# Snow crab and ocean variability

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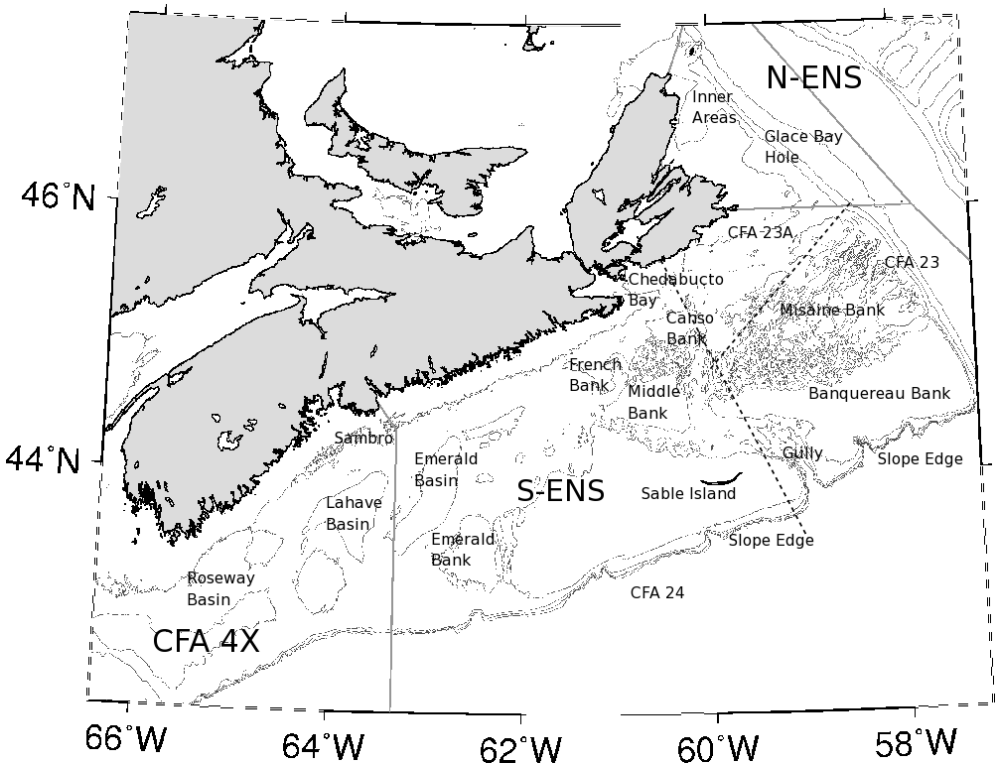
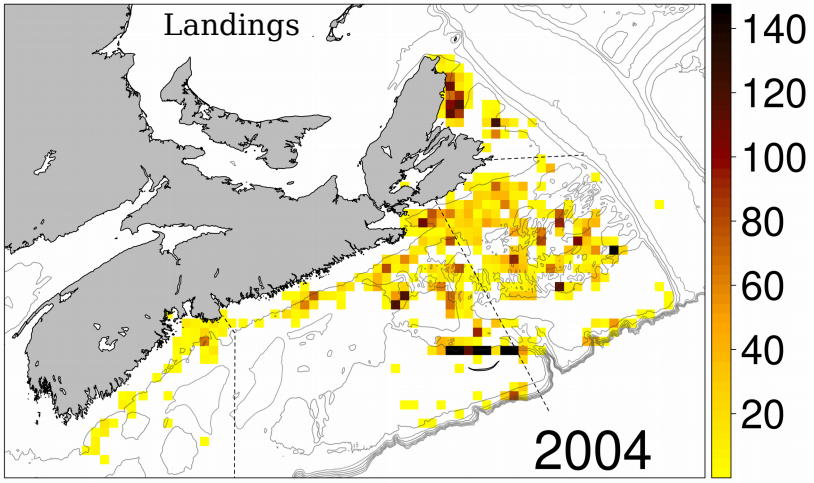
# Outline

- Fishery
- Biology
- Ocean variability
- Challenges

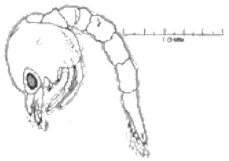


# Fishery

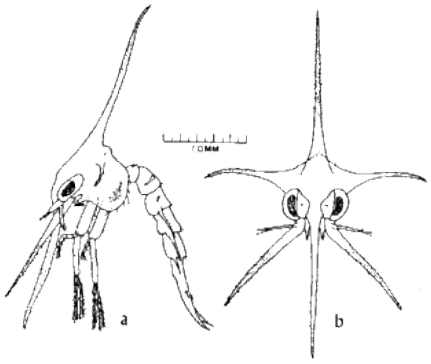
- Conical traps
- Deployed at depth (>100m)
- Low by-catch (< 0.02% of total catch)
- Low impact upon substrate
- Low impact upon SARA species and with biodegradable panels
- Involvement of fishers in co-management, research and assessment
- Many direct and indirect socio-economic benefits to local communities from the fishery and supporting activities: bait, processors, transport, infrastructure, etc.

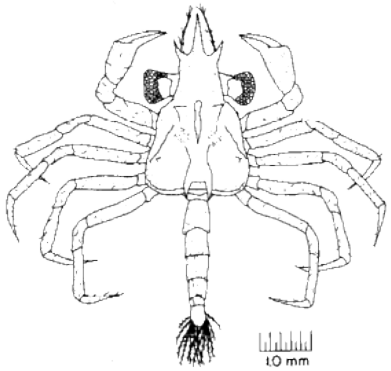
# Snow crab life cycle



Prezoea stage (Haynes 1973)

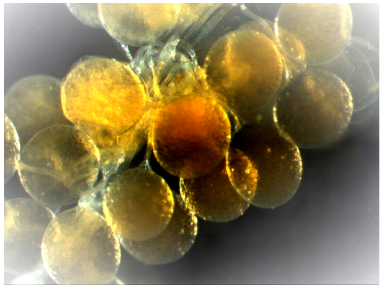



Stage I Zoea (Haynes 1973)



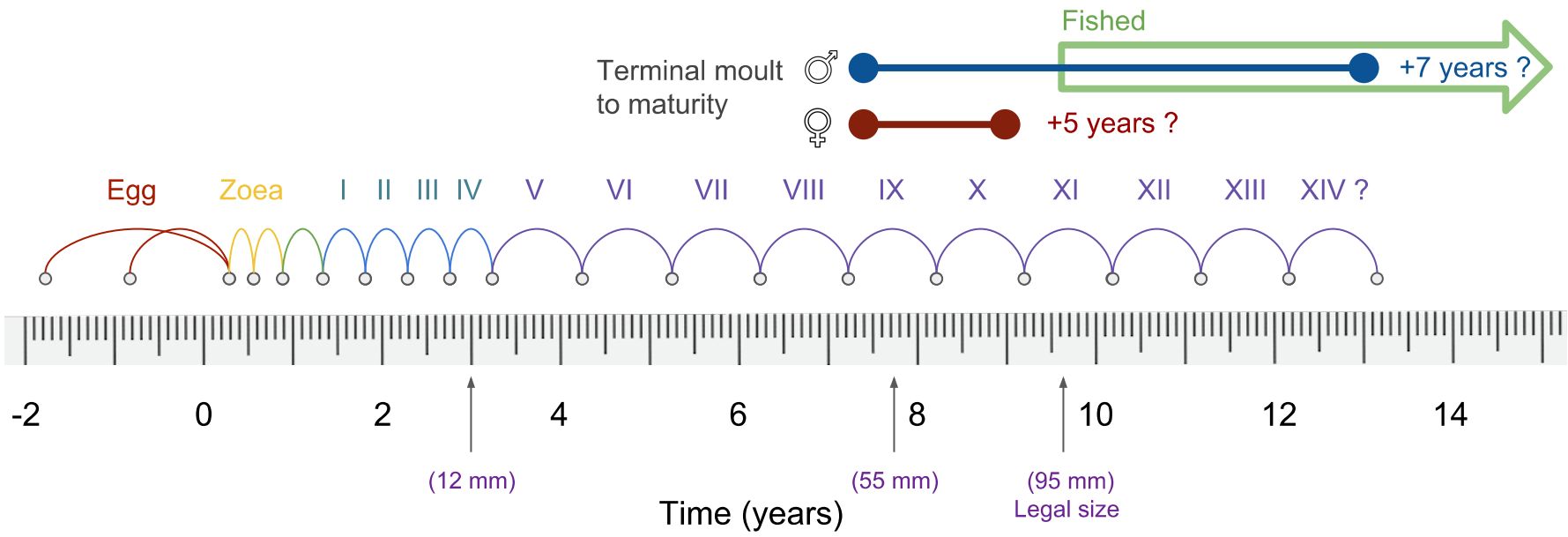

Megalopa (Jewett and Haight 1977)

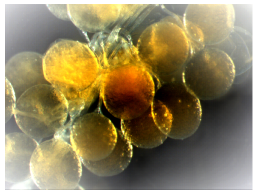
Adult (Squires 1990)

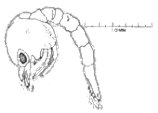


Urban, D. and Hart, D. 1999. Biology of the Tanner crab *Chionoectes bairdi* in Alaska: A Report to the Alaska Board of Fisheries. Regional Information Report 4K99-22. Alaska Department of Fish and Game Division of Commercial Fisheries. 211 Mission Road, Kodiak, AK 99615.

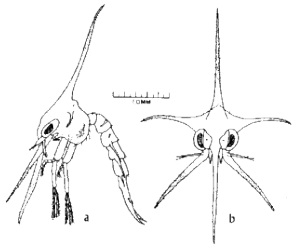
# Snow crab life cycle



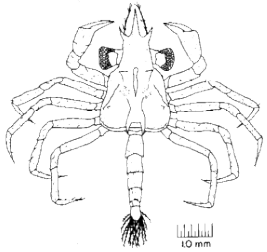





Prezoea stage (Haynes 1973)



Stage I Zoea (Haynes 1973)

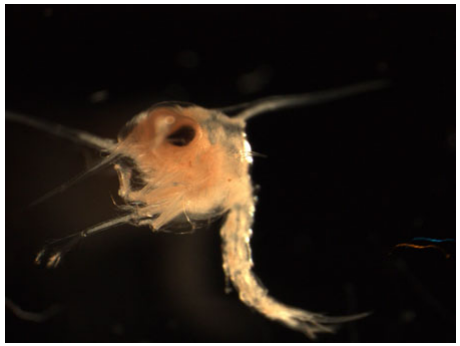


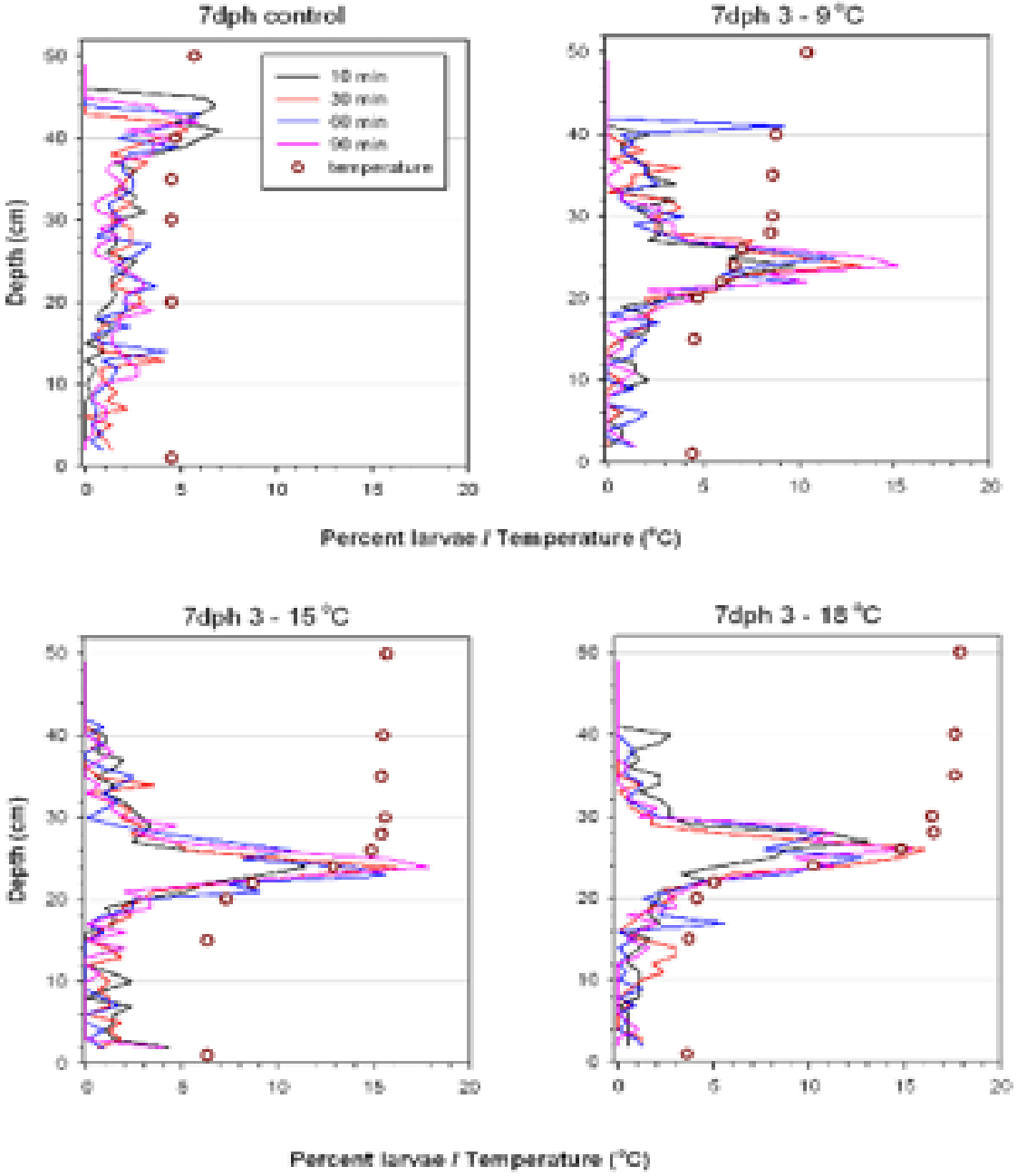
Megalopa (Jewett and Haight 1977)

Adult (Squires 1990)

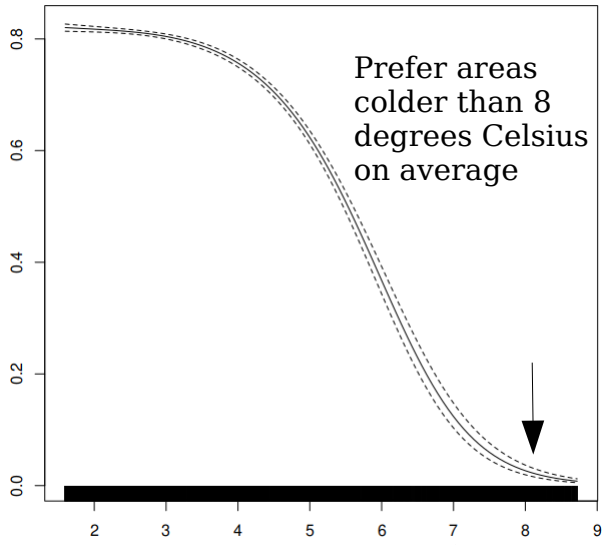
# Larvae

7 days post-hatch

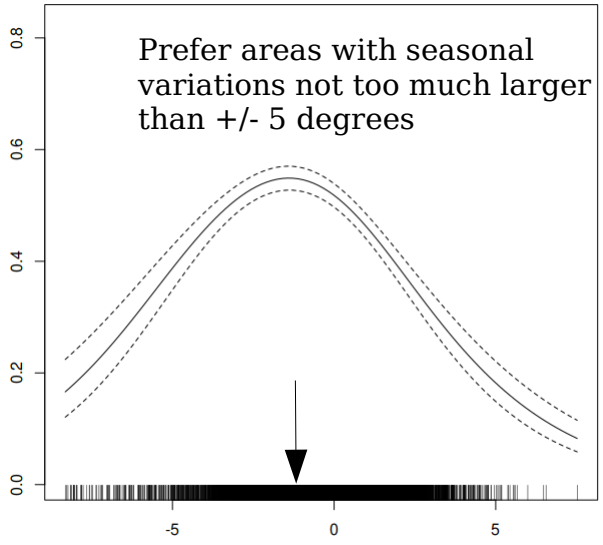




# Fished snow crab

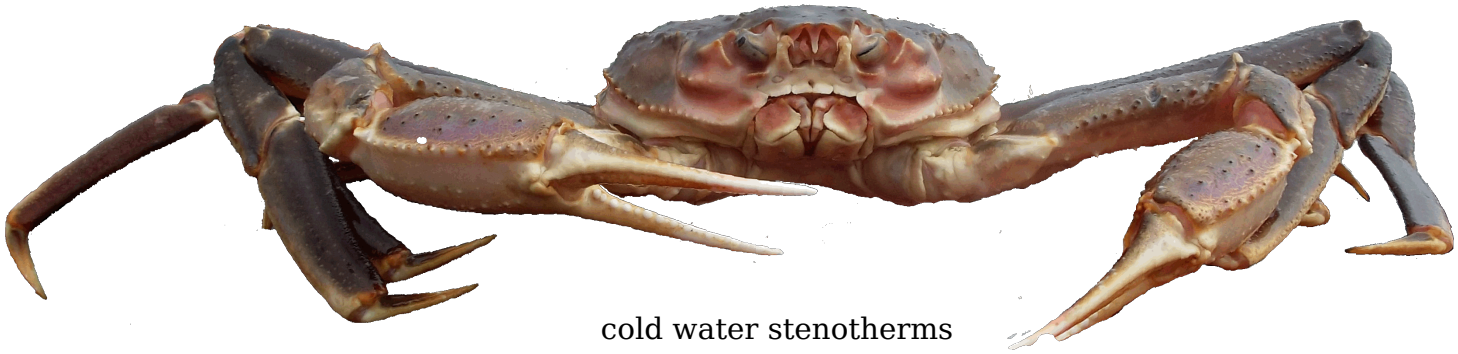



Long-term mean temperature

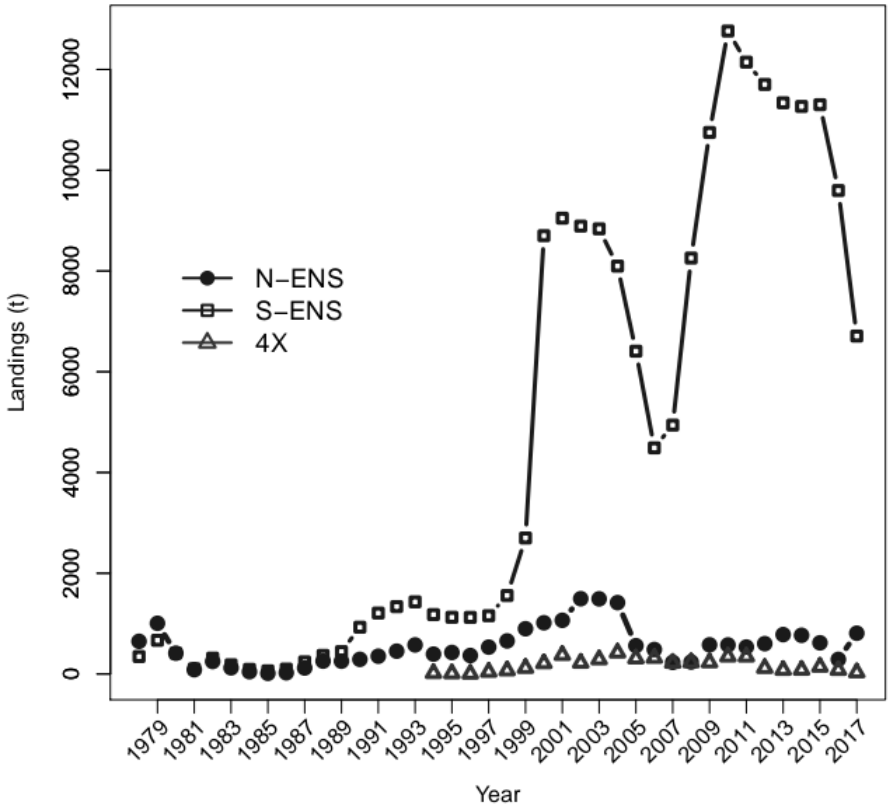


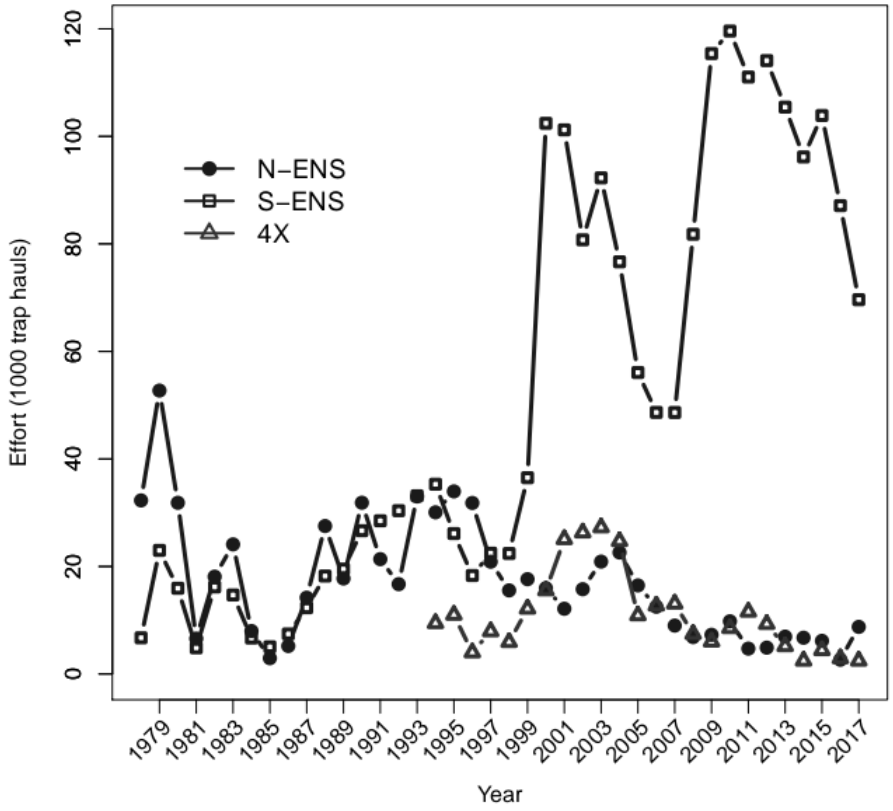

Difference from long-term mean temperature

Upper metabolic limit in lab

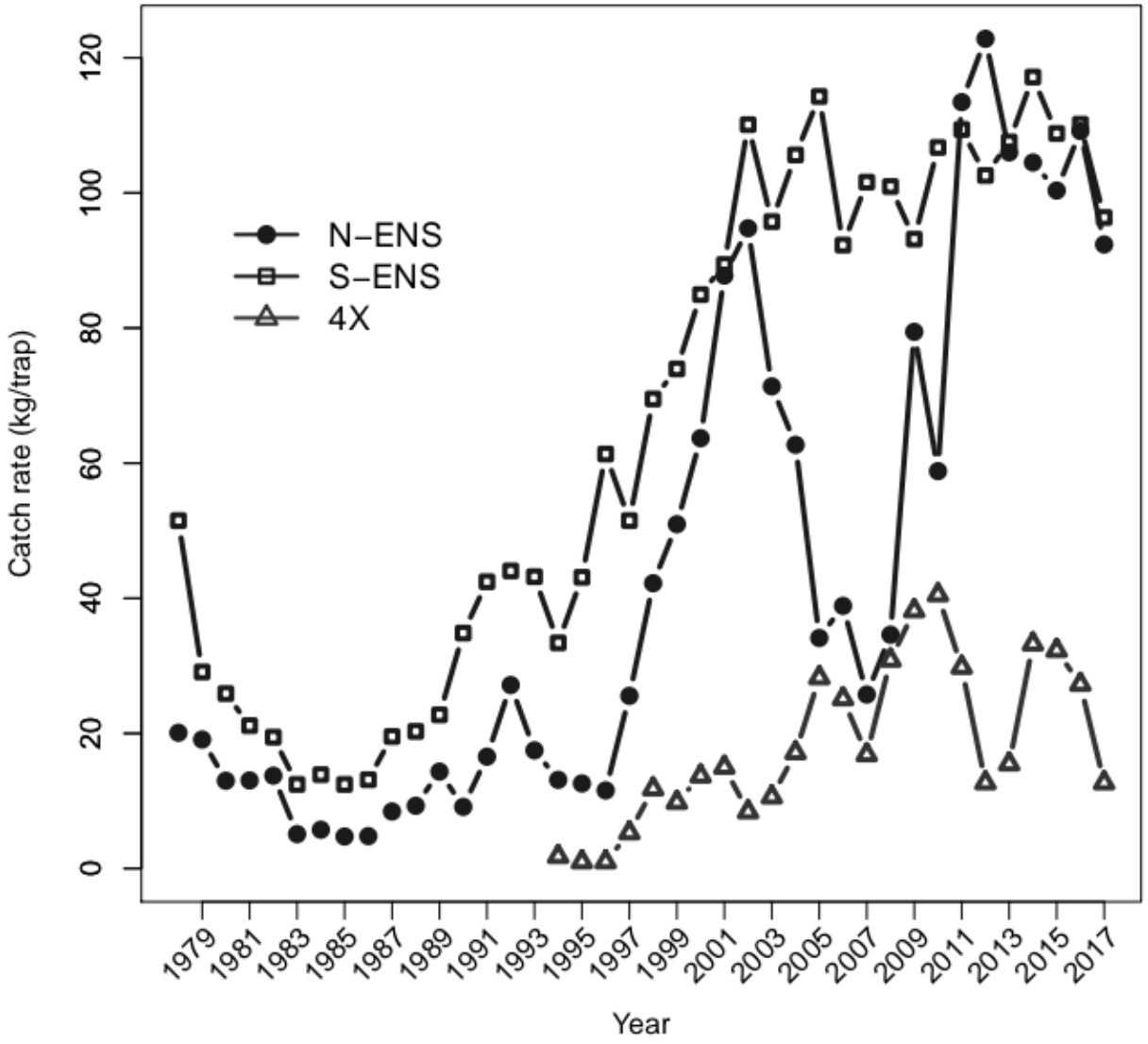


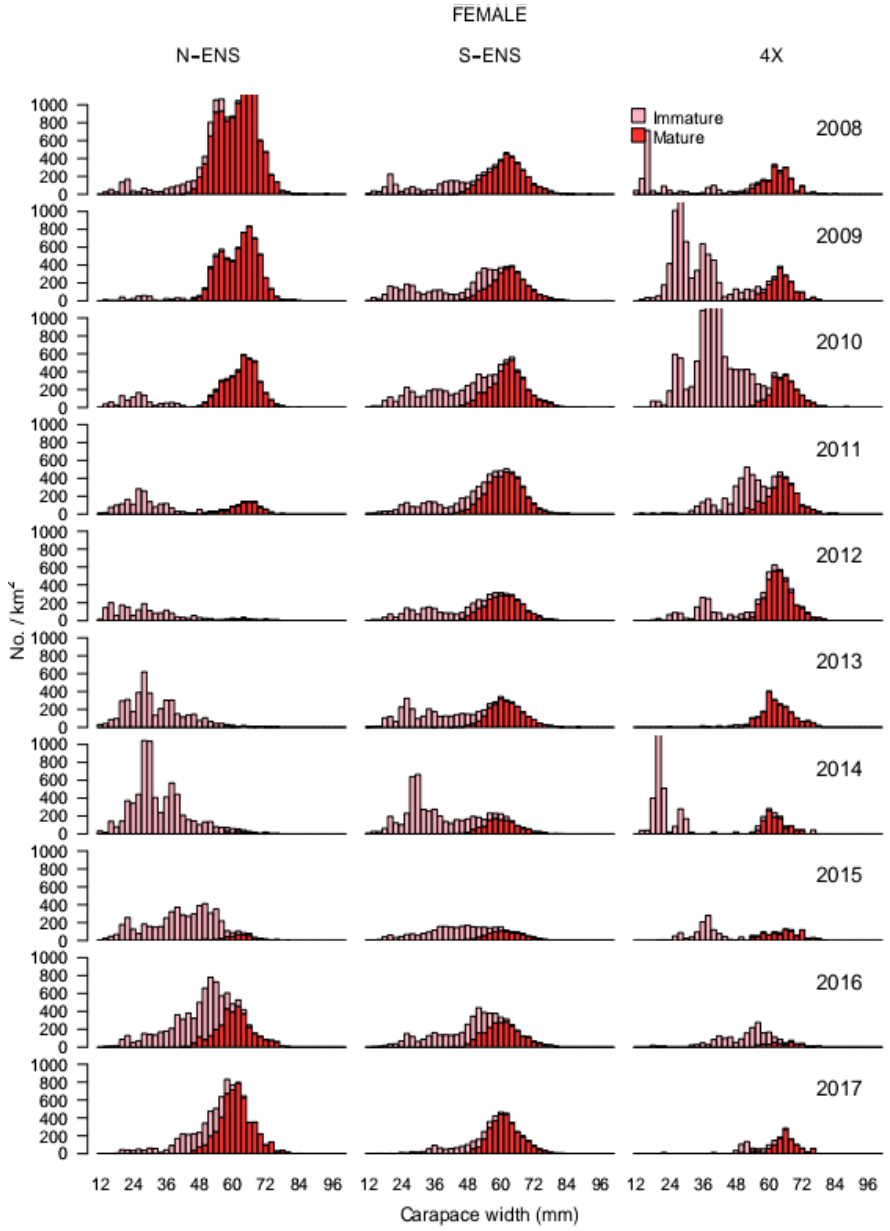
cold water stenotherms

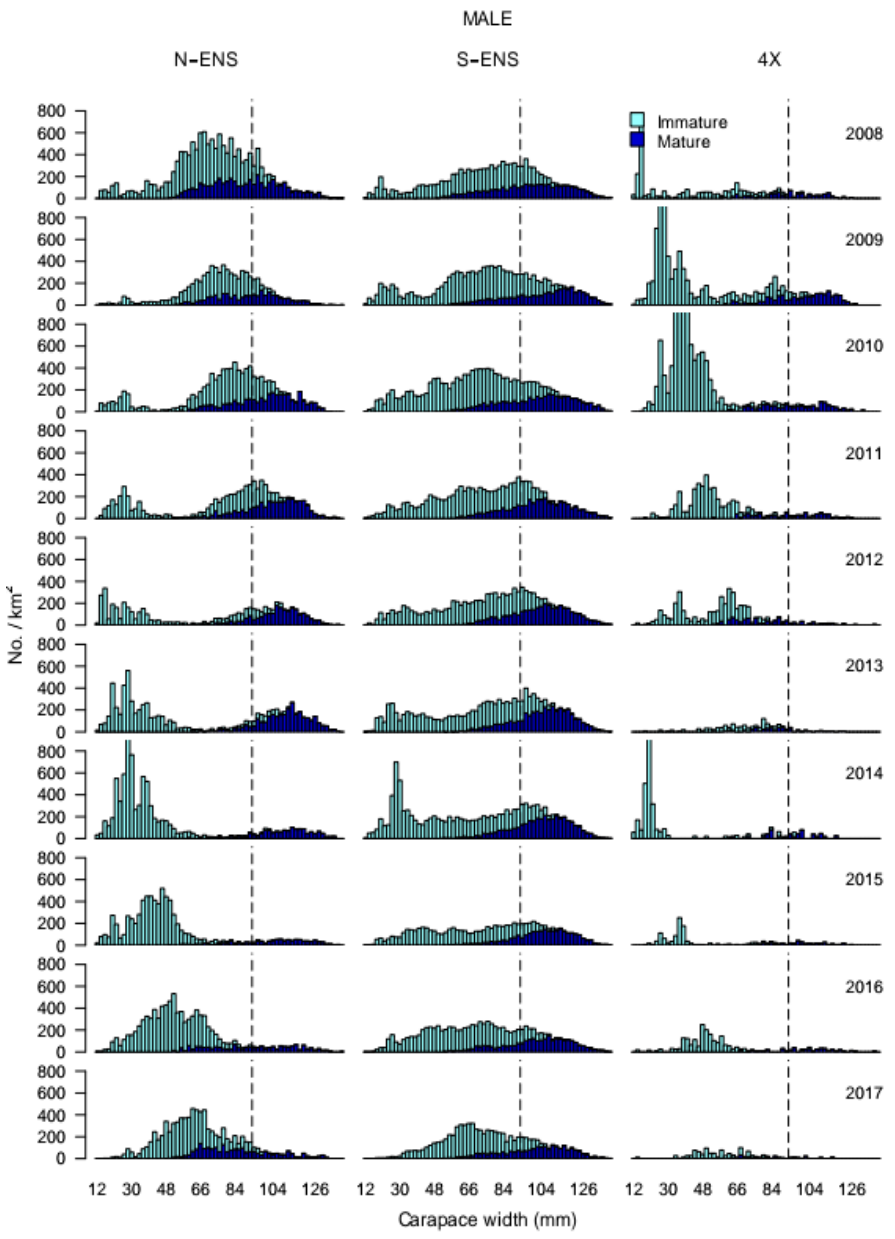

Landings (t)
0
2000
4000
6000
8000
10000
12000
N−ENS
S−ENS
4X
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
Year

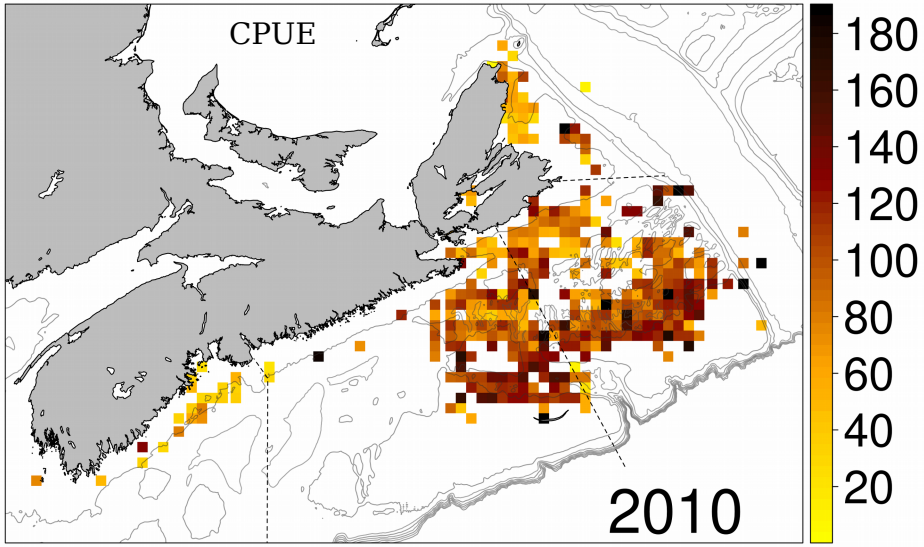

Effort (1000 trap hauls)
0
20
40
60
80
100
120
N−ENS
S−ENS
4X
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
Year

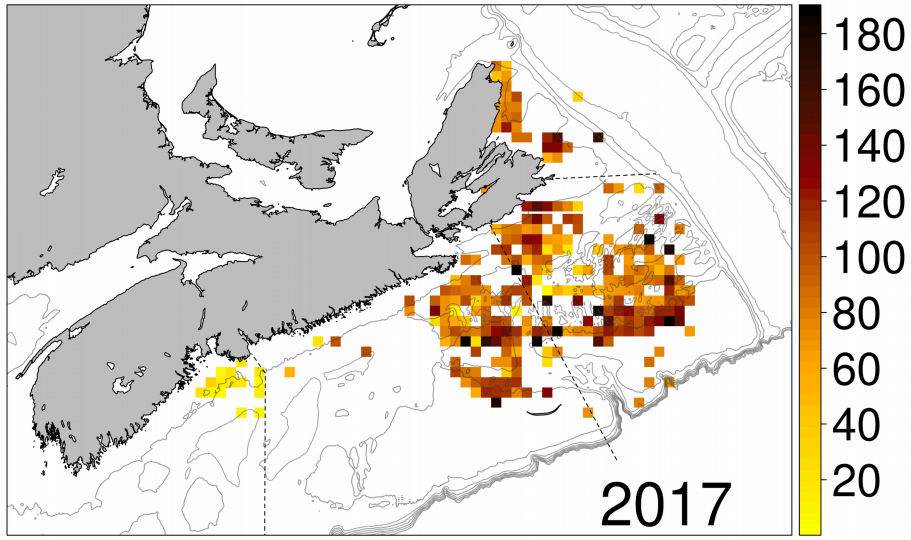
CPUE

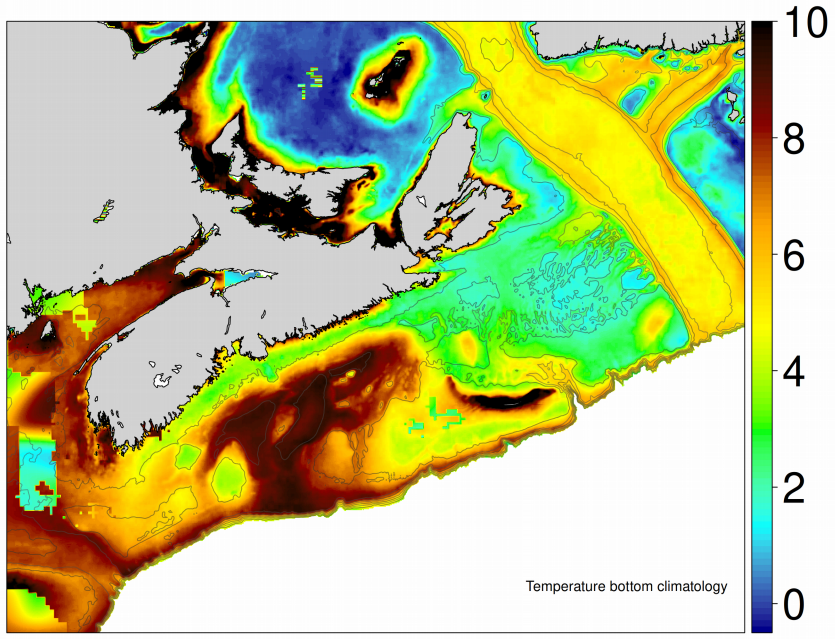

N–ENS
S–ENS
4X
Catch rate (kg/trap)
0
20
40
60
80
100
120
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
Year

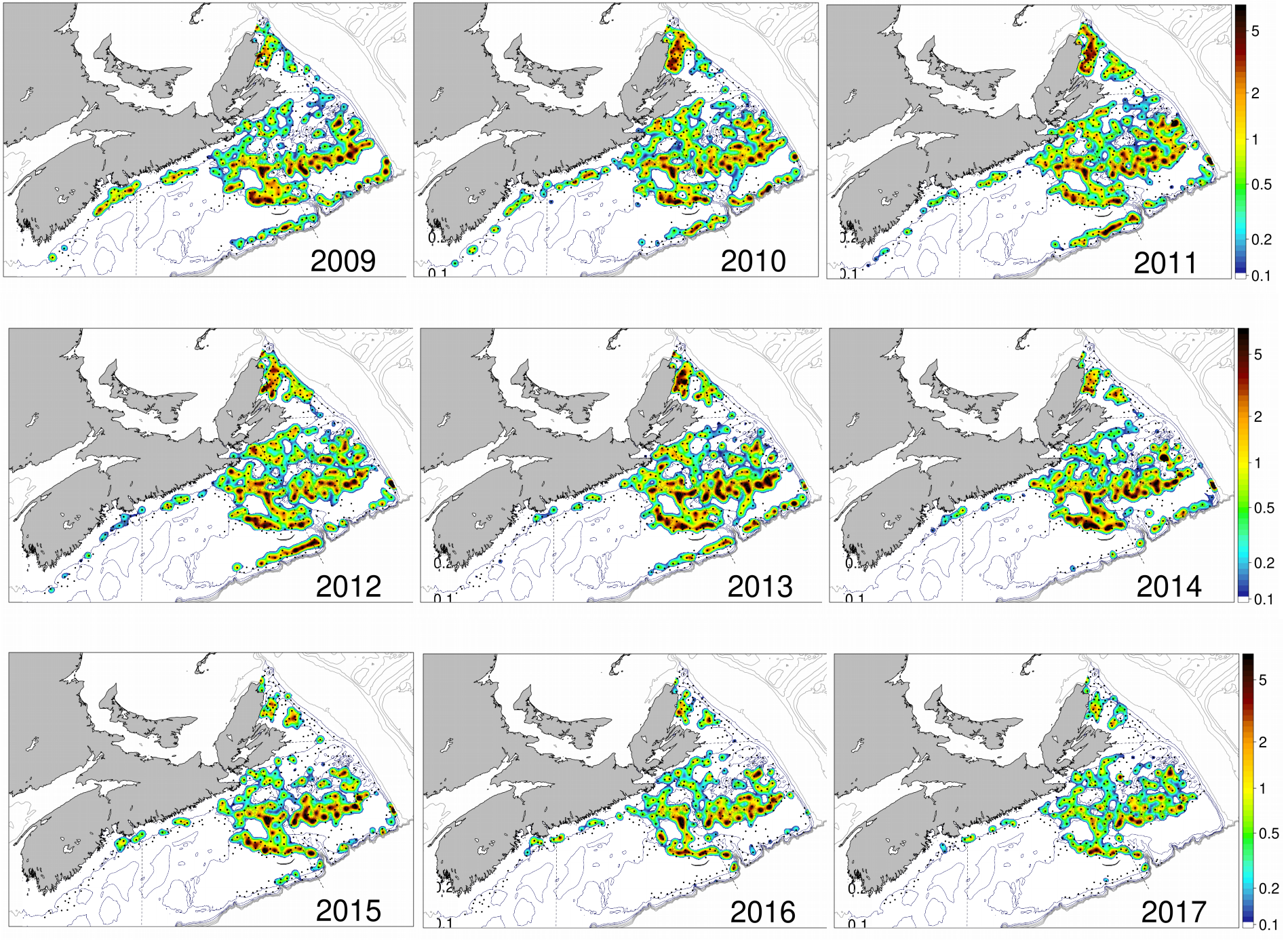

FEMALE
N-ENS
S-ENS
4X
Immature
Mature
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
No. / km²
Carapace width (mm)

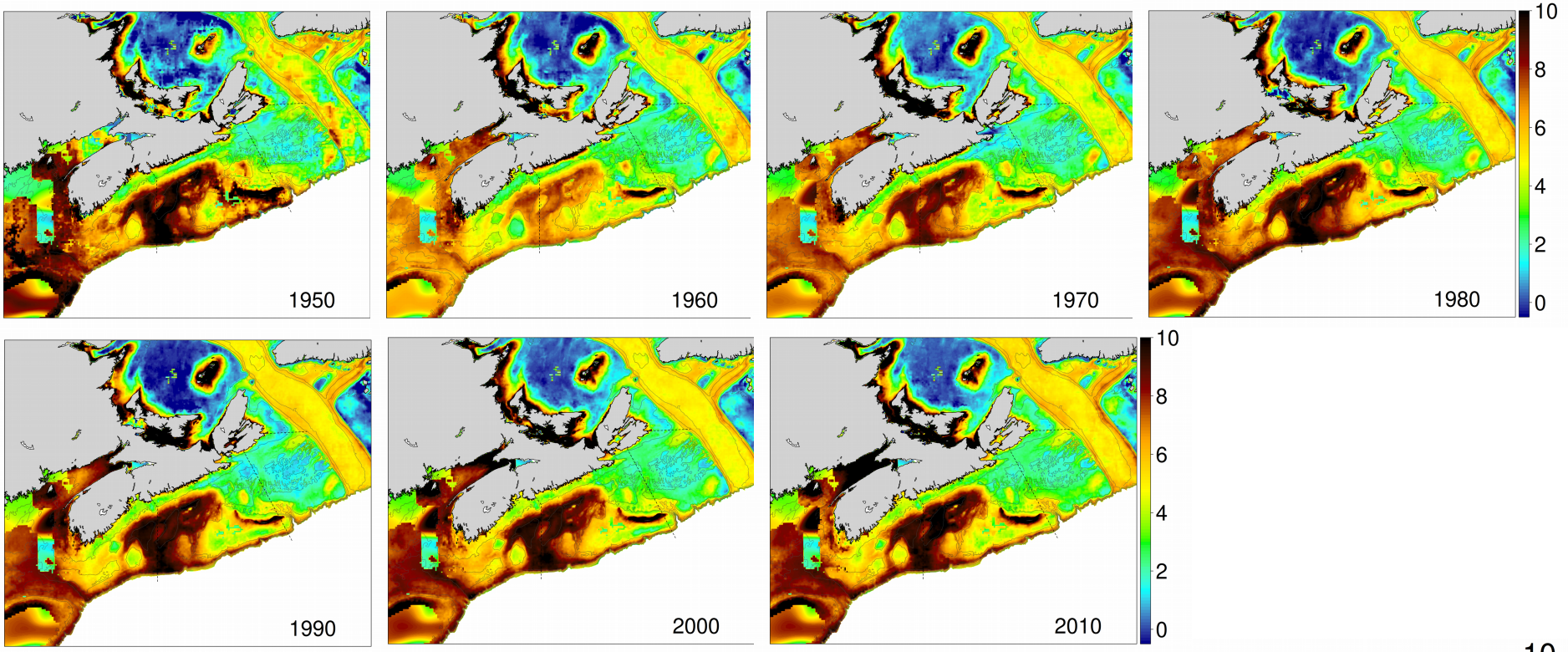

MALE
N-ENS
S-ENS
4X
Immature
Mature
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
No. / km²
Carapace width (mm)

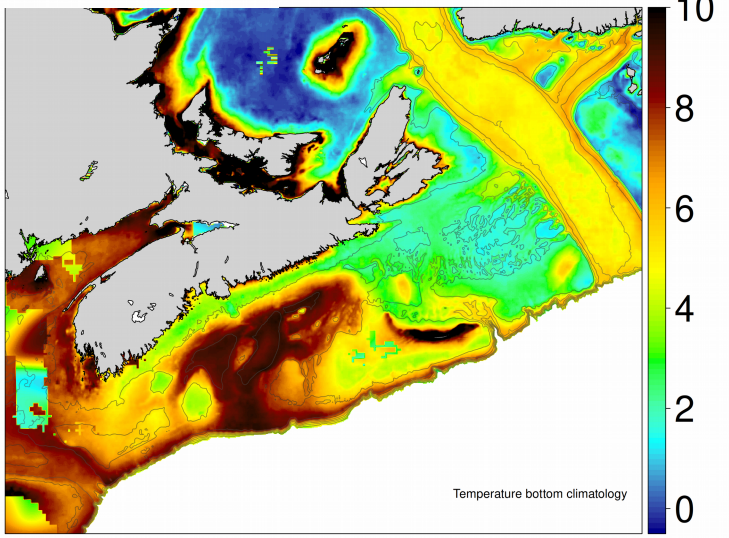

CPUE
180
160
140
120
100
80
60
40
20
2010


180
160
140
120
100
80
60
40
20
2017

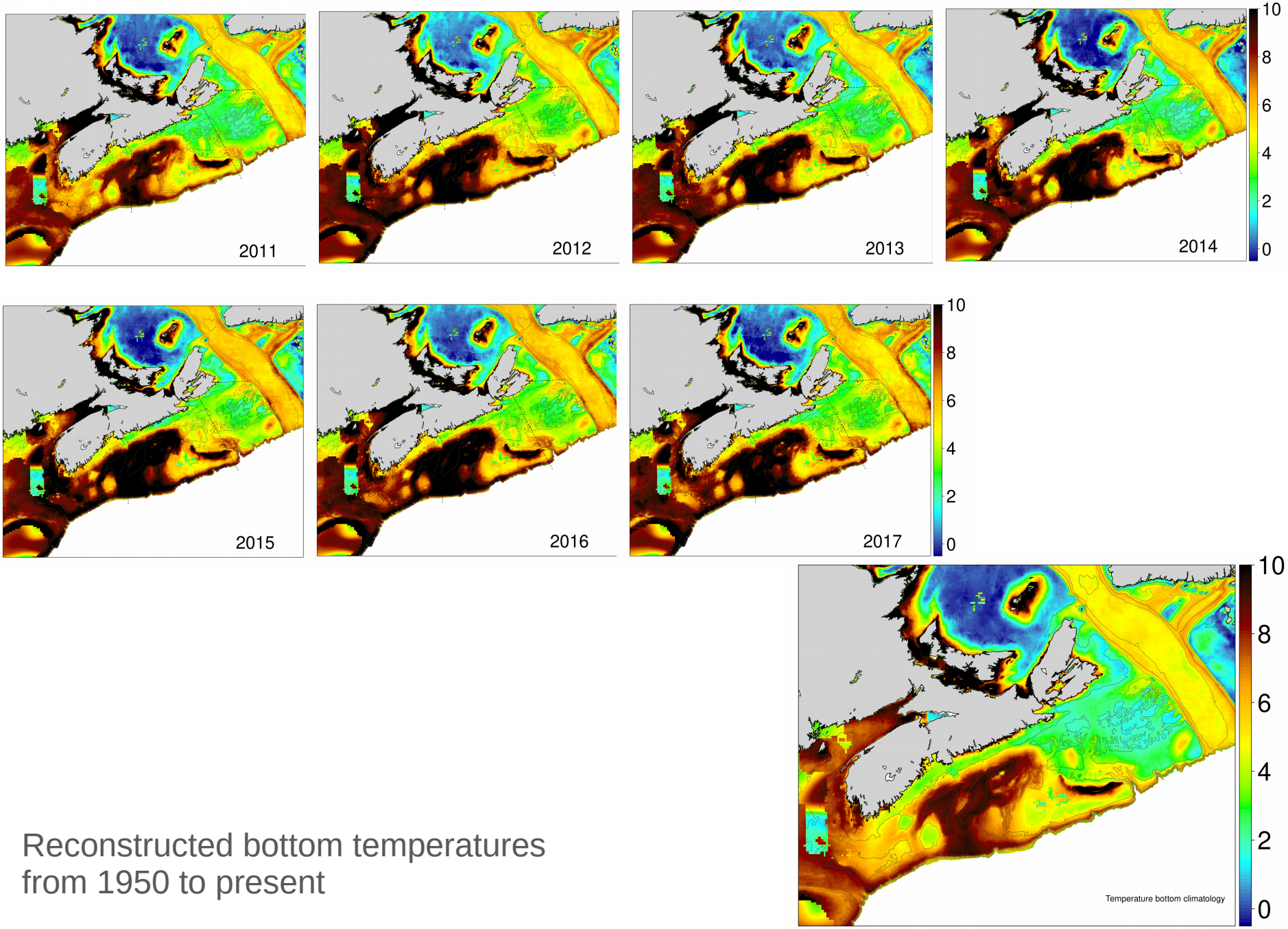

10
8
6
4
2
0
Temperature bottom climatology


2009
2010
2011
2012
2013
2014
2015
2016
2017
5
2
1
0.5
0.2
0.1



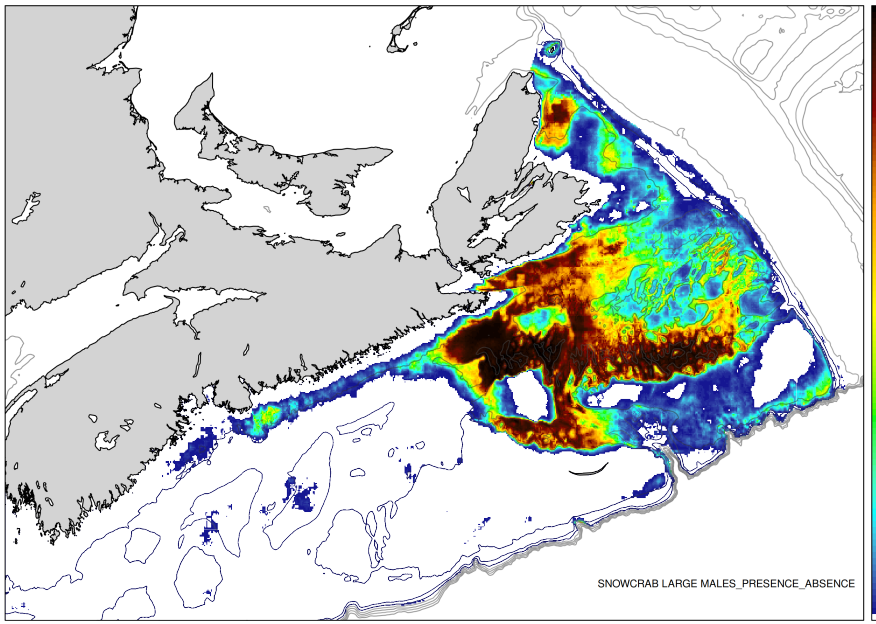




Reconstructed bottom temperatures from 1950 to present

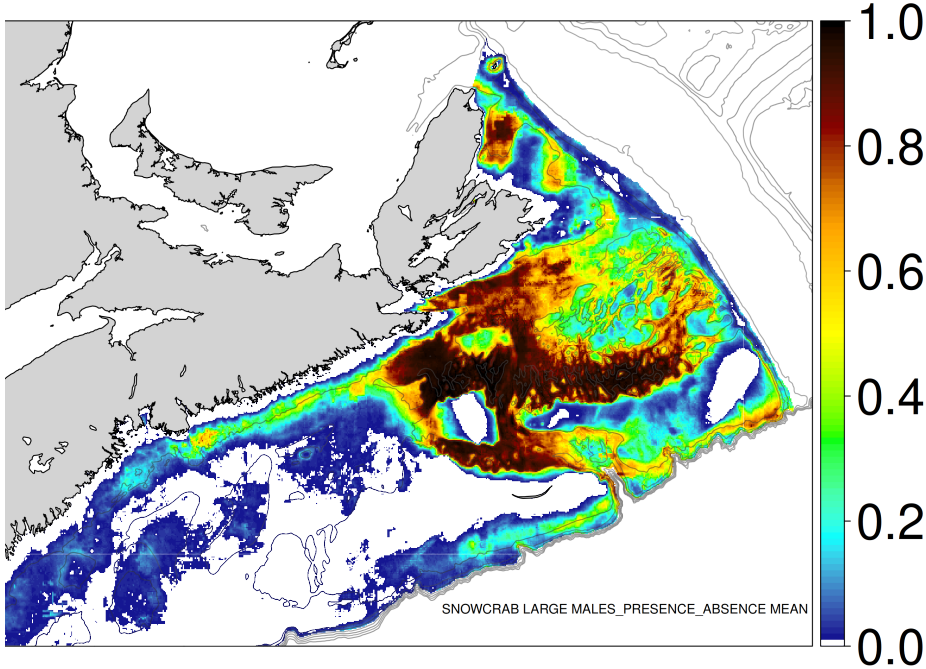



Reconstructed bottom temperatures
from 1950 to present

# Snow crab habitat



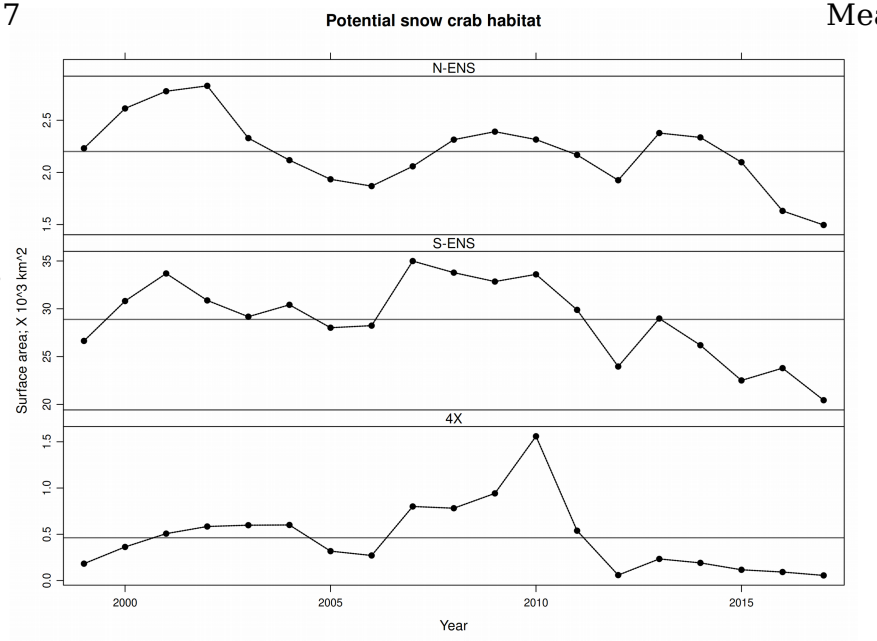

2017

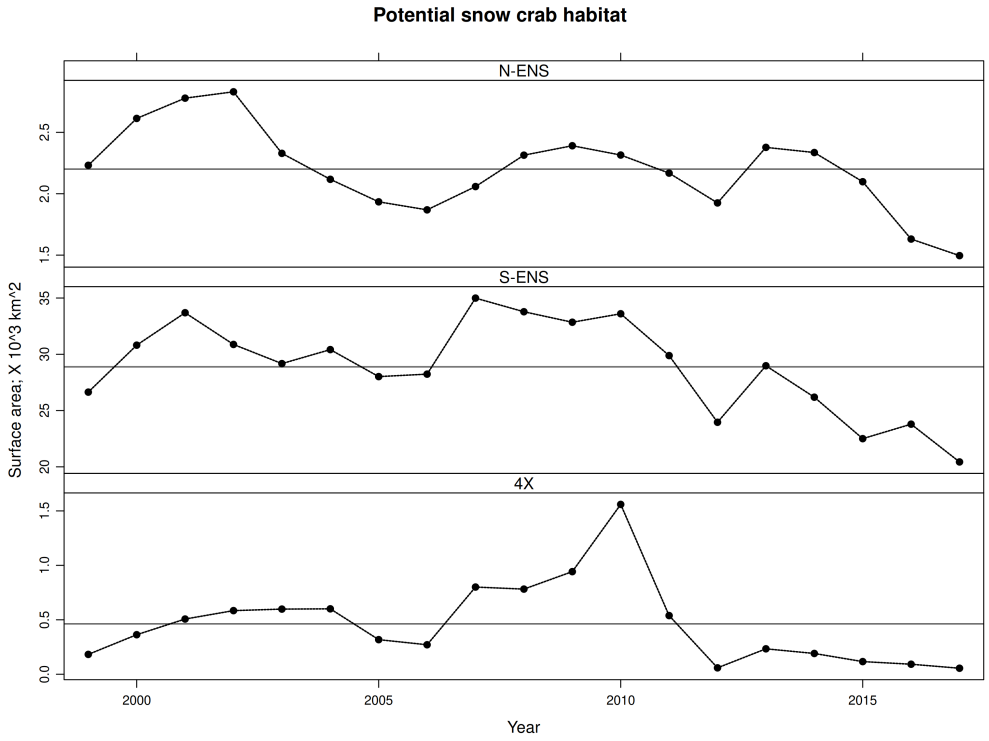


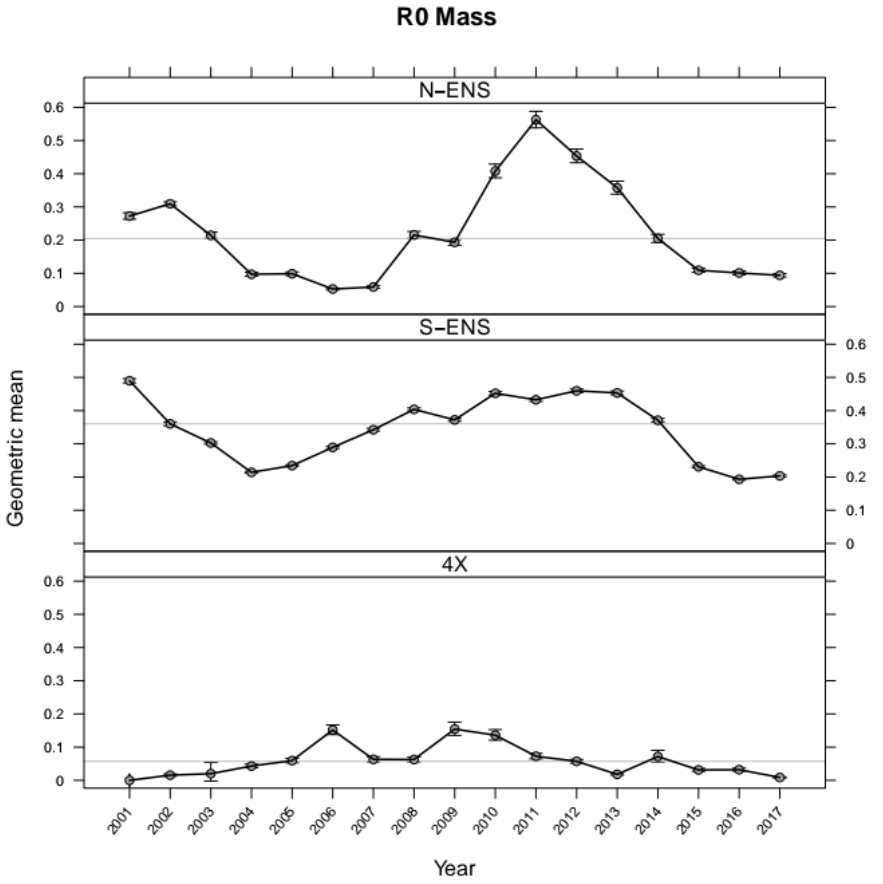

Mean (1999-2017)

Habitat space shrinks

Connectedness declines



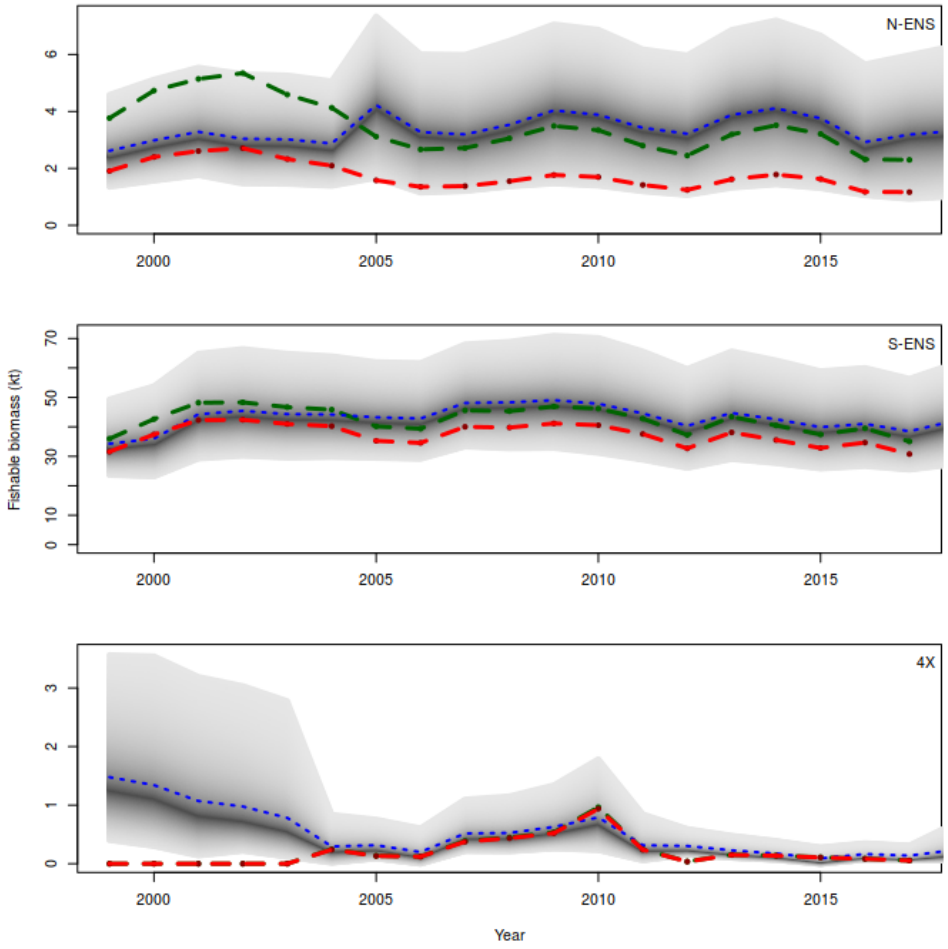

Potential snow crab habitat
N-ENS
S-ENS
4X
Surface area; X 10^3 km^2
Year
2000
2005
2010
2015

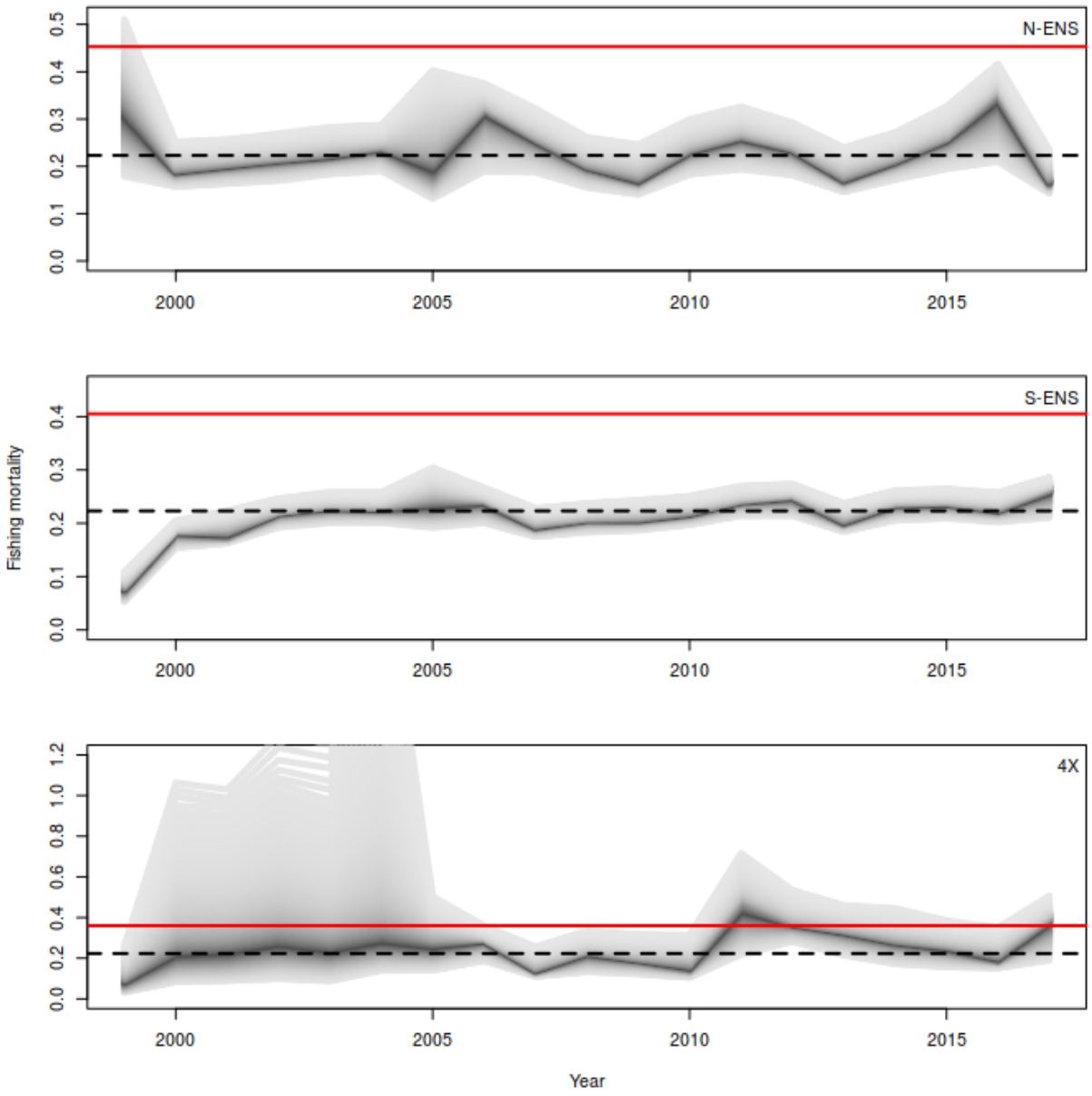

R0 Mass
N-ENS
S-ENS
4X
Geometric mean
Year
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017

Challenges for fisheries

- Ocean, ecosystems, habitats and organisms shift and adapt and do not have a concept of boundaries, but fishing areas are “fixed” in stone – some fishing areas will be winners and others losers
- Snow crab fishers have been able to mitigate this somewhat by having “large” fishing areas but still, e.g., area 4X is disconnected and having a difficult time
- Fishing areas may develop predators and preys that were previously not observed – transients and uncertainty in ecological restructuring require more adaptive management systems and fishers will also need to be more adaptive (“diversify your portfolio”)
- Connectivity alterations can have a large effect upon stability/sustainability
- Growth rates, reproductive rates and disease/natural mortality rates can all be expected to change, depending upon the unique life history traits of the species in focus
- Fishing practice that is more precautionary seems to stabilize dynamics by making the fishery more resistant to environmental and ecological variability (NENS vs SENS)

End

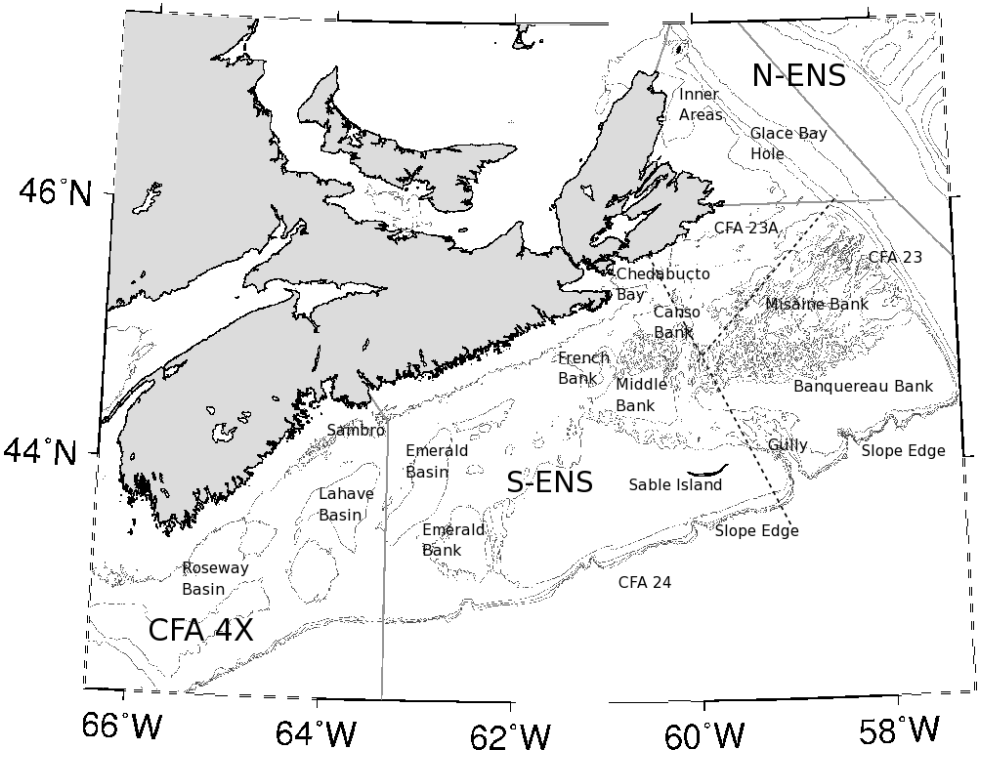

N-ENS
S-ENS
4X
Fishable biomass (kt)
Year
0
2
4
6
10
30
50
70
1
3
2000
2005
2010
2015


N-ENS
S-ENS
4X
Fishing mortality
Year
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.8
1.0
1.2
2000
2005
2010
2015

# DFO / Gov. of Canada's Obligations

- DFO is required to manage ocean resources in a **precautionary, integrated, ecosystem-based** manner (Oceans Act [1996] and numerous Canadian policies & international agreements [1982, 1983, 1992, 2003 …]). That is:

*Avoid risky decisions because ecosystems are complicated and can do the unexpected, even with the best of scientific information.*




- The Maritimes Region snow crab fishery is **co-managed** by Fisheries and Aquatic Management (FAM) and the fishers
- To support this management, Maritimes Region FAM **annually** requests a scientific assessment of 4VWX snow crab. (This frequency is unlikely to change).
- There are three management units: N-

ENS = Eastern Nova Scotia
CFA = Crab Fishing Area

# Current Management Practices

- No. licenses (limited entry – conservation)
- Trap limits (safety/conservation)
- Individual Boat Quotas (IBQs)
- Individual Transferable Quotas (ITQs)
- Dockside monitoring (100% – enforcement, effort monitoring)
- Mandatory logbooks (effort monitoring)
- At-sea monitoring by certified observers (5% to 10% of landings – enforcement, by-catch monitoring)
- Season and area restrictions (variable – market/conservation driven)
- Satellite Vessel Monitoring Systems (enforcement)
- Size (largest only; > 95 mm carapace width – market/conservation driven)
- Sex (male-only – market/conservation driven)
- Shell-hardness (hard-shelled only – market/conservation driven)
- Soft shell protocol (<20% soft – control handling mortality/reduce fishing costs)
- Voluntary return of immature crab
- **Co-management** (joint-stewardship) with fishers and DFO
- **Total Allowable Catches** (TACs – control over-exploitation)

# Notable characteristics of the 4VWX snow crab fishery

- By-catch is low .. clean fishery (< 0.02% of total catch, mostly other crabs and lobsters)
- Low impact upon substrate (traps with biodegradable panels)
- Low impact upon SARA species
- High and generally positive involvement of fishers in co-management and assessment process
- Science was funded directly by fishers > 640 K / annum. With the Larocque process, fishers currently fund about 40% of the survey.
- Many direct and indirect socio-economic benefits to local and provincial jurisdictions derived from the fishery and supporting activities: bait, processors, transport, infrastructure, etc.
- With regards to the Precautionary Approach (PA):
  - Spawning stock biomass (females) is fully protected
  - Males are mostly harvested after mating
  - Exploitation of the fishable biomass is the most conservative in the NW Atlantic (10-20%)
  - Many indicators of ecosystem and stock status are tracked, beyond abundance of the target population.
  - As this fishery is already highly PA-compliant, most of the effort in stock assessment is to optimize/rationalize economic costs/benefits.

SARA = Species At Risk Act
PA = Precautionary Approach