Patterns of Brachyura larval assemblages support highly variable hydrographic conditions in mangroves of the Gulf of Guayaquil's inner estuary

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Why care about Brachyura (true crab) species?

- Crabs are key species in mangrove-fringed estuarine habitats:
  - Nutrient recycling
  - Waste decomposition
  - Bioturbation in sediments
- The red mangrove crab (*Ucides occidentalis*) has a high socio-economic and cultural importance in the region.

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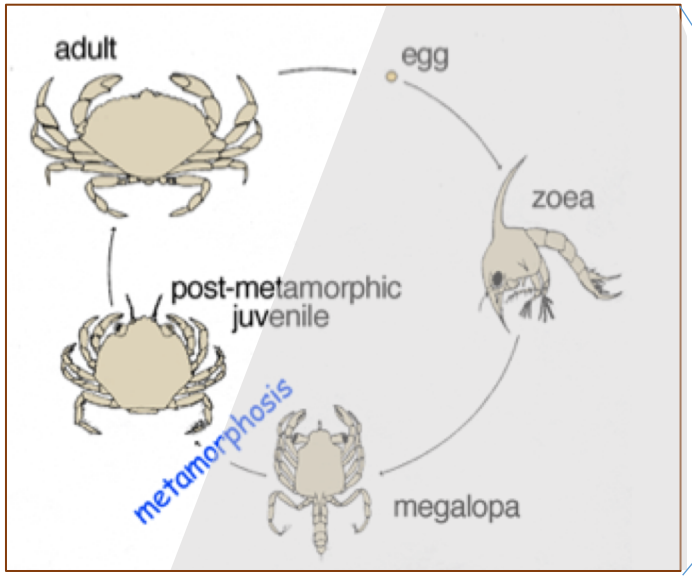
Larval assemblages are ’footprints’ in the ecosystem

Crab larvae can have different:

- Mechanisms of larval retention and dispersion
- Timing of larval release
- Physiological tolerance to variability in water conditions
  - e.g. salinity, temperature, oxygen

Zoea stages of *Ucides occidentalis*



Planktonic life-forms

- Larval assemblages reflect water conditions and dynamics in the estuary.
- Some species can be used as indicators of ecological change

The Gulf of Guayaquil: a highly dynamic estuarine system

Principal human impacts on estuary

- Contaminants (industrial, domestic and from agriculture/aquaculture)
- Hydrological alteration (e.g. Daule-Peripa dam and Bulu Bulu-Cañar diversion)
- Overfishing (e.g. red mangrove crab, black arks).
- Habitat loss (e.g. shrimp farms, urbanization, logging).
- Climate change (sea level rise, sea warming).

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Aims, broader goal and hypothesis

- Explore spatio-temporal patterns in the community structure of brachyuran larval assemblages living in mangrove tidal creeks of two locations within the inner estuary of the Gulf of Guayaquil.
- Determine the contribution of hydrographic parameters in the major observed biotic patterns.
- **Broader goal:** establish an ecological baseline, which could be applied in future studies using crab larval assemblages, to investigate water impacts occurring in the estuary.
- **Hypothesis:** RMC larvae would dominate larval assemblages; so density patterns could be used to explain water conditions and dynamics occurring in the GG's inner estuary.

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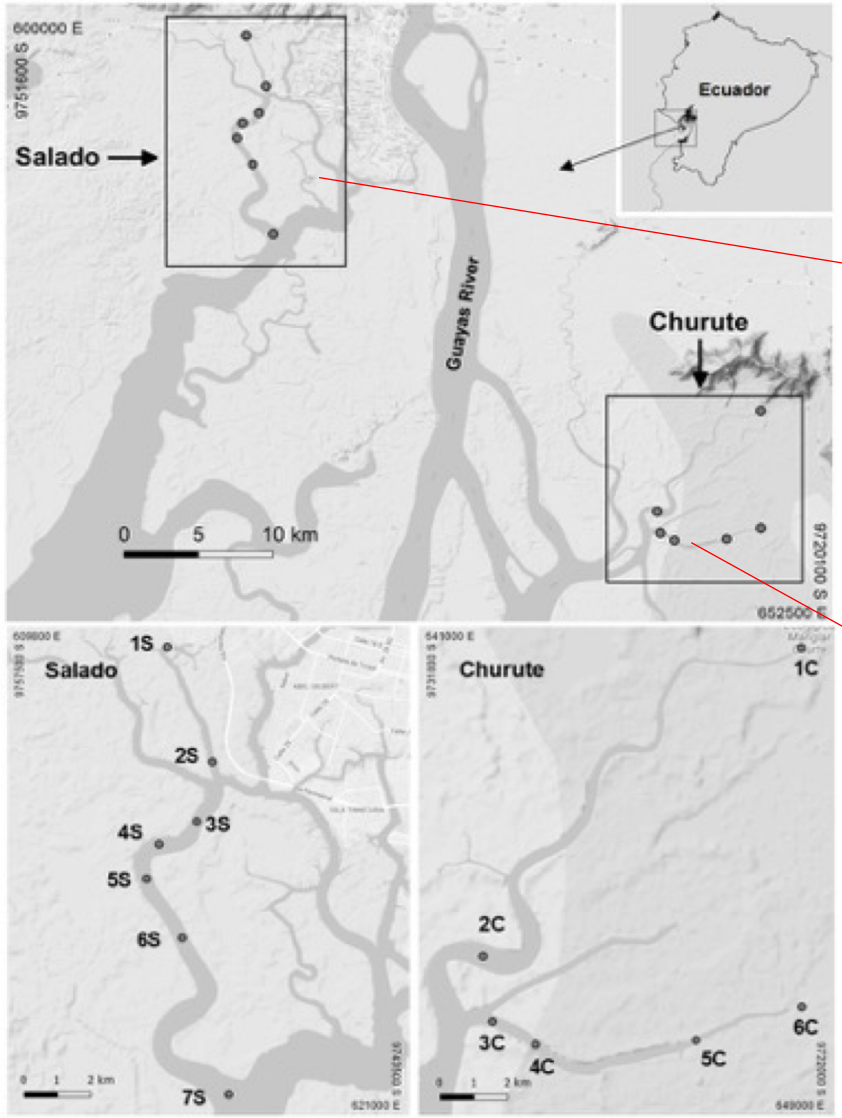
Methods

- Two locations (esteros) monitored in a quarterly basis
  - Feb-2016 to Aug-2017
- Sampling of crab larvae in midpoint of mangrove tidal creek: vertical tows with zooplankton net



Manglares “El Salado”

Manglares Churute

- Hydrographic parameters: temperature, salinity, conductivity, depth, turbidity, pH, oxygen, nitrites, ammonium, phosphates

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Results: spatial patterns

- In Salado, 12 morphospp.
- In Churute, 4 morphospp.
- Salado > Churute
  - Morphological richness
  - Diversity
  - Evenness
- Salado < Churute in RMC density.
- Salado = Churute in Brachyura density.
- Within-location variability higher in Churute.

	Salado		Churute	
Community metrics				
	Mean (SD)	CV	Mean (SD)	CV
Richness (S)	4.65 (3.08)	0.66	0.78 (0.52)	0.67
Shannon-Wiener diversity (H')	0.84 (0.61)	0.73	0.01 (0.04)	4.00
Pielou's evenness (J')	0.58 (0.29)	0.50	0.37 (0.36)	0.97
Density (m^{-3})				
	Mean (SD)	CV	Mean (SD)	CV
Brachyura (total)	47.40 (69.47)	1.47	157.79 (368.90)	2.34
By morphospecies:				
Ocypodidae:				
Morph. 1 (RMC)	25.45 (57.38)	2.25	155.15 (369.94)	2.38
Morph. 2	13.22 (26.27)	1.99	2.62 (8.46)	3.23
Panopeidae	1.03 (2.32)	2.25	0.01 (0.04)	6.83
Portunidae/Menippidae	1.29 (2.98)	2.32	0.01 (0.06)	4.36
Pinnotheridae:				
Morph. 1	0.61 (1.22)	1.99	-	-
Morph. 2	0.46 (1.20)	2.62	-	-
Morph. 3	0.09 (0.31)	3.51	-	-
Morph. 4	0.37 (1.83)	4.91	-	-
Grapsidae	2.68 (8.39)	3.13	-	-
Majoidea	0.71 (1.40)	1.97	-	-
Dorippoidea	1.22 (3.88)	3.17	-	-
Cryptochiroidea	0.27 (1.03)	3.80	-	-

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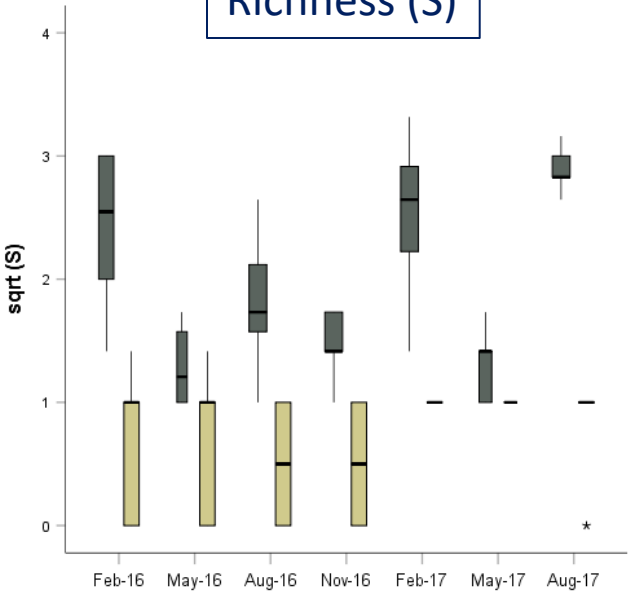
Results: temporal patterns

Significant differences among dates, and dates between locations

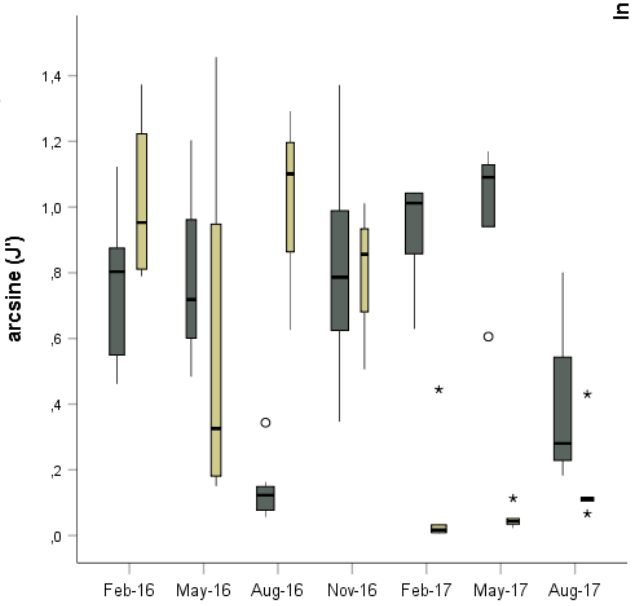
Richness (S)



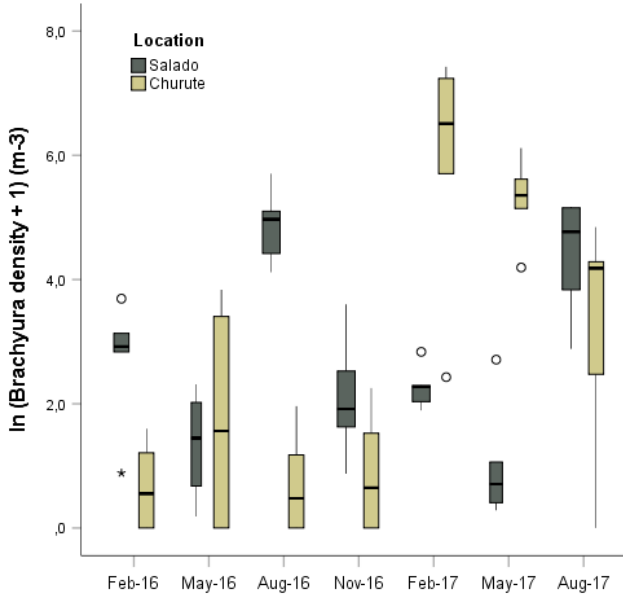
Salado > Churute
among all dates

Evenness (J')

2016: Churute > Salado
2017: Salado >> Churute



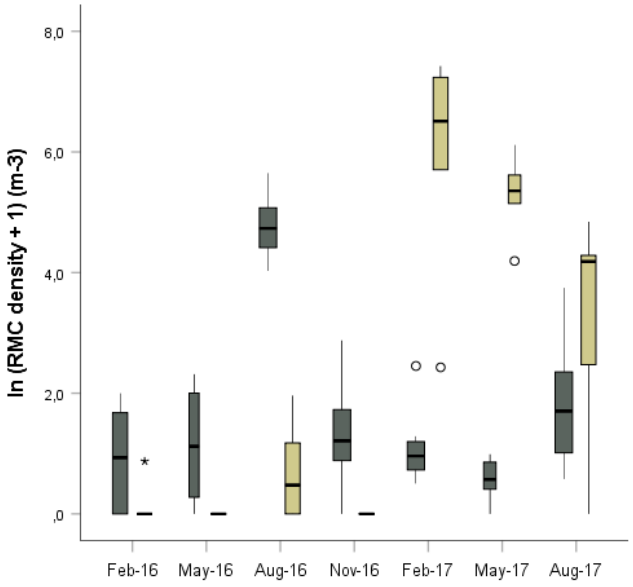
Brachyura density



2016: Salado > Churute
2017: Churute > Salado

RMC density

2016: Salado >> Churute
2017: Churute >> Salado



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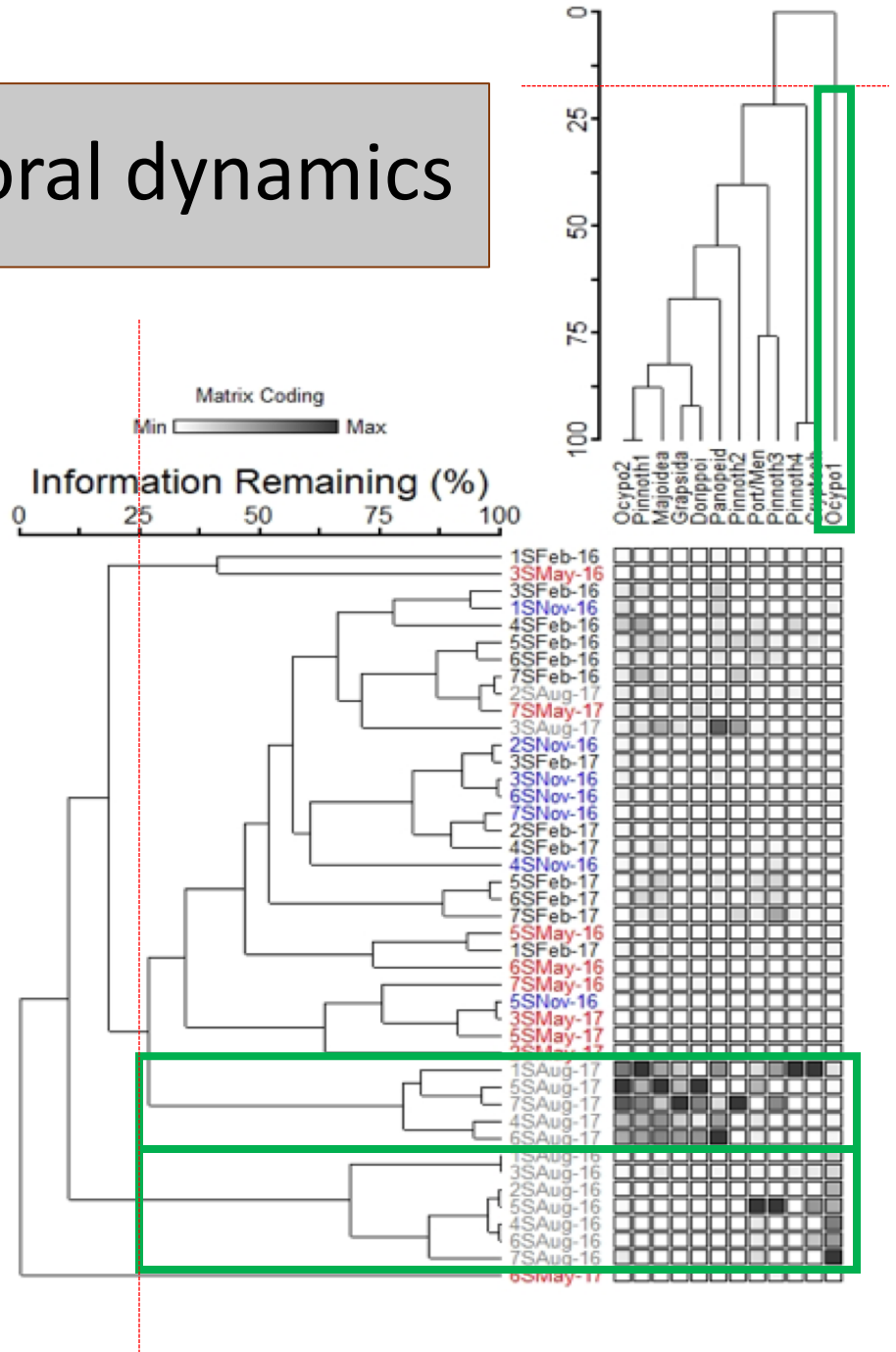
Results: Salado community's temporal dynamics

- Two-way cluster analysis based on Bray-Curtis distance measure.
- Aug-16: highest densities of RMC among dates.
- Aug 17: highest morphological richness among dates.



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Results: Contribution of hydrographic parameters

- BEST (Biota and/or Environmental Matching) analysis:
  - Spearman rank correlation between **biotic** and **abiotic** matrices
- Hydrographic parameters explained 35-40% of variability in biotic data.
- Selected parameters:
  - pH (both locations)
  - Turbidity (both locations)
  - Conductivity (in Salado)
  - Temperature (in Churute)

Salado

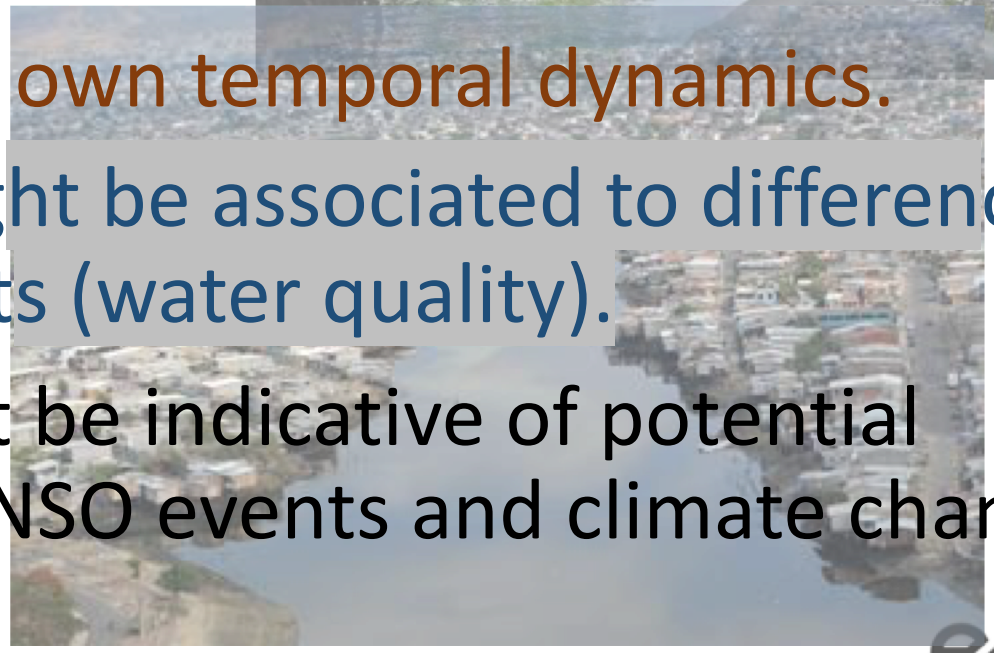
	pH		Turbidity (NTU)		Conductivity (µS/cm)		Temperature (∘C)	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Feb-16	7.32	0.14	5.12	6.66	34292.64	924.57	29.79	0.27
May-16	7.00	0.06	5.22	2.38	25131.57	397.29	29.30	0.27
Aug-16	7.10	0.14	4.04	1.83	36854.64	685.50	26.54	0.77
Nov-16	7.50	0.17	3.00	2.01	43857.14	1009.72	27.29	1.49
Feb-17	7.54	0.09	4.02	2.33	40700.00	702.38	29.27	0.36
May-17	7.64	0.17	7.66	3.20	18204.29	2060.14	29.16	0.24
Aug-17	7.45	0.05	(4.84)	(0.00)	33014.29	722.10	26.24	0.45
Global	7.36	0.25	4.84	3.32	33150.65	8375.45	28.23	1.53

Churute

	pH		Turbidity (NTU)		Conductivity (µS/cm)		Temperature (∘C)	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Feb-16	(7.34)	(0.00)	38.95	7.64	4472.77	1512.75	28.40	0.48
May-16	(7.34)	(0.00)	(76.00)	(38.57)	5110.01	3283.50	28.45	0.68
Aug-16	7.37	0.16	10.11	2.25	25311.77	4840.65	26.32	0.41
Nov-16	7.36	0.10	9.28	7.10	29300.00	2659.51	26.83	0.41
Feb-17	6.61	0.36	(376.65)	(200.75)	1630.00	994.69	26.83	0.70
May-17	7.88	0.16	399.33	261.77	1216.50	779.74	26.15	1.06
Aug-17	7.48	0.09	(151.72)	(0.00)	17350.00	6152.61	25.35	0.39
Global	7.34	0.38	151.72	196.08	12055.86	11490.62	26.90	1.23

Discussion

- High dissimilarity in composition and structure of crab larval assemblages between locations and within locations (in lesser degree).
- Each location experienced its own temporal dynamics.
- Spatio-temporal patterns might be associated to differences in hydrology & human impacts (water quality).
- Interannual differences might be indicative of potential responses of crab larvae to ENSO events and climate change.



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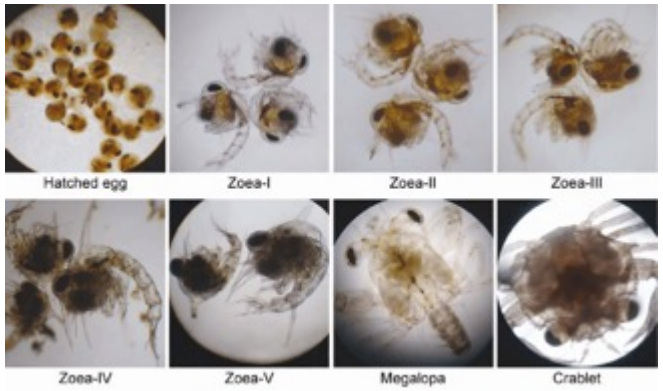
Future steps and Conclusions



- Longer time-series of biotic data with comparable methodological approaches.
- Description of crab larval stages of RMC and other species.
- Incorporation of habitat (e.g. mangrove extent) and other hydrographic parameters (e.g. COD, flow velocity) in models.
- Management measures should account local conditions in estuary and evolve according to emergent threats (i.e. adaptive management).
- Need to involve fishers, local communities and staff from the MPAs in research and monitoring programs.

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