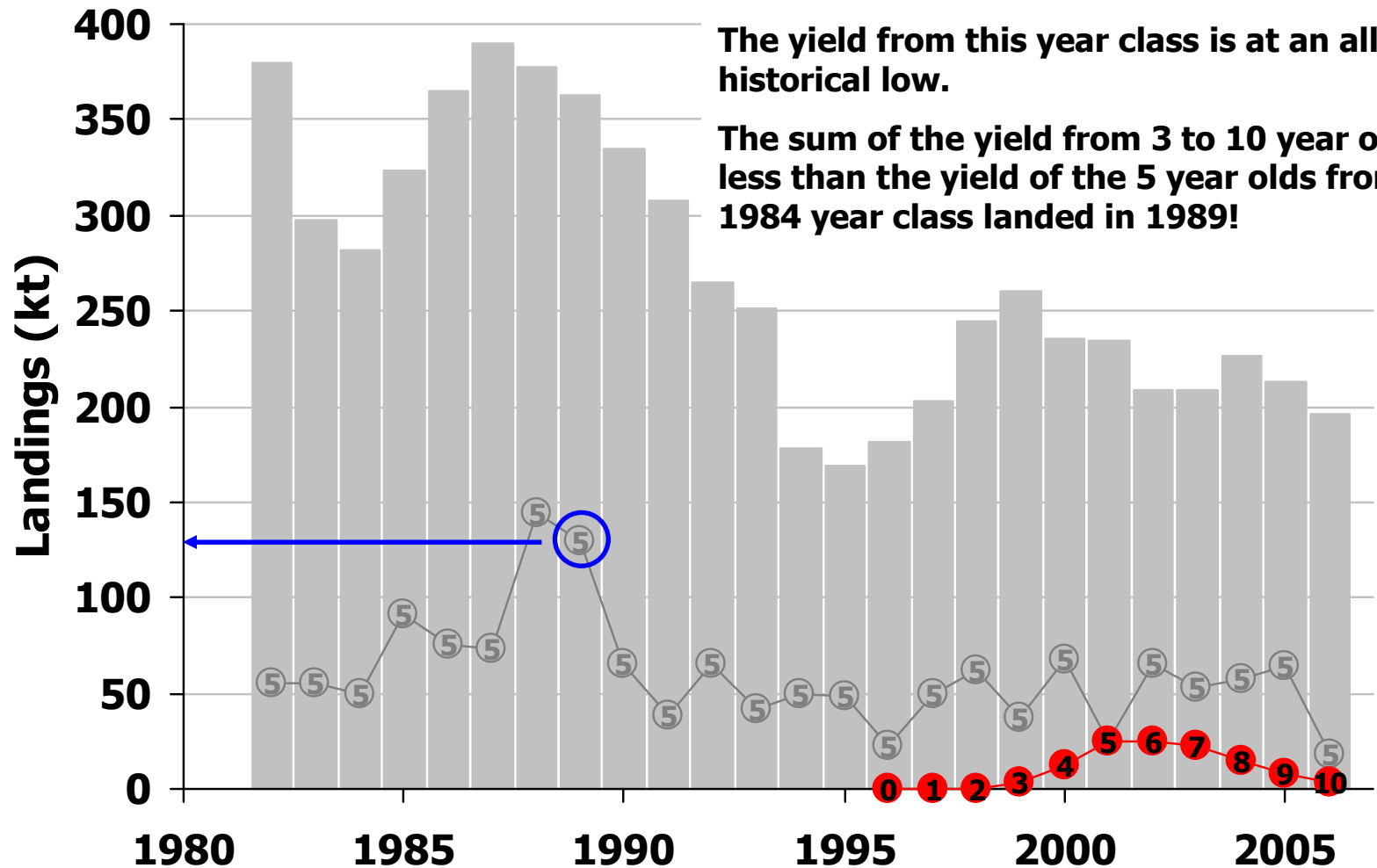


## Yield of 1984 and 1985 year classes



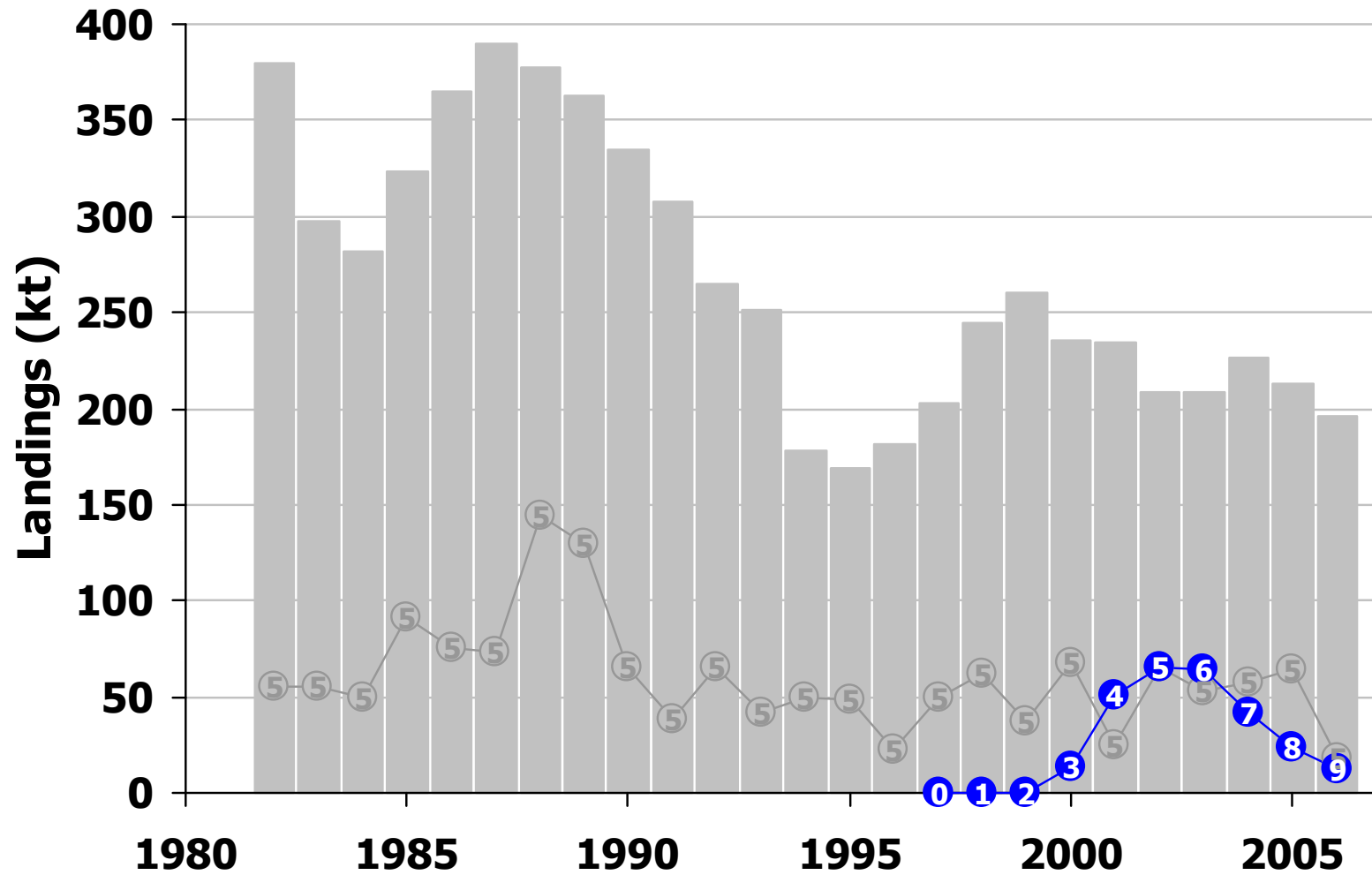
## The yield of the 1996 year class

**Total yield: 115 kt**



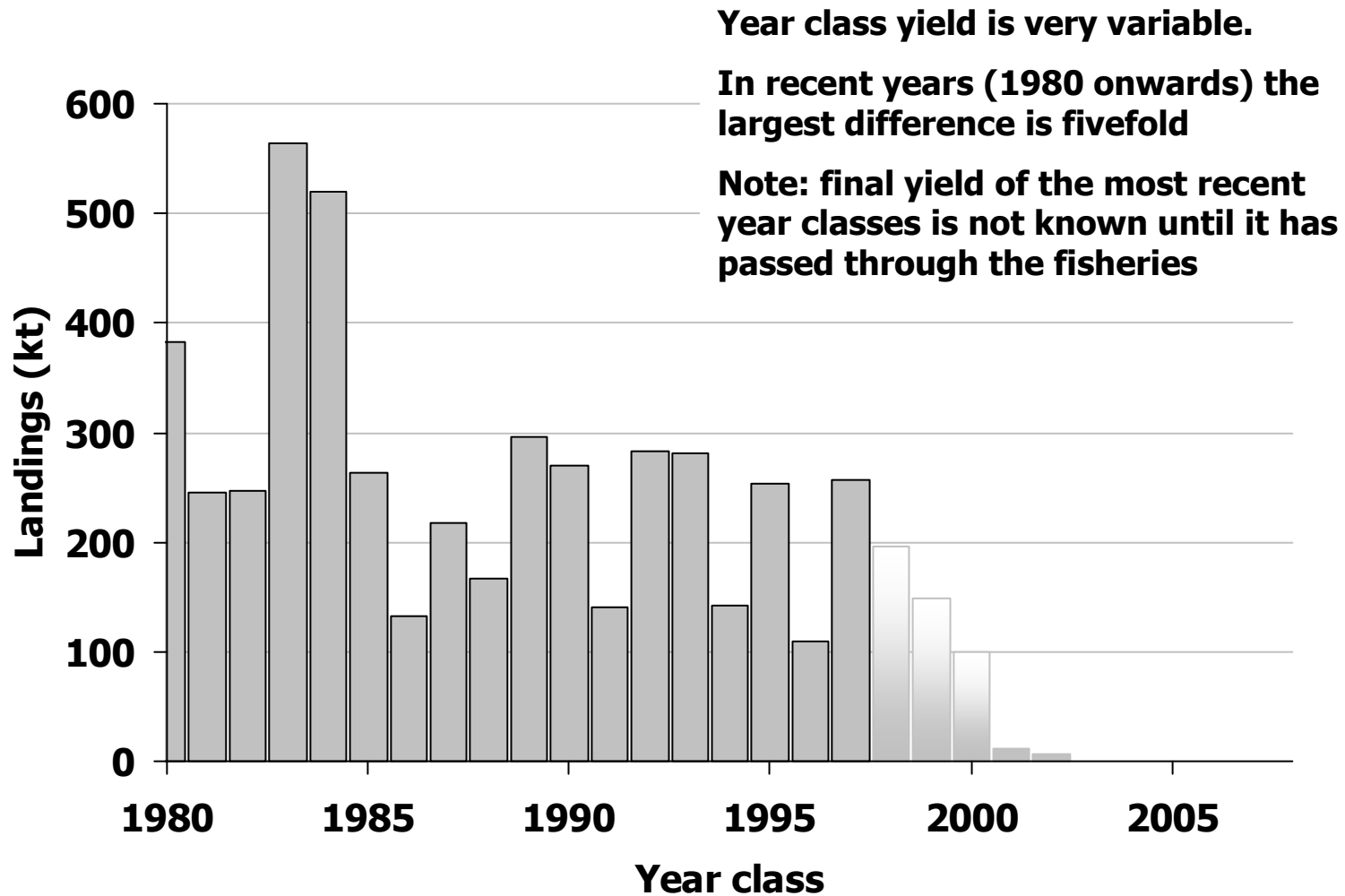
# The yield of the 1997 year class

**Total yield: 280 kt**



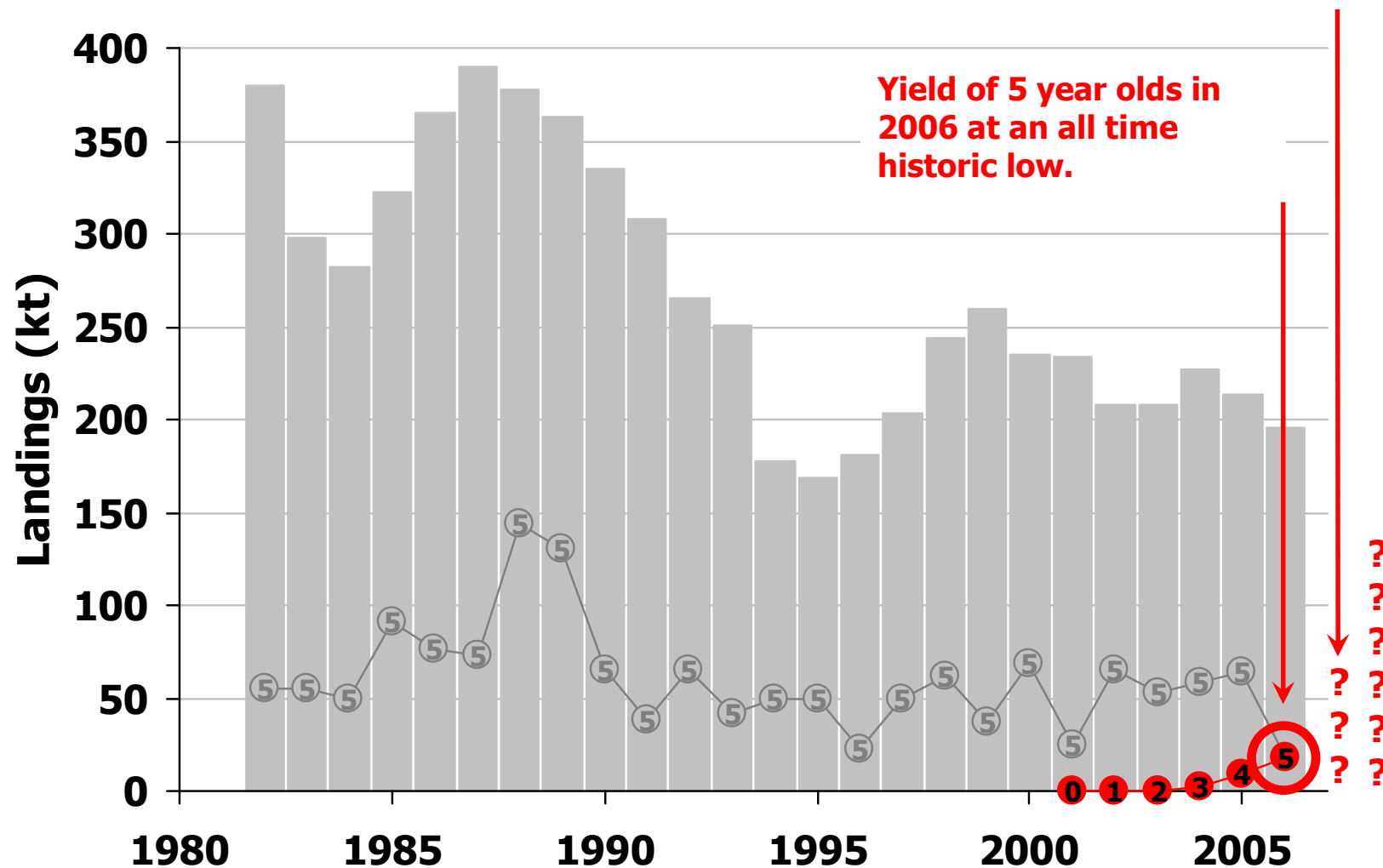
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## Yield by yearclasses



# The yield of the 2001 yearclass

What is the future yield from this year class?



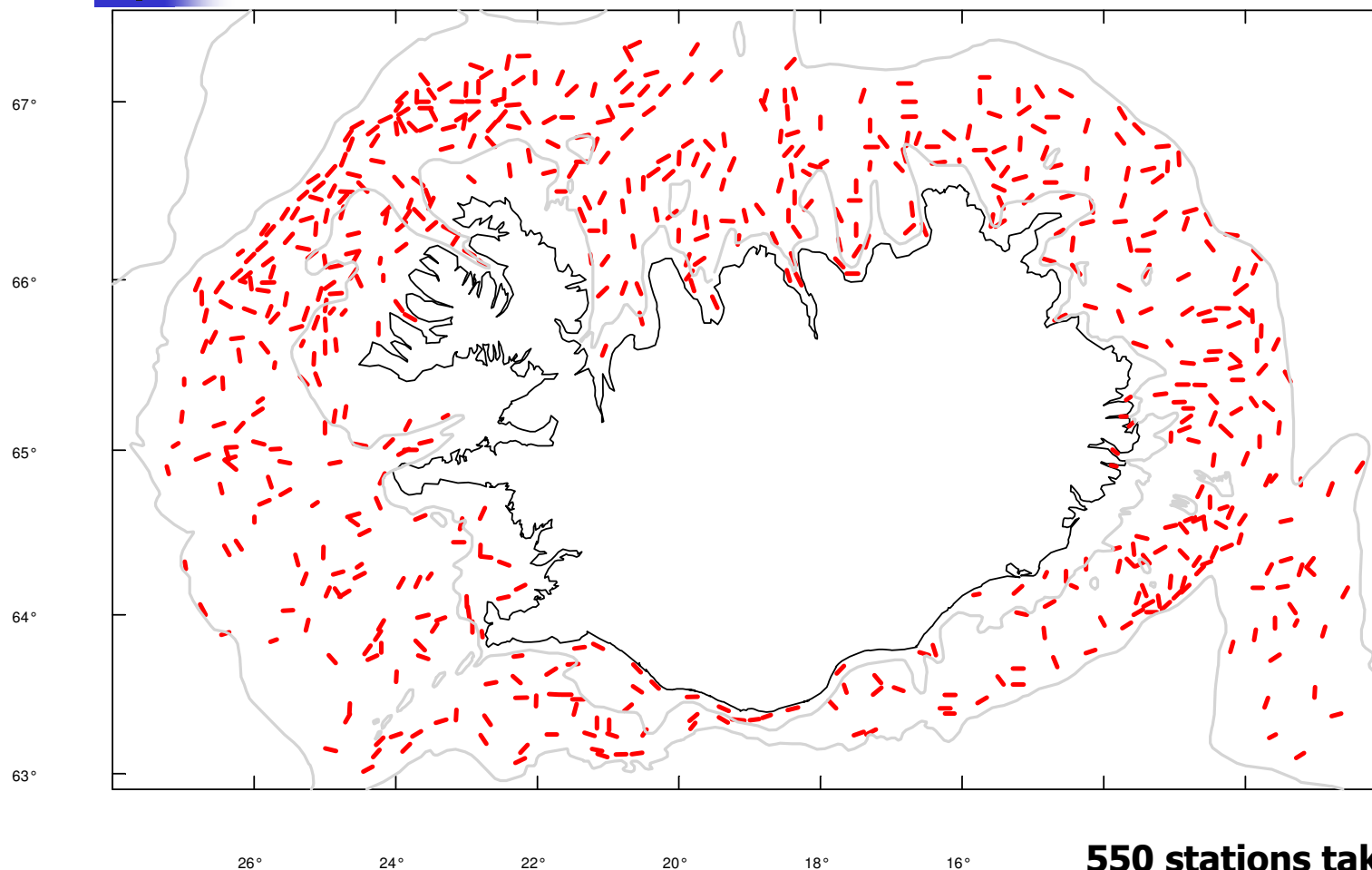
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## The information in the commercial catches – when aged

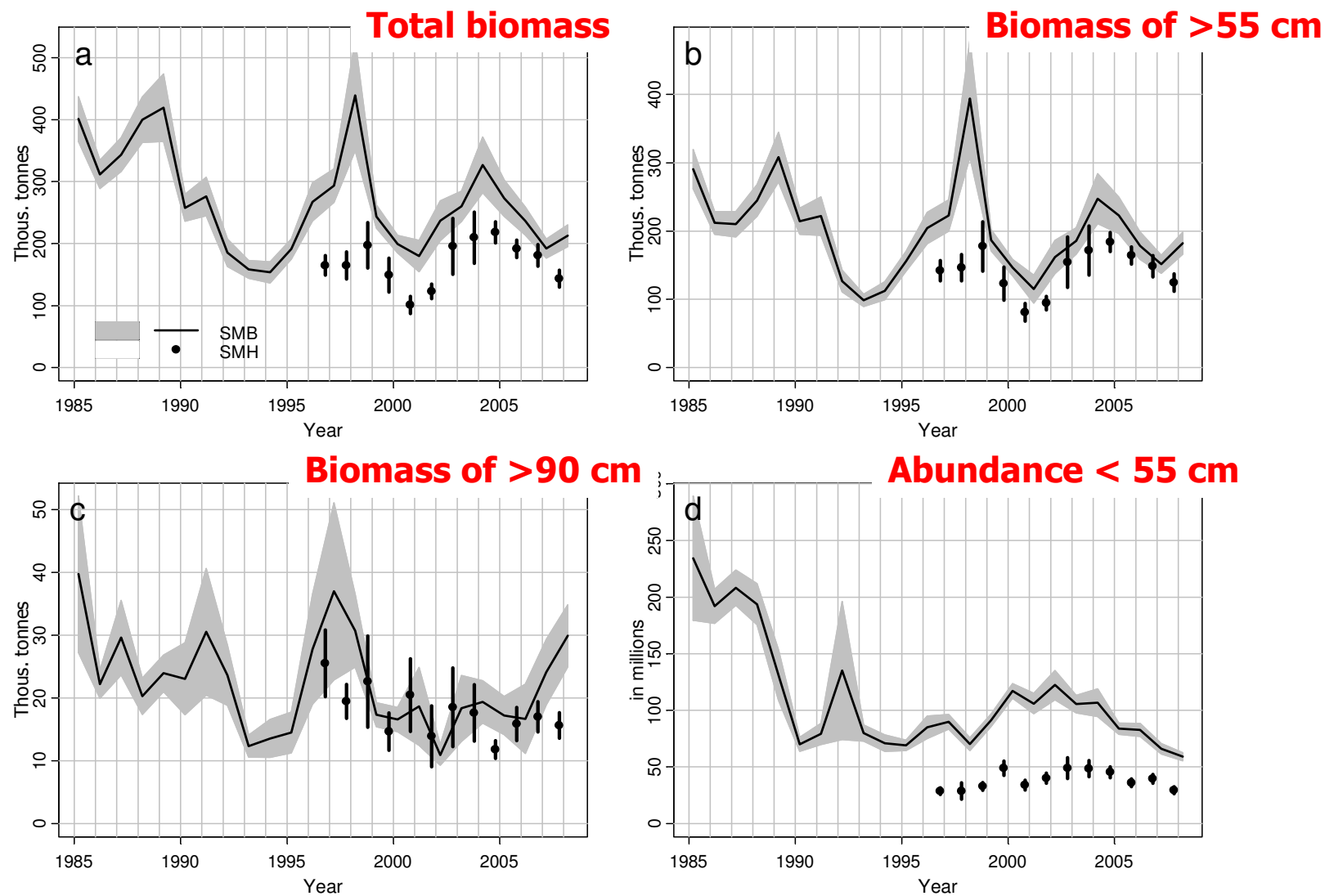
- The inter-year-class yield can be highly variable
  - The difference fivefold in recent years
- The pattern of the catch history among year classes is similar
  - The yield increase from age 3 to age 5-6 and then declines
    - This development is independent of the actual amount
    - The decline in the catches of older age groups is a proxy for mortality
- Indication about likely yield in each year class become apparent right at age 3 and 4
  - If a lot of fish are caught as 3 and 4 year olds, one can expect that future yield from that year class will be high. And vice versa.
- The pattern observed and the amount give basis for making short term prediction on future catches based on catches alone.
  
- But what about predicting catches of year classes that have yet not appeared in the fisheries?

## Scientific surveys: The Icelandic spring bottom trawl survey

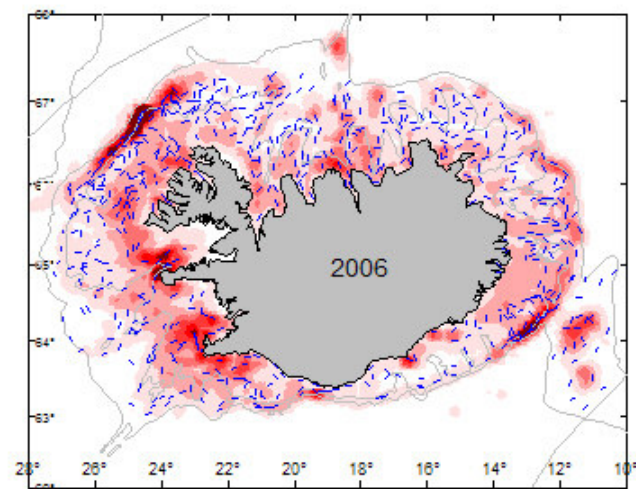
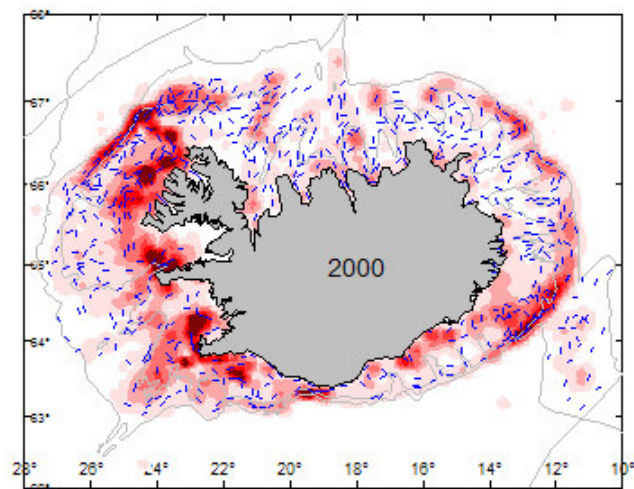
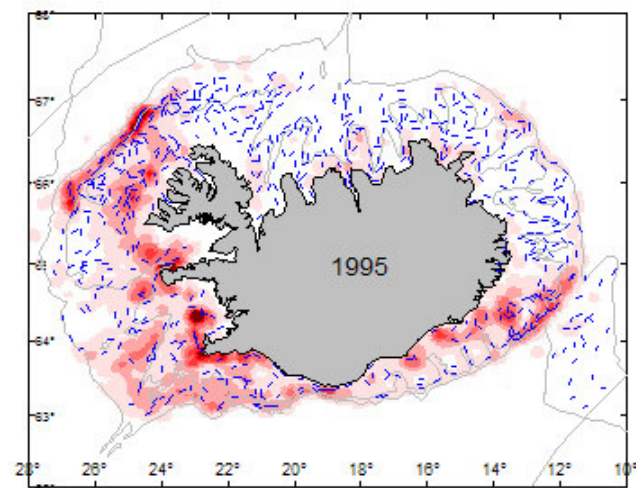
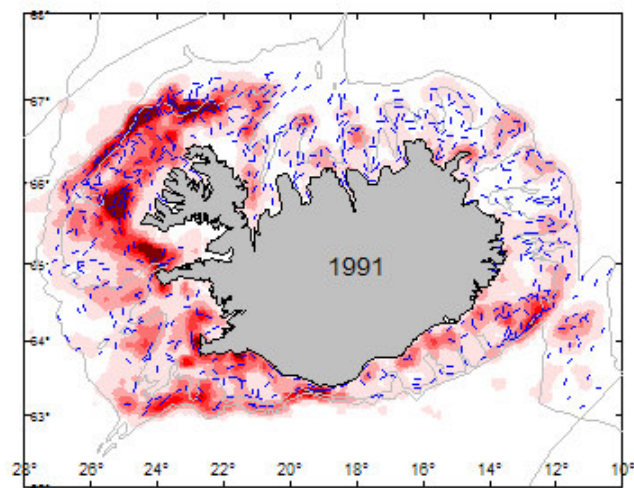


**550 stations taken per year**  
**Standardized approach**  
**5000 cod aged and weighted**  
**150 thousand cod length**  
**measured**

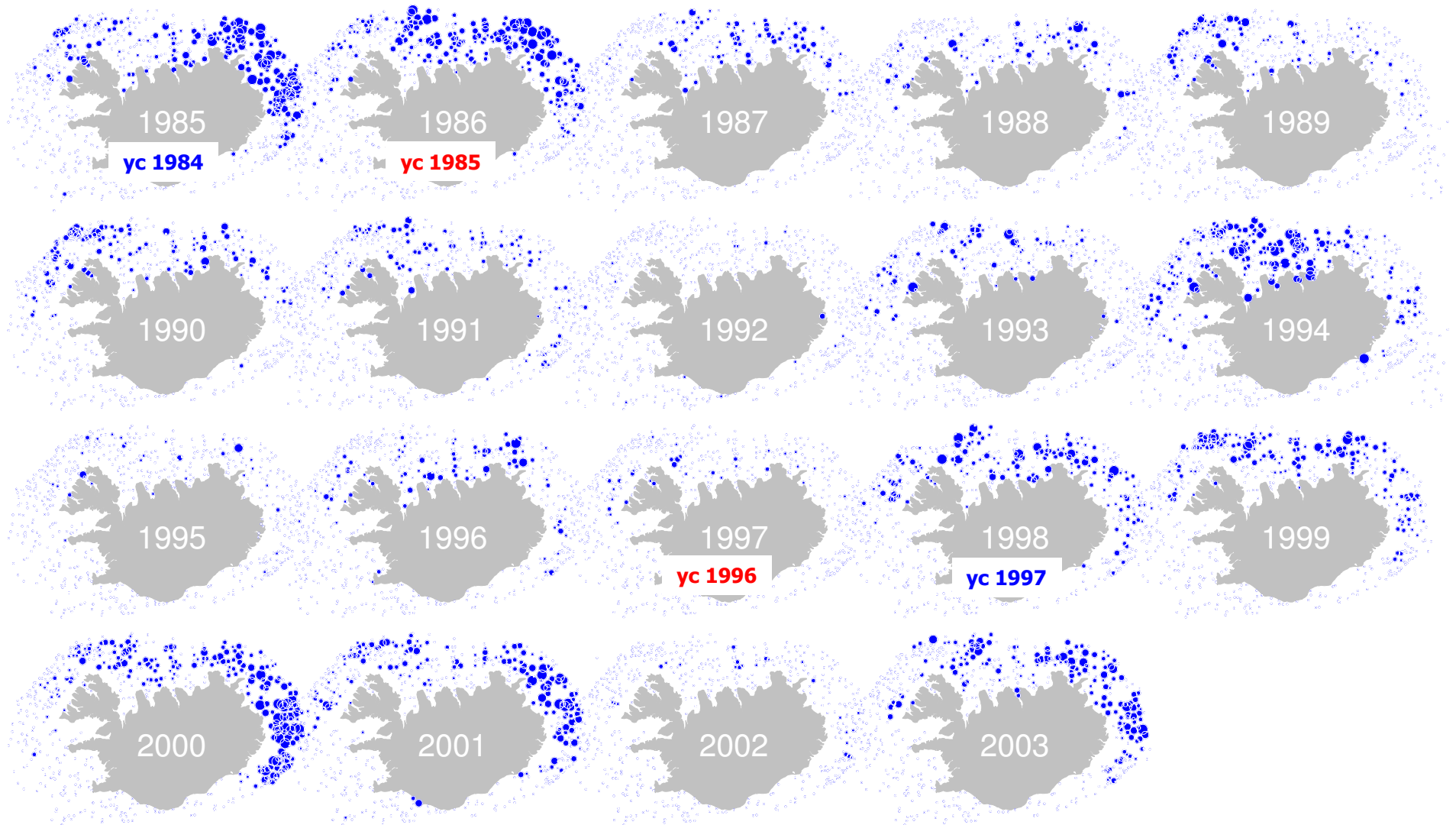
# iCod: Biomass and abundance indices



## Survey stations and cod catches

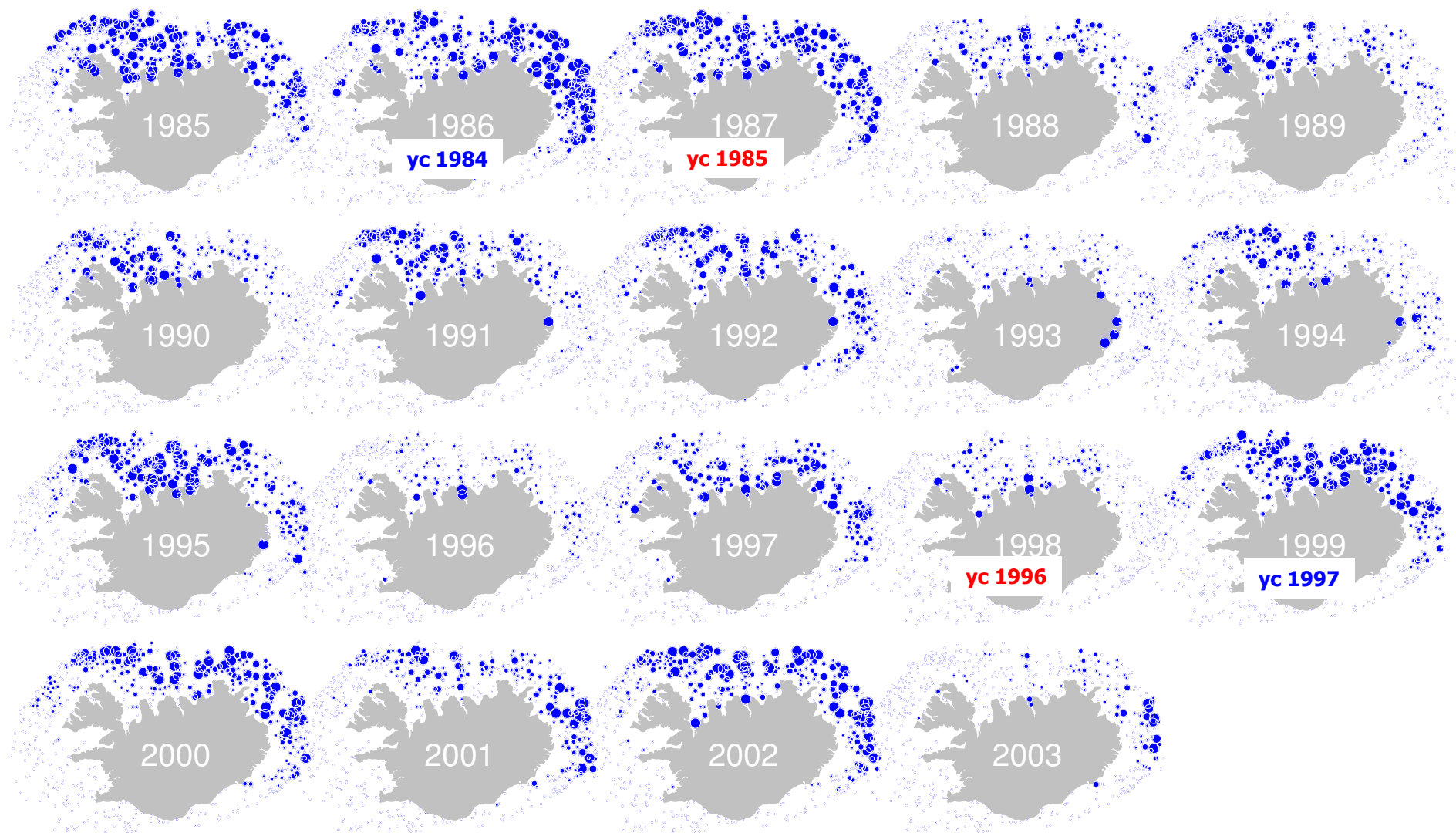


## Cod: Distribution and abundance of age 1



15 cm long

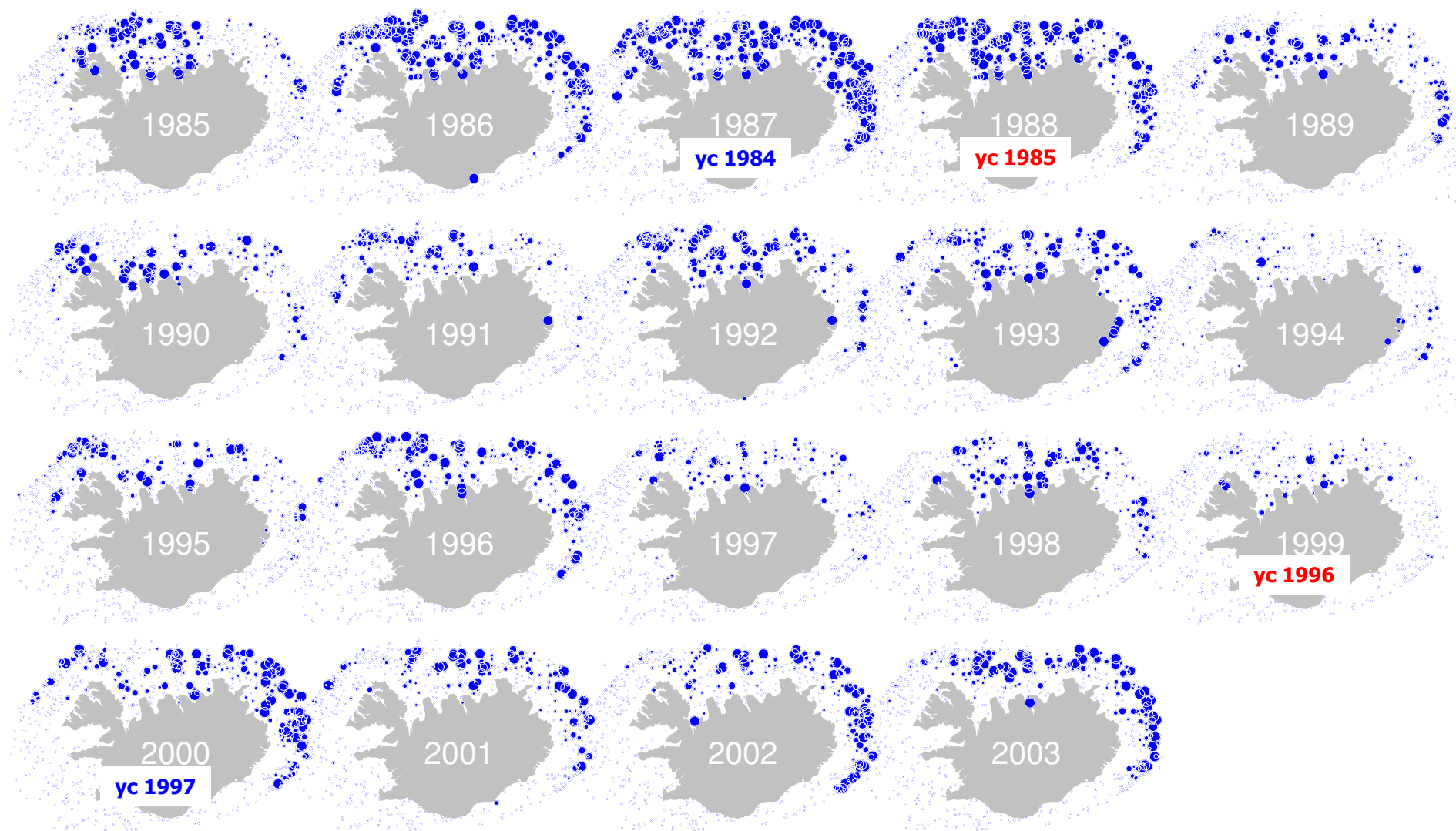
## Cod: Distribution and abundance of age 2



25 cm long

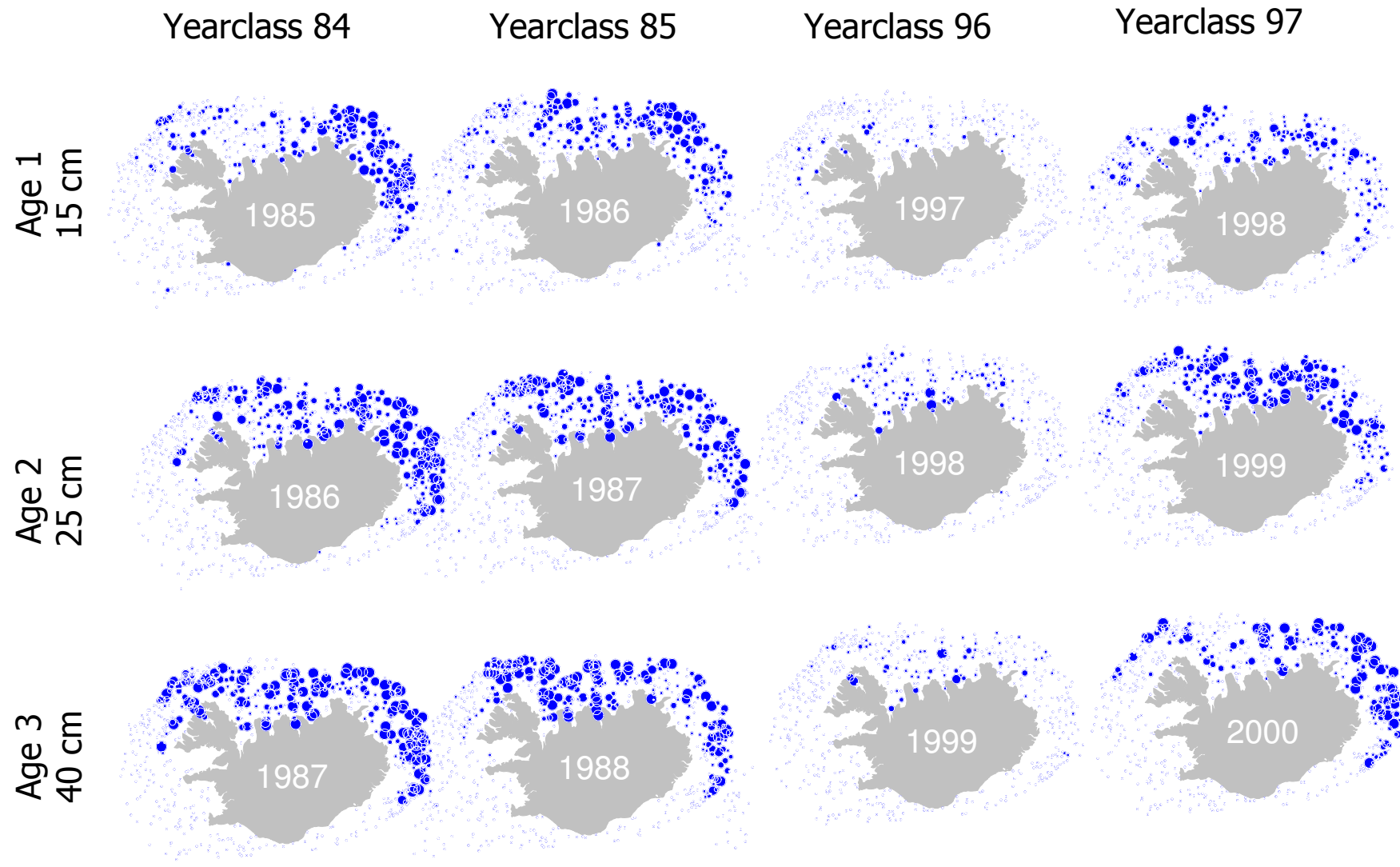


## Cod: Distribution and abundance of age 3



40 cm long

## Distribution and abundance of selected year classes





[illegible]

**Age -->**

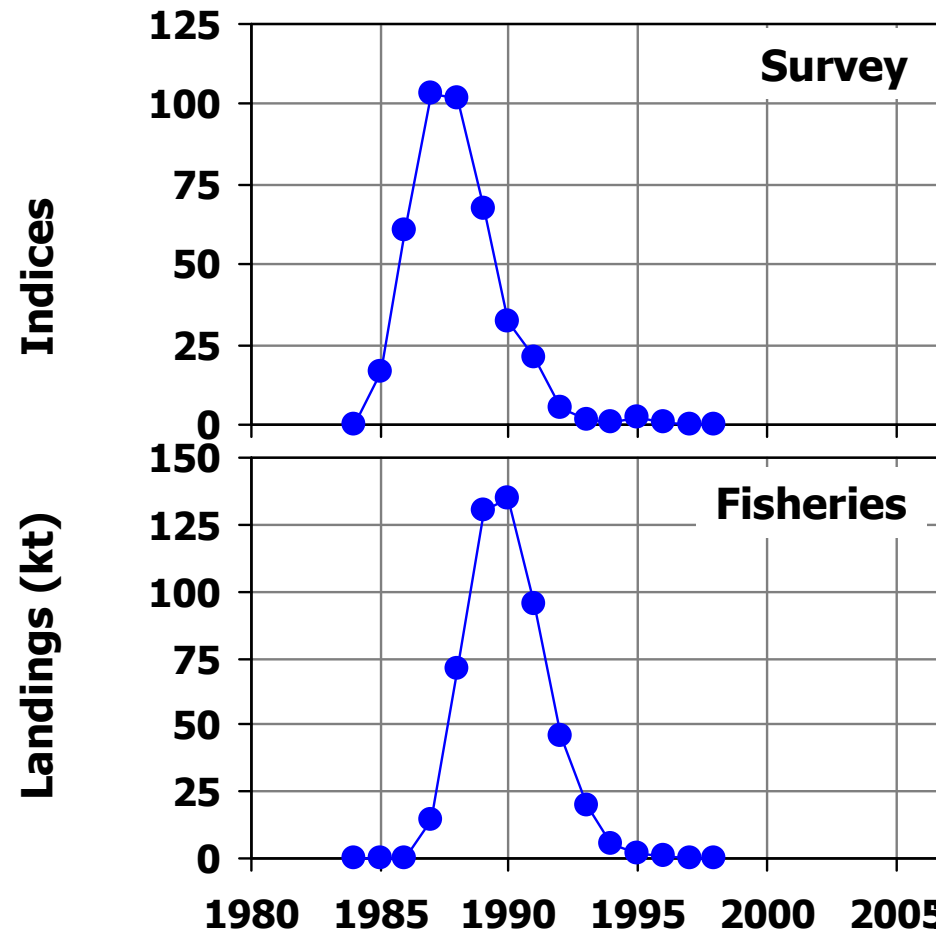
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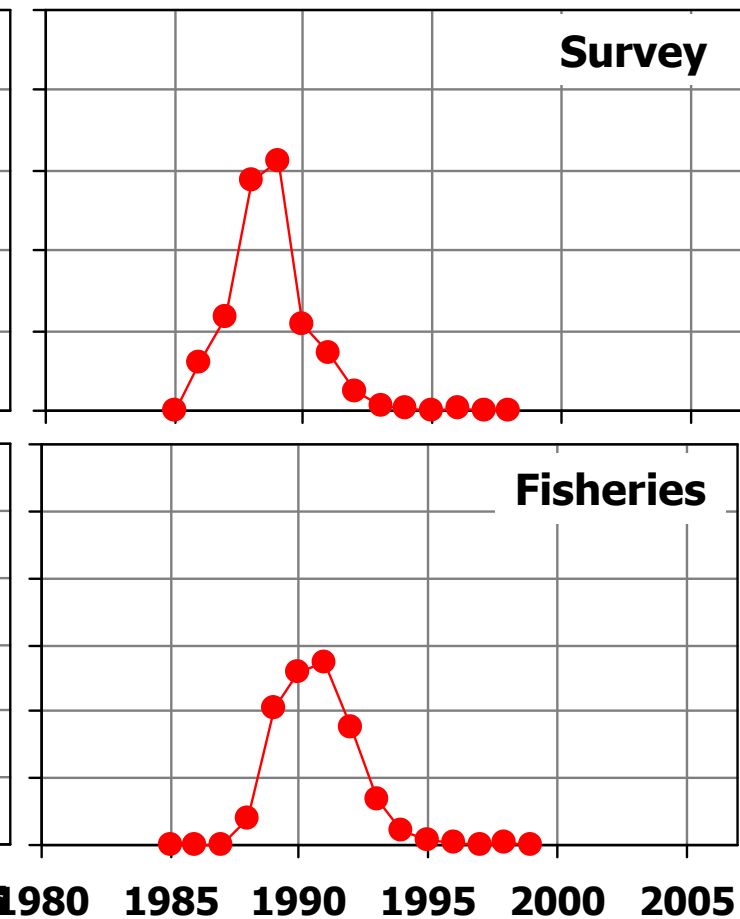
## The information in the surveys – when aged

- The inter-year-class abundance is highly variable
- The pattern of the “catch” history among year classes is similar
  - The abundance increases from age 1 to age 3-4 and then declines
    - This development is independent of the actual amount
    - The decline in the catches of older age groups is a proxy for mortality
- Indication about size of the year classes become apparent right at age 1 and 2
  - I.e. year class strength is determined at a relatively young age
  - Scientific measurements of year class strength are obtained before the commercial fisheries know what is ahead
- The pattern observed and the amount give basis for making short term prediction on future stock development, independent of the commercial catches.
- But what about the link between the catches and the survey?

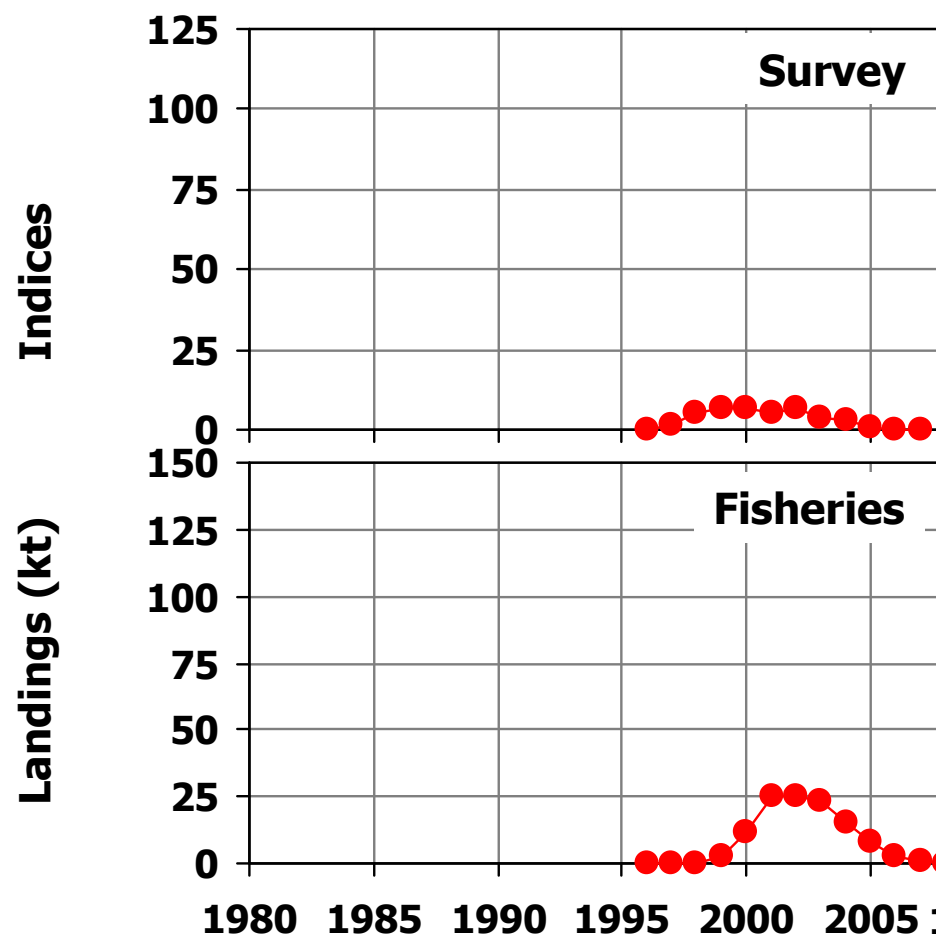
Yearclass 1984



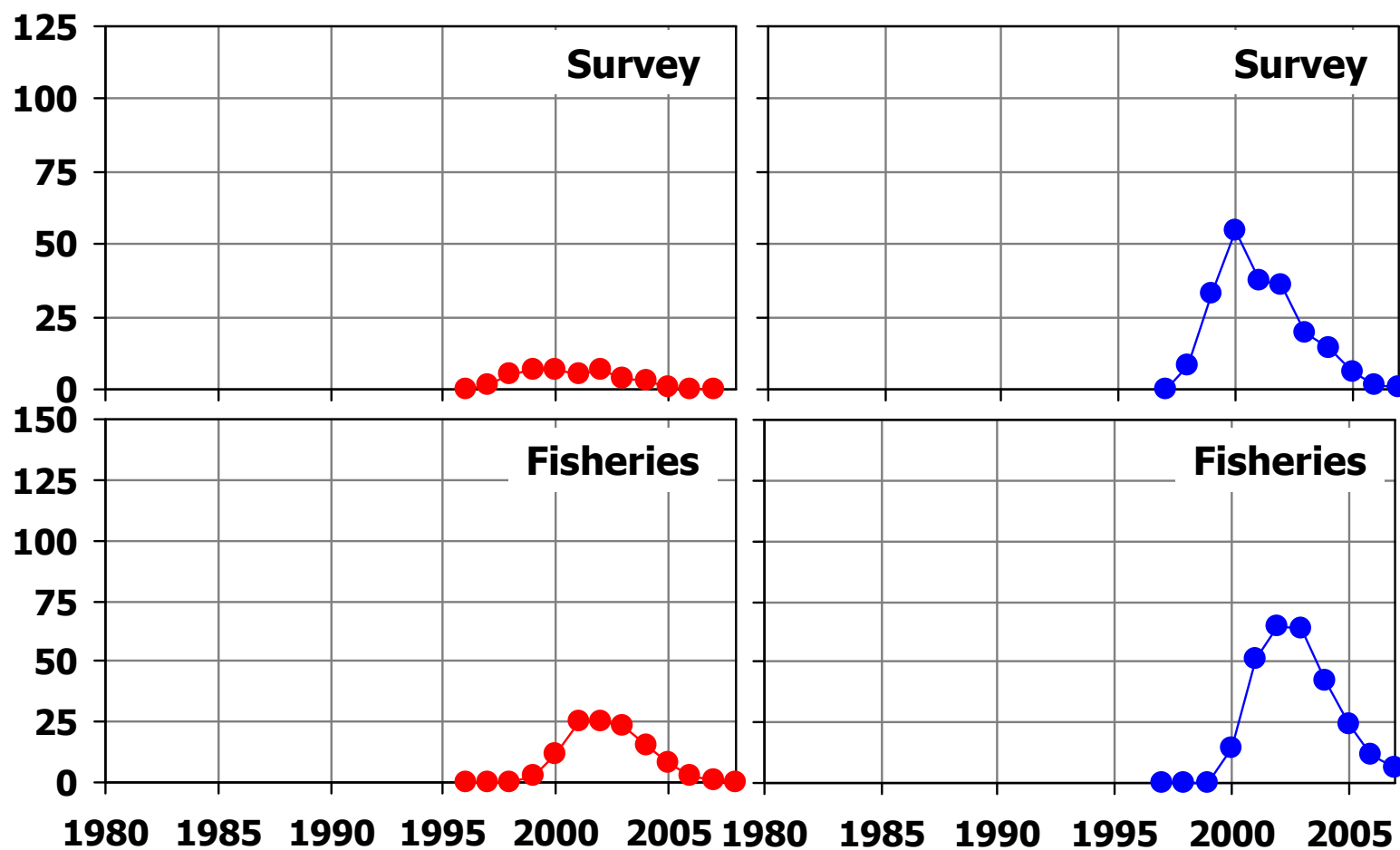
Yearclass 1985



Yearclass 1996

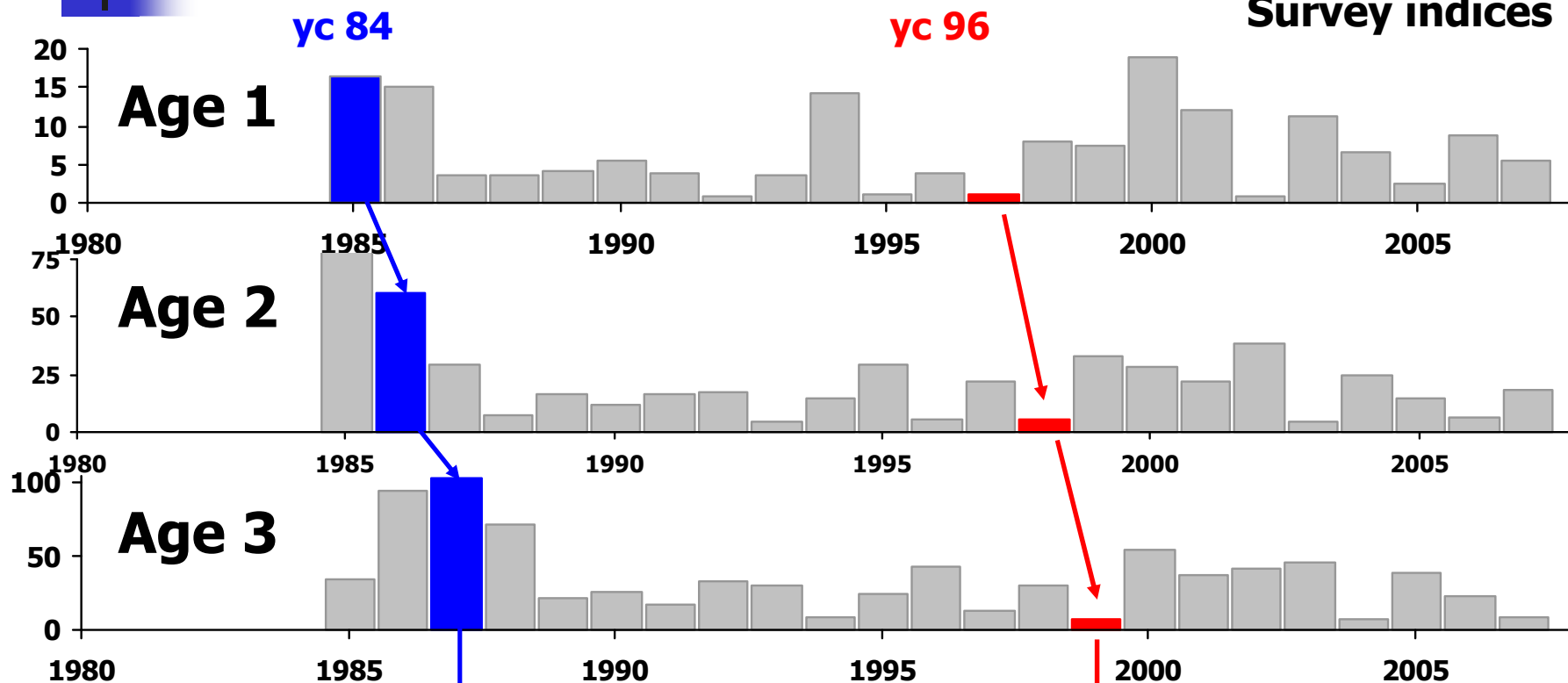


Yearclass 1997

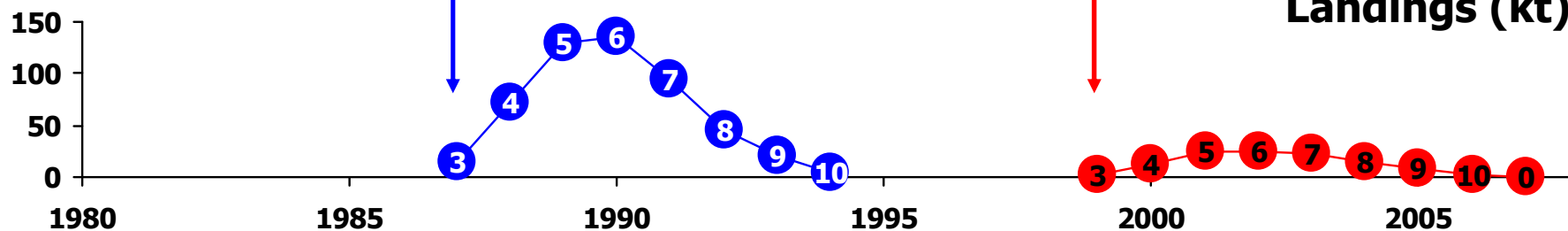


# Survey indices and catches

## Survey indices



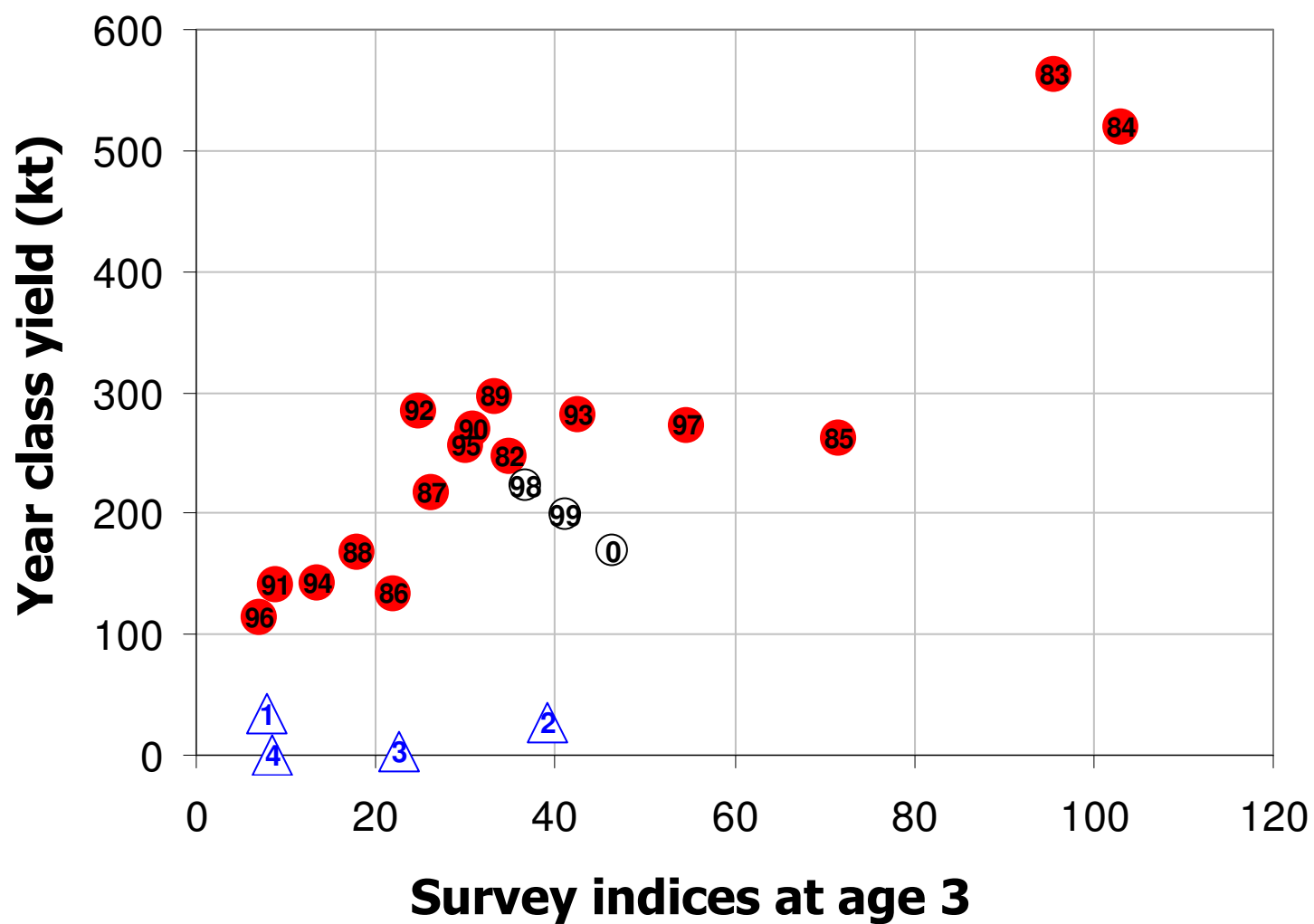
## Landings (kt)



[illegible]



## Survey indices at age 3 and consecutive year class yield



- The assessment if iCod is based on two independent sets of measurements:
  - Age disaggregated information of the commercial catches
  - Age based survey indices from scientific surveys
- There is a relatively good consistency among the two sets of measurements
- Predicting the development in the short term can be done almost visually.
- A formal analytical model should be just a summary of the observations, where model assumption should have minimum influence.
  - For the iCod, the assessment results are mostly data driven.
  - In many cases, where data may be poorer, the results may be largely assumption driven.

