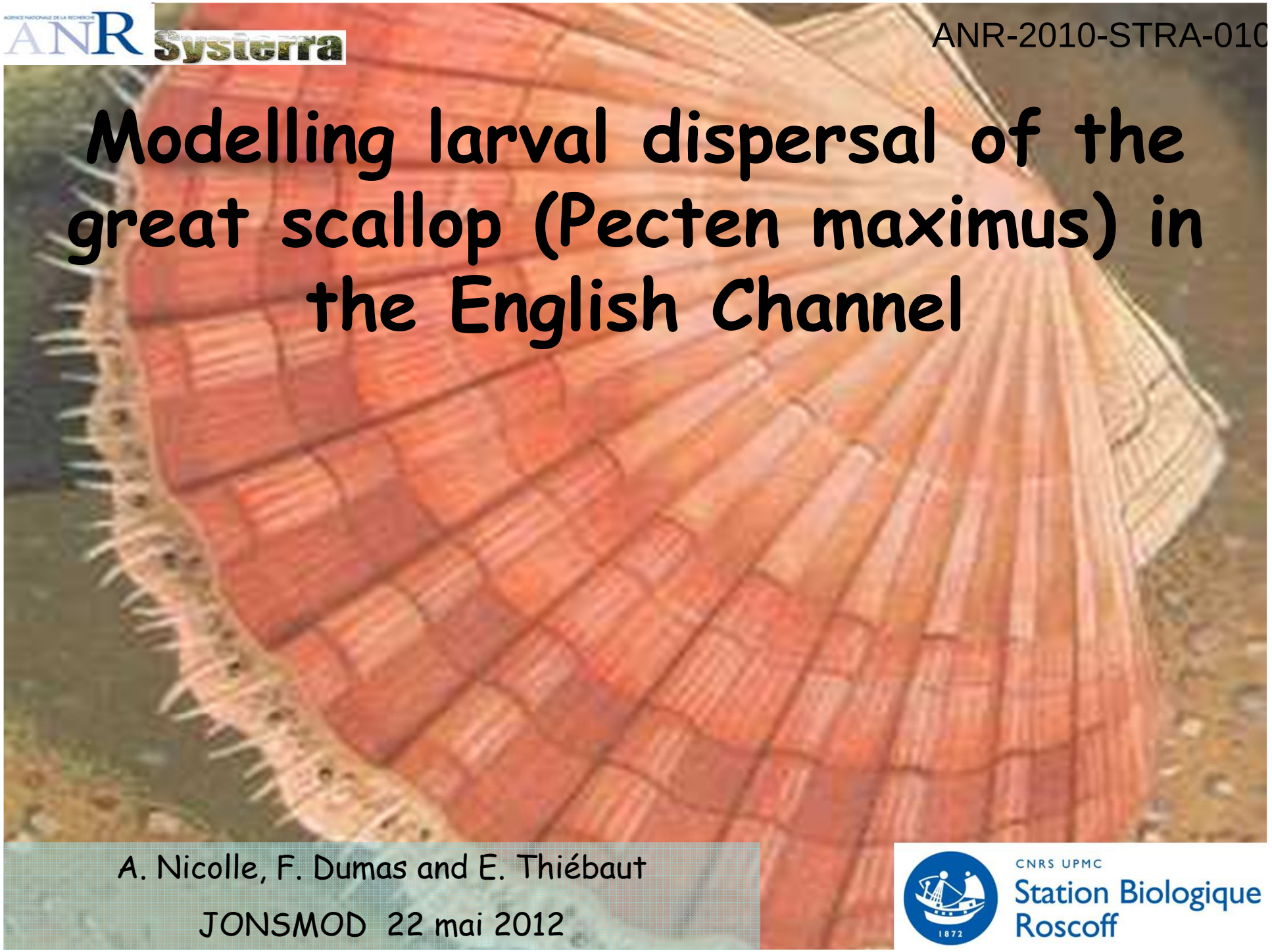
ANR Systerra

ANR-2010-STRA-010

Modelling larval dispersal of the great scallop (Pecten maximus) in the English Channel



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JONSMOD 22 mai 2012

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Roscoff

Study context

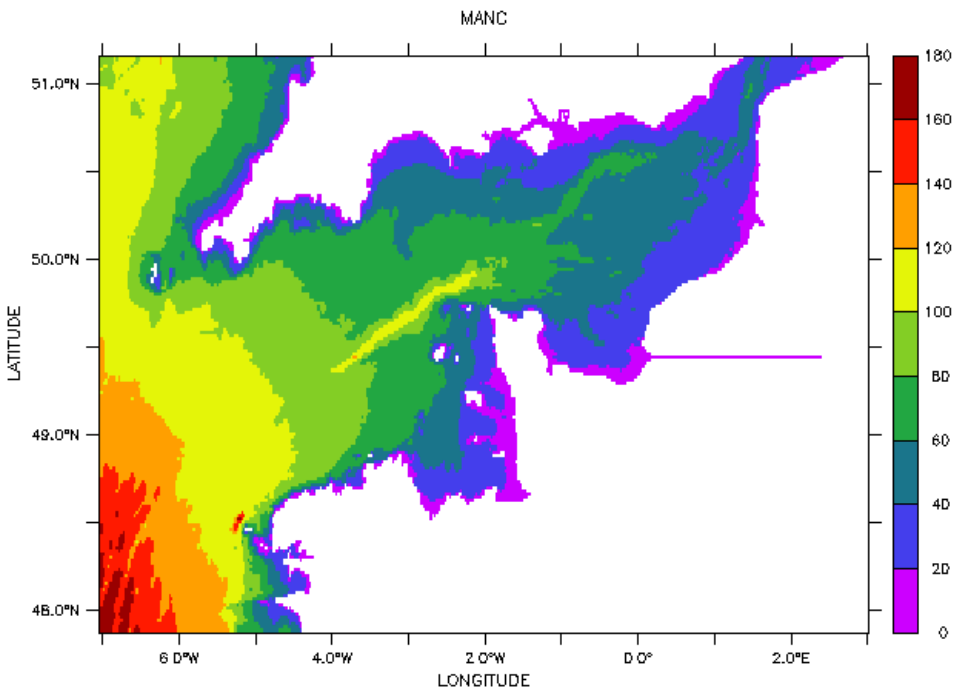
- Preliminary results of Task 3 of project ANR COMANCHE
- Pecten maximus = first specie landed by french flotilla
- Management of the different stocks of English Channel totally independent : different fish period, minimal size of caught…
- Are theses stocks really independent?
- For species with bentho-pelagic life cycle , the larval dispersive phase is determinant for :

1) understand the mechanisms responsible of larval retention in the nursery area or connectivity between neighbors' populations

2) definition of effective strategy of spatial resource management

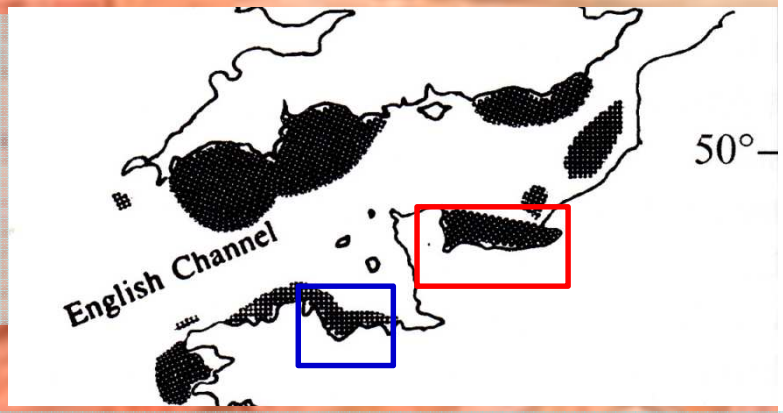
Study area

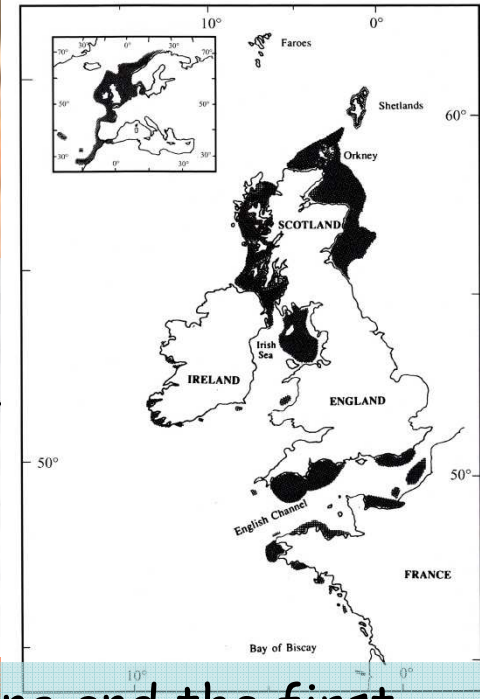
- Shallow water (max depth =100 m)
- Tide
- Wind
- River plume (Seine…)



Biology of great scallop

Stocks = Bay of Morlaix / Lannion ; Bay of St Brieuc ; Bay of Saint Malo ; Bay of Seine ; eastern channel and south coast of England

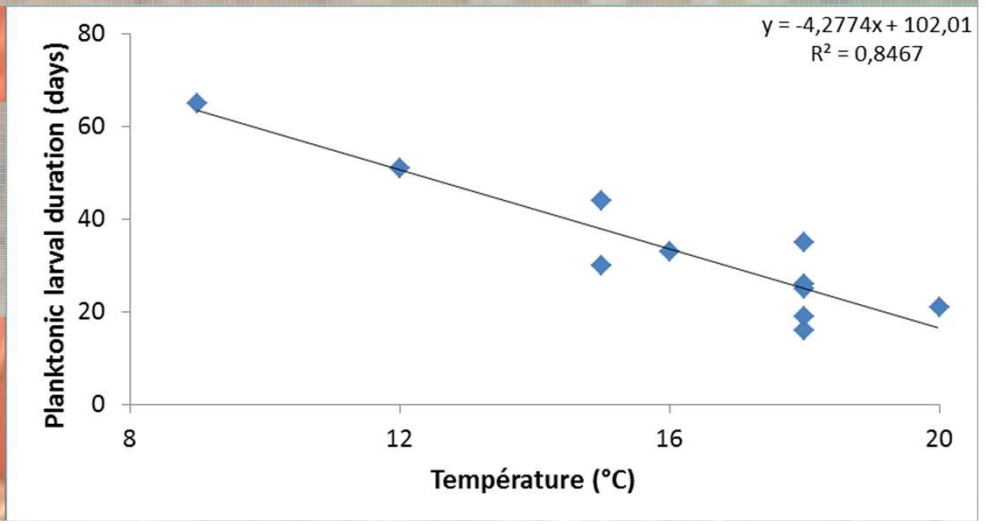




Spawning period = Bay of St Brieuc = 2 significant spawning and the first for T° = 16°C

= Bay of Seine = more spawning but the first for T°= 16°C

Planktonic larval duration (PLD) strongly related to the Temperature = law of Arrhénius



Study objectives

- What are the processes controlling Pecten larvae transport?
- Where are concentrated the larvae during settling?
- Is there a link between the two different strategy of spawning and the retention power of the two bays?
- What are the source and sink populations in these two bays?

Modelling method

- Model simulation 0 – reference simulation :
  - PLD : 40 days
  - No biologic behavior
  - Bay of St brieux : 2 spawning episodes : one for T=16°C and the other 3 weeks later
  - Bay of Seine : many spawning episodes : one for T=16°C and every 8 days until the end of August
  - 10 years of simulation (2000 à 2009)

- Model simulation 1

= reference simulation +

  - Influence of the variability of the planktonic larval duration : taking account of the law of Arrhénius in the model

Modelling method

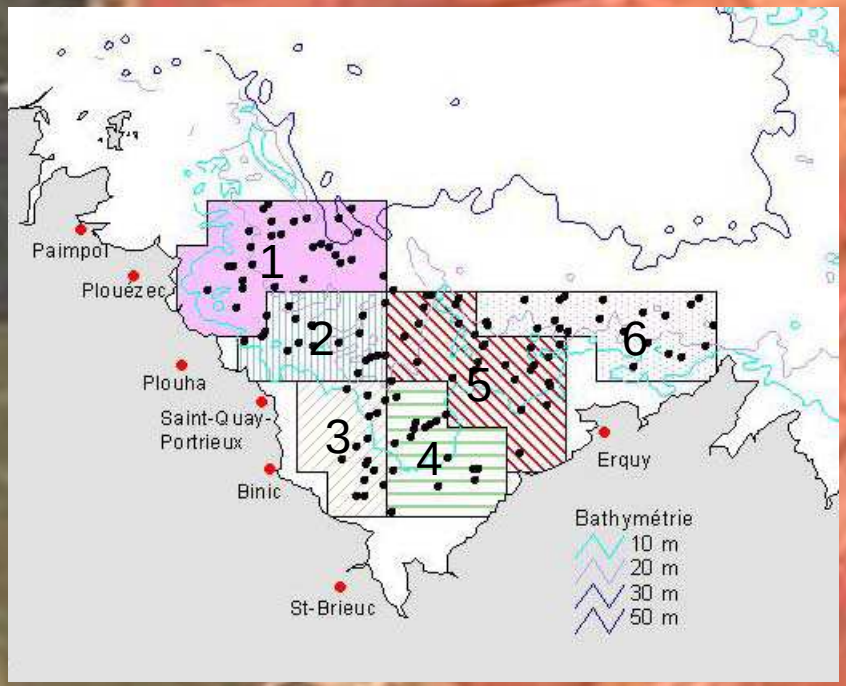
- hydrodynamic model (MARS 3D)

- Choice of Bay of St Brieuc and Bay of Seine for test zone because :
    1) really well known stock cartography
    2) two different spawning strategy

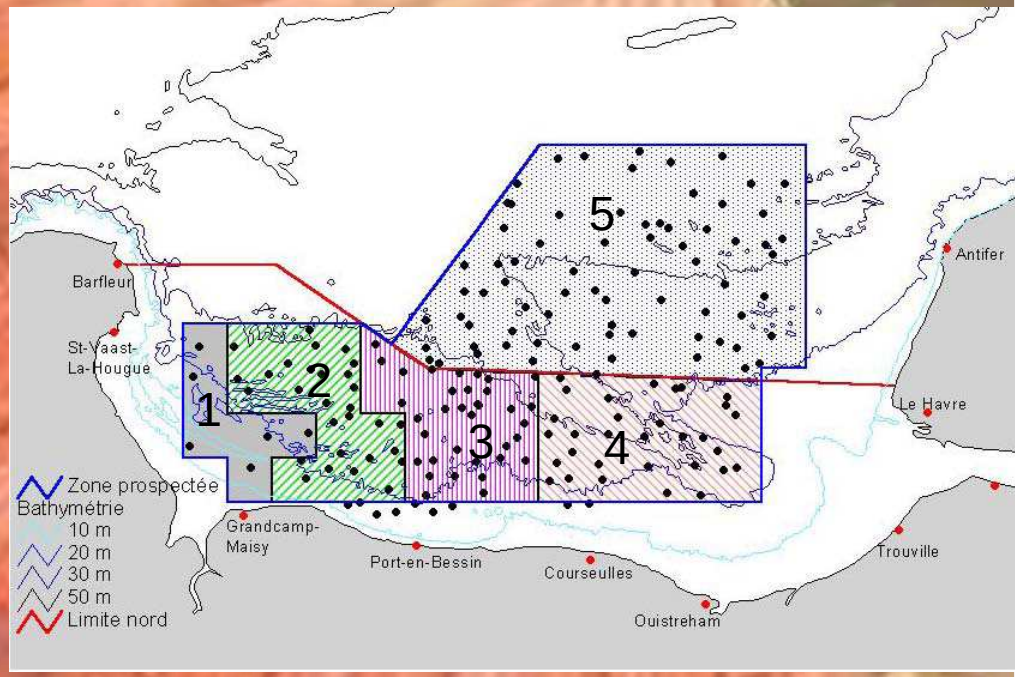
- lagrangian experiments :
    1) passive transport for 40 days
    2) PLD related to Temperature according the law of Arrhénius

Lagrangian experiments

Definition of 6 banks (patches) in the Bay of St Brieuc

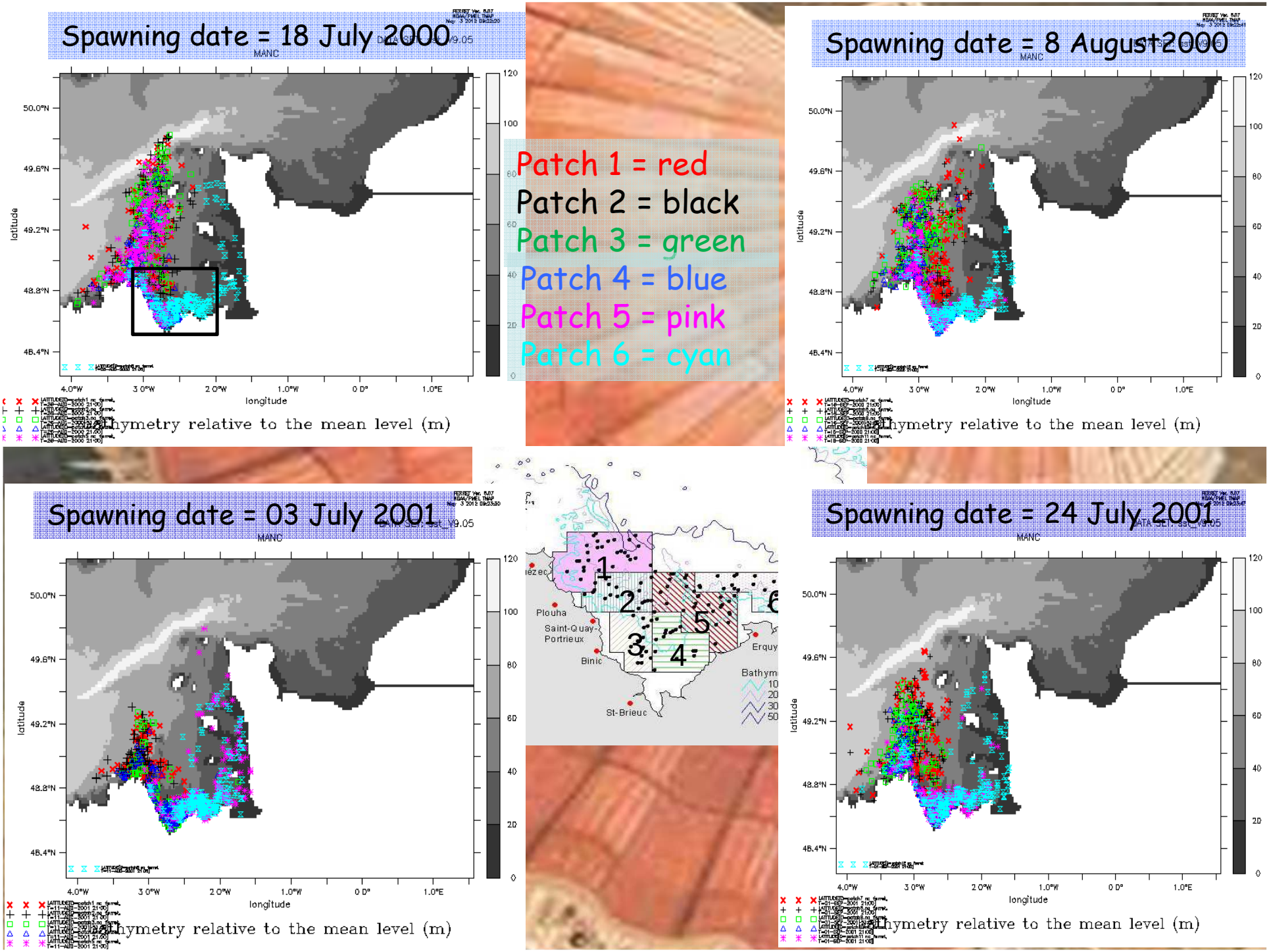


Definition of 5 banks (patches) in the Bay of Seine

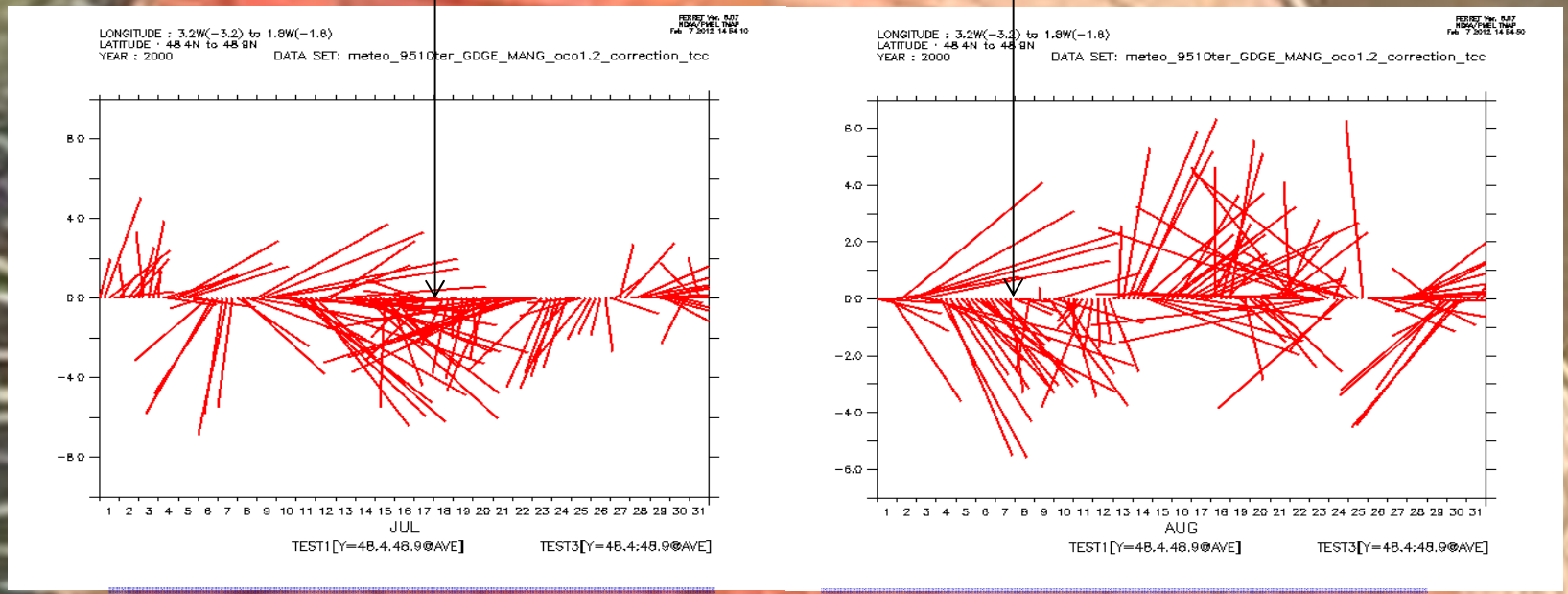


3000 particles per patch homogeneously distributed in the water column


Dispersal after 40 days of passive transport
2000 and 2001
Bay of St Brieuc

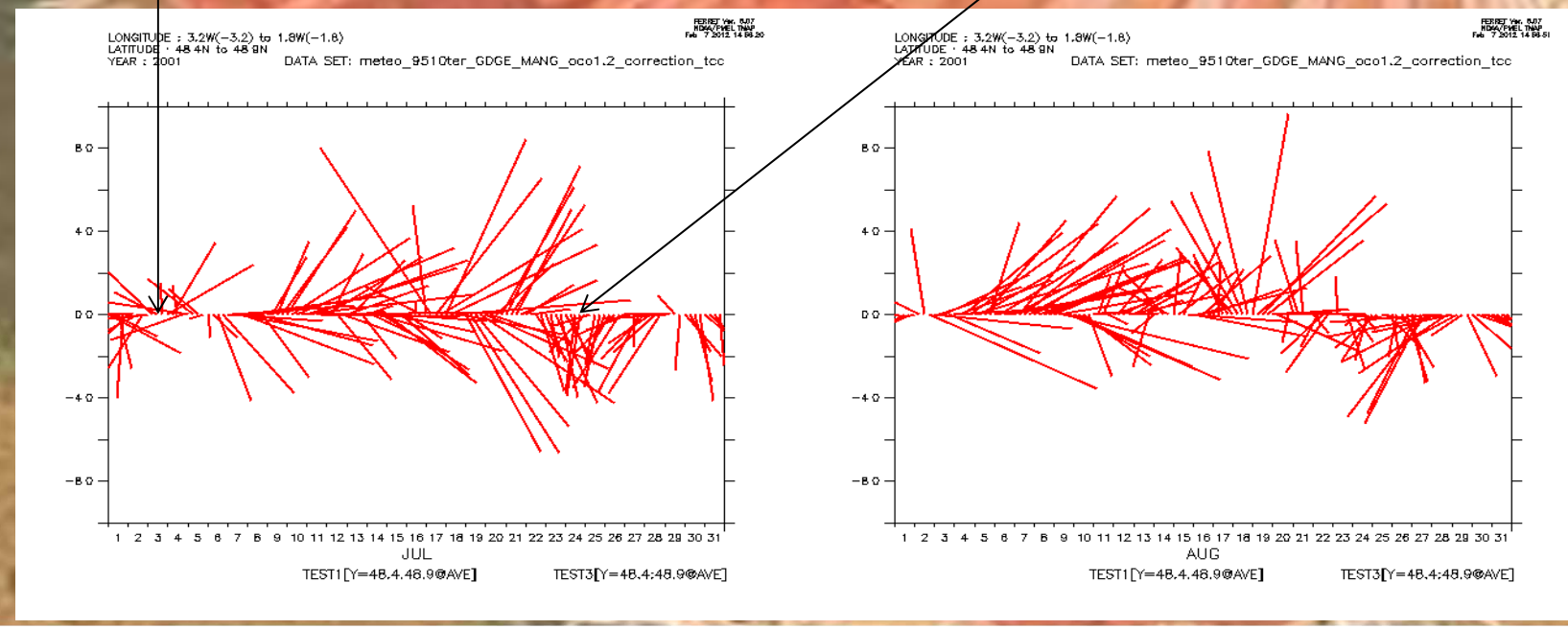

Spawning date = 18 July 2000
Spawning date = 8 August 2000
Spawning date = 03 July 2001
Spawning date = 24 July 2001
Patch 1 = red
Patch 2 = black
Patch 3 = green
Patch 4 = blue
Patch 5 = pink
Patch 6 = cyan
MANC
latitude
longitude
50.0°N
49.6°N
49.2°N
48.8°N
48.4°N
4.0°W
3.0°W
2.0°W
1.0°W
0.0°
1.0°E
120
100
80
60
40
20
0
Bathymetry relative to the mean level (m)
Plouha
Saint-Quay-Portrieux
Binic
St-Brieuc
Erquy
1
2
3
4
5
6

Spawning date = 18 july 2000

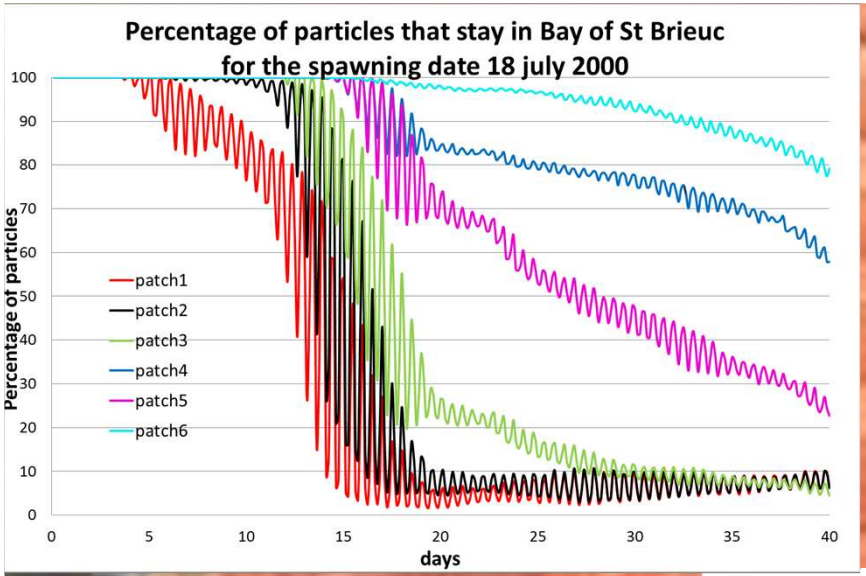


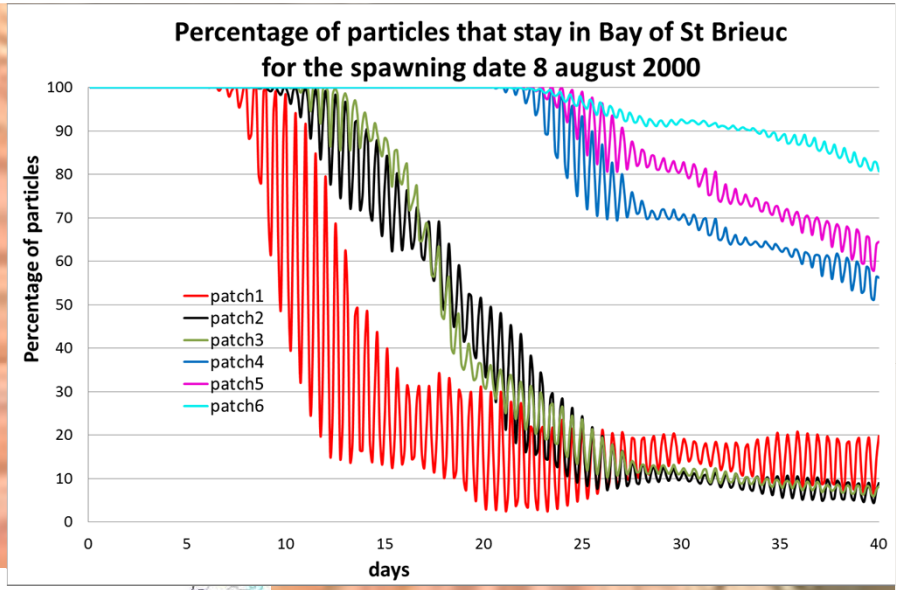
Spawning date = 8 august 2000

Spawning date = 3 july 2001



Spawning date = 24 july 2001





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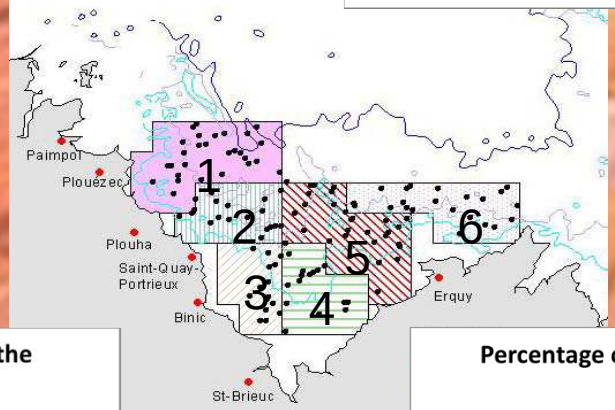
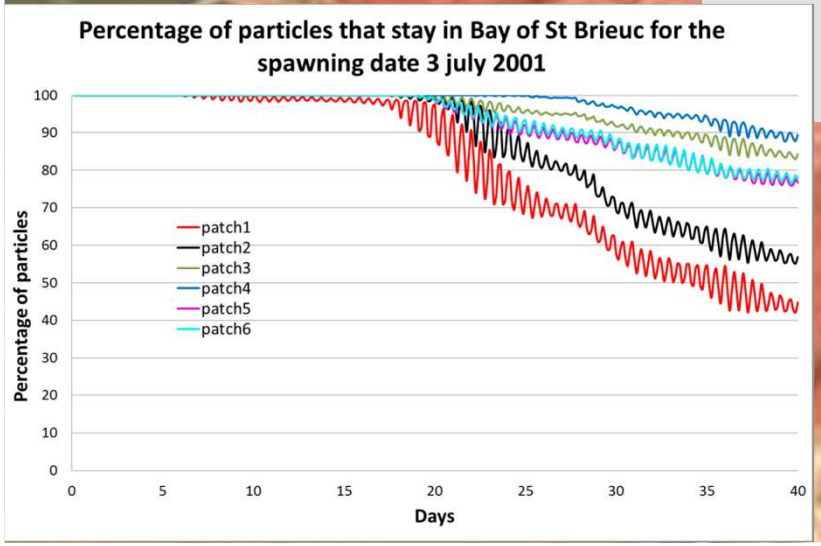
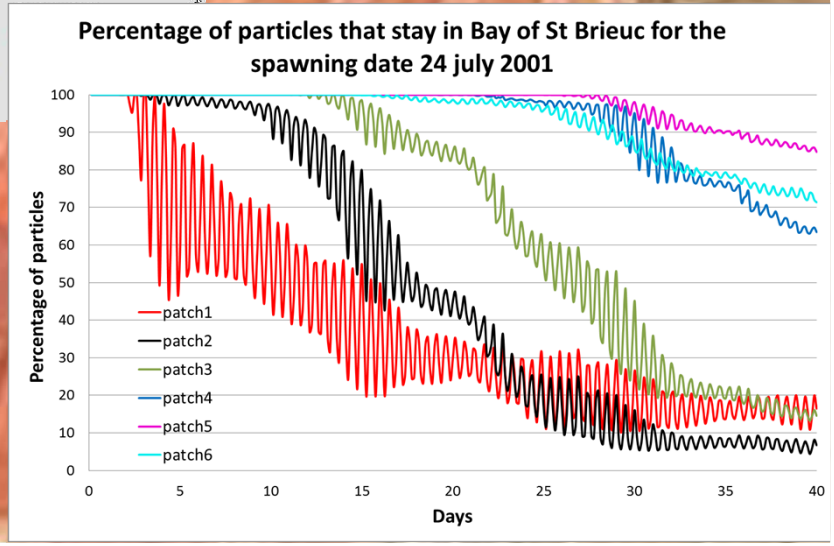
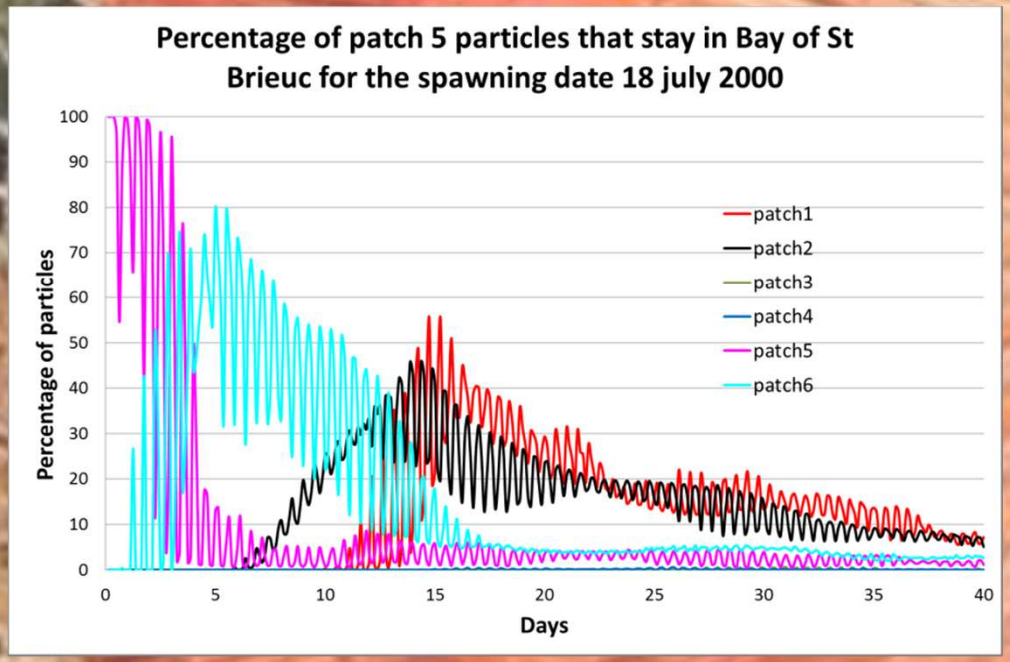
Patch 2 = black
Patch 3 = green

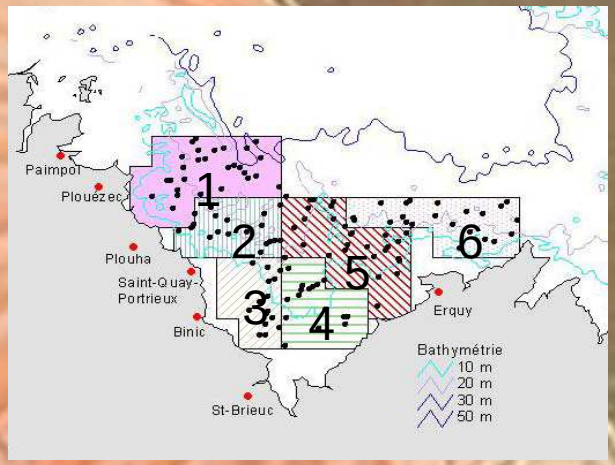


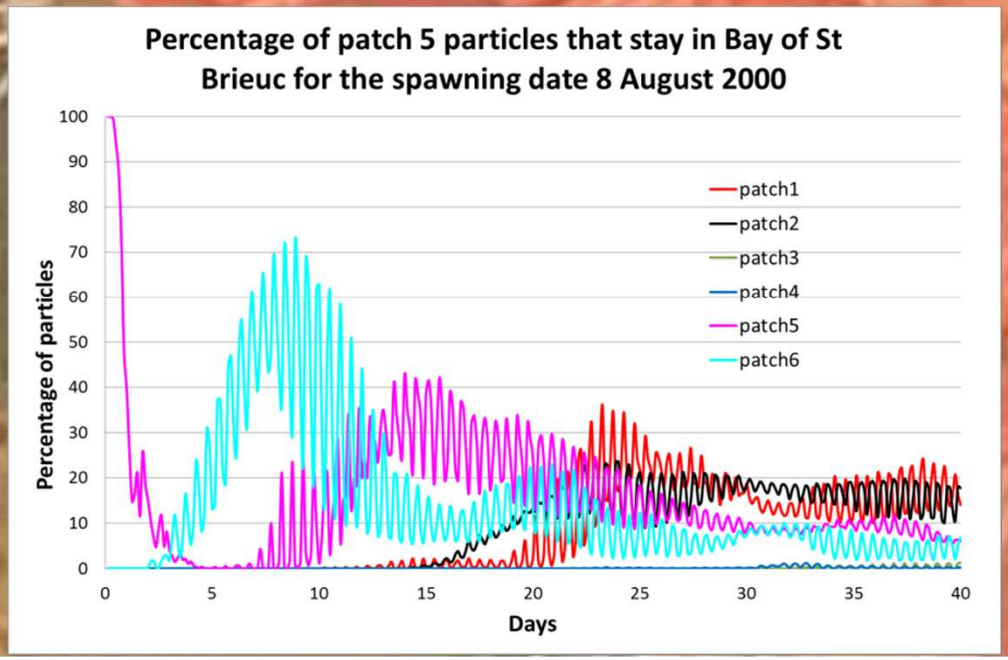
Patch 4 = blue
Patch 5 = pink
Patch 6 = cyan





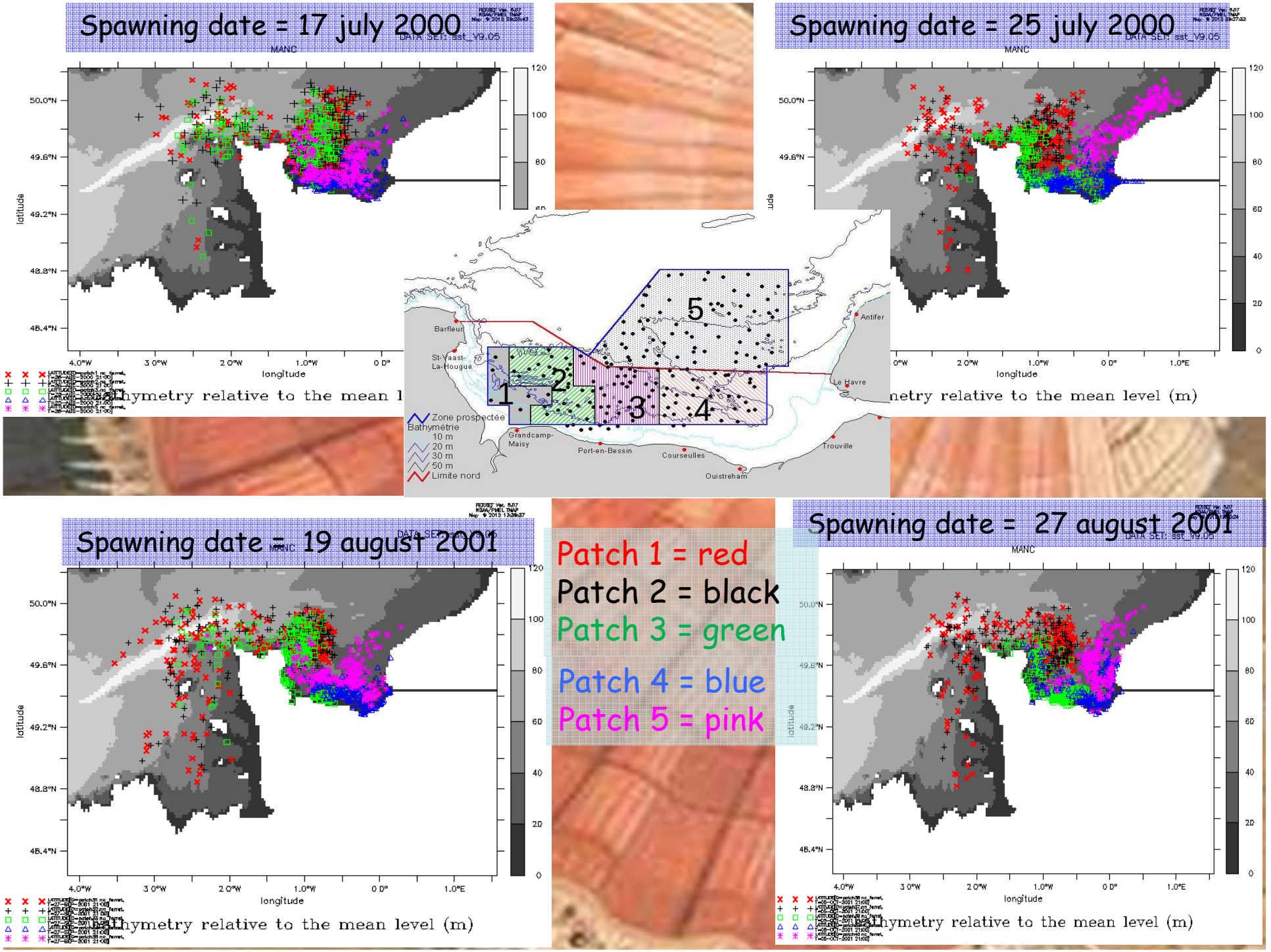




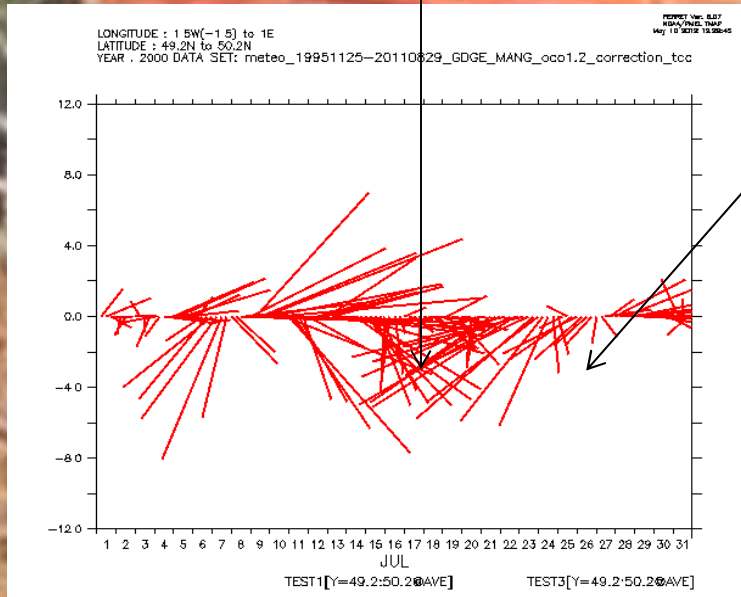


Patch 1 = red
Patch 2 = black
Patch 3 = green
Patch 4 = blue
Patch 5 = pink
Patch 6 = cyan

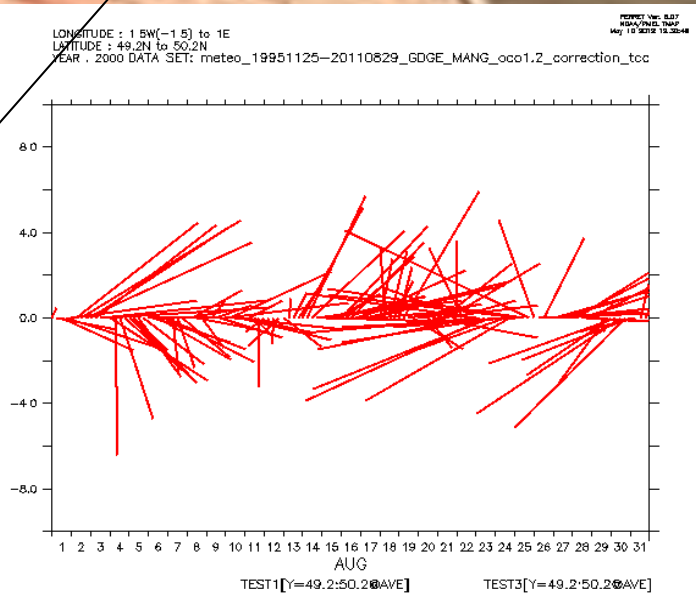

Dispersal after 40 days of passive transport
2000 and 2001
Bay of Seine


Spawning date = 17 july 2000
Spawning date = 25 july 2000
Spawning date = 19 august 2001
Spawning date = 27 august 2001
Patch 1 = red
Patch 2 = black
Patch 3 = green
Patch 4 = blue
Patch 5 = pink
MANC
latitude
longitude
Zone prospectée
Bathymétrie
10 m
20 m
30 m
50 m
Limite nord
Barfleur
St-Vaast-La-Hougue
Antifer
Le Havre
Grandcamp-Maisy
Port-en-Bessin
Courseulles
Trouville
Ouistreham

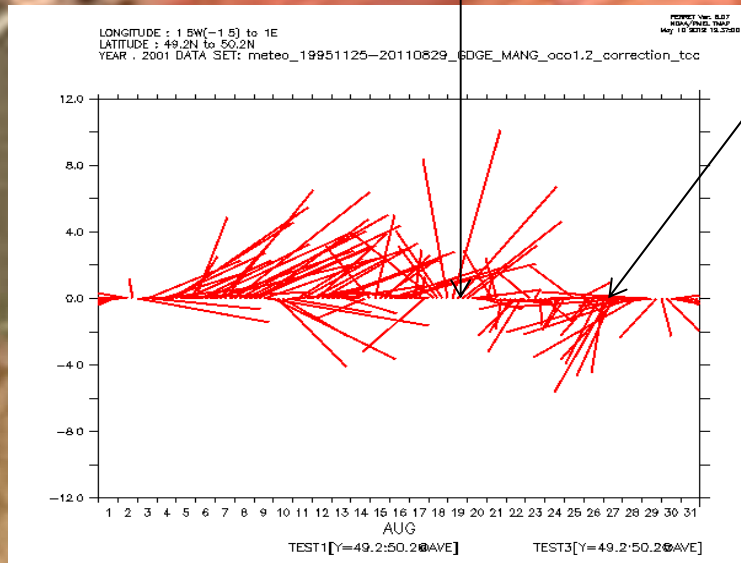
Spawning date = 17 july 2000



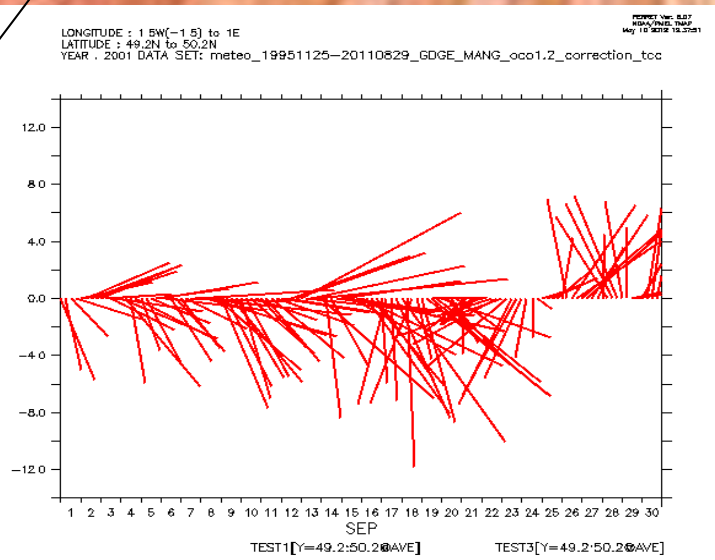
Spawning date = 25 july 2000

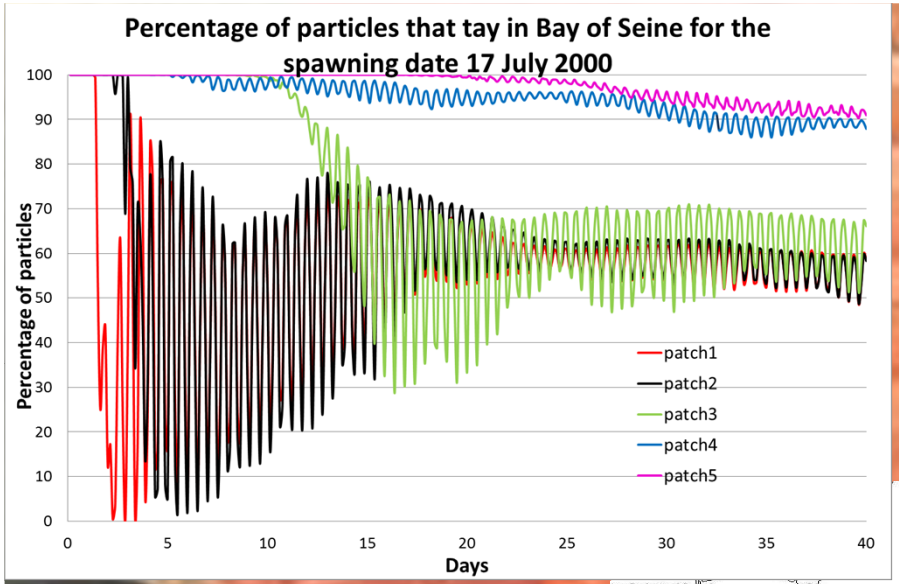


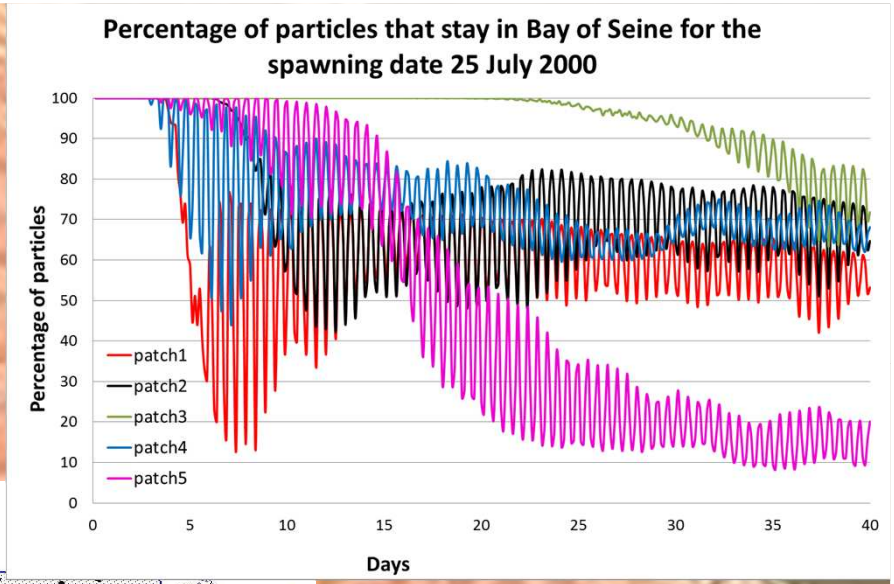
Spawning date = 19 august 2001



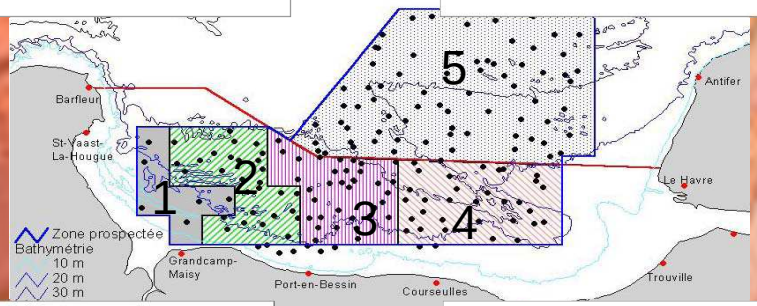
Spawning date = 27 august 2001



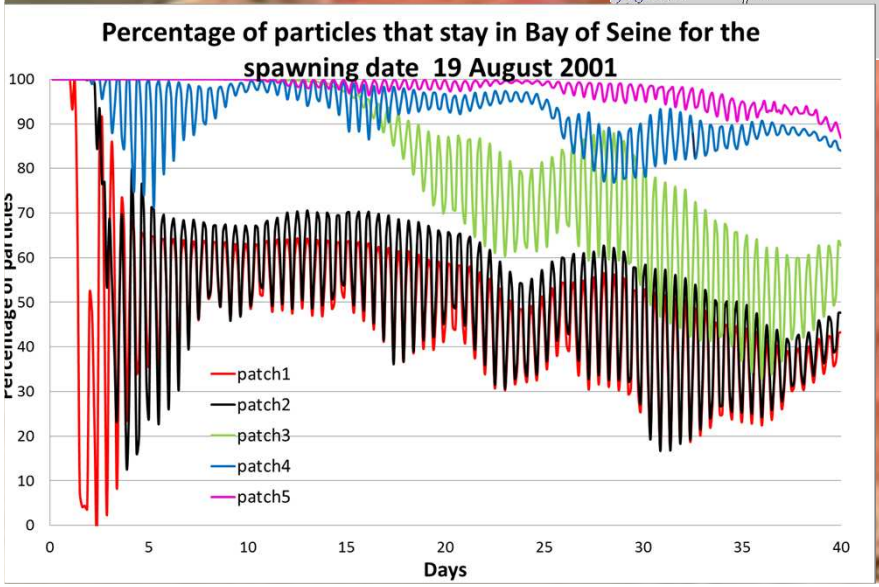


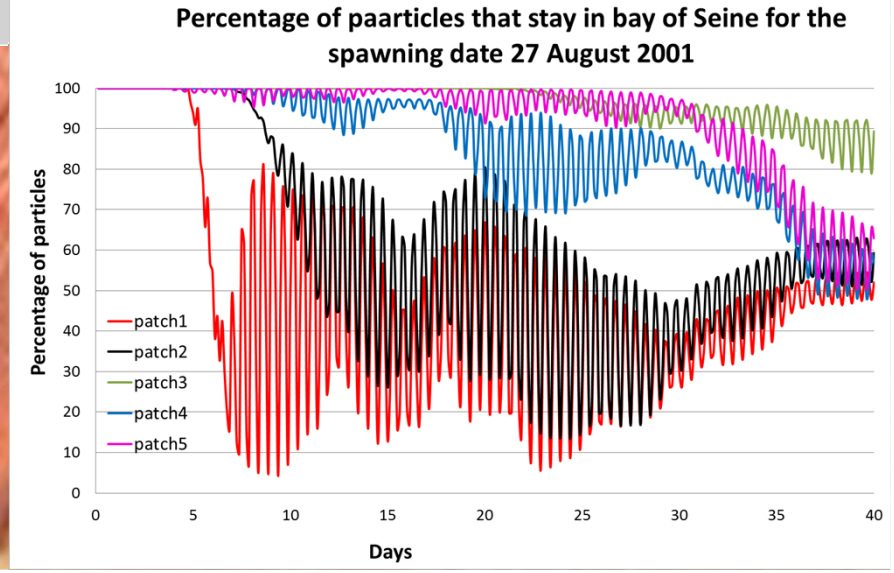


Patch 1 = red
Patch 2 = black
Patch 3 = green

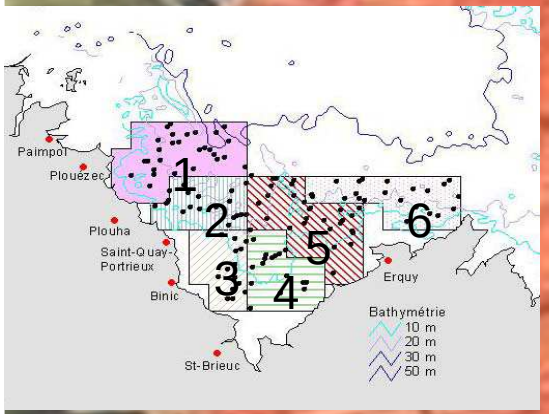


Patch 4 = blue
Patch 5 = pink

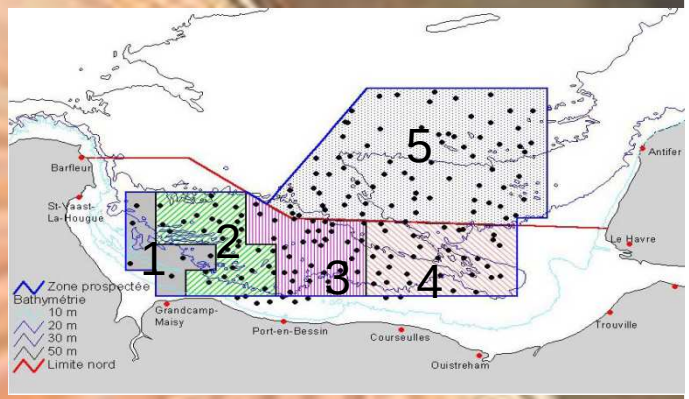


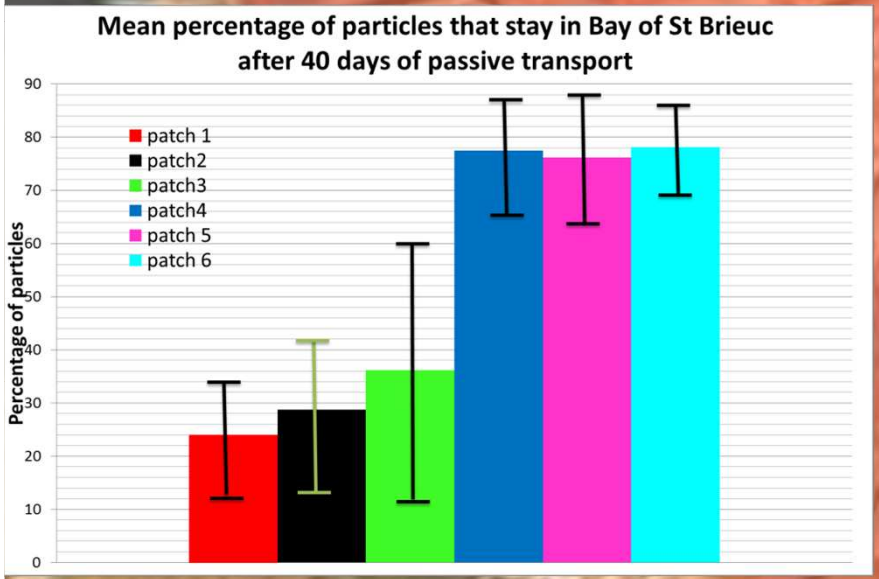


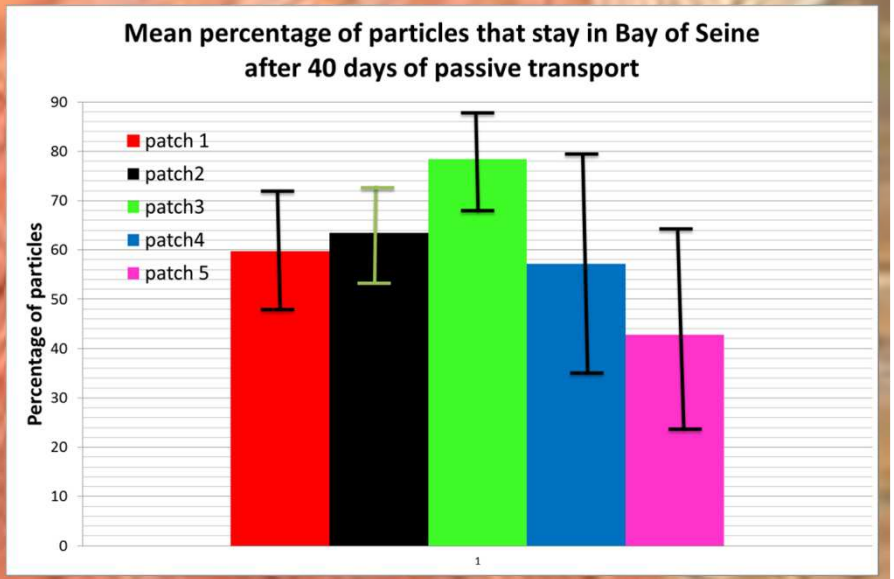
Mean retention of each Bay

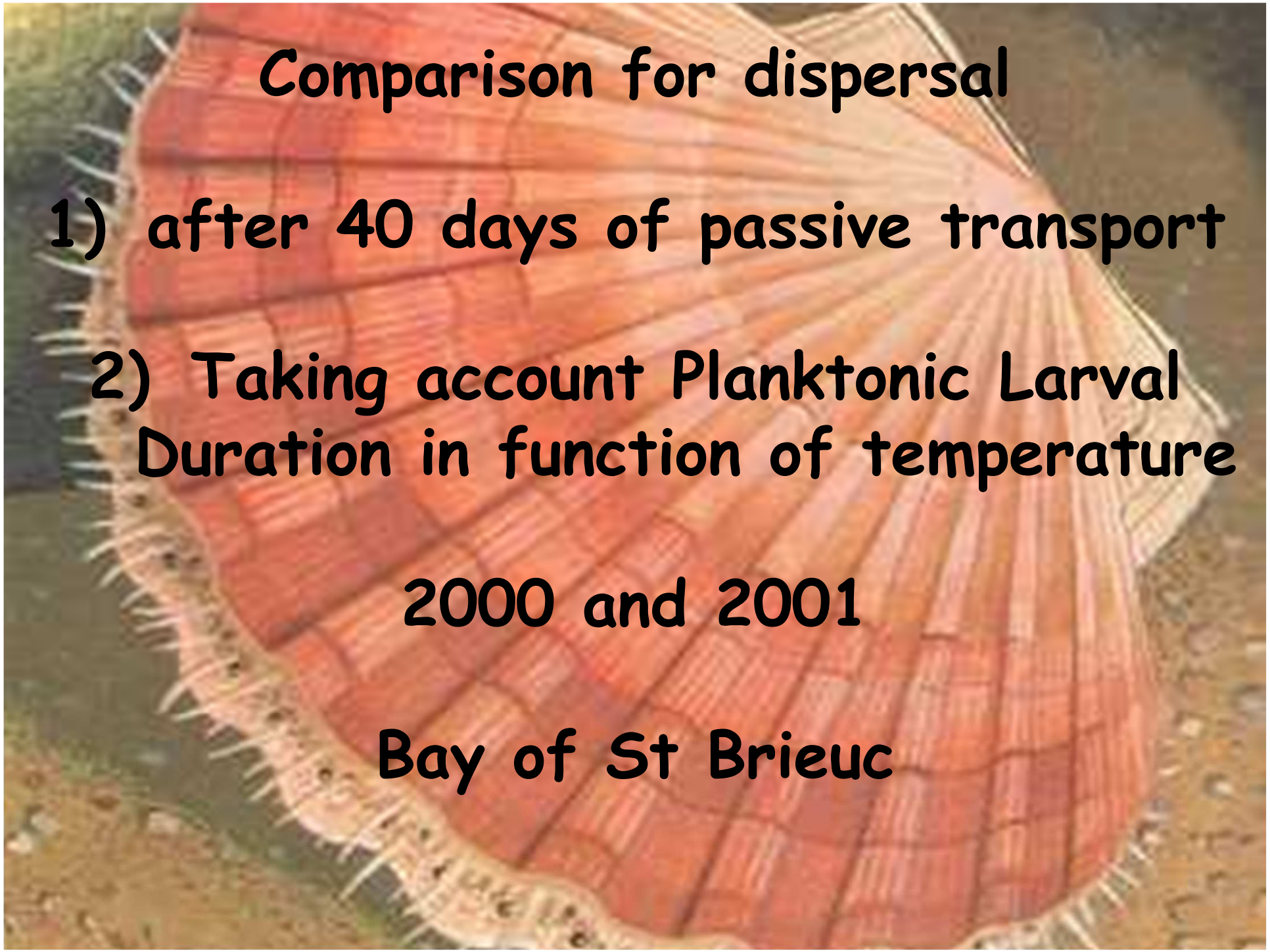


Patch 1 = red
Patch 2 = black
Patch 3 = green
Patch 4 = blue
Patch 5 = pink
Patch 6 = cyan

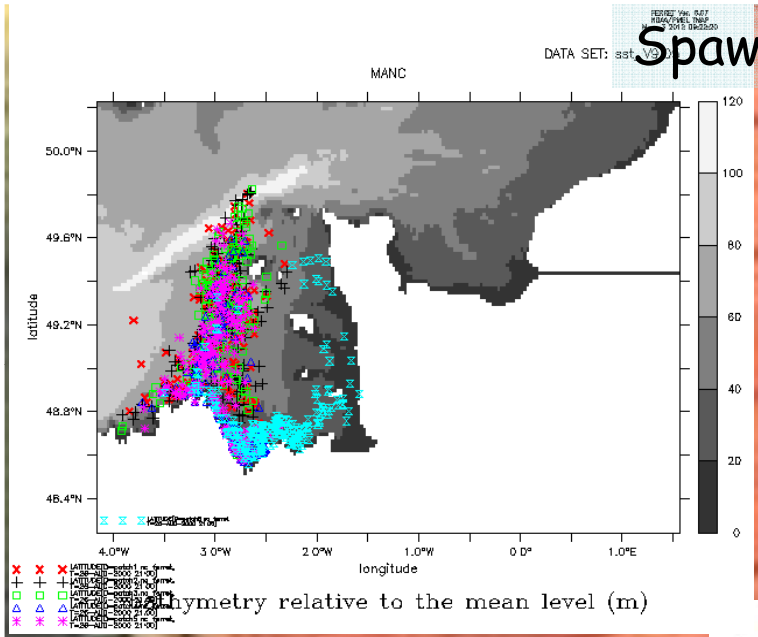







Comparison for dispersal
1) after 40 days of passive transport
2) Taking account Planktonic Larval Duration in function of temperature
2000 and 2001
Bay of St Brieuc

Spawning date = 18 july 2000



Patch 1 = red
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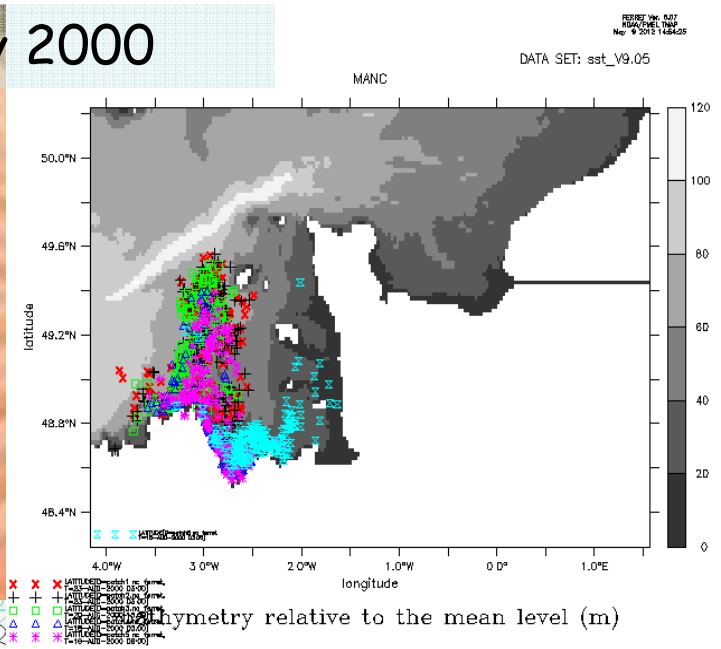
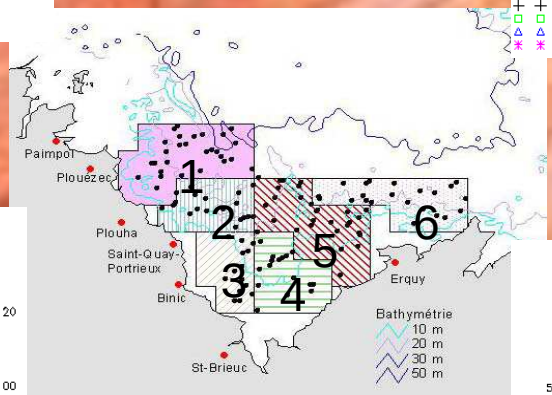
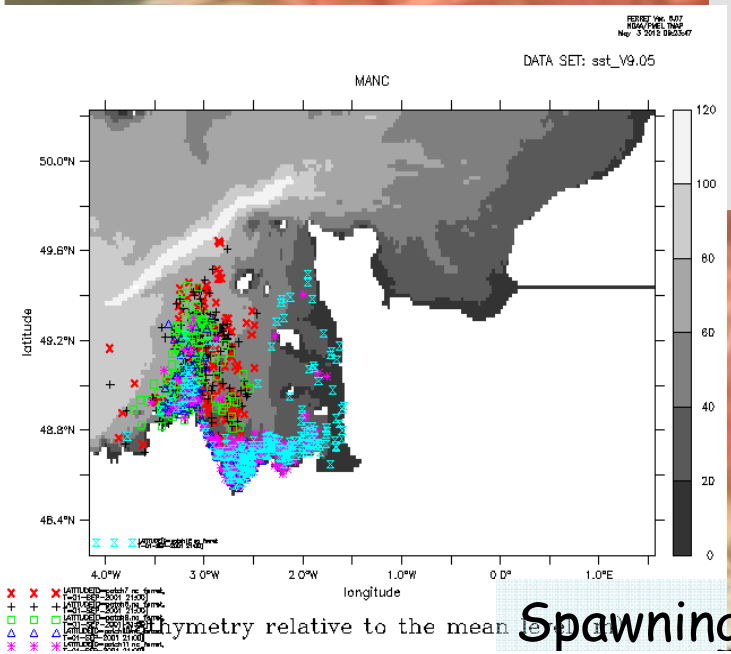


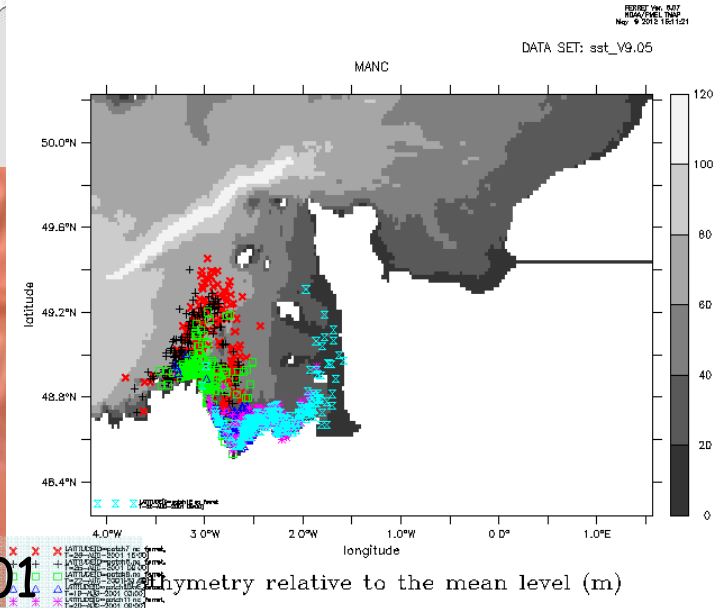
Passive transport



PLD in relation with T°



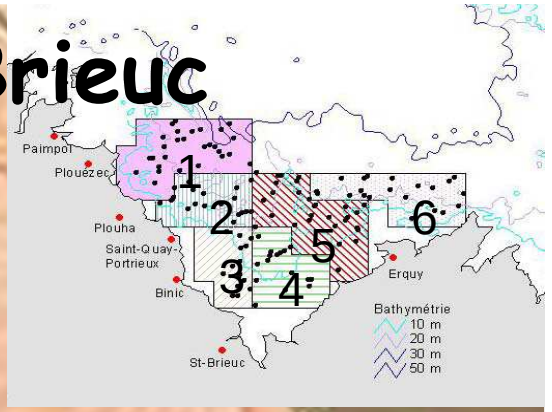
Patch 4 = blue
Patch 5 = pink
Patch 6 = cyan

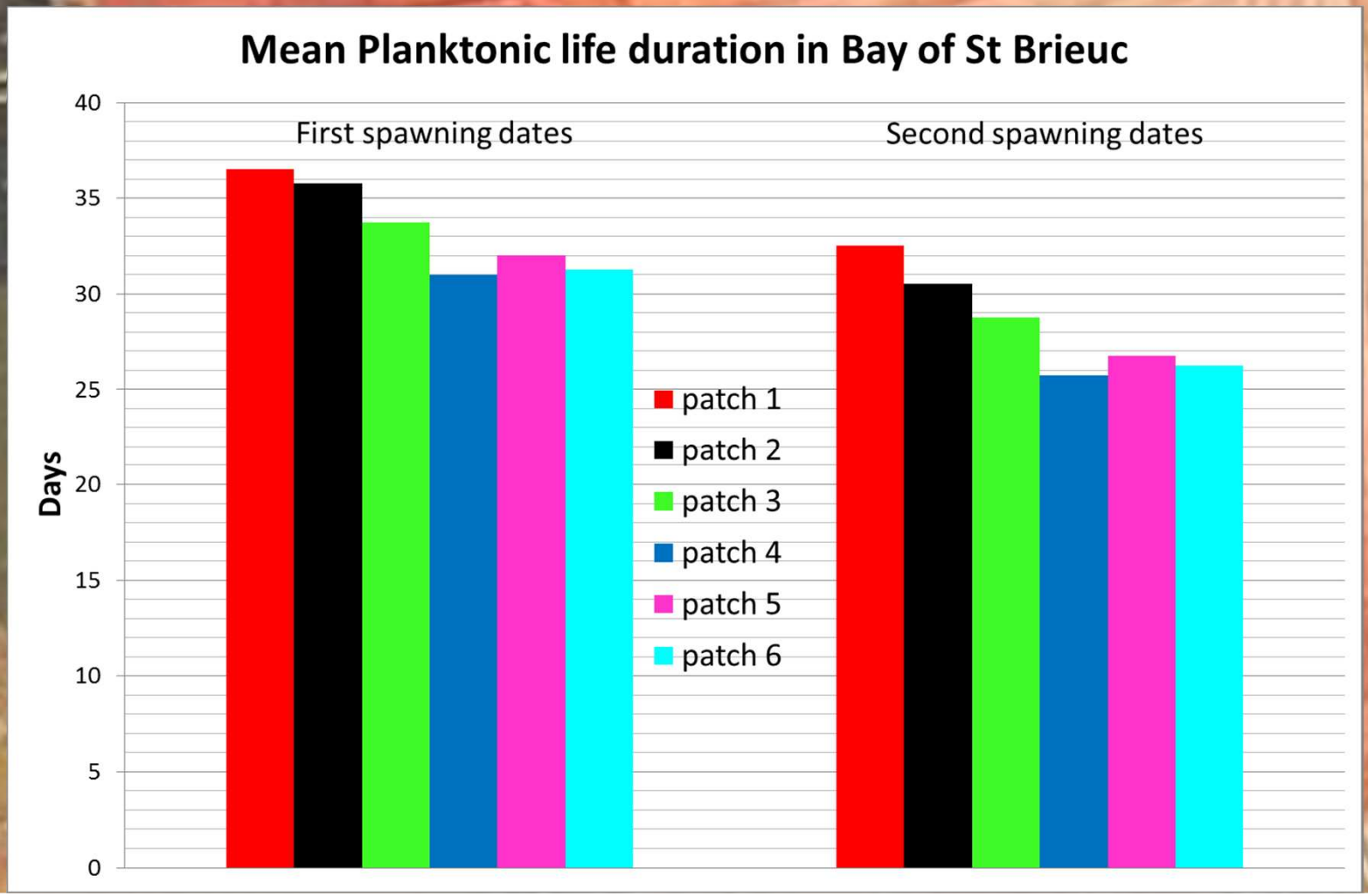


Spawning date = 24 july 2001

Mean PLD in Bay of St Brieuc

Patch 1 = red
Patch 2 = black
Patch 3 = green
Patch 4 = blue
Patch 5 = pink
Patch 6 = cyan



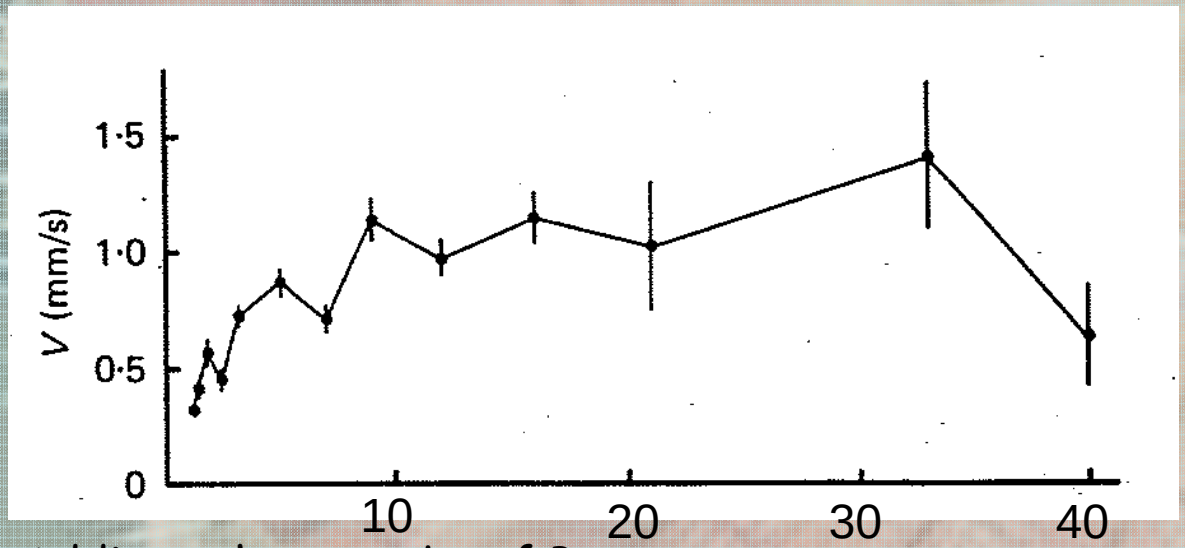


Conclusions

- The wind induced circulation is responsible for the intensity of transport for Pecten larvae and the Temperature is responsible for the duration of this transport.
- The Bay of Seine seems to have a retention power of larvae superior than the Bay of Saint Brieuc.
- For the Bay of Saint Brieuc, it seems that the populations located in the eastern zone of the Bay are the source of the stocks of western zone.
- For the Bay of Seine, it seems that the population located at the north-eastern of the Bay is a probably source of the Pecten stock of eastern channel.

Perspectives

- Adding Pecten larval behavior : swimming speed



- Adding other stocks of Pecten

- Study of connectivity between these different stocks


Thanks for your attention