Assessment of Atlantic mackerel in subareas 3-4

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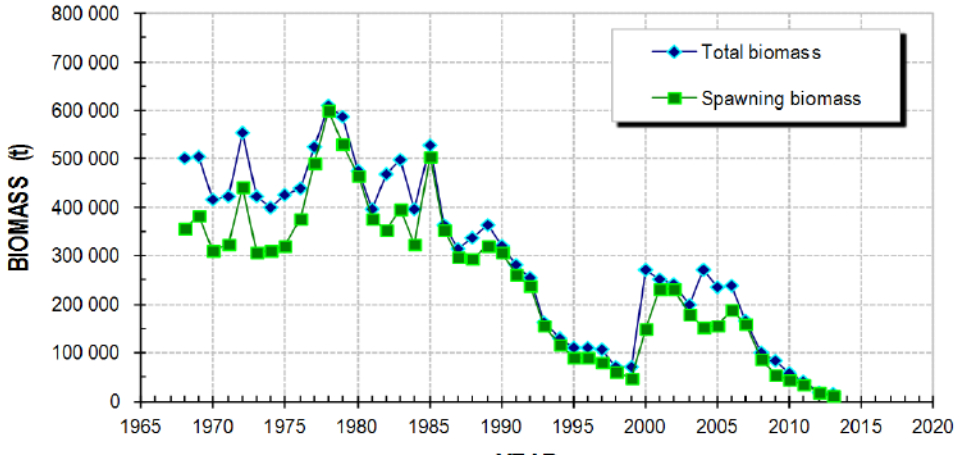
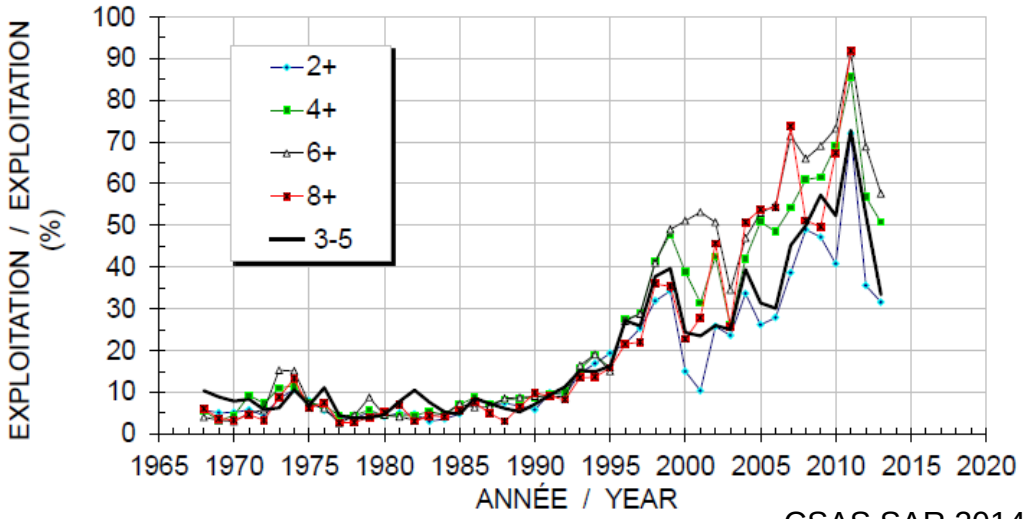
Assessment schedule

- Last assessment: 2014
- 2016 assessment delayed until à 2017
- December 2016: data review (eggs)
- January 2017: framework assessment (new model)
- March 2017: stock assessment
  - Use of new model
  - Data update 2013, 2014, 2015, 2016
    - Landings
    - Biological data
    - Egg surveys

Summary of 2014 assessment

- Commercial landings and biomass ↓, fishing mortality ↑
- Egg survey ↓, contracting age structure
- Modelled stock abundance at lowest historic level in 2013 (~10,000 t)
- Stock status: Critical, as below three possible LRPs
- Based on model and declared catches, Science Advice recommended TAC of 800 t
- Model predicted unrealistically low biomass
- Did not take undeclared catches into account



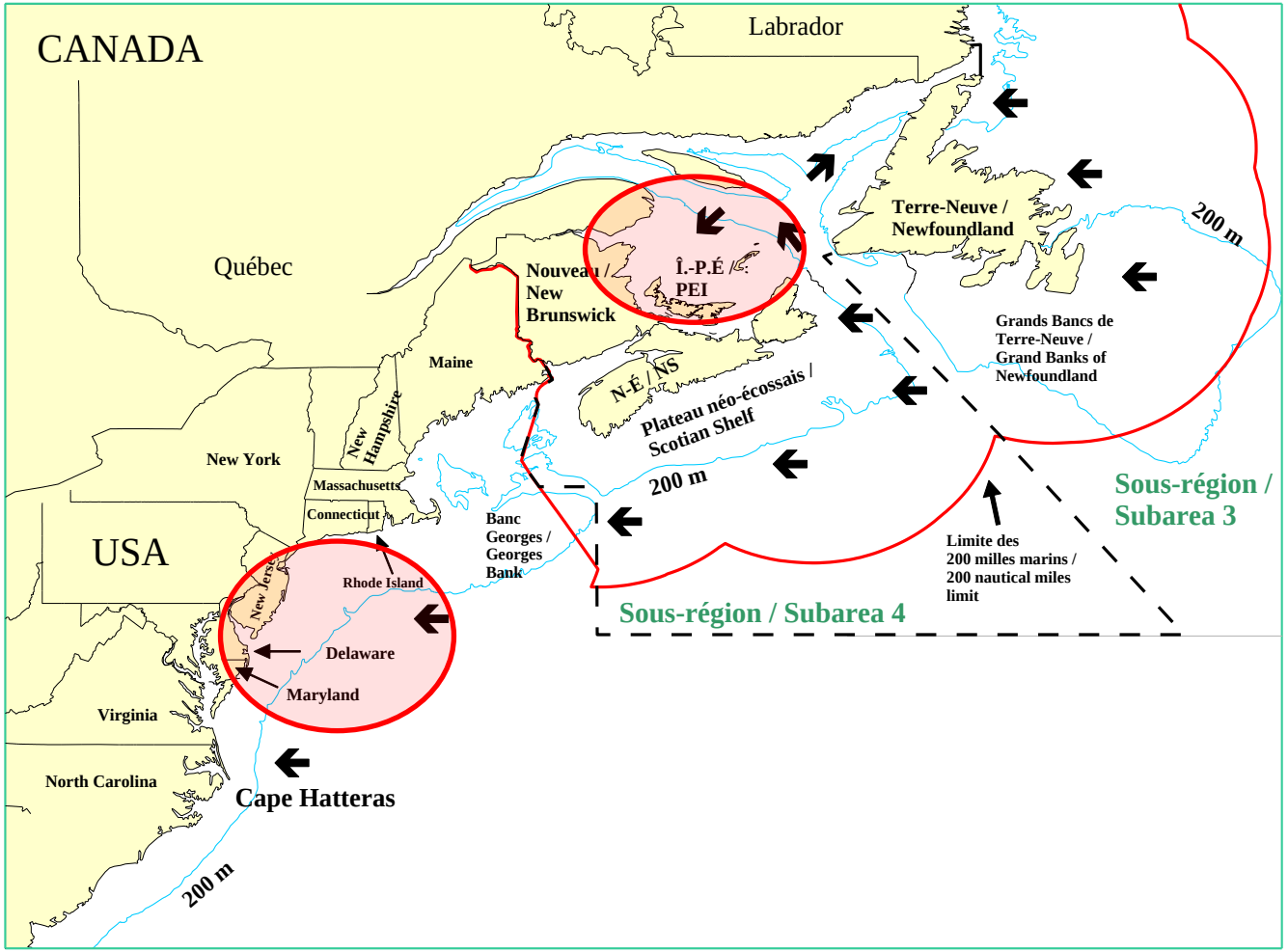


CSAS SAR 2014/030

Undeclared catches

- Mackerel used as bait for crab and lobster fisheries
- Large proportion of undeclared catches: bait for personnal use, fisher-to-fisher sales, recreational fishing, unfilled logbooks
- Differences between management regions
- This creates a major problem affecting the quality of the assessment

Distribution and migration

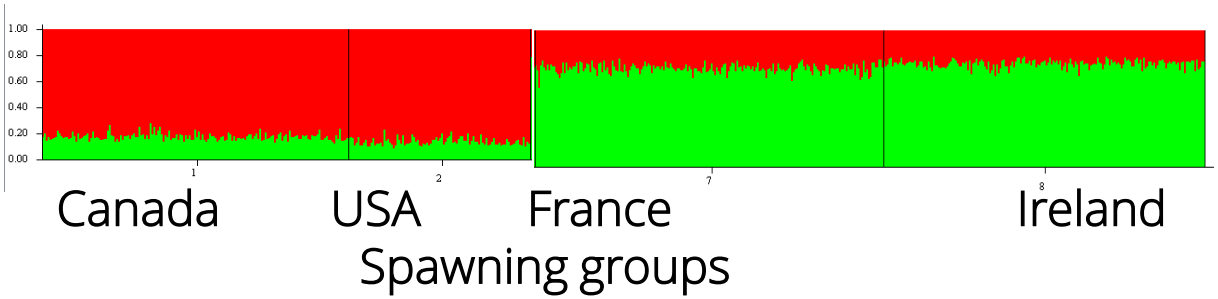


Mackerel population structure

- Mackerel stocks in Europe at very high levels. ICES advised that 2016 TAC should not be higher than **773,842 t**
- Mackerel now abundant in the Central Atlantic (Iceland & Greenland) : TAC 85,000 t in Greenland in 2015
- Where does this Central Atlantic mackerel come from?

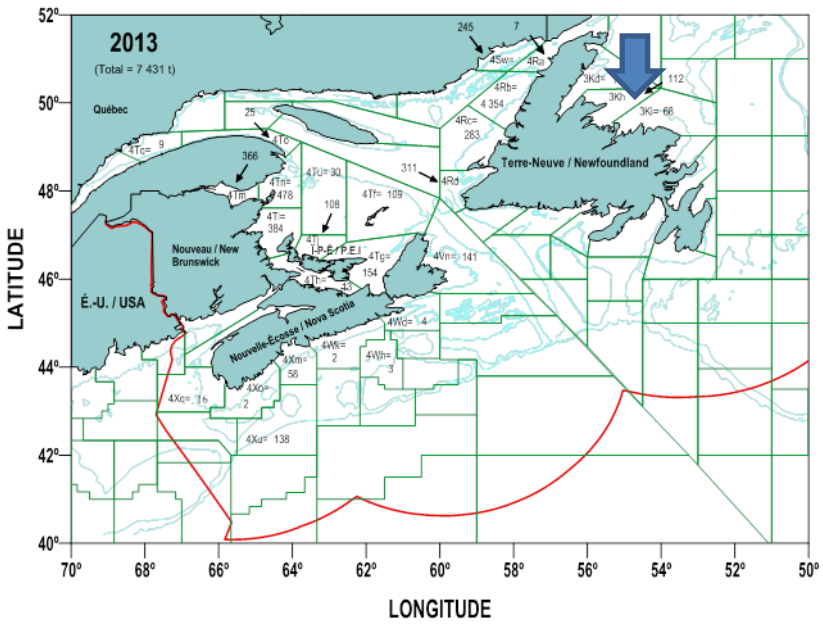
Mackerel population structure

- Recent genetic studies show that North American mackerel population is genetically distinct from the European one (Rodriguez-Ezpelata et al. 2016, Helyar et al. 2013; in prep)
- Mackerel from Iceland and Greenland originate exclusively from Europe
- Canadian and American stocks do not seem genetically distinct although few samples from North America

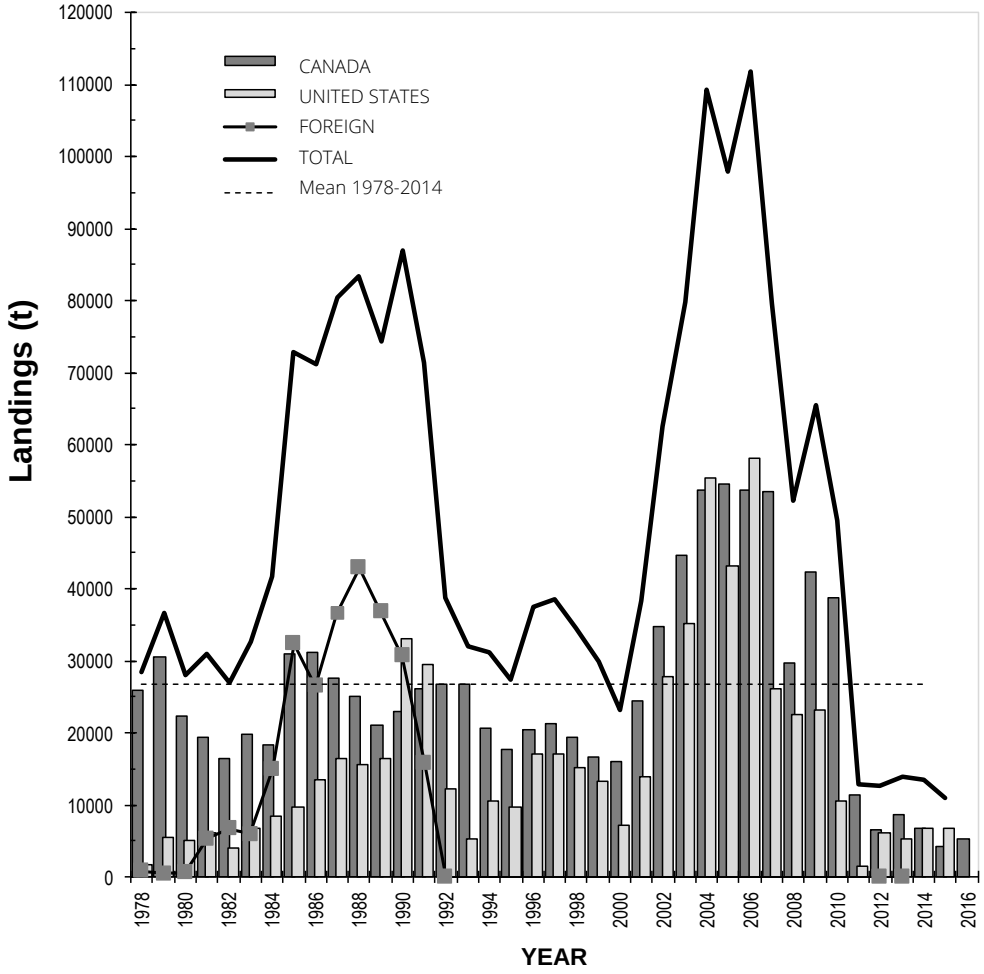


Upcoming research

- Collaborations to increase sample size and improve genetic/genomic studies
- New molecular tools for differences between Canadian and US spawning groups
- Has European population dispersed to North America ?
- Origin of young-of-the-year captured in 3K ?



Commercial catches 2013-2016

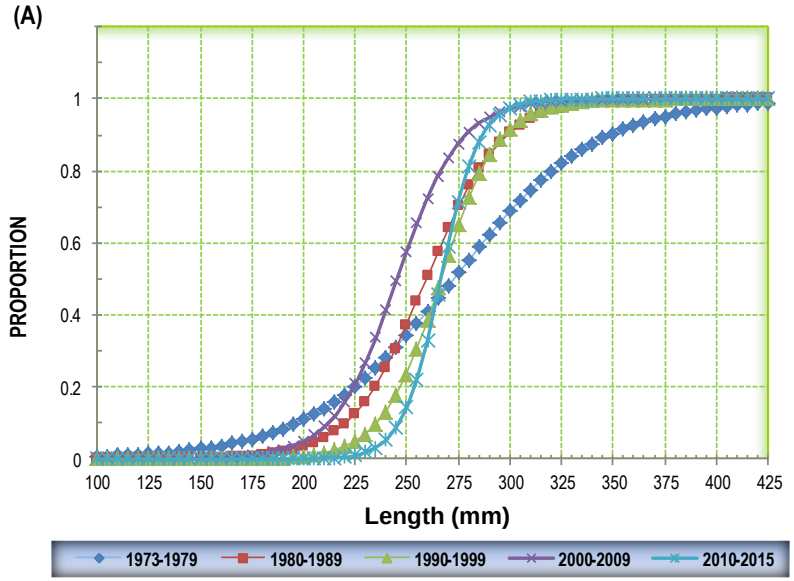


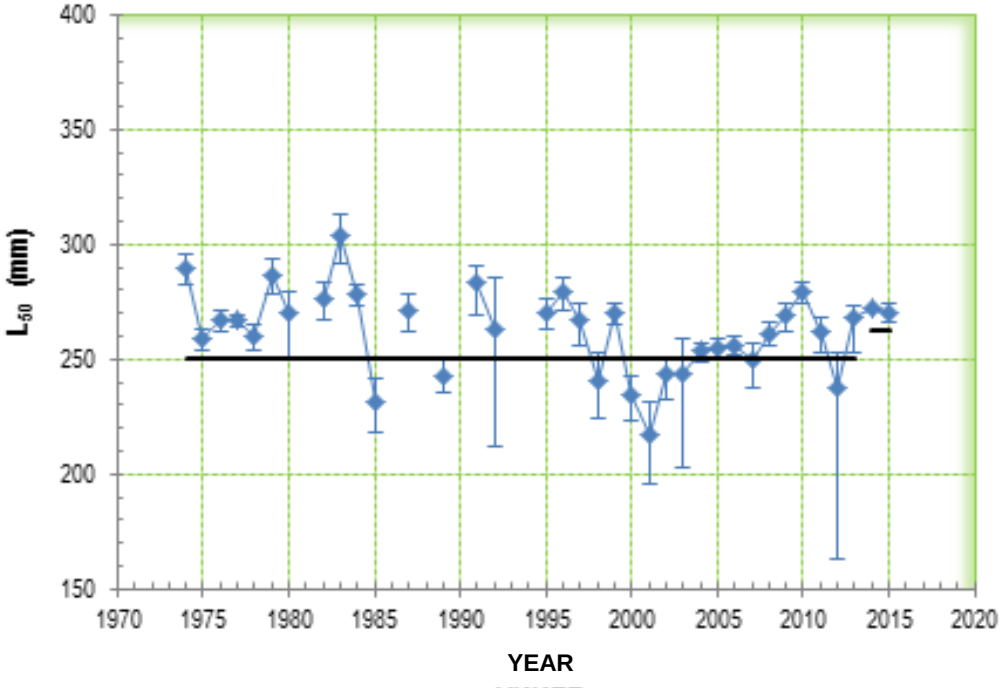
- Reported commercial landings in NAFO subareas 3 and 4 have decreased significantly in recent years. Between 2005 and 2013, they decreased from 54,621 t to 8,663 t before reaching 6,680 t in 2014 and 4,143 t in 2015. In 2016, the TAC of 8,000 t was reached.

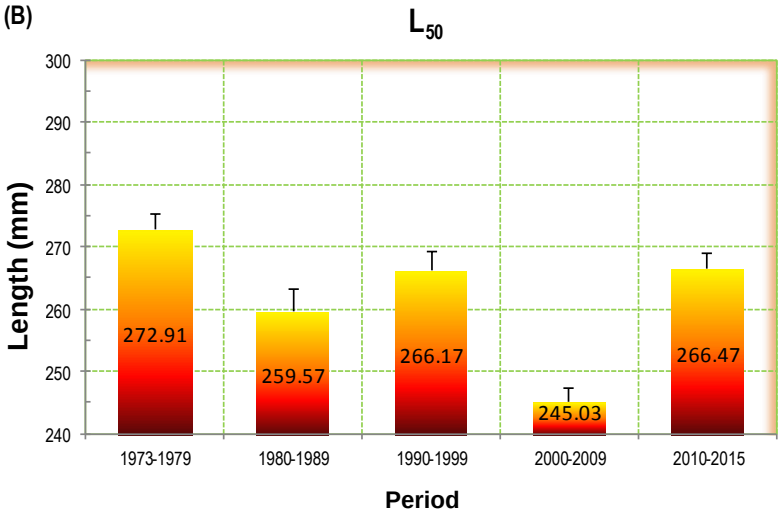
- US landings (commercial and recreational) in NAFO subareas 5 and 6 also decreased significantly in recent years. Between 2005 and 2012, they decreased from 43,220 t to about 6,000 t and have remained at that level from 2013 to 2015.

2016 catches	
Newfoundland	4,610 t
Quebec	852 t
Maritimes	1,203 t
Gulf	935 t (preliminary)

Length at 50% maturity

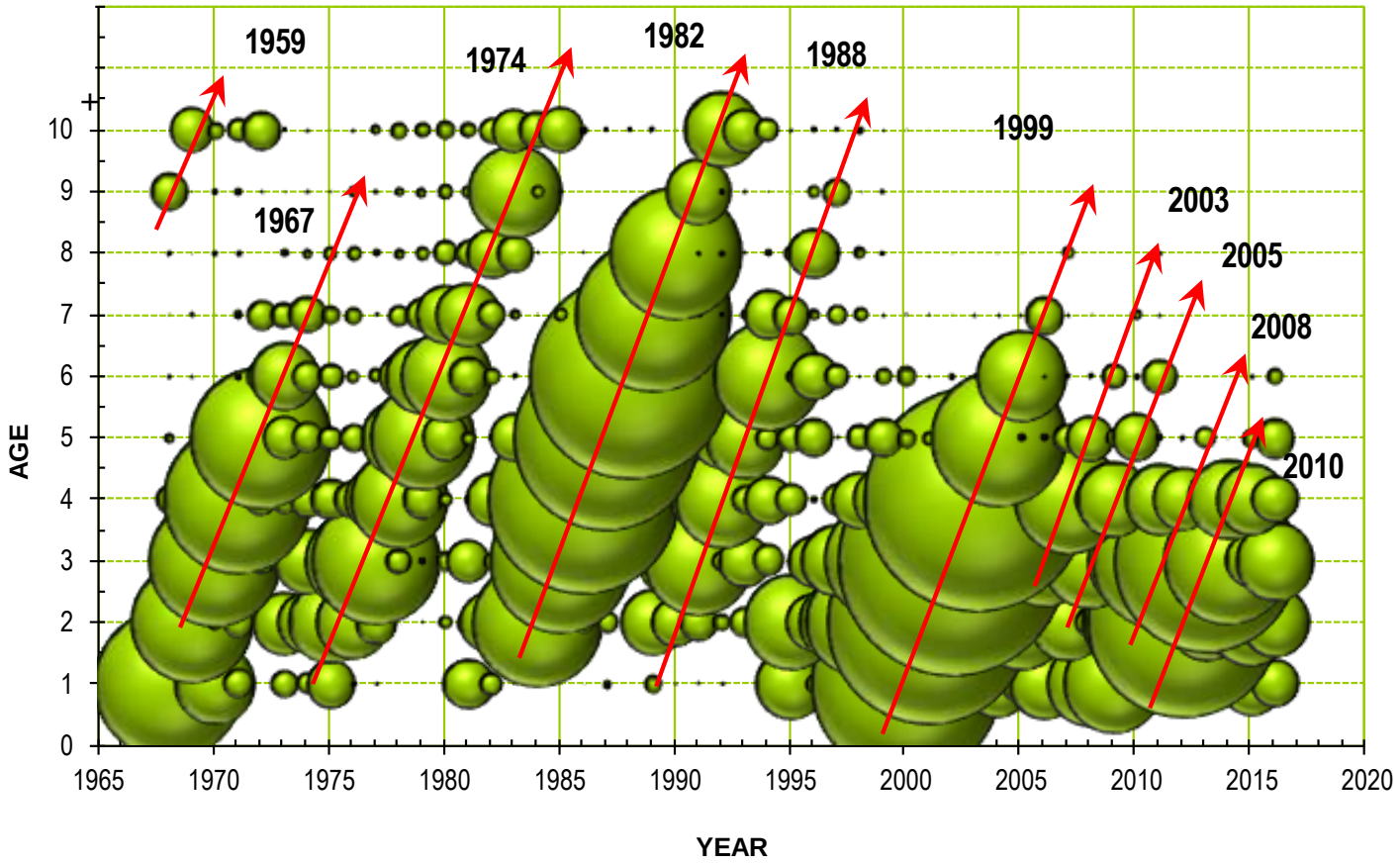






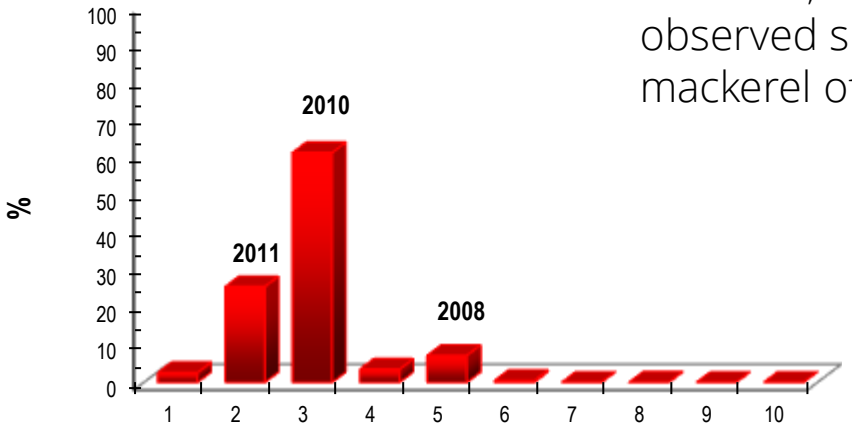
- Following its increase in recent years, the length at 50% maturity has remained slightly above the minimum authorized length of 263 mm.

Catch at age

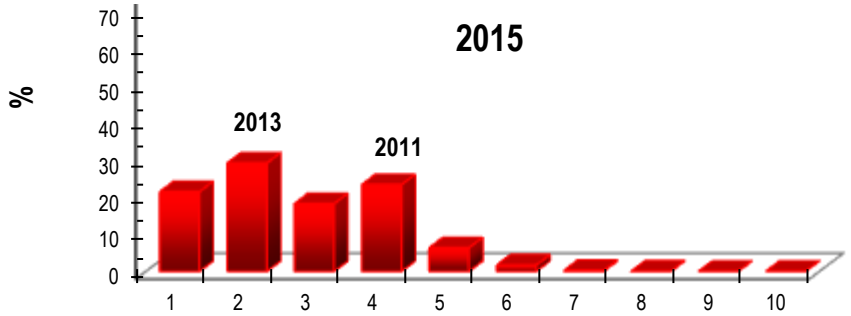

1959
1974
1982
1988
1999
2003
2005
2008
2010
1967
AGE
YEAR
0
1
2
3
4
5
6
7
8
9
10
+
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

- The age structure in the fishery has contracted considerably since 2000 following the disappearance of fish older than 7 years. However, a slight improvement has been observed since 2013, with an increase of mackerel of ages 5 and 6.

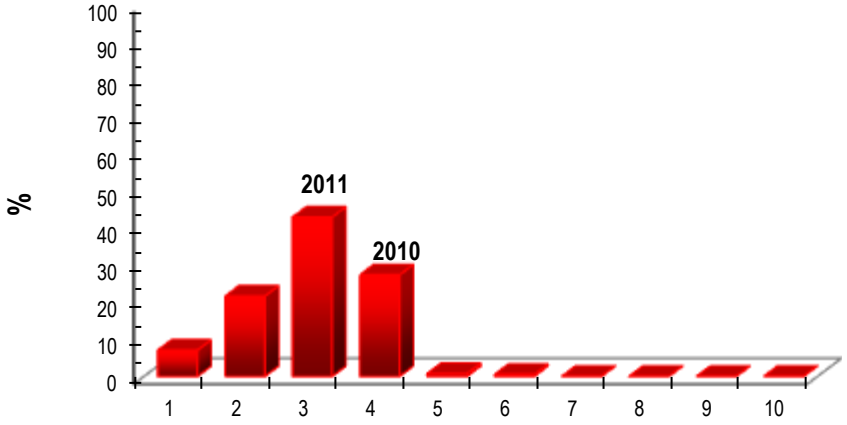
2013



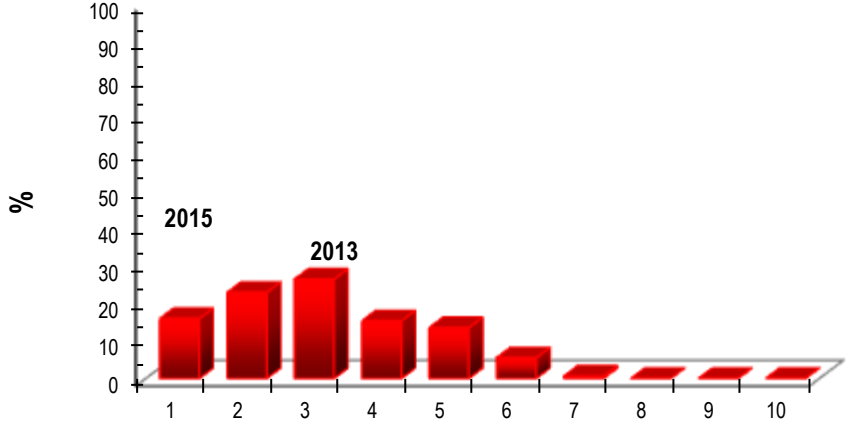
2015



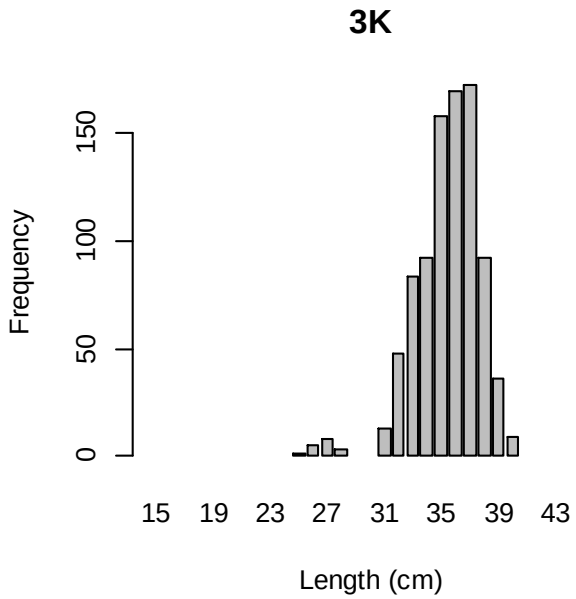
2014

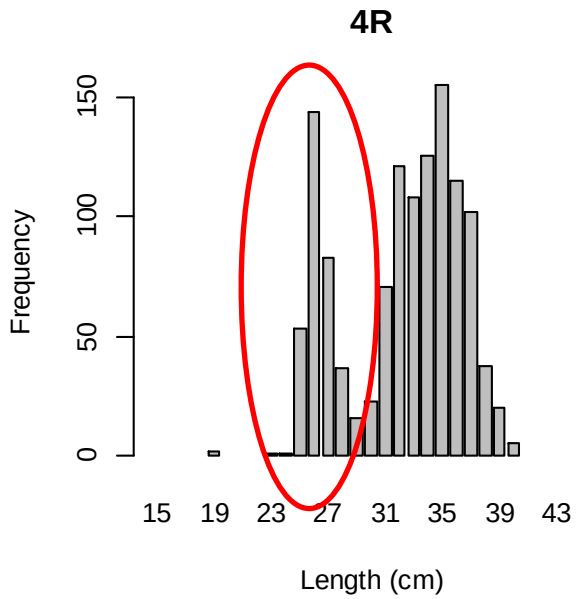


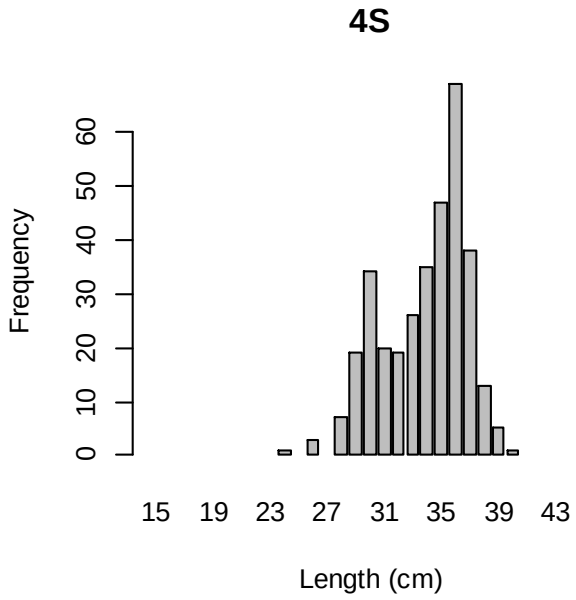
2016

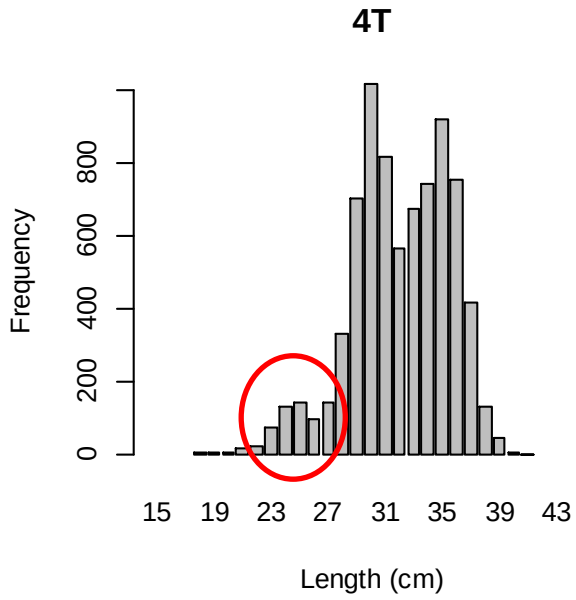


2016 length frequencies

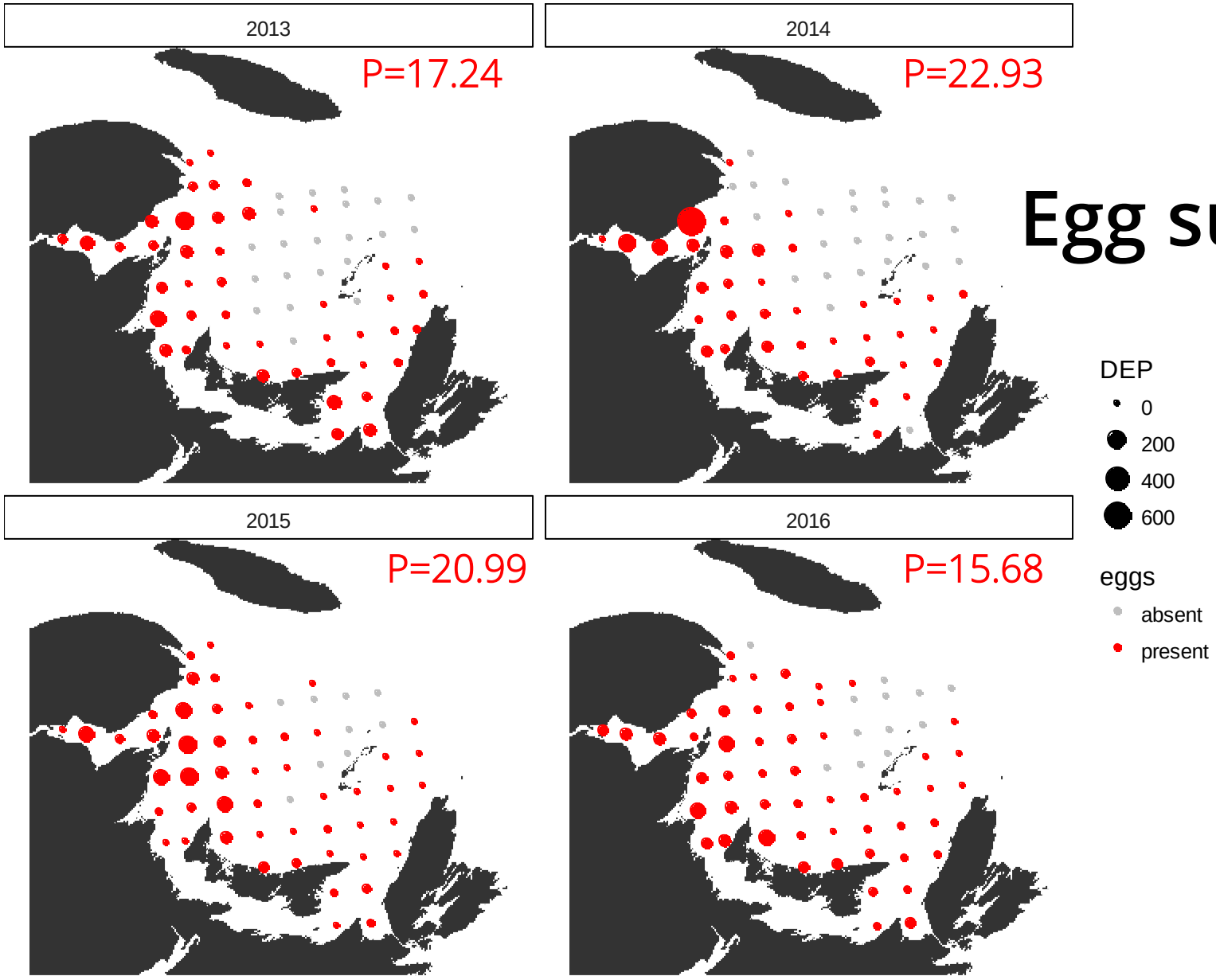






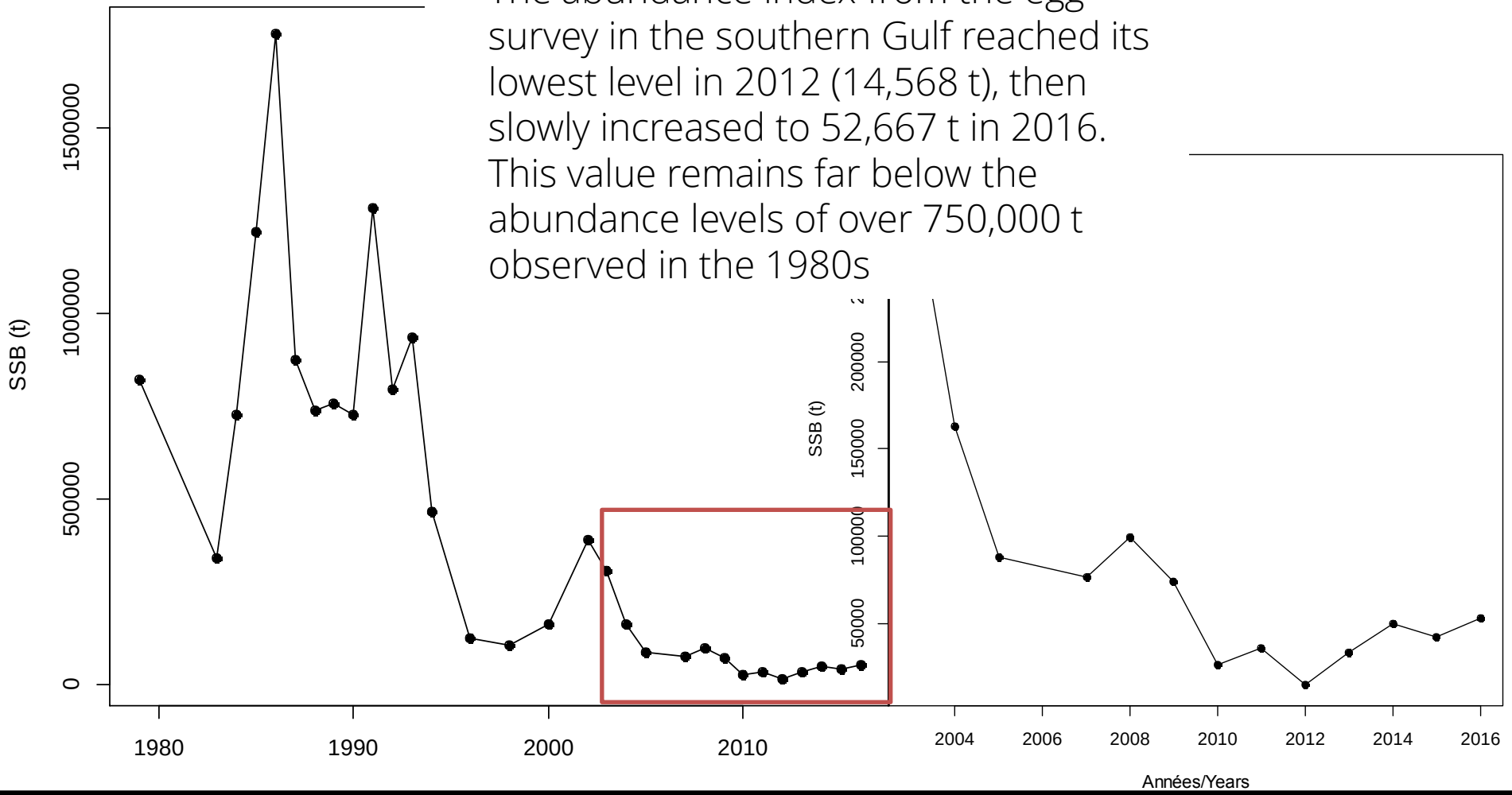


Egg surveys


2013
P=17.24
2014
P=22.93
2015
P=20.99
2016
P=15.68
DEP
0
200
400
600
eggs
absent
present

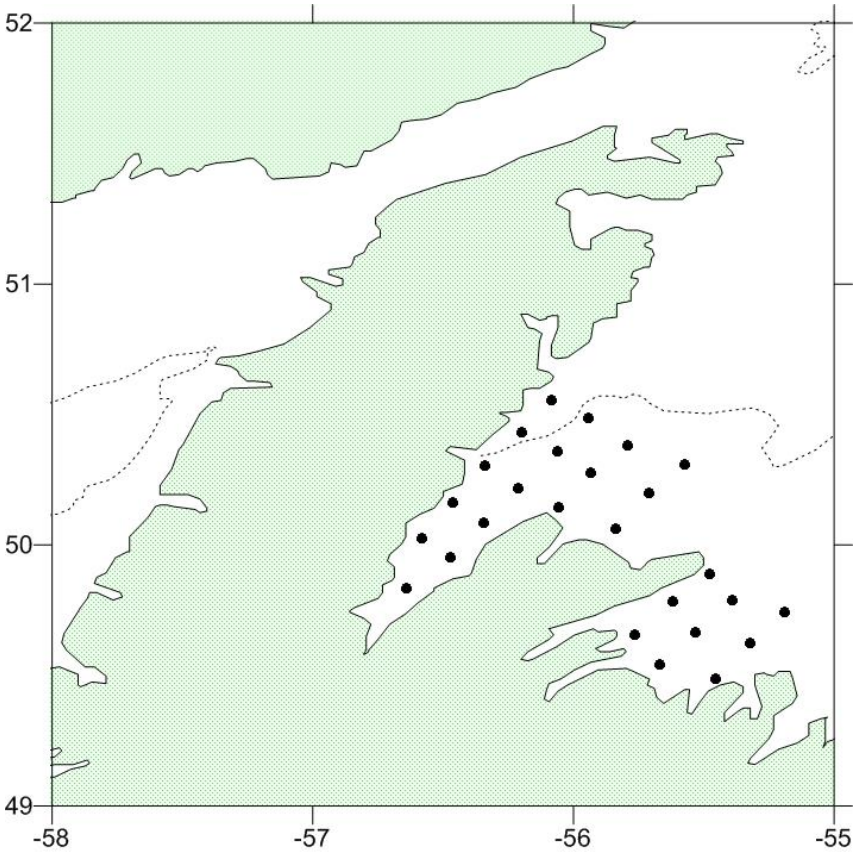
Abundance index (eggs)

- The abundance index from the egg survey in the southern Gulf reached its lowest level in 2012 (14,568 t), then slowly increased to 52,667 t in 2016. This value remains far below the abundance levels of over 750,000 t observed in the 1980s



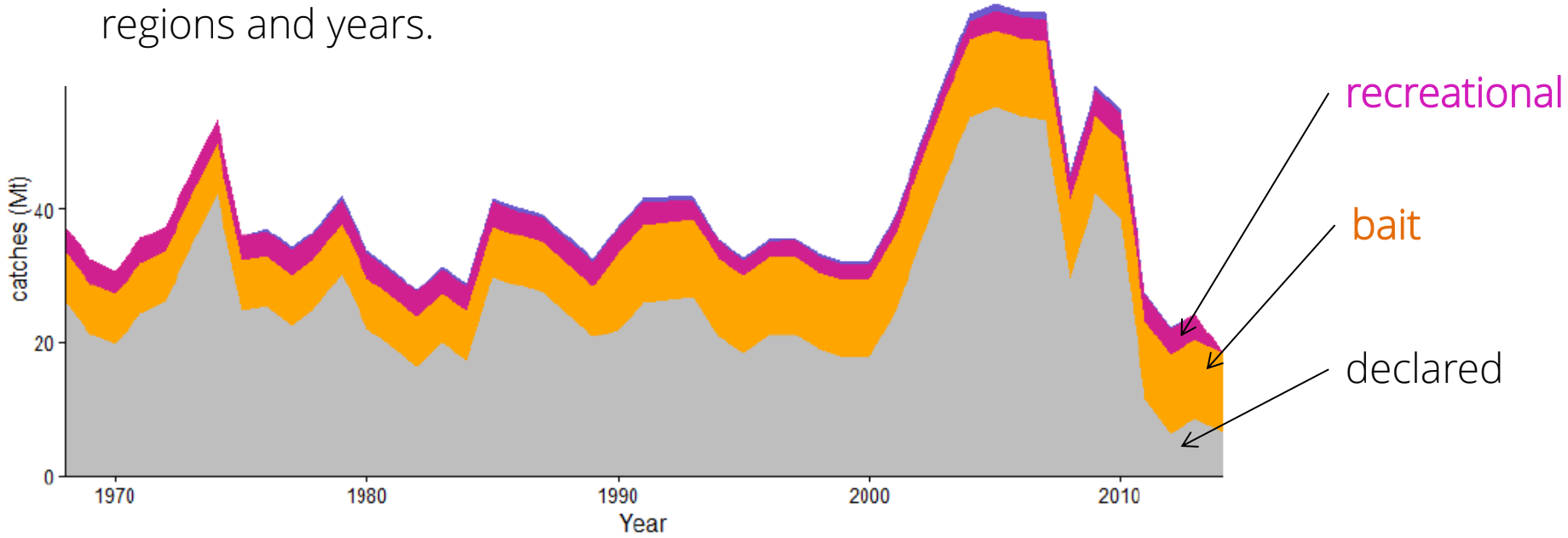
Additionnal egg surveys

- Objective: expand surveys to White Bay and Notre Dame Bay
- Collaborators: Dr. D. Robert (Memorial University), Dr. M. Castonguay & Dr. P. Pepin (MPO), Dr. E. Carruthers (FFAW)
- Dates: June-Aug. 2015 & 2016
- Results: no sign of spawning activity



Undeclared catches

- The issue of unrecorded catches has been investigated using a review of available data on bait needs and recreational fisheries, as well as an online survey aimed at mackerel fishermen. Both approaches show that total catches can reach 150% to 200% of declared catches, and that this ratio varies among regions and years.



Online survey 2016

- 3453 mails (QC, NB, NS,PEI)
- Three facebook groups
- Radio IM
- Forums
- NovaNews

Survey power?

In comparison:

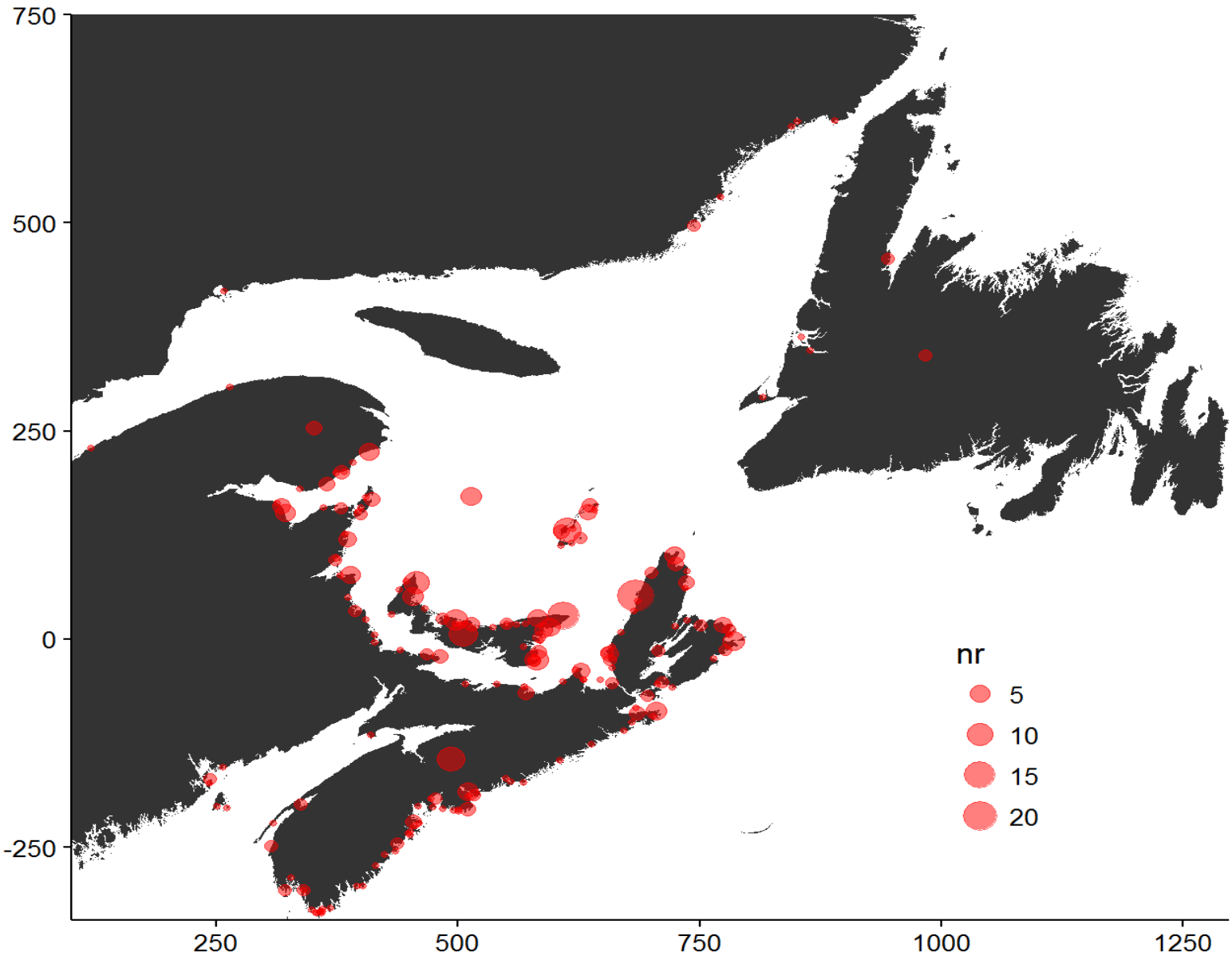
1) Number of licenses 2014 (DFO stats): 8082

=> 390 answers were from licensed fishers = AT LEAST 5%

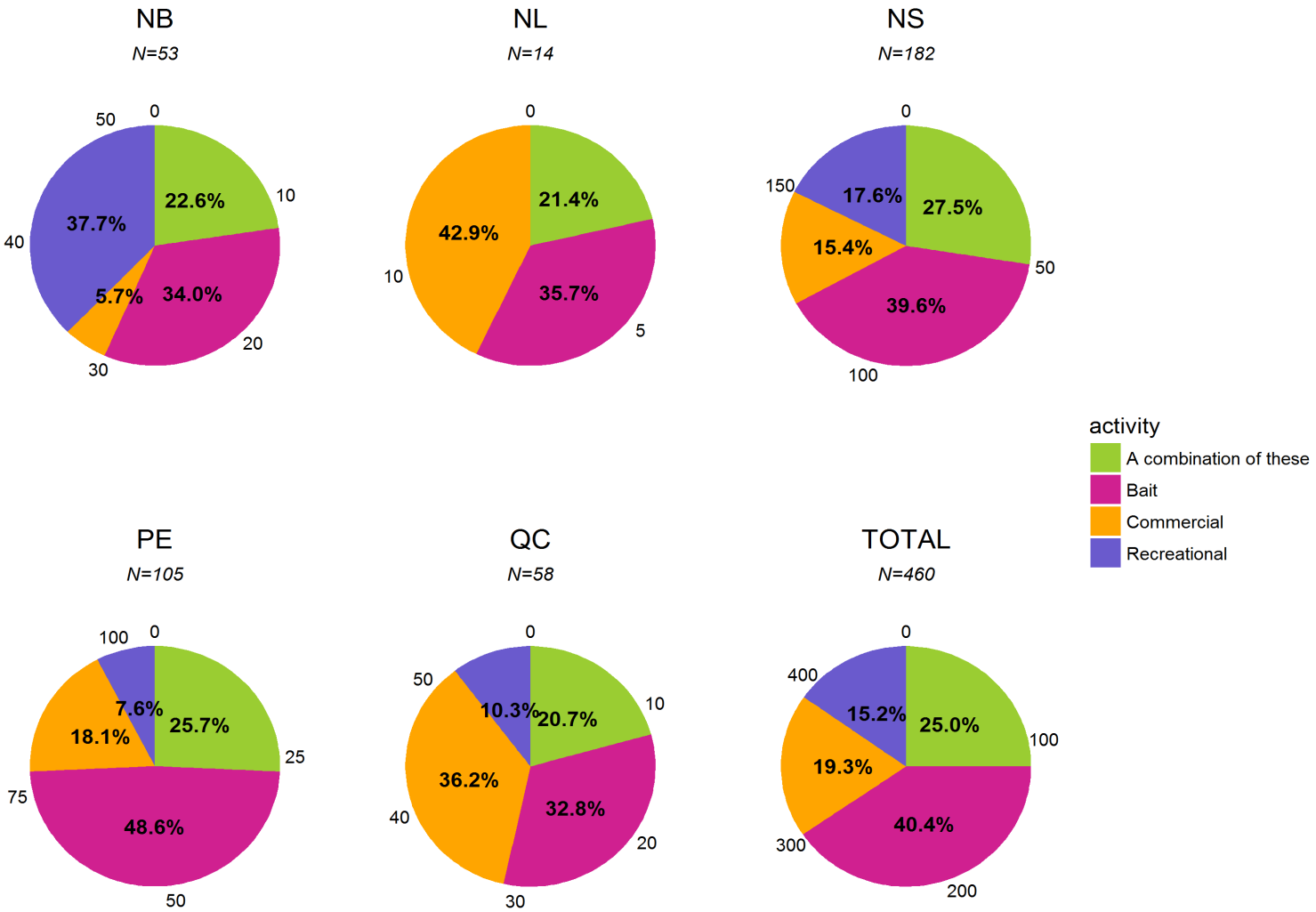
SPECIES	NOVA SCOTIA		NEW BRUNSWICK		P.E.I. GULF	QUEBEC	NEWFOUNDLAND	TOTAL ATLANTIC
	MARITIMES	GULF	MARITIMES	GULF				
MACKEREL	1,909	655	75	1,112	1,258	808	2,265	8,082

2) Catch 2016: ~8000t (TAC)

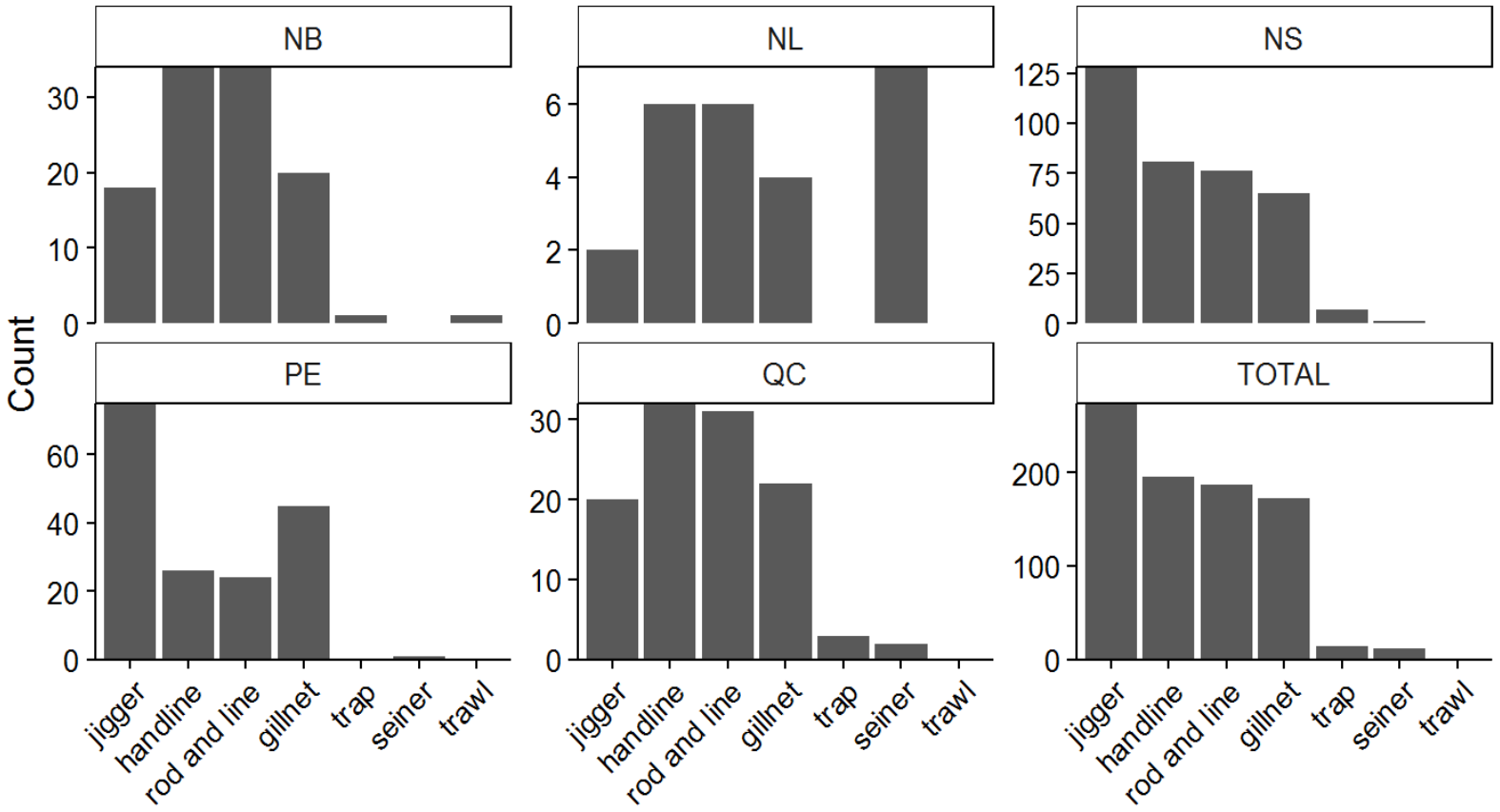
=> declared catch survey participants: 1536t = 19%


750
500
250
0
-250
250
500
750
1000
1250
nr
5
10
15
20

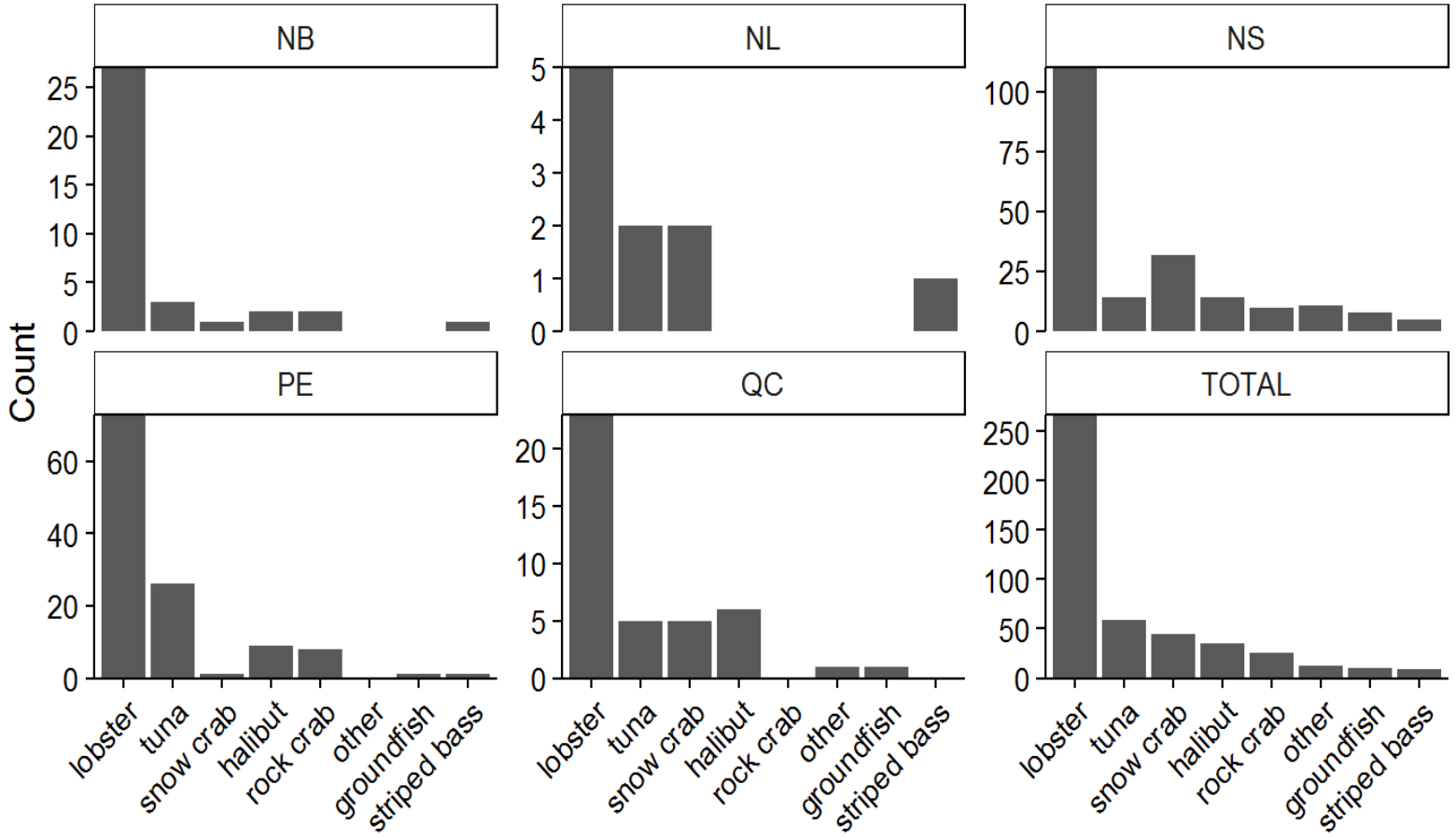
Activity


NB
N=53
0
10
20
30
40
50
22.6%
34.0%
5.7%
37.7%
NL
N=14
0
5
10
21.4%
35.7%
42.9%
NS
N=182
0
50
100
150
27.5%
39.6%
15.4%
17.6%
activity
A combination of these
Bait
Commercial
Recreational
PE
N=105
0
25
50
75
100
25.7%
48.6%
18.1%
7.6%
QC
N=58
0
10
20
30
40
50
20.7%
32.8%
36.2%
10.3%
TOTAL
N=460
0
100
200
300
400
25.0%
40.4%
19.3%
15.2%

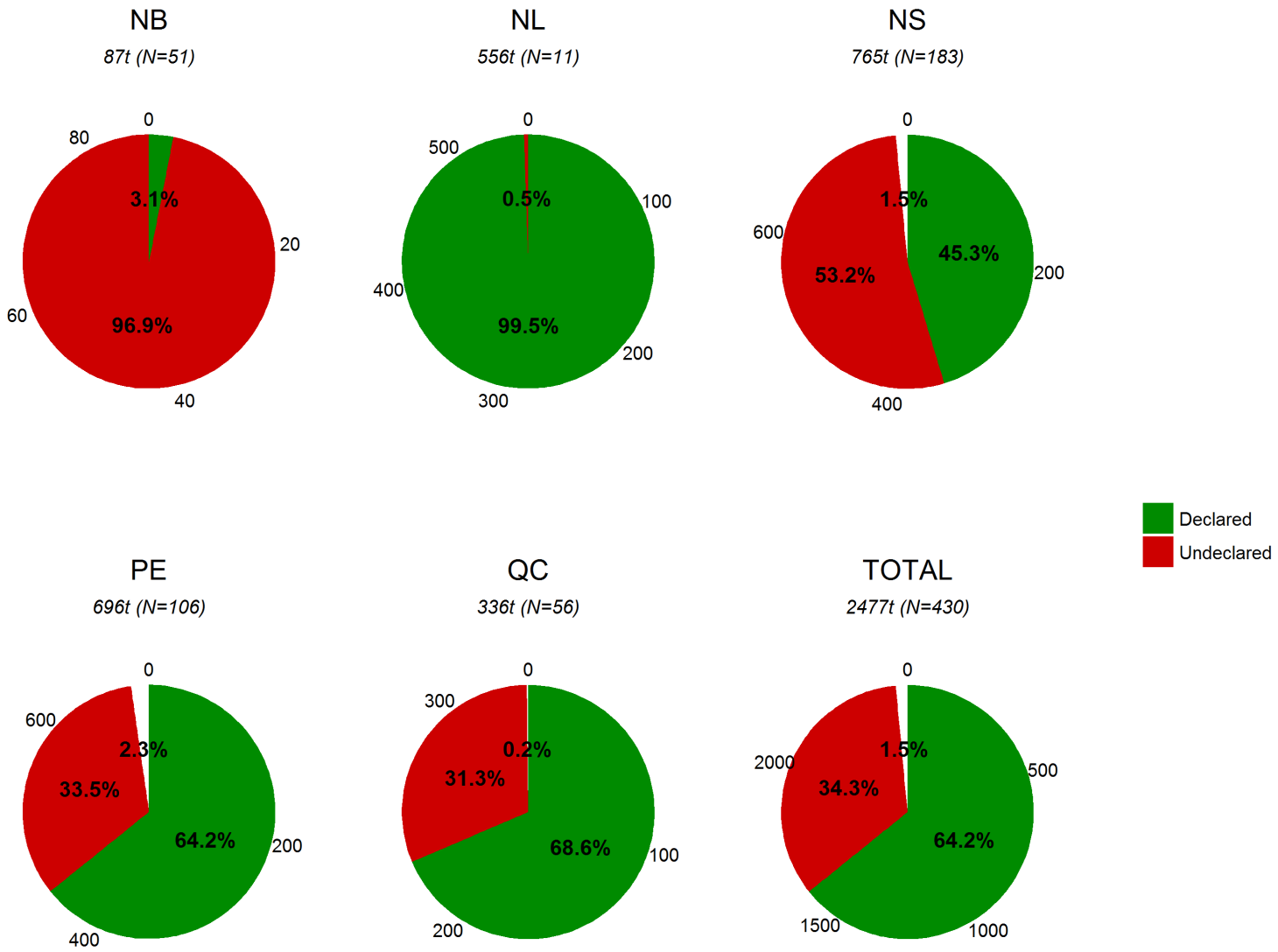
Gear type


NB
NL
NS
PE
QC
TOTAL
Count
jigger
handline
rod and line
gillnet
trap
seiner
trawl

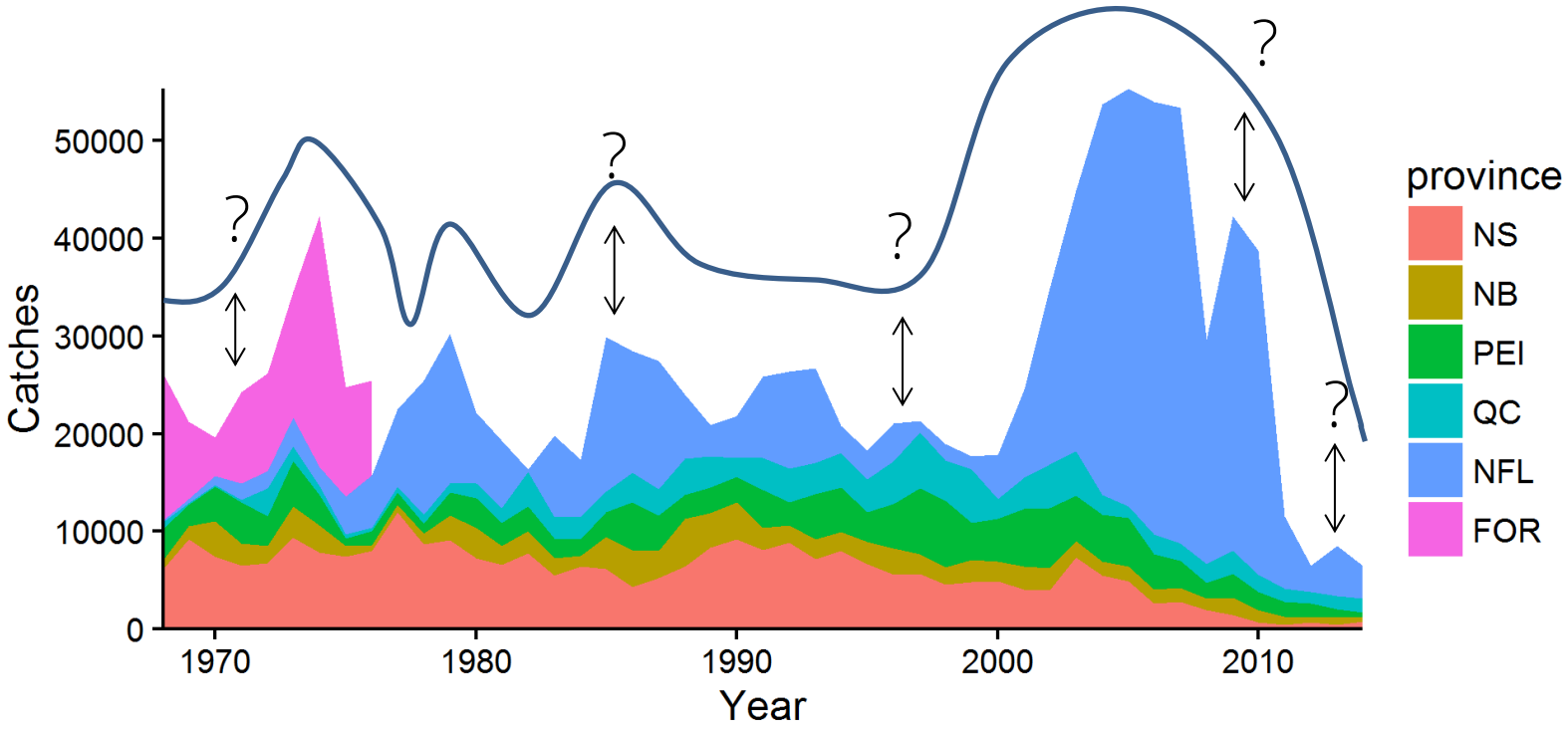
Bait use

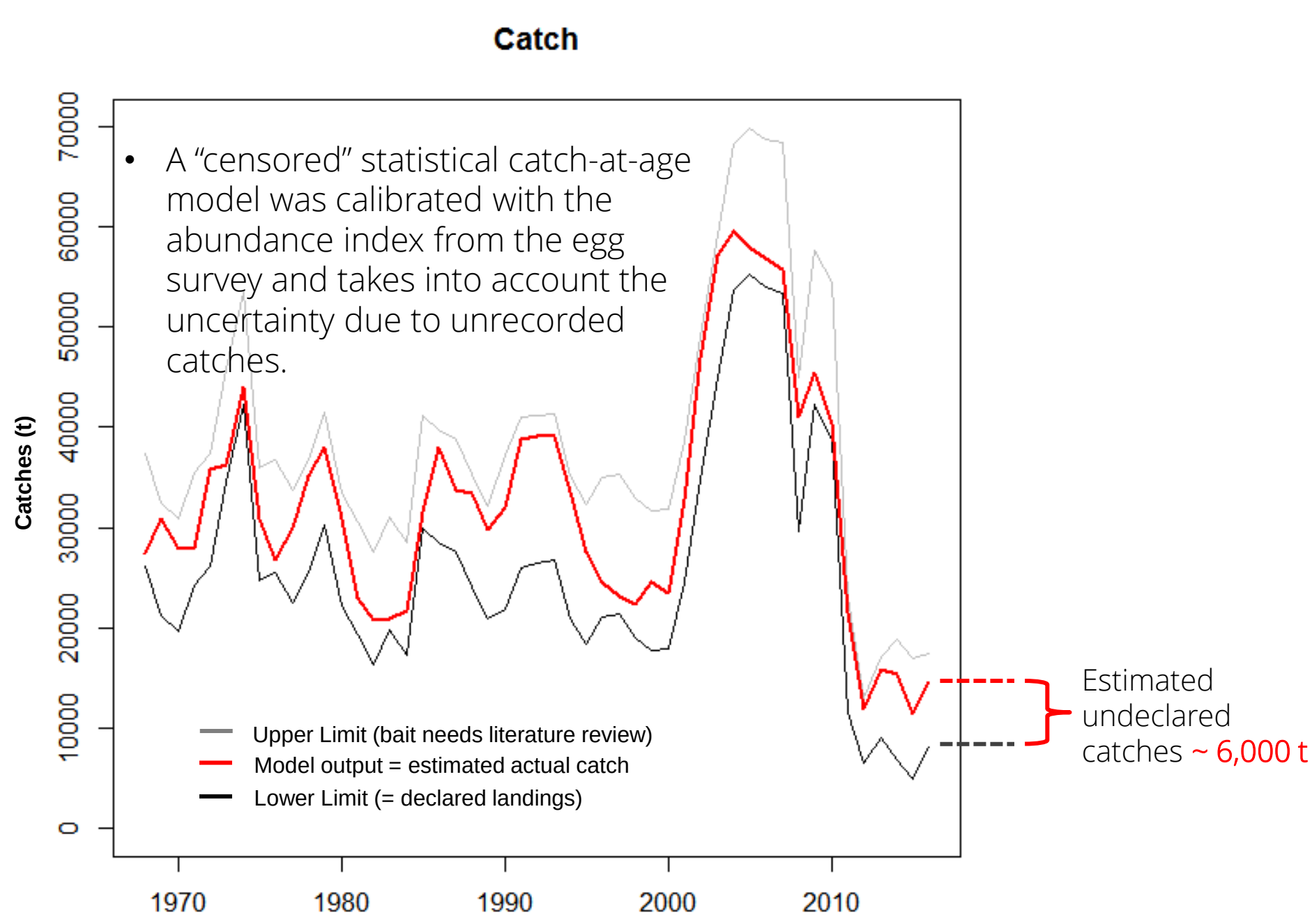

NB
NL
NS
PE
QC
TOTAL
Count
lobster
tuna
snow crab
halibut
rock crab
other
groundfish
striped bass

Declared vs undeclared

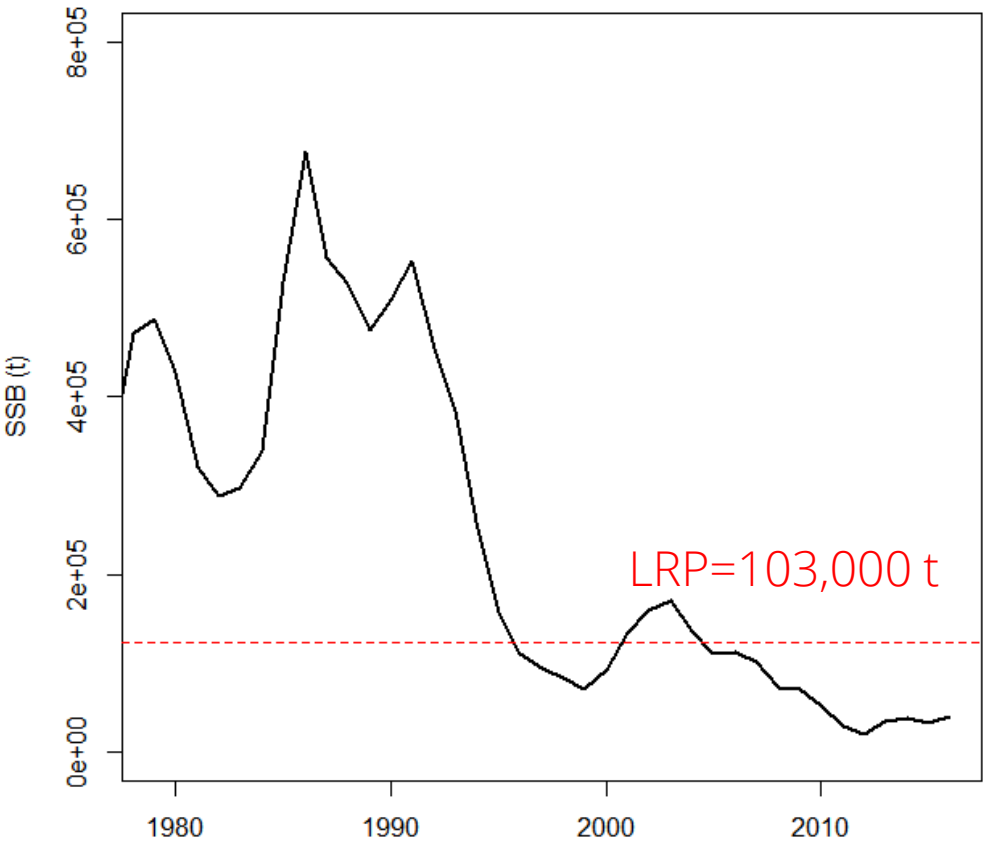


« Censored » approach



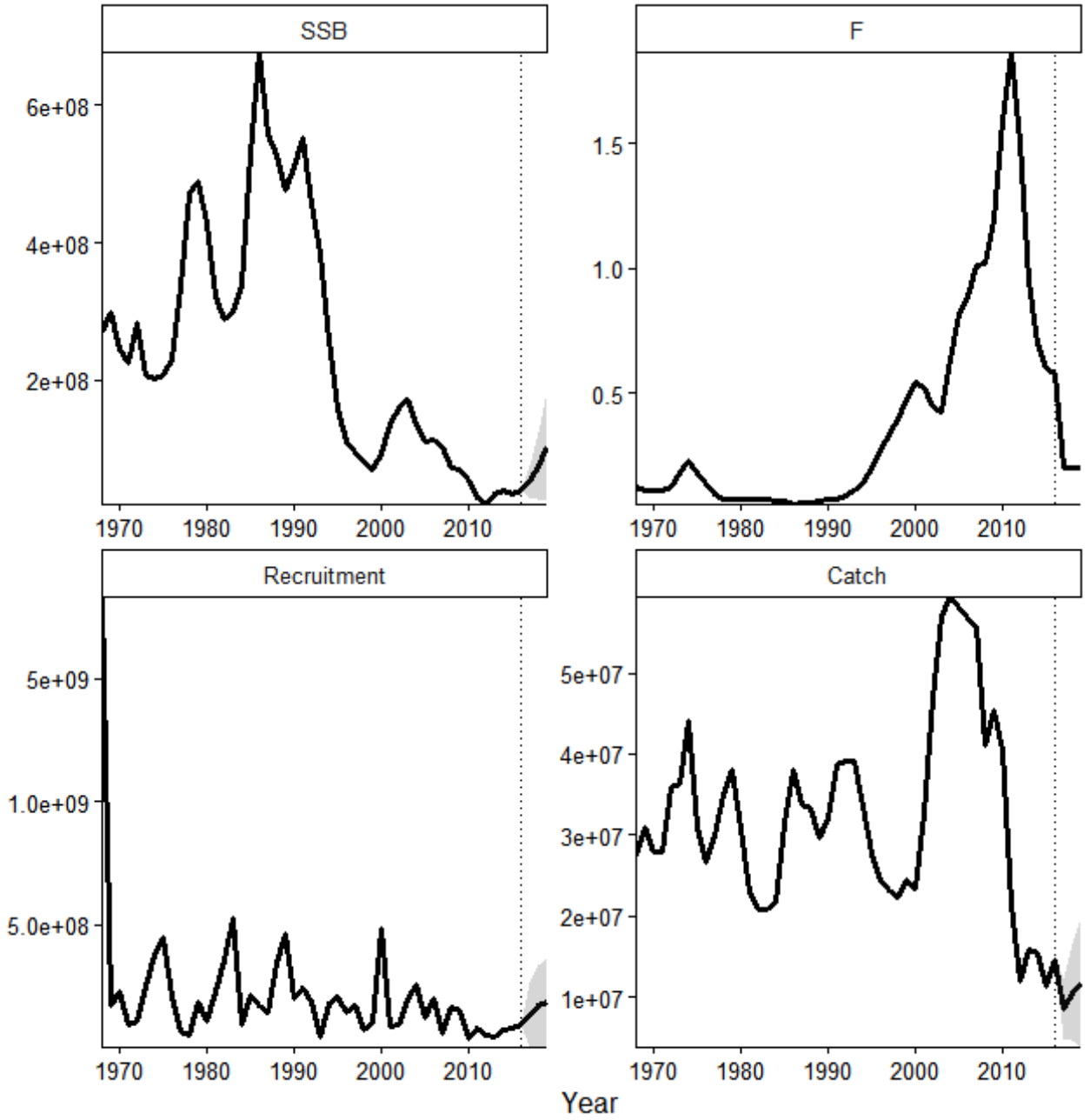

Catch
Catches (t)
0
10000
20000
30000
40000
50000
60000
70000
1970
1980
1990
2000
2010
• A “censored” statistical catch-at-age model was calibrated with the abundance index from the egg survey and takes into account the uncertainty due to unrecorded catches.
Upper Limit (bait needs literature review)
Model output = estimated actual catch
Lower Limit (= declared landings)
Estimated undeclared catches ~ 6,000 t

Stock status



- The new model confirms that mackerel spawning biomass has declined due to high exploitation rates and reached its historical minimum in 2012 (20,000 t). According to the model, the 2016 spawning biomass was 40,000 t.
- The Limit Reference Point (LRP) for this stock is a proxy of $40\%B_{msy}$ based on $F_{40\%}$ derived from a yield-per-recruit analysis. According to the censored model, stock abundance in 2016 was about 40% of the 103,000 t LRP.

- Model projections were used to quantify the risks associated with different catch scenarios. Considering that the stock is in the critical zone, total catches (declared + unreported) should be low enough to facilitate recovery.



declared + undeclared catches (t)		2017		2018		2019		
2017	2018	SSB (t)	Exp. Rate	SSB (t)	Exp. Rate	SSB (t)	prob. >2016	prob. >LRP
0	0	48,283	0.00	77,164	0.00	113,886	0.95	0.56
4,000	4,000	48,283	0.08	72,175	0.06	103,378	0.93	0.50
6,000	6,000	48,283	0.13	68,503	0.09	96,927	0.92	0.46
8,000	8,000	48,283	0.17	64,910	0.12	90,889	0.89	0.42
10,000	10,000	48,283	0.21	62,762	0.16	85,686	0.87	0.40
12,000	12,000	48,283	0.25	59,466	0.21	77,143	0.84	0.34
14,000	14,000	48,283	0.29	56,858	0.24	72,189	0.81	0.30
16,000	16,000	48,283	0.33	54,018	0.29	66,158	0.77	0.26
18,000	18,000	48,283	0.38	50,928	0.36	57,113	0.70	0.20
20,000	20,000	48,283	0.42	47,502	0.42	51,348	0.64	0.17
24,000	24,000	48,283	0.50	41,704	0.59	35,728	0.44	0.09
30,000	30,000	48,283	0.62	33,053	0.90	17,199	0.16	0.02