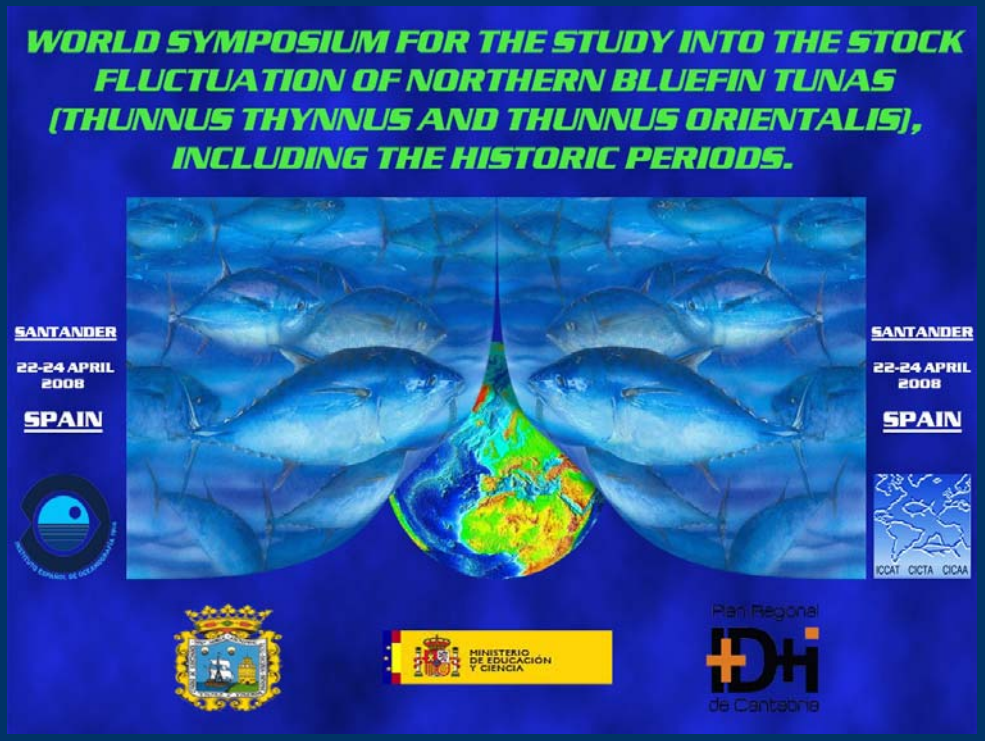
The Development of the Northern European Fishery for North Atlantic Bluefin Tuna, *Thunnus thynnus*, during 1900-1950

Brian R. MacKenzie
Technical University of Denmark
& Aarhus University
National Institute for Aquatic Resources
Charlottenlund, Denmark
brm@aqua.dtu.dk



Acknowledgements

-EU Network of Excellence on
Marine Biodiv. & Ecosyst. Funct.

-EU Network of Excellence on
Ocean Ecosystem Dynamics Eur-oceans

-HMAP (www.hmapcoml.org)

-Danish climate change project

www.conwoy.ku.dk

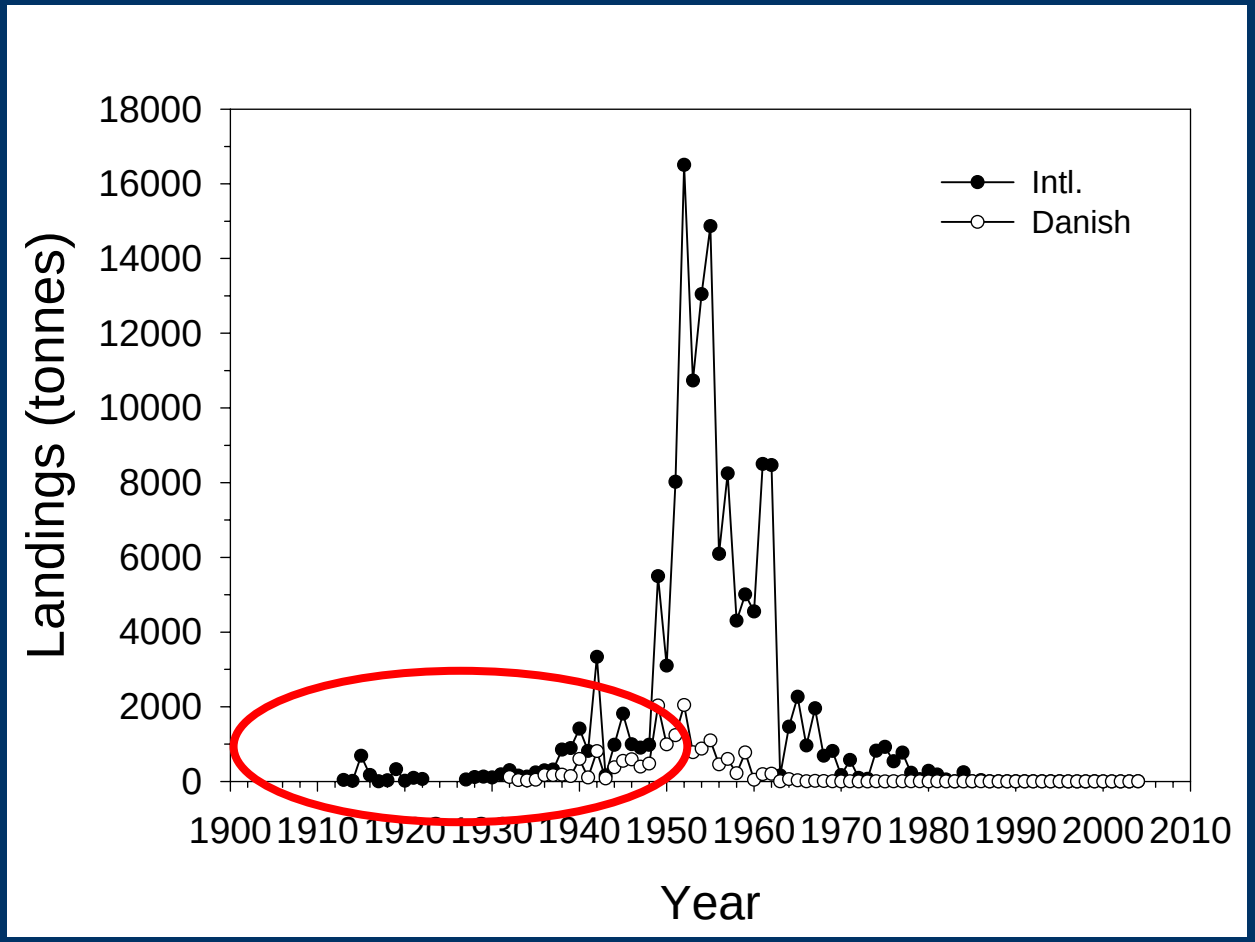
Objectives

Describe development of bluefin tuna fishery in northeastern Europe.

Estimate roles of fishery developments and ecosystem conditions on catch trends up to 1950.

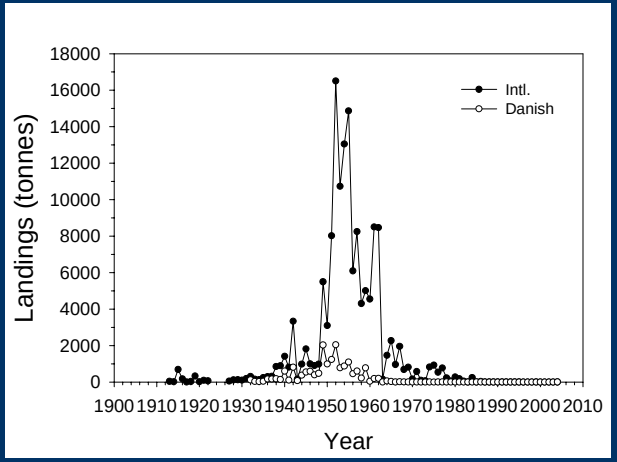
Kattegat
L. Svendsen 1932.

Landings of Bluefin Tuna *Thunnus thynnus* in Northern Europe*



* = Norwegian Sea, North Sea, Skagerrak, Kattegat, Øresund

Catch Development Before 1950



Why did landings increase in early 1900s?

-fishery–related factors: increases in effort, technology, demand?

-ecosystem and population factors?

-changes in temperature, food supply, etc.

-series of a few exceptionally strong yearclasses

Methods

-compile all existing data for presence of bluefin tuna in Northern European waters since 1900

-”presence” = sightings, strandings, landings
-individuals and schools
-fishing industry information (effort, technology, processing)

-compile time series of relevant ecosystem variables

Data sources:

-ICES
-scientific papers, reports, books
-commercial statistics, museum records, ichthyofaunal descriptions
-photographic and video evidence

MacKenzie & Myers 2007
Fish. Res.

Development of Fishery

-many bluefin tuna were regularly seen esp. by herring fishermen

-caught as bycatch in herring fisheries
- -offshore/open water (when hauling herring nets onboard)
- -coastal traps

-some targetted fisheries with harpoons and harpoon-rifles

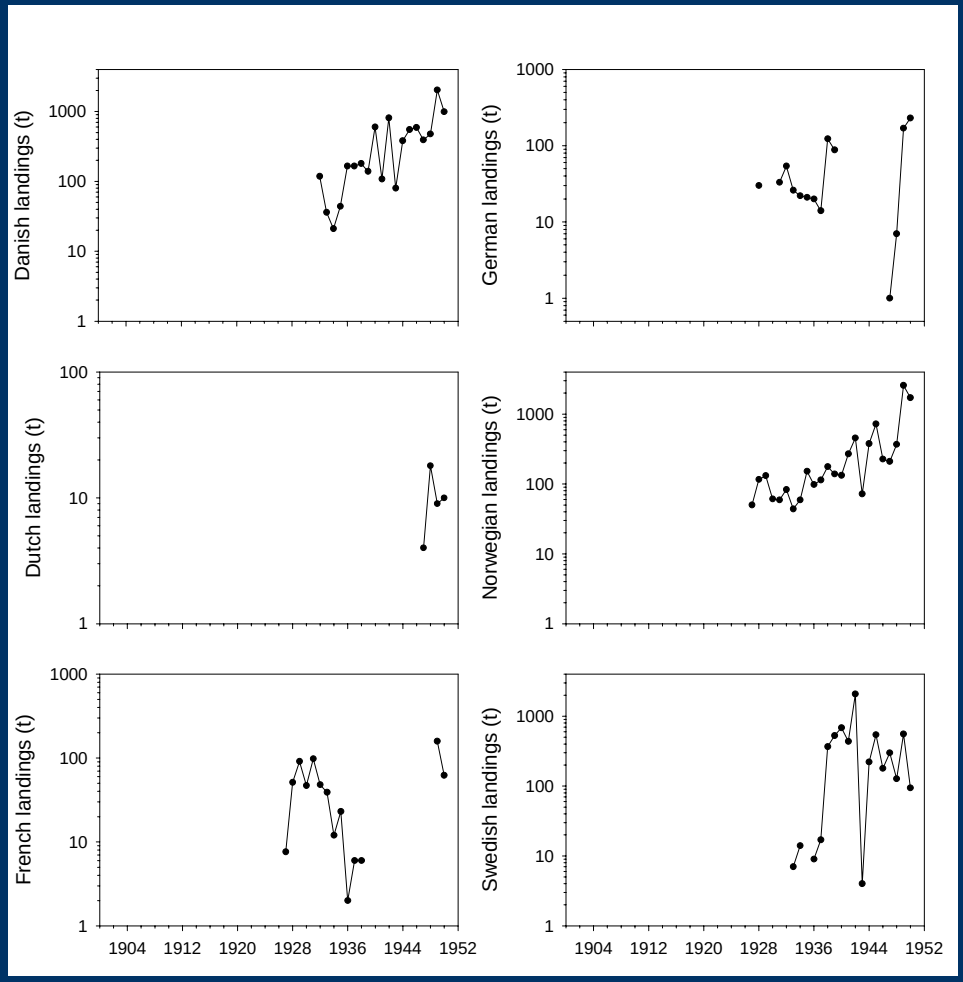
MacKenzie & Myers 2007
Fish. Res.

Development of National Fisheries (ICES data: starts in 1927)

Denmark

Netherlands

France



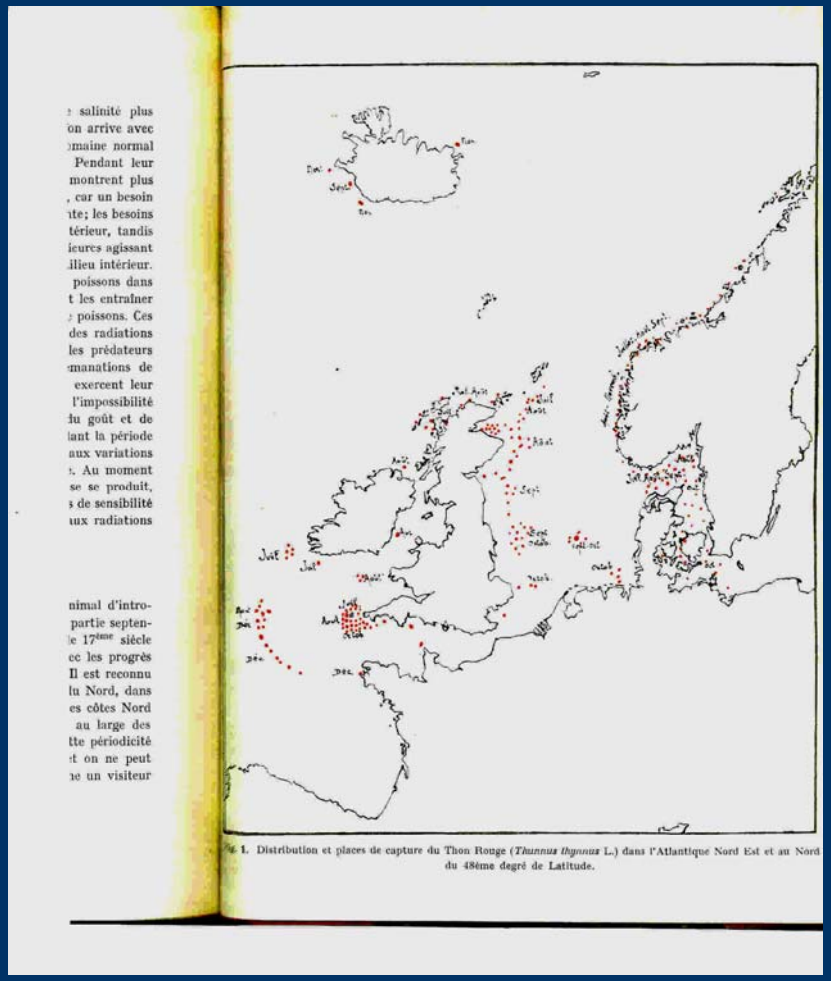
Germany

Norway

Sweden

MacKenzie & Myers 2007
Fish. Res.

Spatial Distribution of Bluefin Tuna Landings and Strandings before 1927



Le Grall 1927
J. du Conseil

A Day at Altona
Fish Auction Hall, Germany, 1910

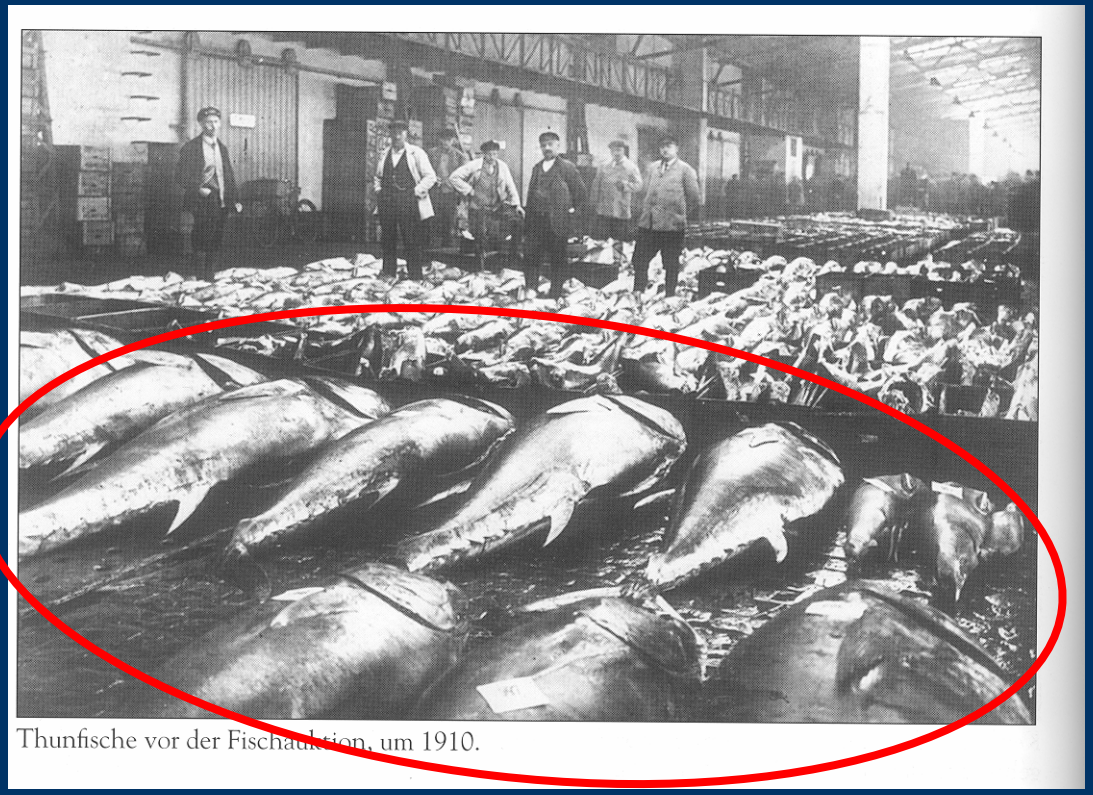

Thunfische vor der Fischauktion, um 1910.

Photo: Brandenburg 2003; Sutton Verlag

-data not in ICES or ICCAT statistics

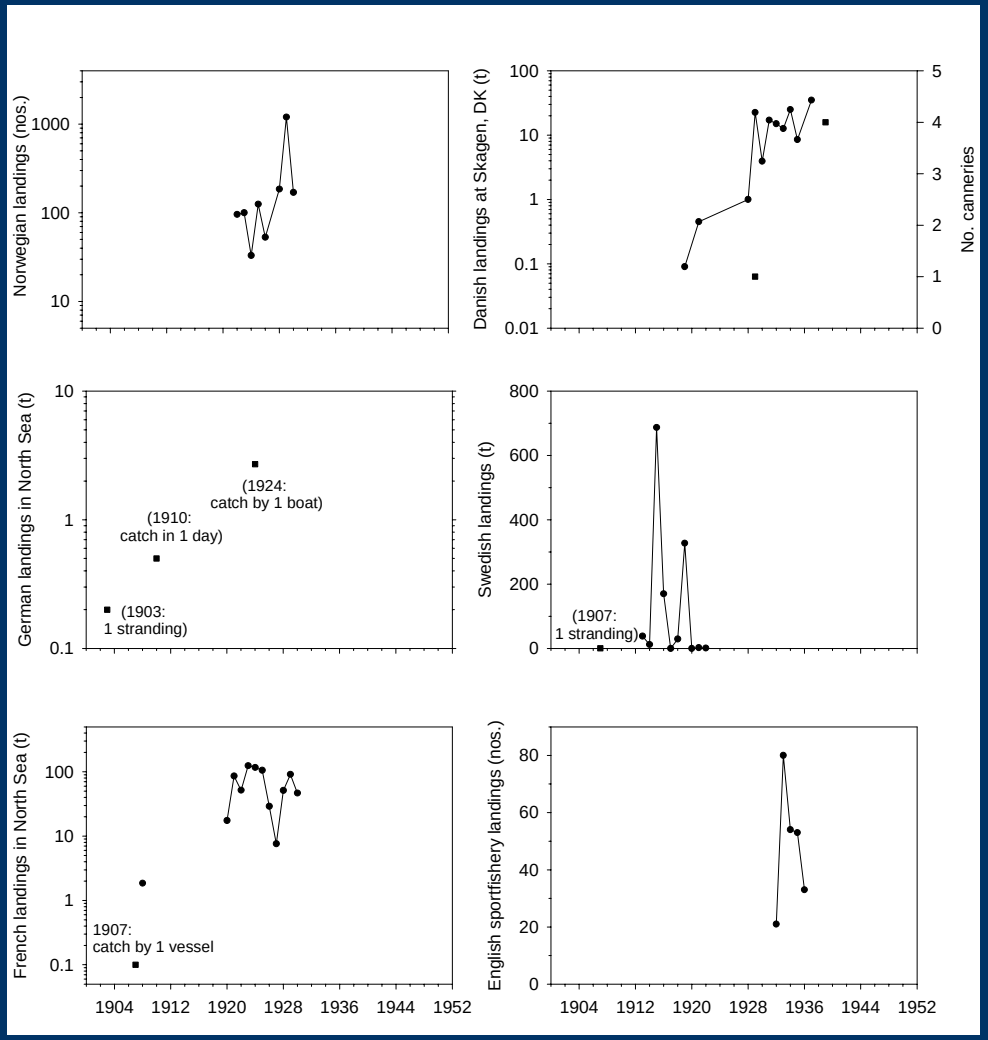
MacKenzie & Myers 2007
Fish. Res.

Development of National Fisheries pre-ICES

Norway

Germany

France



Denmark

Sweden

England

MacKenzie & Myers 2007
Fish. Res.

Bluefin Tuna Sportfishery, Øresund, Denmark, 1949

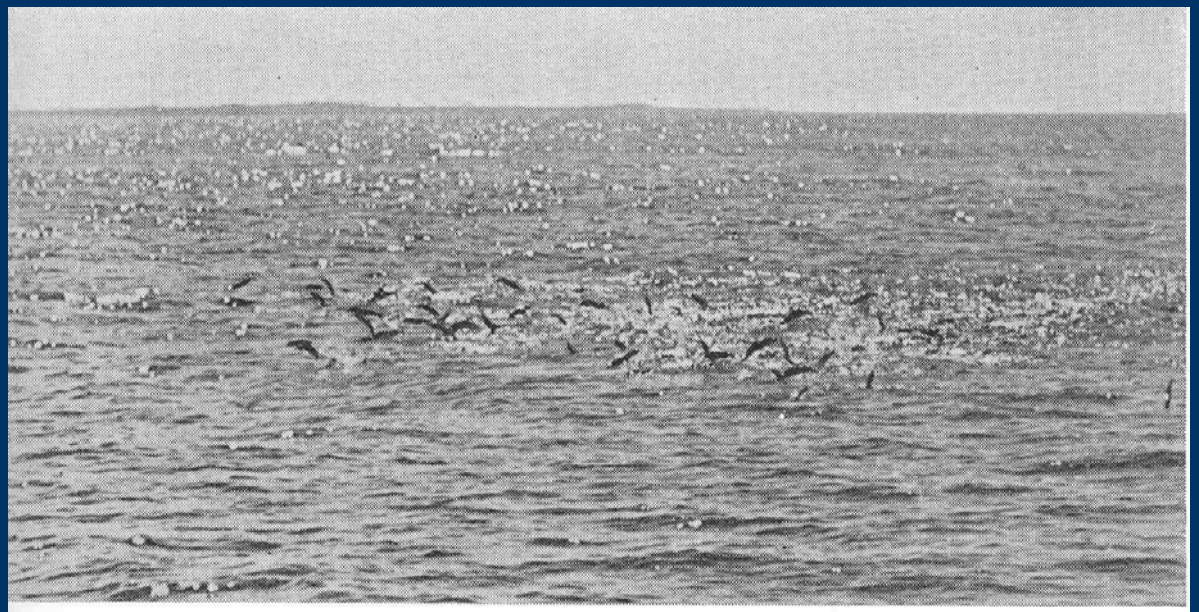
-viewable at www.dfu.dtu.min.dk/nyheder

BluefinTuna School Sightings in North Sea

-schools observed near Dogger Bank during herring fishing

Wolfe Murray 1932
J. du conseil

Prey Escape from Schools of Feeding Bluefin Tuna



Naar Tunfisken jager Hornfisk, springer disse over Vandet i en fortsat lang Række og ligner flyvende Fisk.

Svendsen, L. 1949

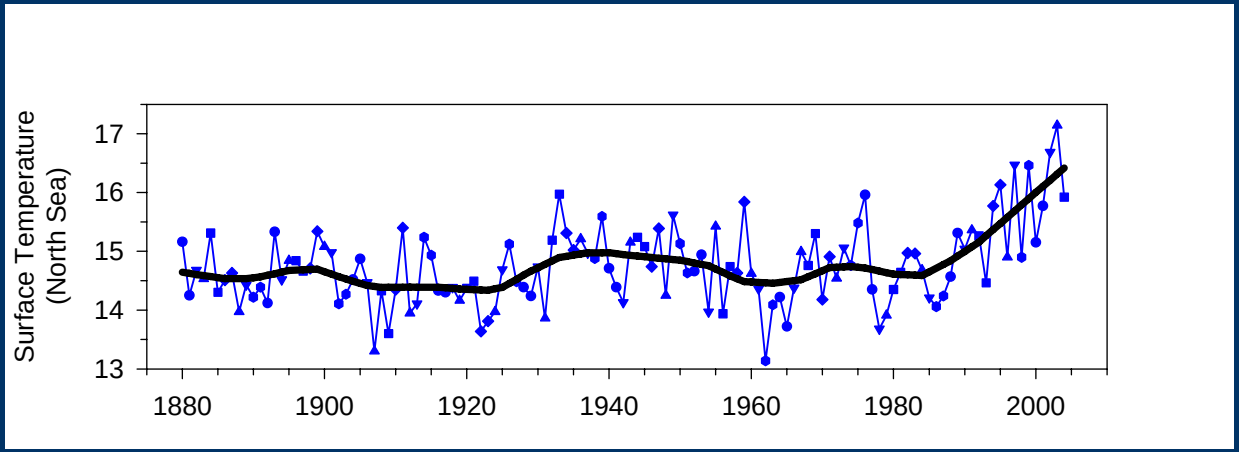
-garfish being attacked from below and jumping above water to escape

Commercial Bluefin Tuna Fishery, Kattegat, Denmark, 1949

MacKenzie & Myers 2007
Fish. Res.

Tuna Presence and Multi-decadal Scale Temperature Variability

North Sea SST during Summer



MacKenzie & Schiedek 2007
Glob. Ch. Biol.

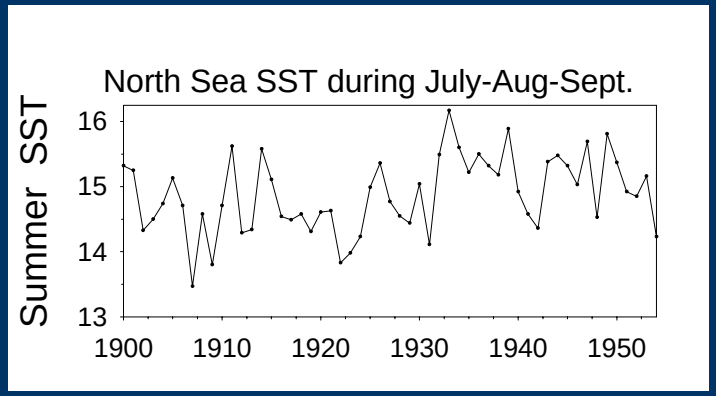
Bluefin tuna were present and abundant during:

-cold periods (1900-1925)

-warm periods (1930-1960).

MacKenzie & Myers 2007
Fish. Res.

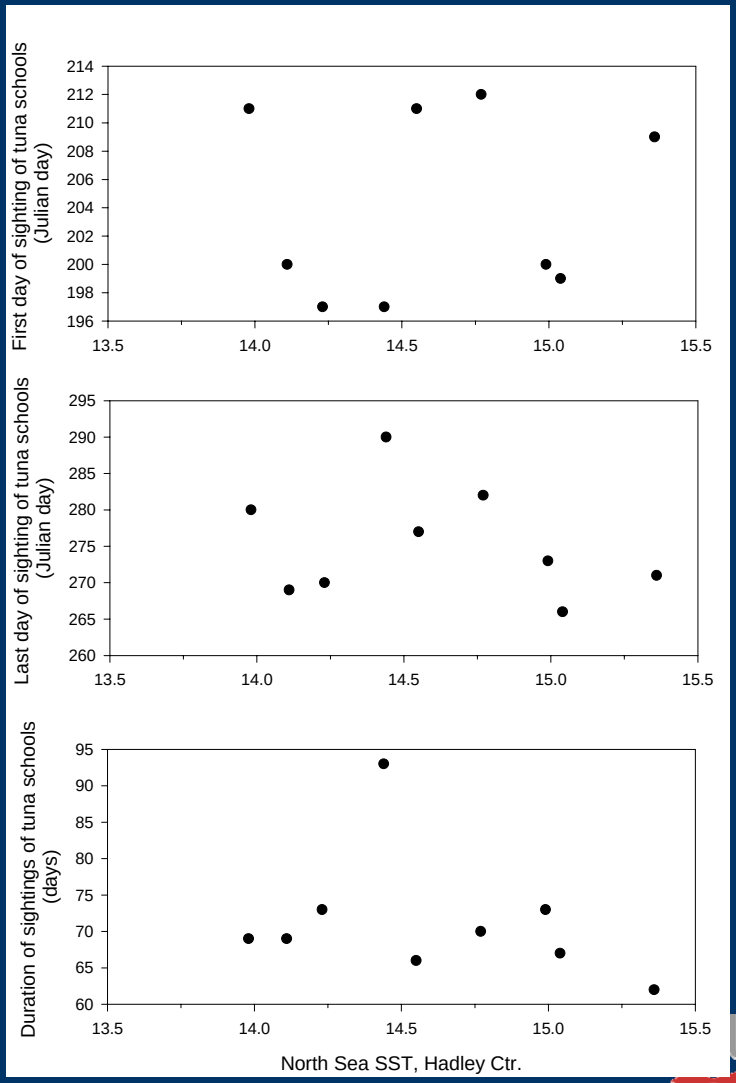
School Sightings & Temperature 1923-31



First day

Last day

Duration

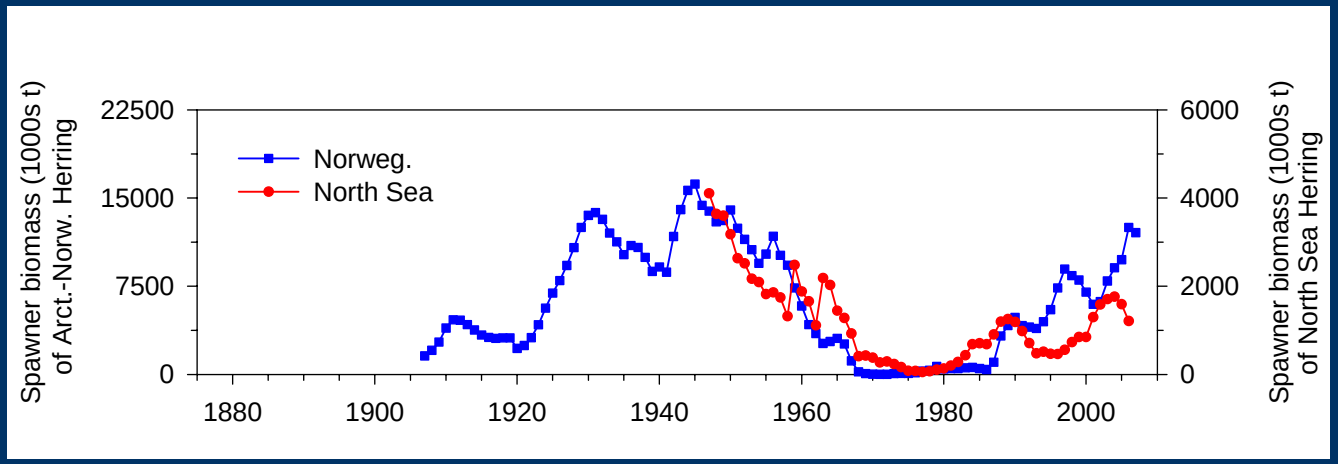


-presence/absence not related to interannual varations in regional SST

MacKenzie & Myers 2007
Fish. Res.

Tuna Presence and Multi-decadal Food Variability

-herring were main prey of bluefin tuna in North and Norwegian Seas (Tiews 1964; 1978)



Torsten & Østvedt 2000; ICES 2007

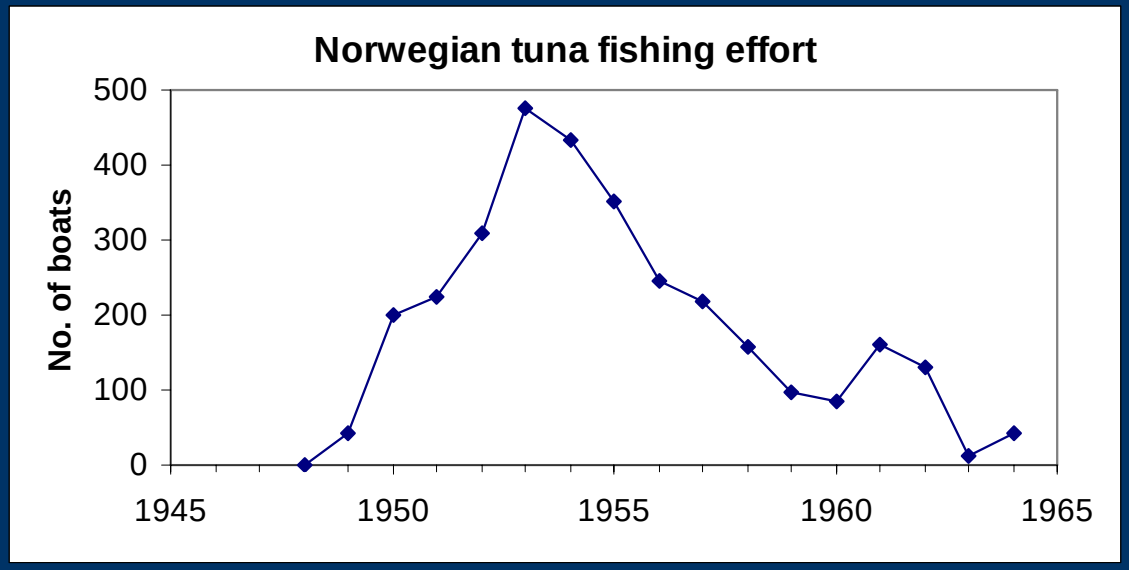
Bluefin tuna were present and abundant during:

-low-food periods (1900-1925)

-high-food periods (1930-1960).

Industrialisation of Northern European Bluefin Tuna Fisheries (1)

-huge increase in effort (boats, gears, fishing skill)

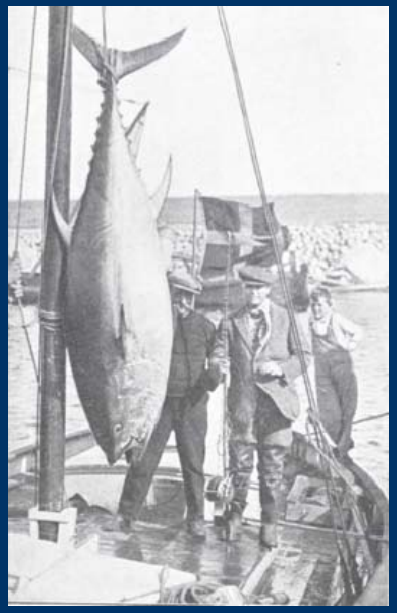


Hamre et al. 1966

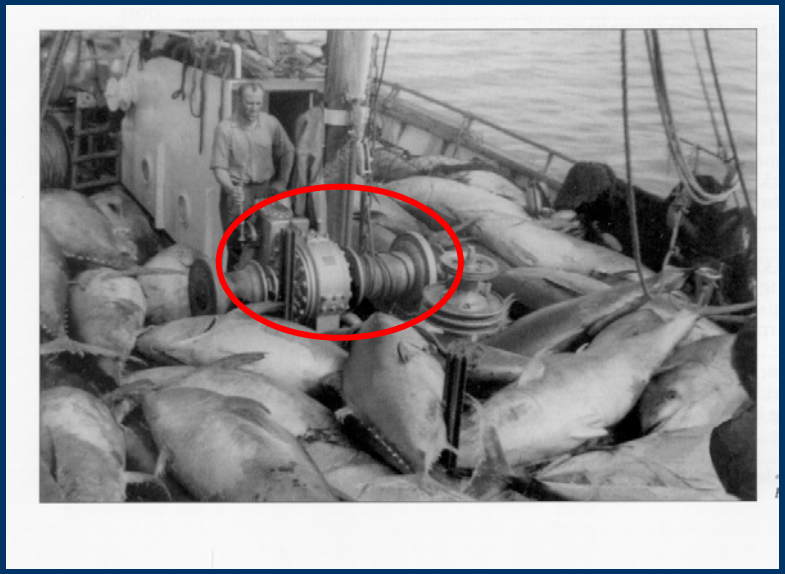
Development of Fishing Methods

Hanson, B. 1927
Norway

L. Svendsen 1932
So. Kattegat, DK



L. Svendsen 1932
So. Kattegat, DK



M. Tangen, 1999
Norway

Industrialisation of Northern European Bluefin Tuna Fisheries (2)

-huge increase in technology and skill

-harpoons, harpoon-rifles, rod-reel, handlines, hydraulically-operated purse seines

-increase in demand and canneries (e. g., first Danish cannery built in 1920s; others followed in DK and Norway)

-all these fishery-related changes lead to large increases in landings

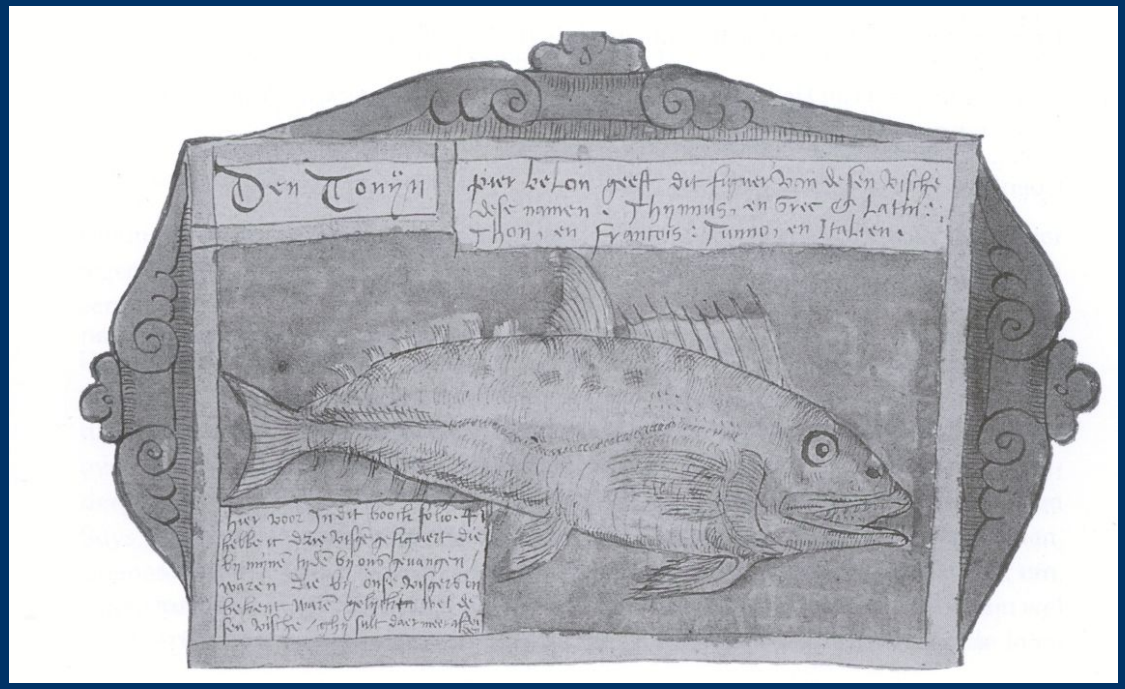
Presence Before 1900

Tuna bones during Medieval (Enghoff 1999)

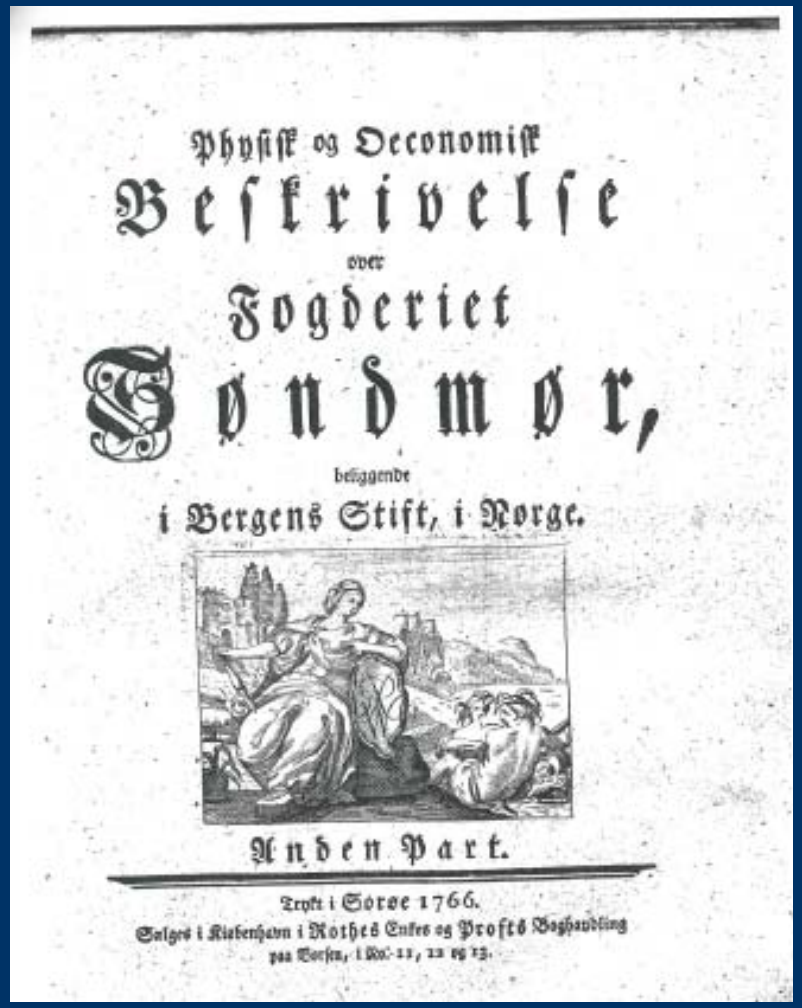
183 tuna caught in 1548 (Rørdam 1887)

1 fish caught 1545

Bluefin Tuna at Dutch Fish Market, 1545



Bluefin Tuna Fishing in Norway in 1760s

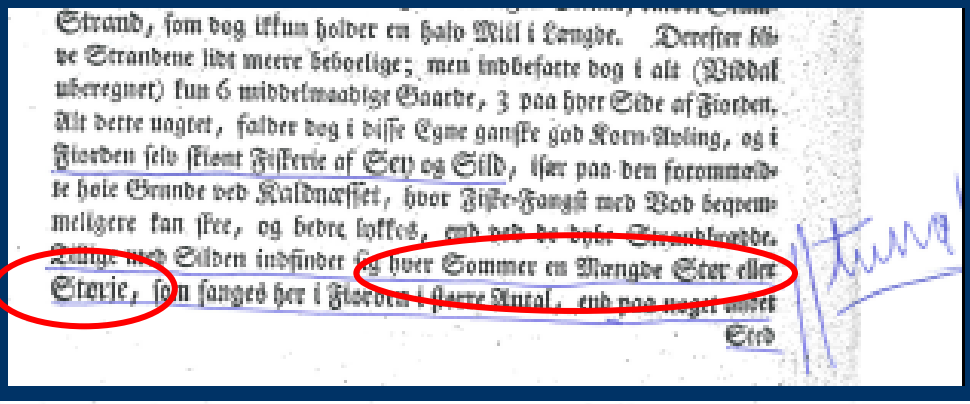

Physisk og Oeconomisk
Beskrivelse
over
Fogderiet
Søndmør,
beliggende
i Bergens Stift, i Norge.
Anden Part.
Trykt i Sorøe 1766.
Sælges i Kiøbenhavn i Rothes Enkes og Probst Boghandling

Strøm, Hans. 1766.

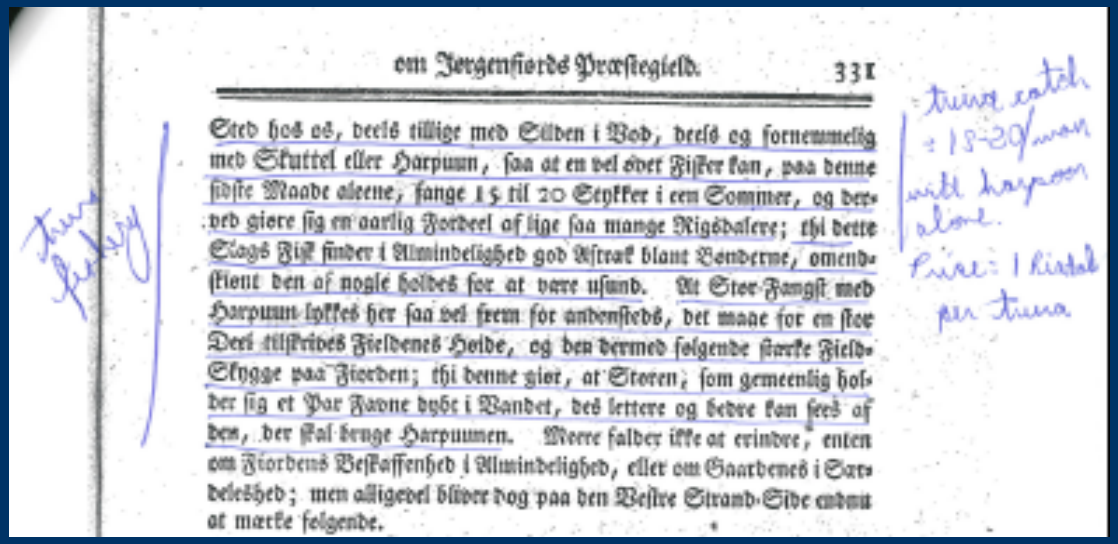
Physical and Economic Description of Søndmør Tax District, Bergen Parish, Norway. Part 2

Bluefin Tuna Fishing in Norway in 1760s

Documents written by professor and theologian Hans Strøm:



Strand, som dog ikkun holder en halv Miil i Længde. Derefter blive Strandene lidt meere beboelige; men indbefatte dog i alt (Biddal uberegnet) kun 6 middelmaadige Gaarde, 3 paa hver Side af Fiorden. Alt dette uagtet, falder dog i disse Egne ganske god Korn-Avling, og i Fiorden selv skiønt Fiskerie af Sey og Sild, især paa den forommeldte høie Grunde ved Kaldnæsset, hvor Fiske-Fangst med Vod bequemmeligere kan skee, og bedre lykkes, end ved de høie Strandbredde. Tillige med Silden indfinder sig hver Sommer en Mængde Stør eller Storje, som fanges her i Fiorden i større Antal, end paa noget andet Sted



om Jørgenfiords Præstegield. 331

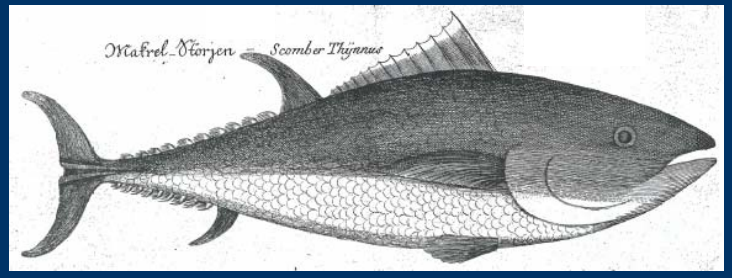
Sted hos os, deels tillige med Silden i Vod, deels og fornemmelig med Skuttel eller Harpuun, saa at en vel øvet Fisker kan, paa denne sidste Maade alene, fange 15 til 20 Stykker i een Sommer, og derved giøre sig en aarlig Fordeel af lige saa mange Rigsdalere; thi dette Slags Fisk finder i Almindelighed god Afsatz blant Bønderne, omendskiønt den af nogle holdes for at være usund. At Stør-Fangst med Harpuun lykkes her saa vel fremfor andensteds, det maae for en stor Deel tilskrives Fieldenes Høide, og den dermed følgende stærke Field-Skygge paa Fiorden; thi denne giør, at Støren, som gemeenlig holder sig et Par Favne dybt i Vandet, des lettere og bedre kan sees af den, der skal bruge Harpuunen. Meere falder ikke at erindre, enten om Fiordens Beskaffenhed i Almindelighed, eller om Gaardenes i Særdeleshed; men alligevel bliver dog paa den Vestre Strand-Side endnu at mærke følgende.

Bluefin Tuna Fishing in Norway in 1760s

Every summer a large amount of tuna comes with the herring.

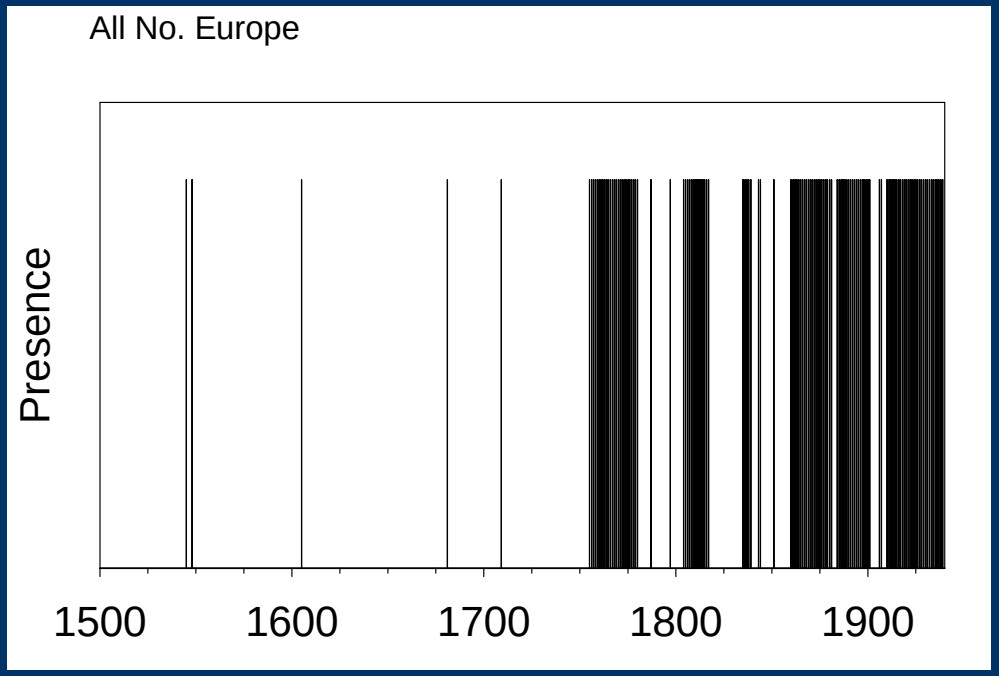
One man could catch 15-20 tuna per summer using a harpoon in the 1760s in Jørgenfjord, Norway.

-H. Strøm 1766



H. Strøm 1788

Bluefin Tuna in Northern Europe Before 1900

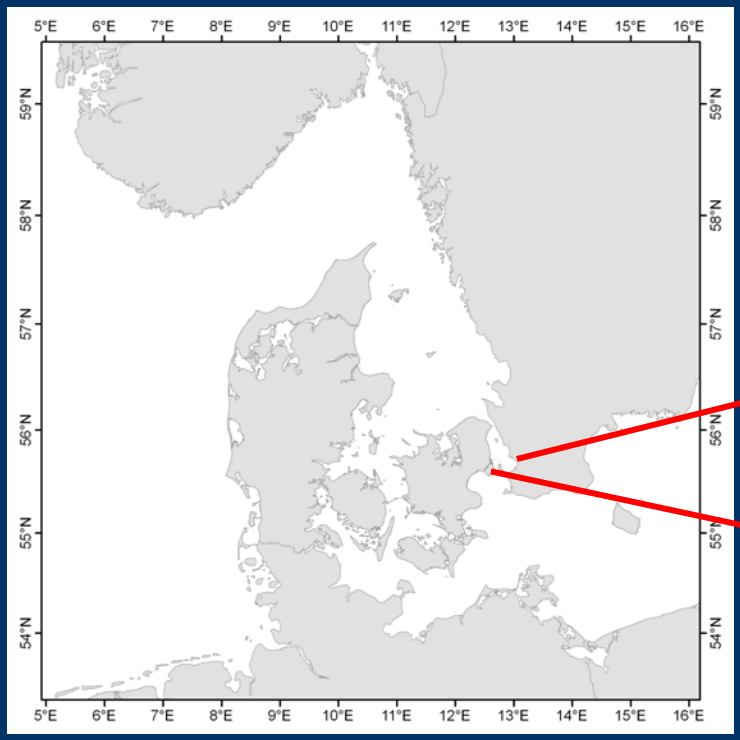


-based on fish fauna lists, fishery records, archaeological remains, etc.

-present several decades and centuries in past

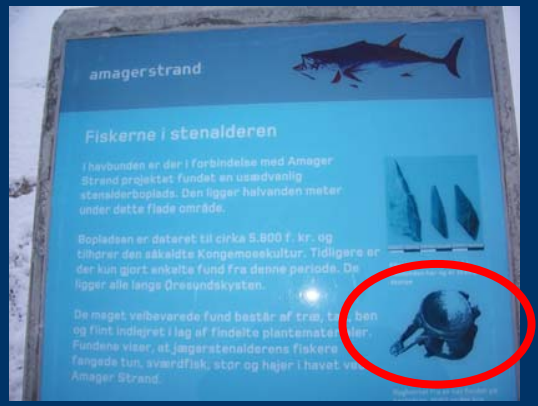
MacKenzie, in prep.

Bluefin Tuna Near Copenhagen During the Stone Age (ca. 7000-3900 BC)



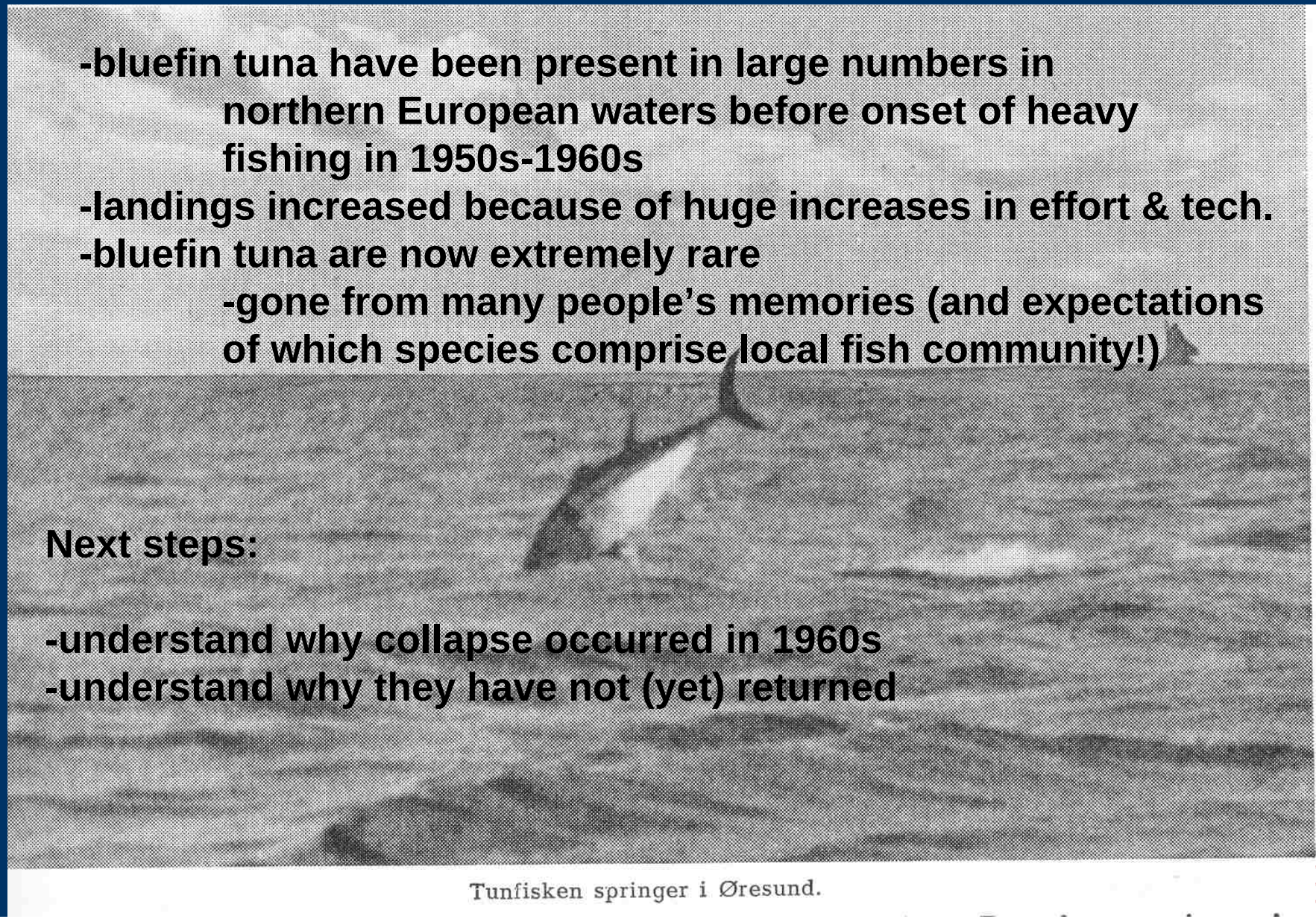
Landskrona, Sweden (4000 BC; Eriksson & Magnell 2001)

Amager Beach, Copenhagen (5800 BC)



Enghoff et al. 2007
Fish. Res.

Conclusions (Pre 1950)



-bluefin tuna have been present in large numbers in northern European waters before onset of heavy fishing in 1950s-1960s

-landings increased because of huge increases in effort & tech.

-bluefin tuna are now extremely rare

-gone from many people's memories (and expectations of which species comprise local fish community!)

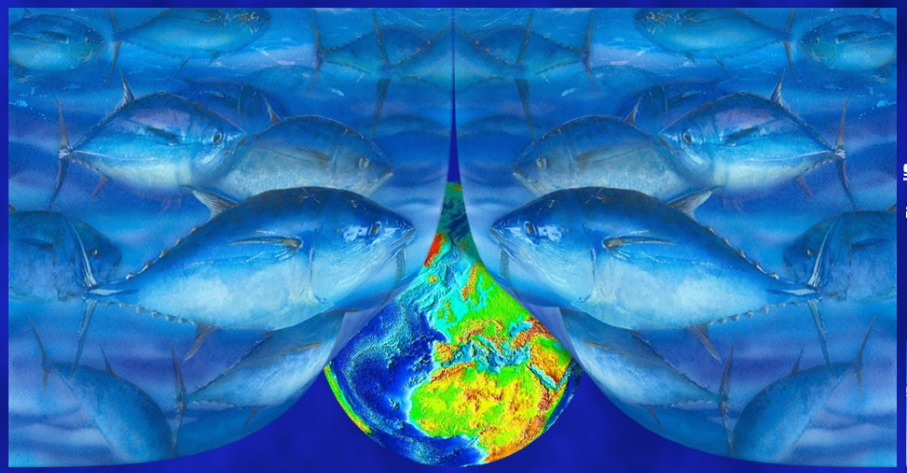
Next steps:

-understand why collapse occurred in 1960s

-understand why they have not (yet) returned

Tunfisken springer i Øresund.

WORLD SYMPOSIUM FOR THE STUDY INTO THE STOCK FLUCTUATION OF NORTHERN BLUEFIN TUNAS (THUNNUS THYNNUS AND THUNNUS ORIENTALIS), INCLUDING THE HISTORIC PERIODS.



SANTANDER

22-24 APRIL 2008

SPAIN

SANTANDER

22-24 APRIL 2008

SPAIN

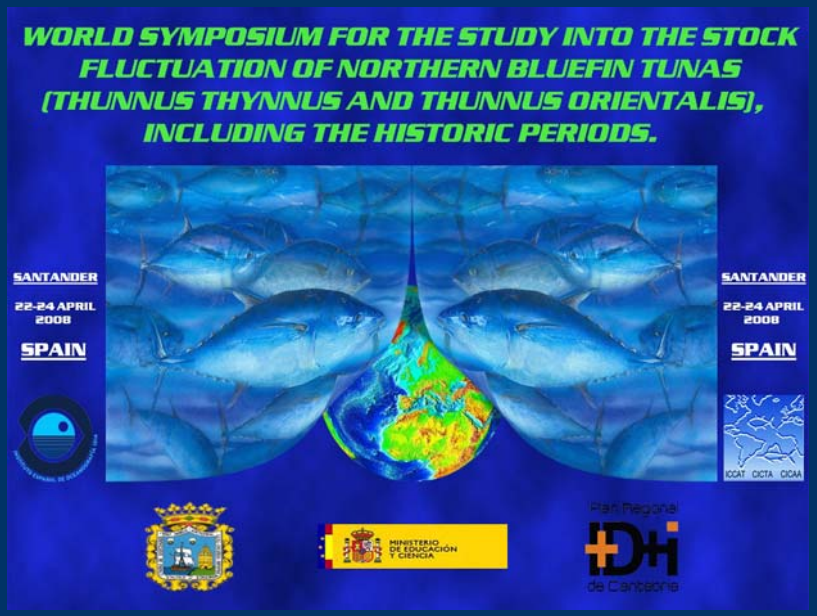
INSTITUTO ESPAÑOL DE OCEANOGRAFÍA 1914

ICCAT CICTA CICAA

MINISTERIO DE EDUCACIÓN Y CIENCIA

Plan Regional I+D+i de Cantabria

Ecological and Fishing Influences on Presence of Bluefin Tuna in Northern European Waters



Brian R. MacKenzie
Technical University of Denmark & Aarhus University
National Institute for Aquatic Resources
DK-2920 Charlottenlund, Denmark
brm@aqua.dtu.dk

Talk Outline

1. Development of fisheries – catch, effort, environmental data pre-1950s (MacKenzie and Myers 2007: Fish. Res.)

2. Current state – why a decline and disappearance in 1960s
   -hypotheses

3. Prospects for recovery and reappearance

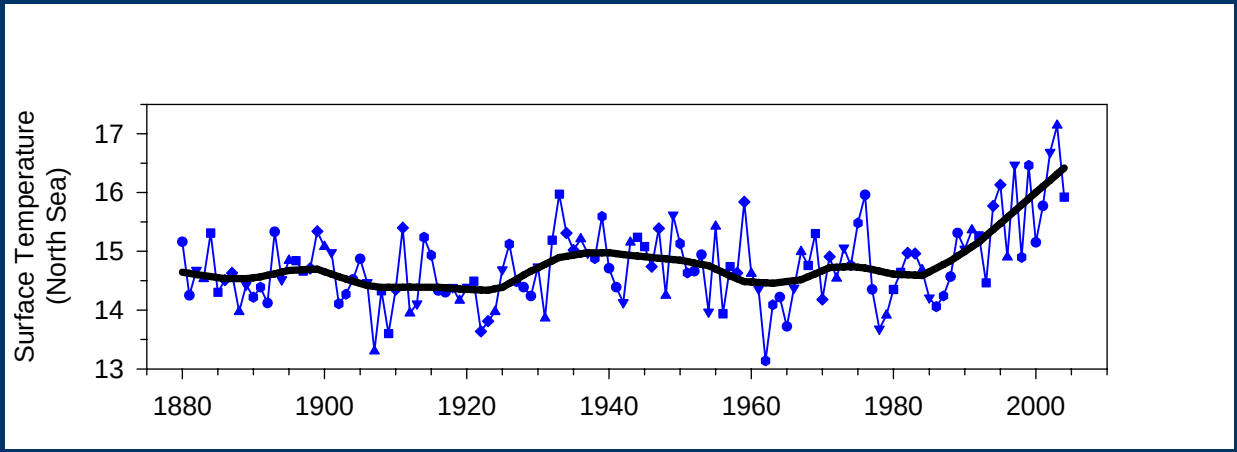
Hypotheses for Decline

Hypothesis
Temperature (too cold?)
Food abundance – not enough?
Change in migration pattern
Change in numbers of recruits migrating to region, due to -overexploitation of spawners and/or recruits -env. effects on recruitment processes

-need to understand processes over large areas

Tuna Presence and Multi-decadal Scale Temperature Variability

North Sea SST during Summer



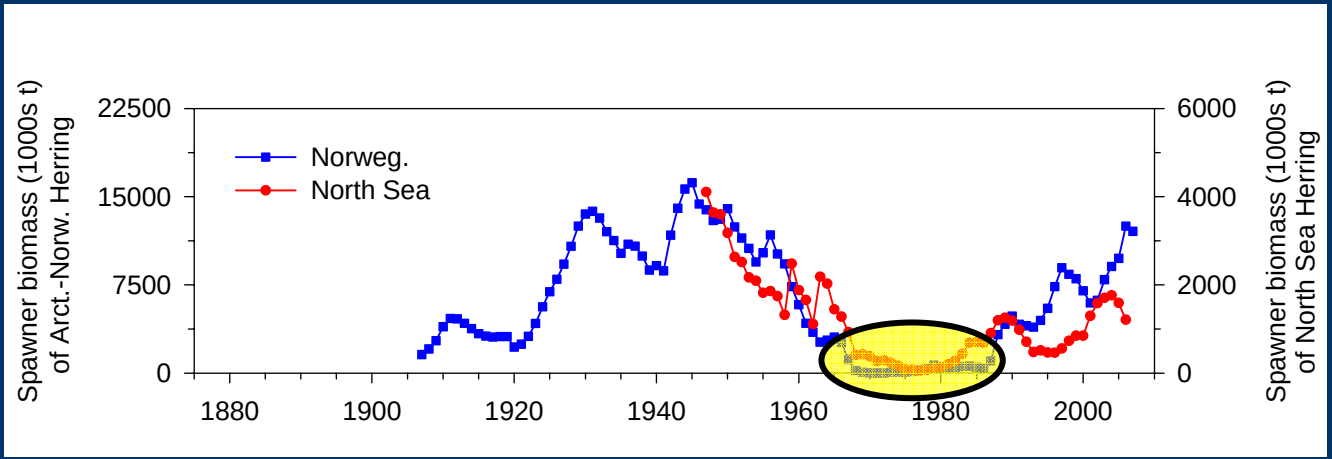
MacKenzie & Schiedek 2007
Glob. Ch. Biol.

SST during most of 1960s similar to earlier decades
when BFT were also present
-BFT also are good thermal-regulators and are usually seasonally present until SST < ~11-12 C
-decline not likely due to low temperature

MacKenzie & Myers 2007
Fish. Res.

Was Disappearance Related to Loss of Key Prey Species (Herring)?

-herring collapsed in both Norwegian and North Seas in 1960s (mainly due to overfishing; Fiksen & Slotte 2002; Cushing 1995):



Torsten & Østvedt 2000; ICES 2007

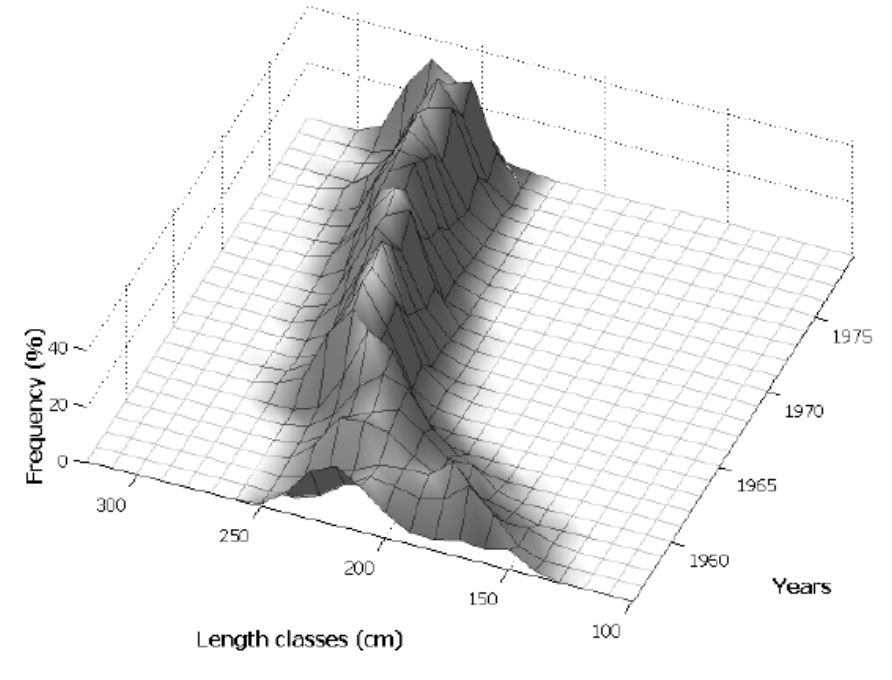
-bluefin tuna may have altered migration pattern since main food supply was nearly eliminated

MacKenzie et al., in prep.

Increase in Size

Despite loss of prey, some big tuna still migrated here during 1960s-1980s.

Decline accompanied by increase in size and age in Norwegian catches:



Fromentin & Powers 2005

-similar aging seen in Spanish catches (Pusineri et al. 2002)

Why Did Medium-Sized Tuna Stop Migrating to Northern Europe?

Possible reasons:

-young tuna changed their migration pattern (e. g., went somewhere else, stayed in Mediterranean, etc.)

-reduced *production* of young tuna (low recruitment) due to fewer adults

-lower *survival* of young tuna as juvenile exploitation increased (e. g., juvenile landings were 450,000/year in B. Biscay and Morocco during 1949-62; Cort & Nøttestad 2007)

Cause of Decline

Main reason probably exploitation.

Disappearance followed increasing and heavy exploitation of bluefin tuna and its prey in several areas:

Species	Area	LH Stage
BFT	Norwegian Sea	Mainly adults
BFT	North Sea	Mainly adults
BFT	Bay of Biscay	Mainly juveniles
Herring	Norwegian Sea	Juv. + adults
Herring	North Sea	Juv. + adults

MacKenzie et al.,
in prep.

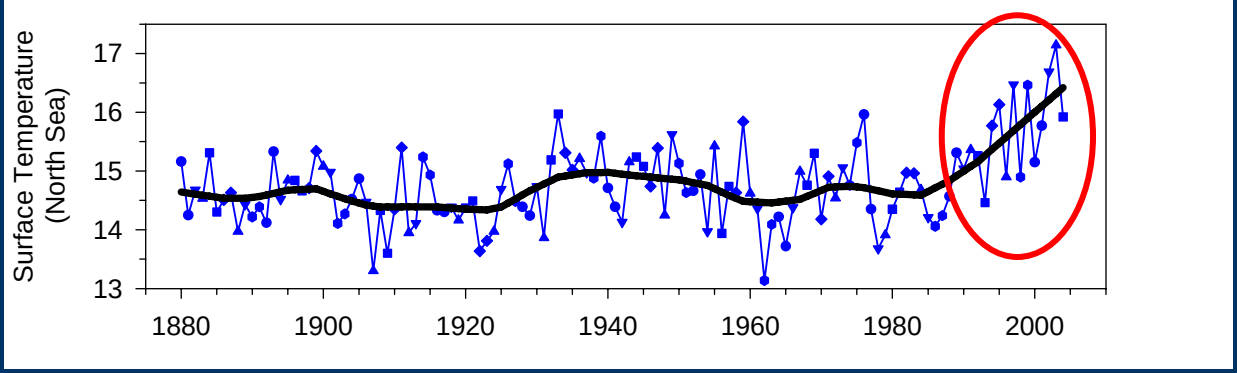
Reappearance

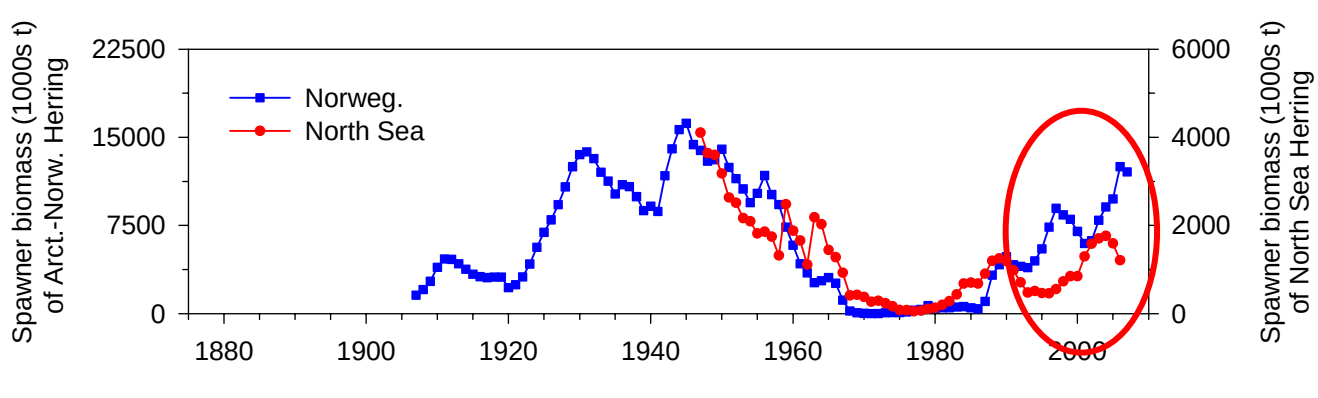
Will they return?

When?

Tuna Presence and Ecosystem Properties

If presence depends on warm temperatures and high food abundance, then there should be lots of tuna in these waters:





MacKenzie et al.
n prep.

Immigration of “Southern” Species to Northern European Waters

-ocean warming is allowing many fish species to expand habitats to North and Norwegian Seas…

ICES Marine Science Symposia, 219: 261–270. 2003.

Changes in fish distribution in the eastern North Atlantic: Are we seeing a coherent response to changing temperature?

K. Brander, G. Blom, M. F. Borges, K. Erzini, G. Henderson, B. R. MacKenzie, H. Mendes, J. Ribeiro, A. M. P. Santos, and R. Toresen

REPORTS

Science 308: 1912-1915 (2005)

Climate Change and Distribution Shifts in Marine Fishes

Allison L. Perry,[1]* Paula J. Low,[2]† Jim R. Ellis,[2] John D. Reynolds[1]*

Vol. 284: 269–278, 2004 | MARINE ECOLOGY PROGRESS SERIES Mar Ecol Prog Ser | Published December 21

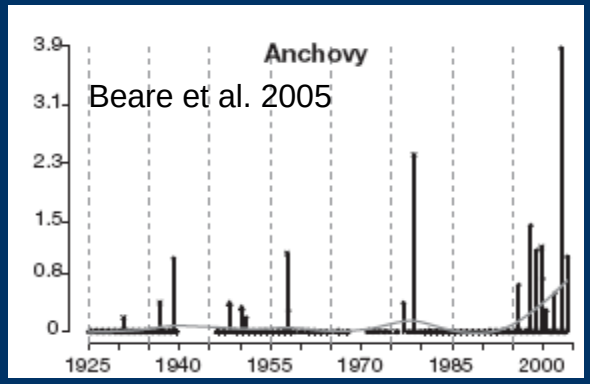
Long-term increases in prevalence of North Sea fishes having southern biogeographic affinities

D. J. Beare*, F. Burns, A. Greig, E. G. Jones, K. Peach, M. Kienzle, E. McKenzie, D. G. Reid

Fisheries Research Services, Marine Laboratory, PO Box 101, Victoria Road, Torry, Aberdeen AB11 9DB, UK

“Southern” Species Moving North

Anchovy, survey data, 1925-2004



torsdag den 21. september 2006 FISKERI TIDENDE

Sværdfisk i nettet

Ud over brisling var der også en enkelt sværdfisk i nettet, da Jens Granlund og makkeren Dennis Rasmussen i sidste uge trak trawlet op i Baaring Vig. En stor krabat på 2,65 meter og 66 kg.

- Først troede vi, det var en gren, men da trawlet kom helt om bord, kunne vi se, at det var en sværdfisk, siger Jens Granlund.

Han regner ikke med at fange flere sværdfisk foreløbig.

- Nej, det var første gang i mine 28 år som fisker. Og sikkert også sidste gang. Jeg tror ikke på, at farvandene bliver så varme, at det bliver noget, vi kommer til at opleve oftere, siger Jens Granlund.

Sværdfisken har uden tvivl været på jagt efter brisling, som er en af dens foretrukne fødeemner. Det er netop grunden til, at den er havnet i nettet hos Jens Granlund og makkeren Dennis Rasmussen. Men der sker ikke noget ved at få en sværdfisk i nettet, selvom navnet kunne antyde noget andet.

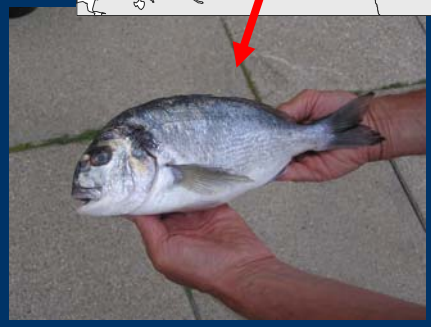
- Sværdet er ikke skarpt eller spidst, så den ødelægger ikke trawlet, påpeger Jens Granlund.

Den store fisk blev i øvrigt solgt til Baaring Fisk, som anslår, at sværdfisken rækker til mellem 300 og 400 fiskemenuer.

- cki

Skipper Jens Granlund (tv.) og makkeren Dennis Rasmussen med den store sværdfisk, som de fik i nettet i sidste uge. Den er 2,65 meter og vejer 66 kg. (Foto: Peter Leth-Larsen, Fyens Stiftstidende)

Swordfish *Xiphias gladius;* 66 kg
Little Belt
September, 2006



Gilthead seabream *Sparus aurata*
Guldborgsund, western Baltic
July 2007

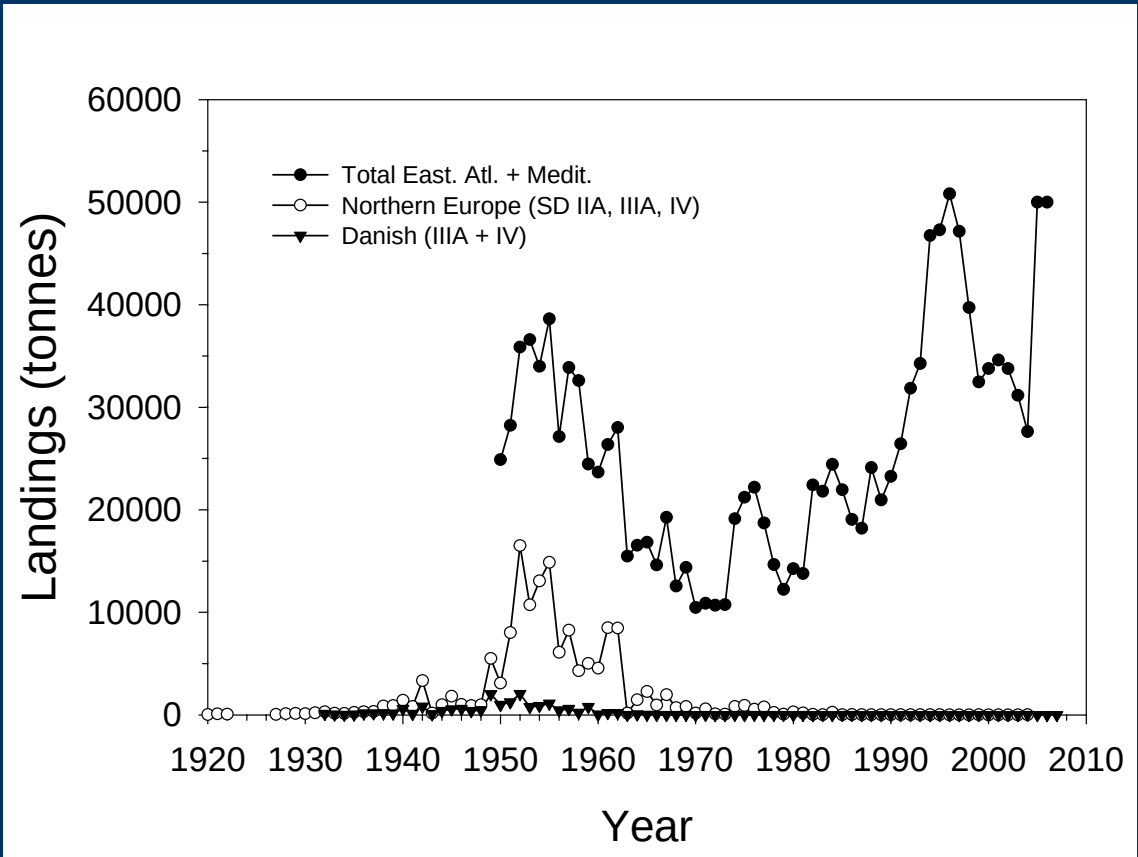
Bluefin Tuna Reappearance?

Bluefin tuna still very rare

-1 caught as bycatch in Skagerrak in 2004

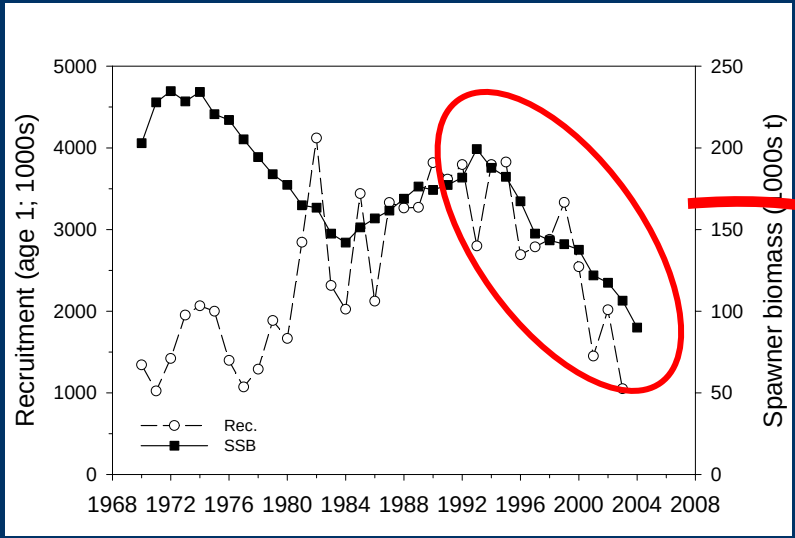
-must consider other explanations related to population and fishing

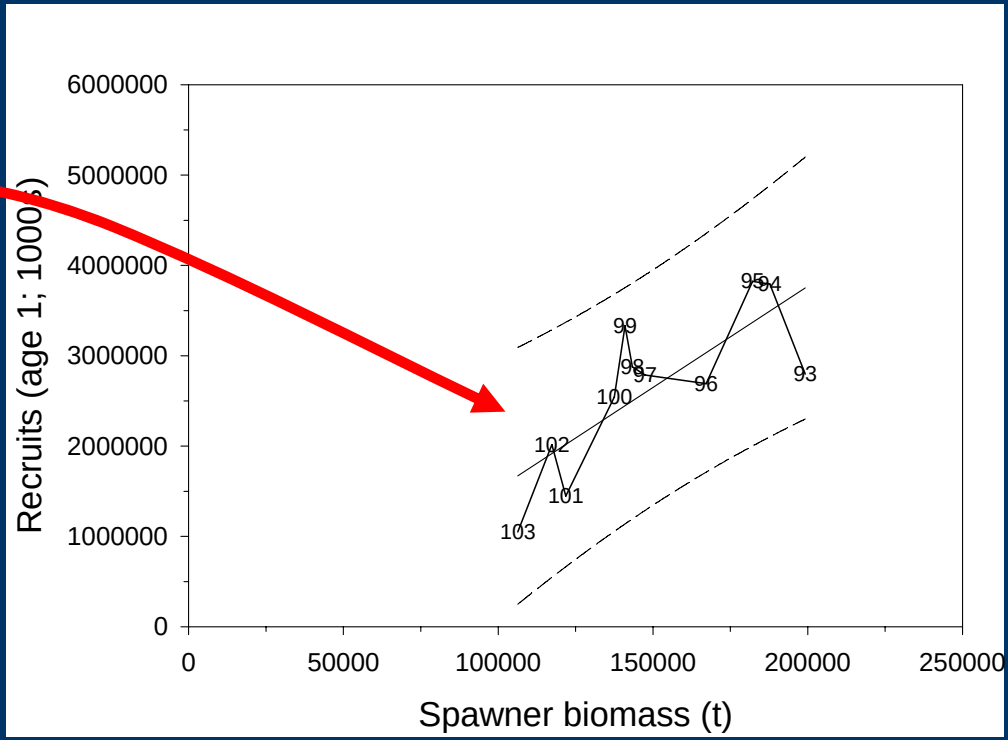
Bluefin Tuna Catch Development



-large increase in reported landings in recent decades

Spawner – Recruit Temporal Development





-decrease of spawner biomass is now limiting recruitment

MacKenzie et al. in prep.

Reproductive Potential

In other fish species and populations:

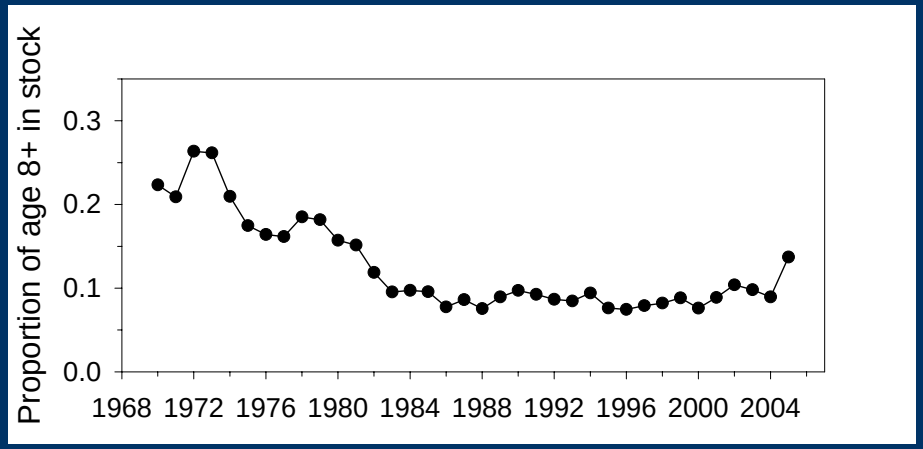
-older, larger females and repeat spawners produce

-more eggs/g,
-better quality eggs
-eggs over larger areas
-eggs over longer periods of the year

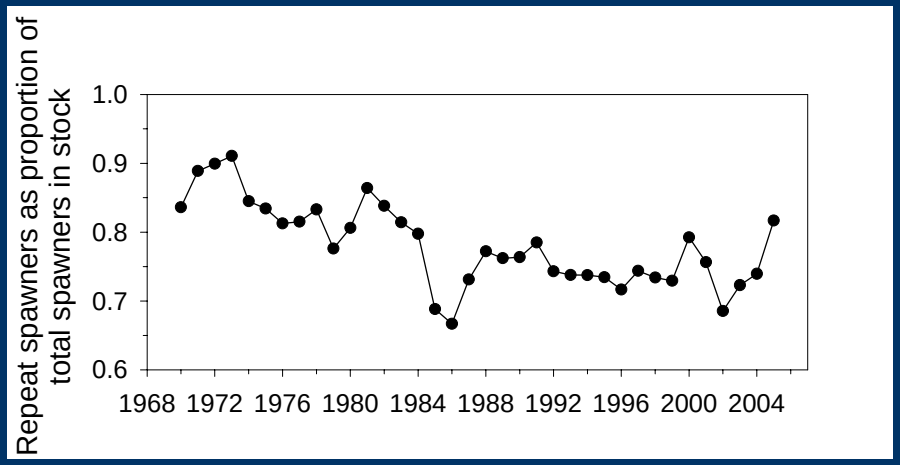
(Kjesbu, Marshall, Marteinsdottir, papers…)

How has age structure of bluefin tuna changed relative to reproductive potential?

Population Demographics



-proportion of old tuna in stock has declined, even from 1970



-proportion of repeat spawners has decreased

Trends in Population Demographics

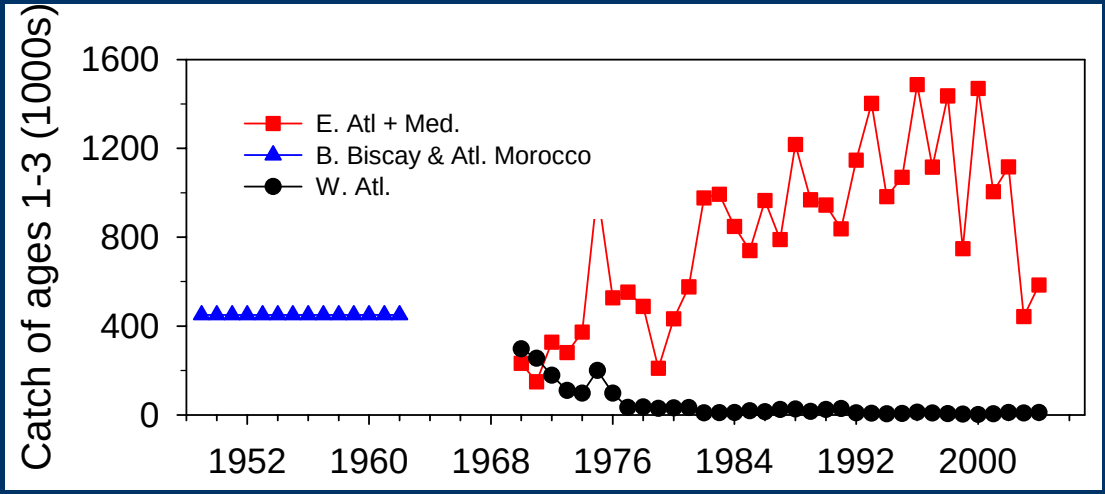
Reproductive potential of bluefin tuna has probably been reduced, for reasons in addition to the decrease in biomass of spawners.

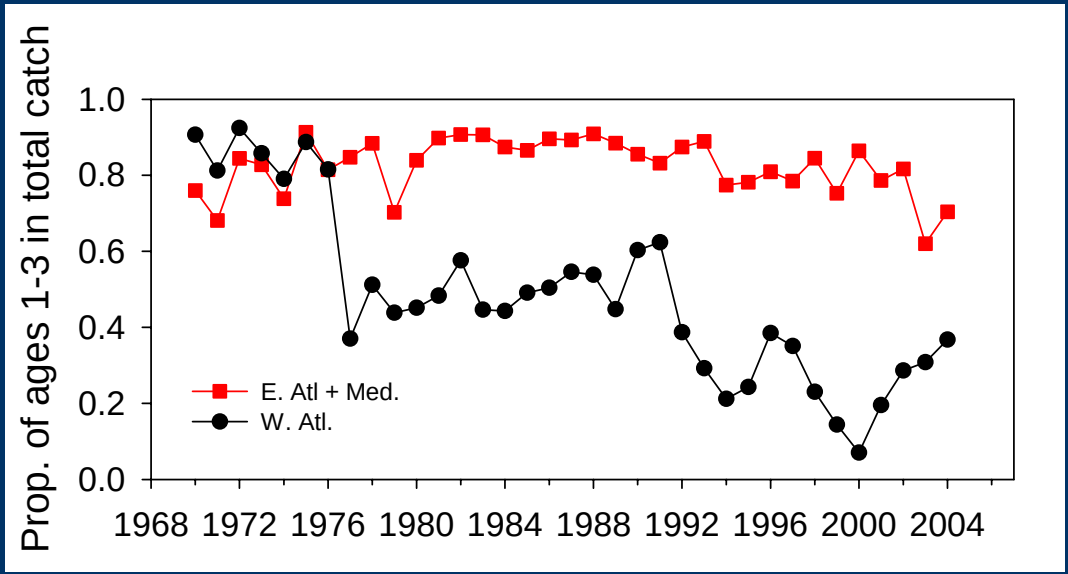
-*quality* of reproductive output may have decreased

(assuming that BFT respond like other fish species?)

-this will make recovery difficult and slower.

Landings of Juvenile Bluefin Tuna





Large numbers of 0-groups are also caught in E. Atl. and Med. but landings are unknown (ICCAT 2003, 2006).

ICCAT 2006 (1970-2004);
Cort & Nøttestad 2007 (1949-62)

Fishing Pattern in Eastern Atlantic

-landings in Eastern Atlantic and Mediterranean dominated by immature fish

-effects on past and future population dynamics needs to be investigated and quantified.

-existing studies suggest exploitation of juveniles and adults is not sustainable (Fromentin & Fonteneau 2001)

-many bluefin tuna not being given opportunity to reproduce

Conclusions (post 1950)

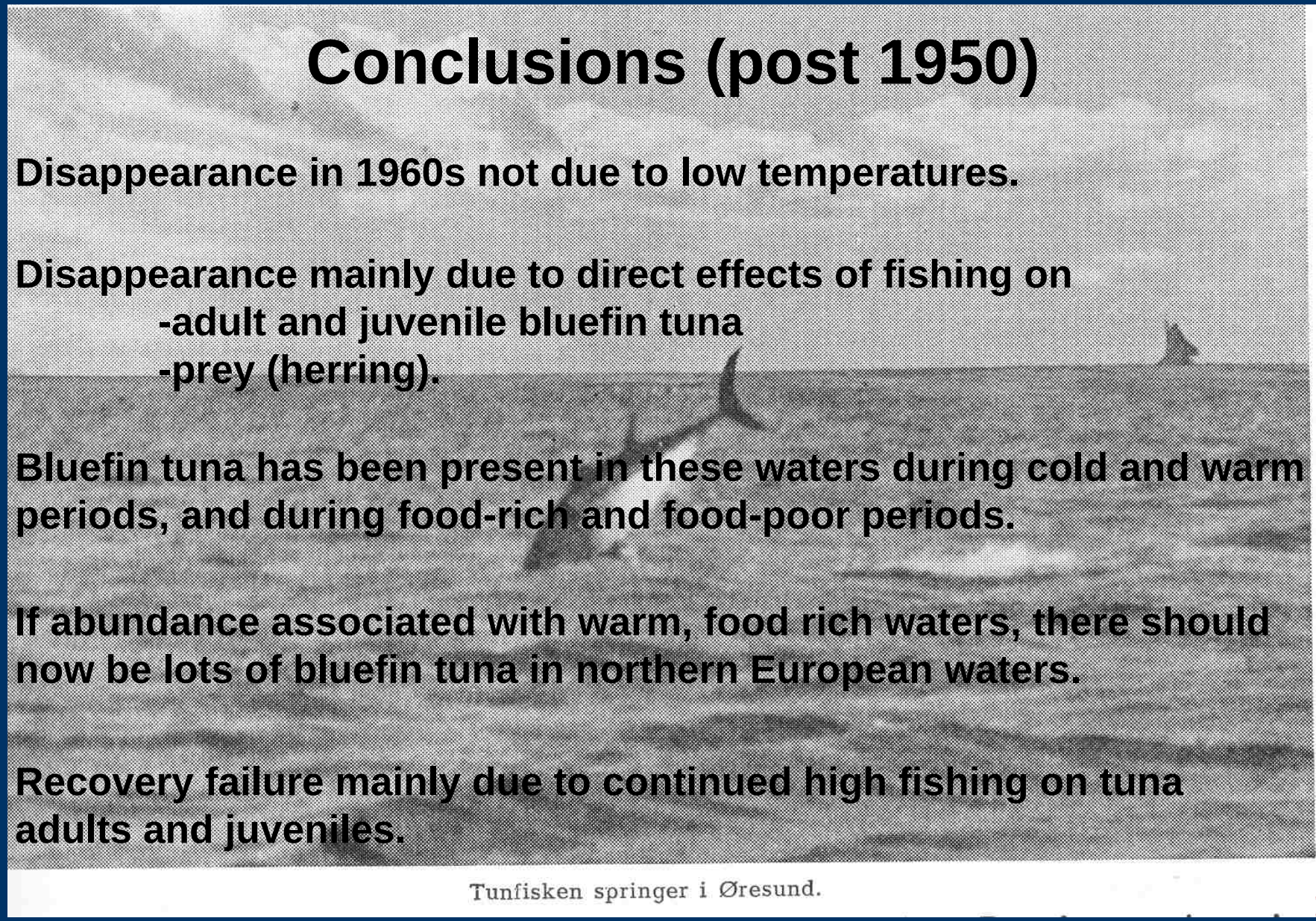
Disappearance in 1960s not due to low temperatures.

Disappearance mainly due to direct effects of fishing on
-adult and juvenile bluefin tuna
-prey (herring).

Bluefin tuna has been present in these waters during cold and warm periods, and during food-rich and food-poor periods.

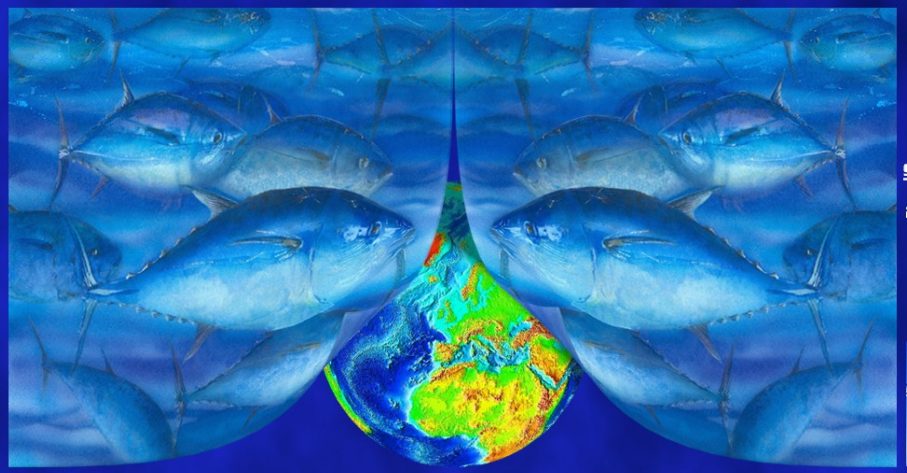
If abundance associated with warm, food rich waters, there should now be lots of bluefin tuna in northern European waters.

Recovery failure mainly due to continued high fishing on tuna adults and juveniles.



Tunfisken springer i Øresund.

WORLD SYMPOSIUM FOR THE STUDY INTO THE STOCK FLUCTUATION OF NORTHERN BLUEFIN TUNAS (THUNNUS THYNNUS AND THUNNUS ORIENTALIS), INCLUDING THE HISTORIC PERIODS.



SANTANDER

22-24 APRIL 2008

SPAIN

SANTANDER

22-24 APRIL 2008

SPAIN

INSTITUTO ESPAÑOL DE OCEANOGRAFÍA 1914

ICCAT CICTA CICAA

MINISTERIO DE EDUCACIÓN Y CIENCIA

Plan Regional I+D+i de Cantabria