Flood Tide Transport of Blue Crab Postlarvae: Limitations in a Lagoonal Estuary

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Blue Crab

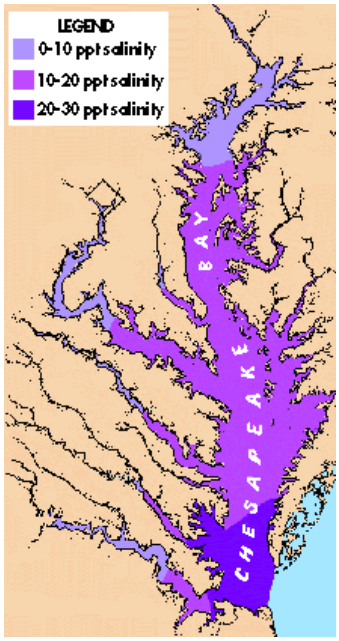
- spawns in the ocean
- matures in the estuary
- how does it get there?

Flood Tide Transport

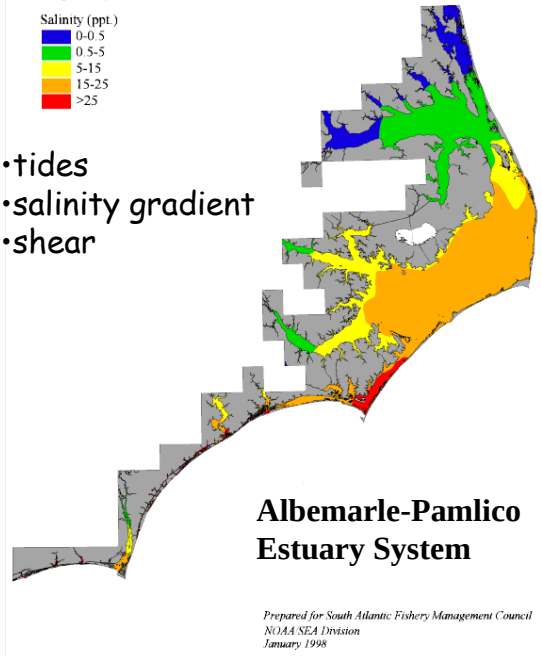
- up on flood, down on ebb
- net motion up-estuary

http://www.esva.net/~tomthumbworkshps/emailtrav.htm
http://www.naturalvisions.co.uk/pictures/

Chesapeake Bay



North Carolina Estuaries:
Biologically-Based Salinity Zones



- tides
- salinity gradient
- shear

Albemarle-Pamlico Estuary System

Prepared for South Atlantic Fishery Management Council
NOAA SEA Division
January 1998

Prior Studies

vertical migration in lab, Tankersley et al

- negative phototaxis
- salinity cue
- pressure increase >> tidal

spatial distributions, field/model, Reyns

- large area
- day/night, not flood/ebb
- surface at night => negative phototaxis
- in western part of Sound => might need FTT

New Questions about Pamlico Sound

Blue crab behavior

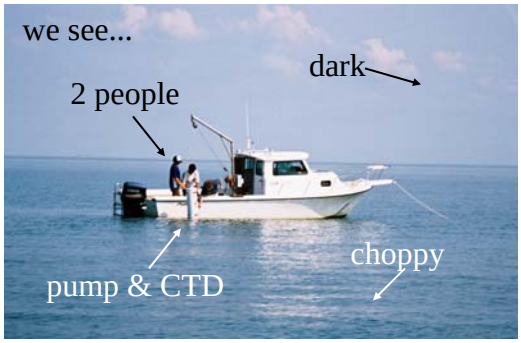
- swim on flood, not ebb?
- what depth?
- respond to salinity?

physics

- currents driven by tide or wind?
- vertical shear?
- salinity increase on early flood?

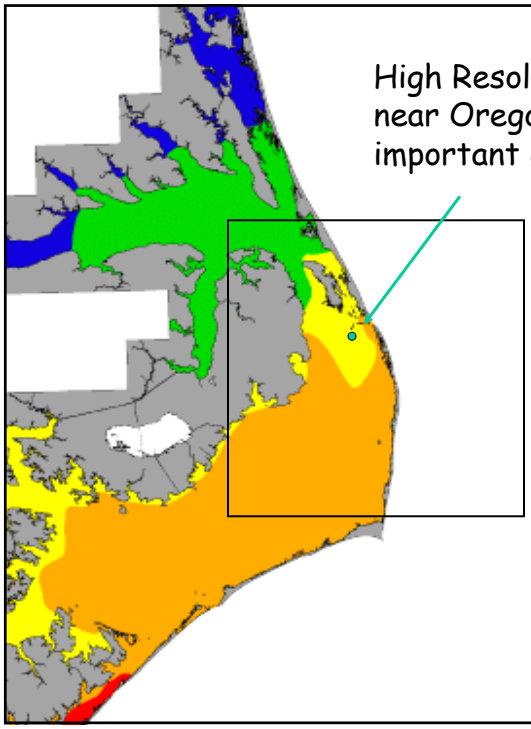
ADCP

- bottom mounted
- upward looking
- currents all depths
- 3 month timeseries
- CTD attached



Dave and Gayle

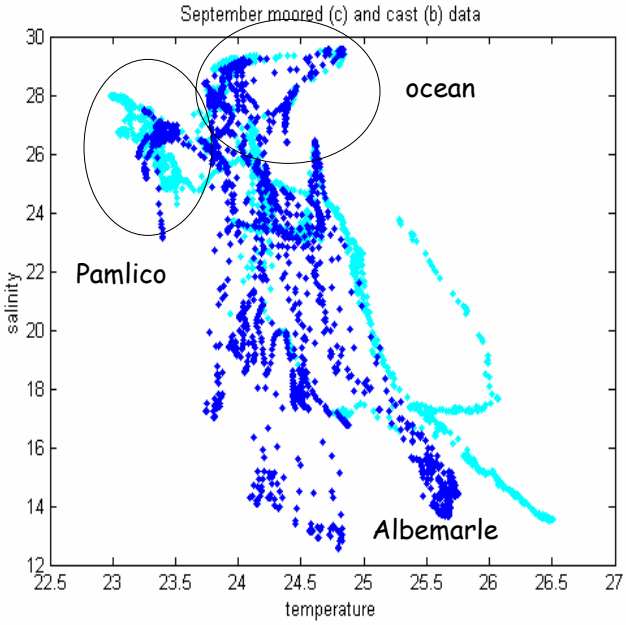
- 7 nights in September
- hourly crab counts, 4 depths
- 1/2 hourly CTD profiles

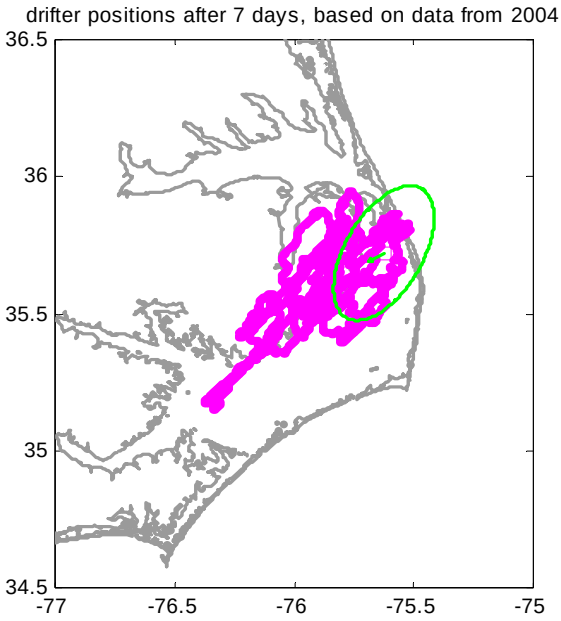


High Resolution Sampling
near Oregon Inlet
important crab source

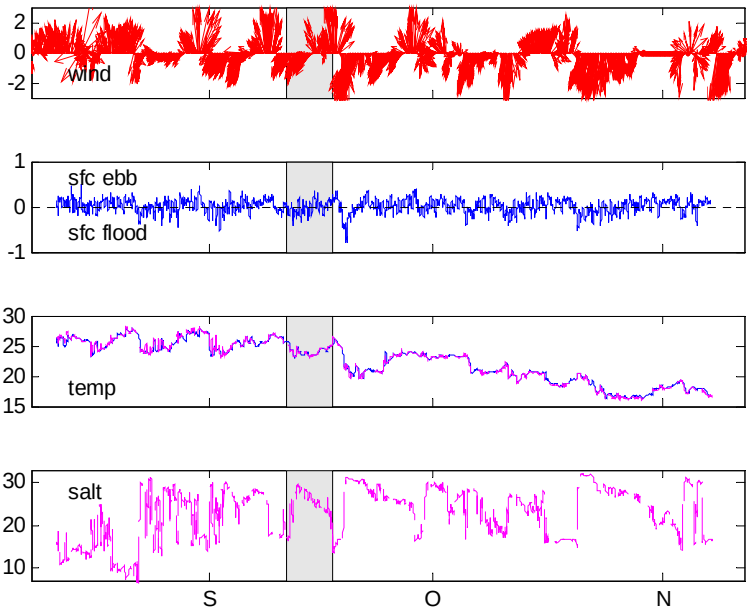
Ocean >28 psu
Pamlico 15 – 25 psu
Albemarle < 5 psu

Wind from NE: salt
Wind from NW: fresh
Wind from S: brackish

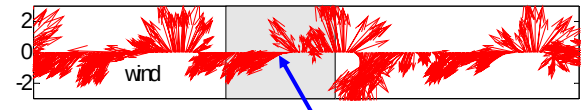




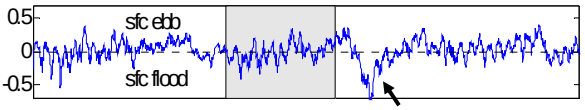
mean currents to SW, cross sound in 7 days



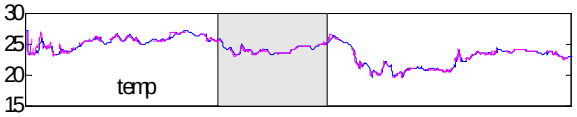
Salinity is not tidal!



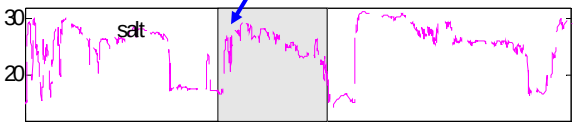
SW-ward wind reverses to N-ward



hurricane: fresh water from Albemarle

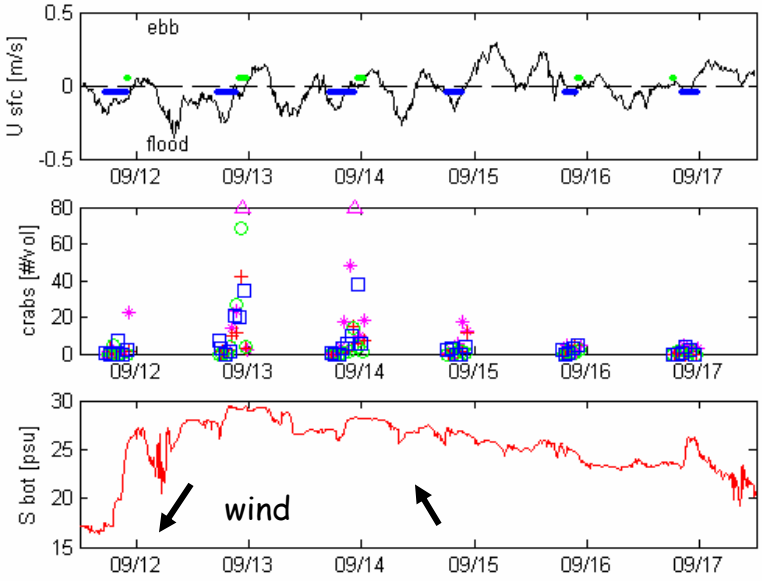


salt water appears, recedes

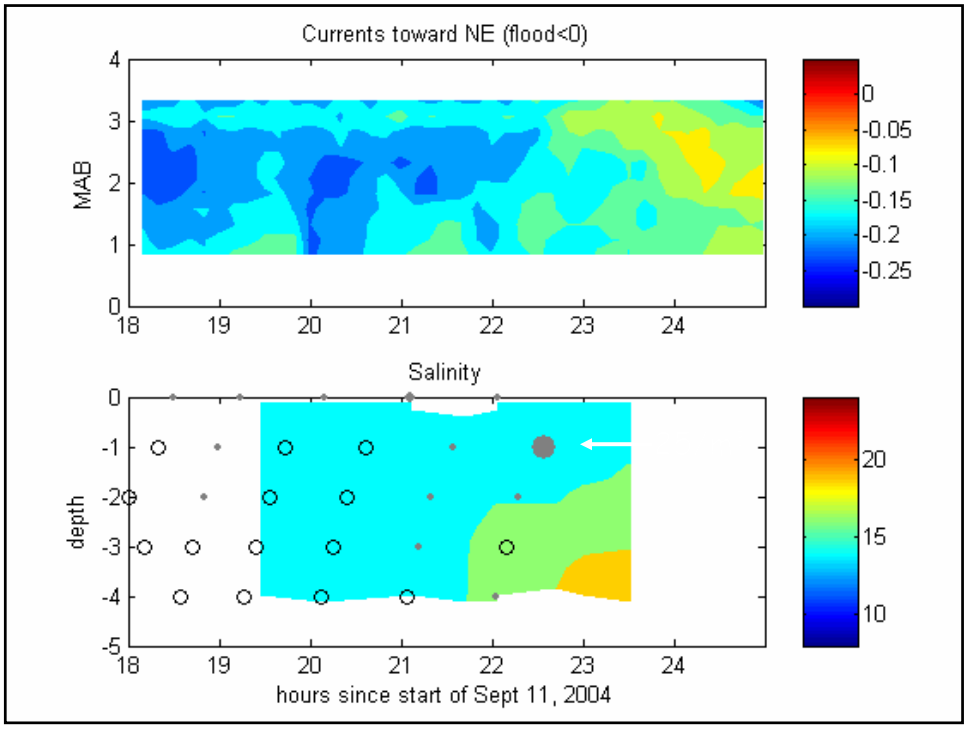


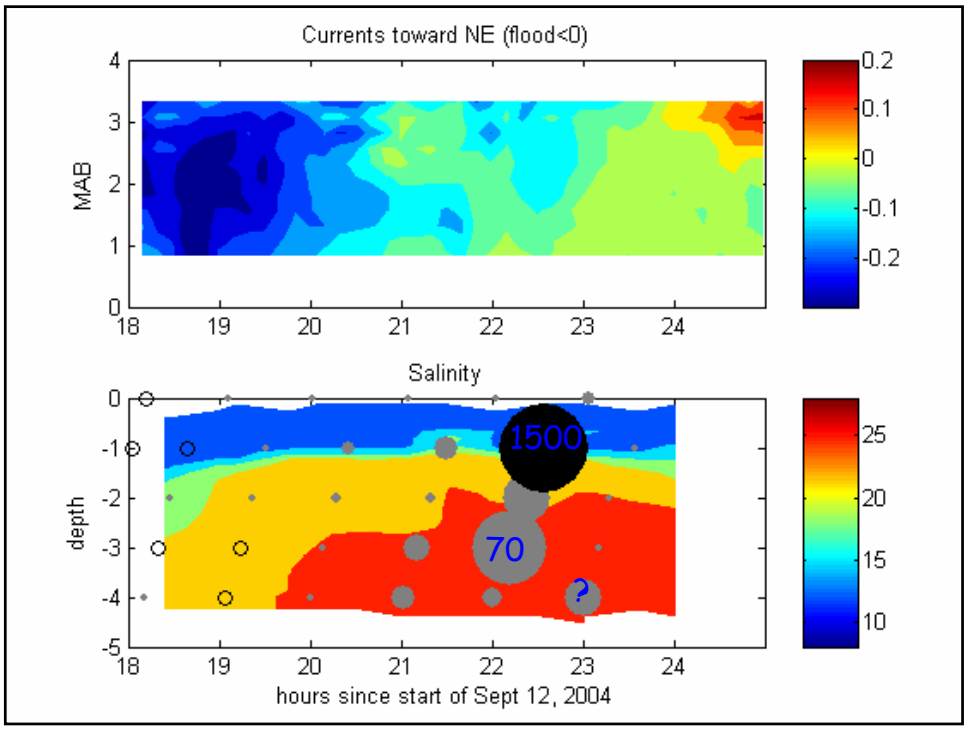
September, 2004

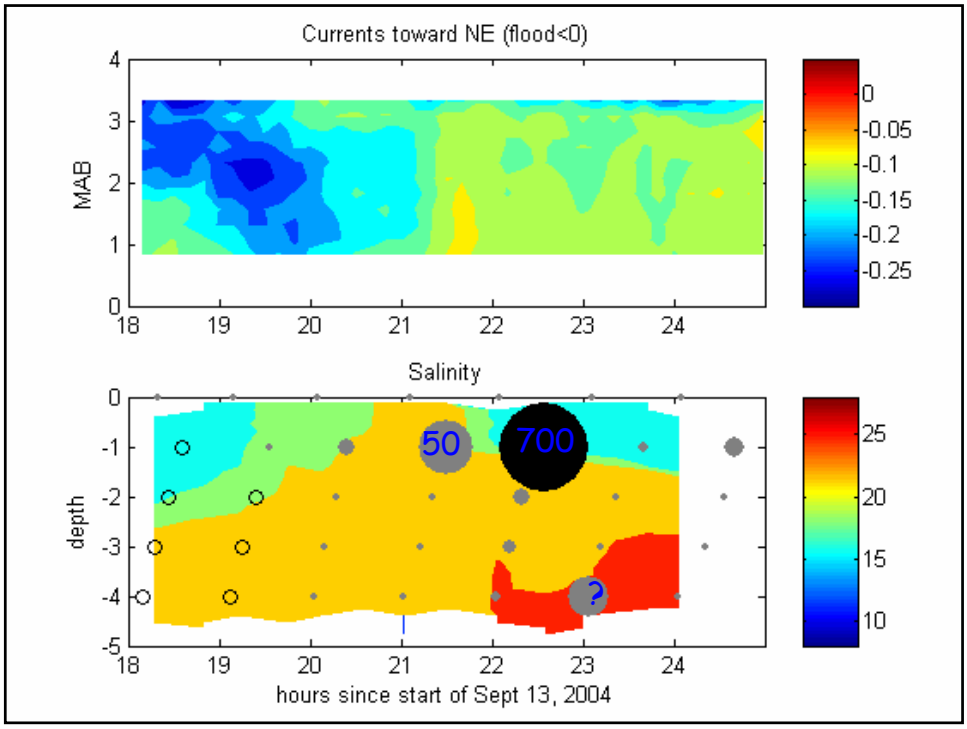
Crab megalopae ride ocean water

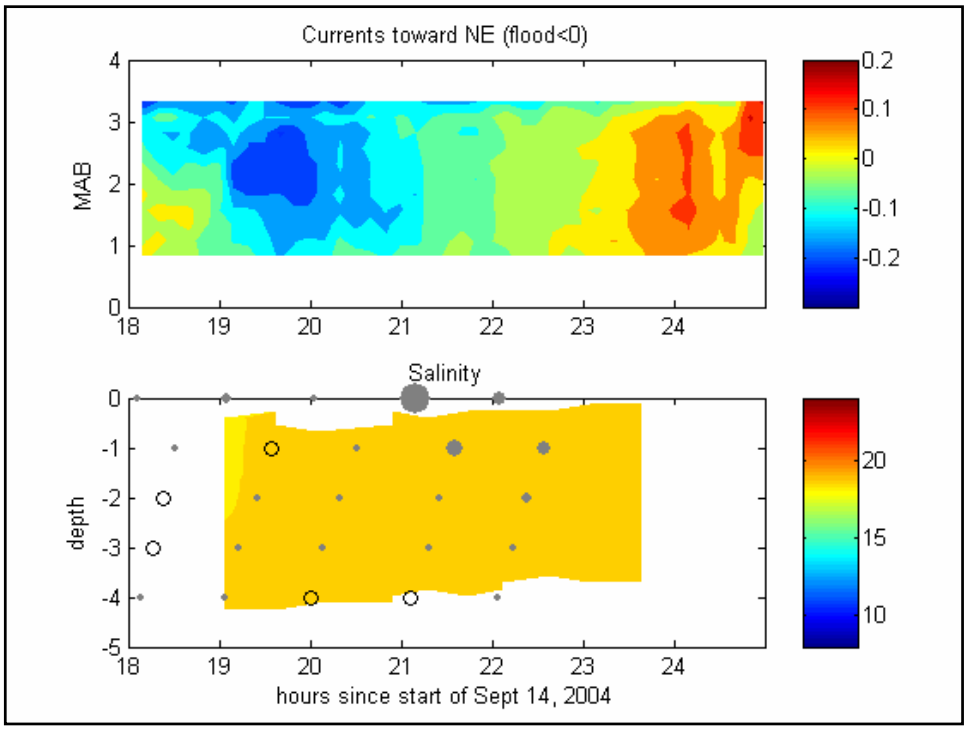


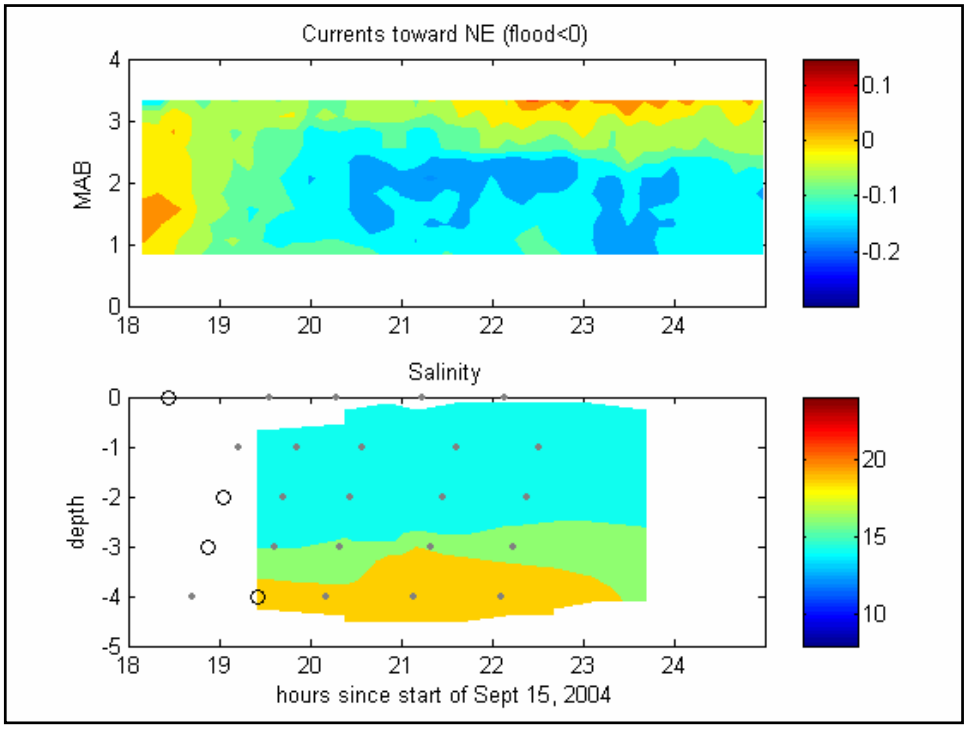
September, 2004

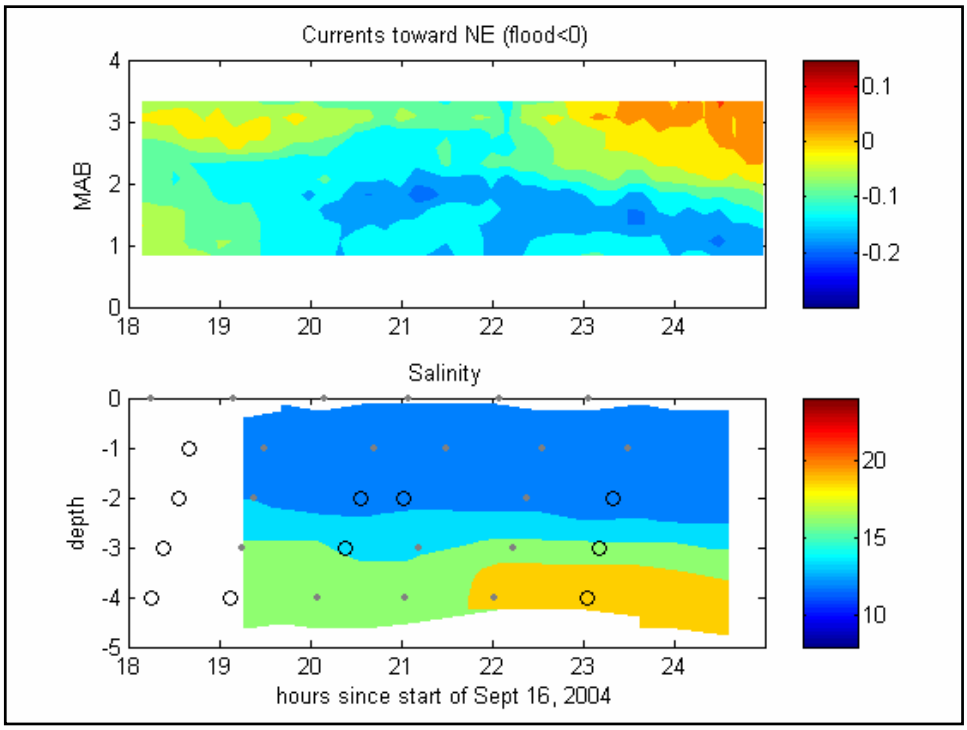

Currents toward NE (flood<0)
MAB
0
-0.05
-0.1
-0.15
-0.2
-0.25
Salinity
depth
20
15
10
hours since start of Sept 11, 2004

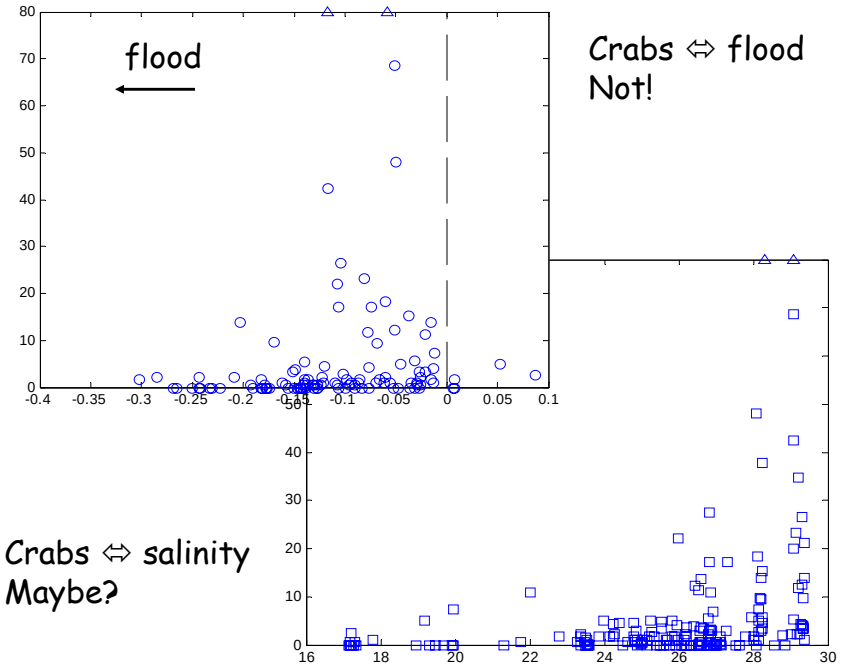

Currents toward NE (flood<0)
MAB
0.2
0.1
0
-0.1
-0.2
Salinity
depth
1500
70
?
25
20
15
10
hours since start of Sept 12, 2004


Currents toward NE (flood<0)
MAB
0
1
2
3
4
18
19
20
21
22
23
24
0
-0.05
-0.1
-0.15
-0.2
-0.25
Salinity
depth
0
-1
-2
-3
-4
-5
50
700
?
25
20
15
10
hours since start of Sept 13, 2004


Currents toward NE (flood<0)
MAB
0
1
2
3
4
18
19
20
21
22
23
24
0.2
0.1
0
-0.1
-0.2
Salinity
depth
0
-1
-2
-3
-4
-5
20
15
10
hours since start of Sept 14, 2004


Currents toward NE (flood<0)
MAB
0.1
0
-0.1
-0.2
Salinity
depth
20
15
10
hours since start of Sept 15, 2004


Currents toward NE (flood<0)
MAB
0.1
0
-0.1
-0.2
Salinity
depth
20
15
10
hours since start of Sept 16, 2004



Summary

- salinity not tidal
- S. increases on late flood / early ebb
- wind from NNW => fresh from Albemarle
- wind from NNE => salt from Ocean
- wind from S => brackish from Pamlico
- crabs not in water at peak flood
- crabs respond to salinity
- 2-day pulse, crabs from ocean

Extras

I've done a lot of analysis on the physical data, mostly convincing myself that near-bottom salinities are driven by wind, not tides. Also figured out that, since the winds were steadily out of the Northeast while we were there, the crabs could get pretty much anywhere passively. Diel or tidal migrations simply reduced the total time spent in favorable currents, and thereby reduced the distance traveled.

The attached ppt shows the biological data. Slide 1, top row is currents averaged over the top few meters. Blue dots marks times that Gayle said it was flooding (based on which way the net went) and green dots mark ebbs. All the critter counts are in the next slide, with purple marks being from the surface and green squares near bottom. The two biggest hits of megalopae were about 1500 on 9/13 and 500 on 9/14 (triangles indicate off scale). As you can see, the big hits followed a sudden increase in bottom salinity, suggesting a wind-driven oceanic influx.

The rest of the plots show currents (blue is flood and red is ebb) and also critter counts overlaid on salinity. Open circles mean no megalopae, gray circles are sized by critter count, and black circles are the really big hits. The crabs aren't getting up in the water on flood! They're going up when salinity increases, but that's on slack or even ebb.