Fine-scale transport of planktonic and early juvenile blue crab settlement to estuarine nursery habitat in Aransas Bay

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Gulf States Marine Fisheries Commission
TCC Crab Subcommittee
28 Oct 2025

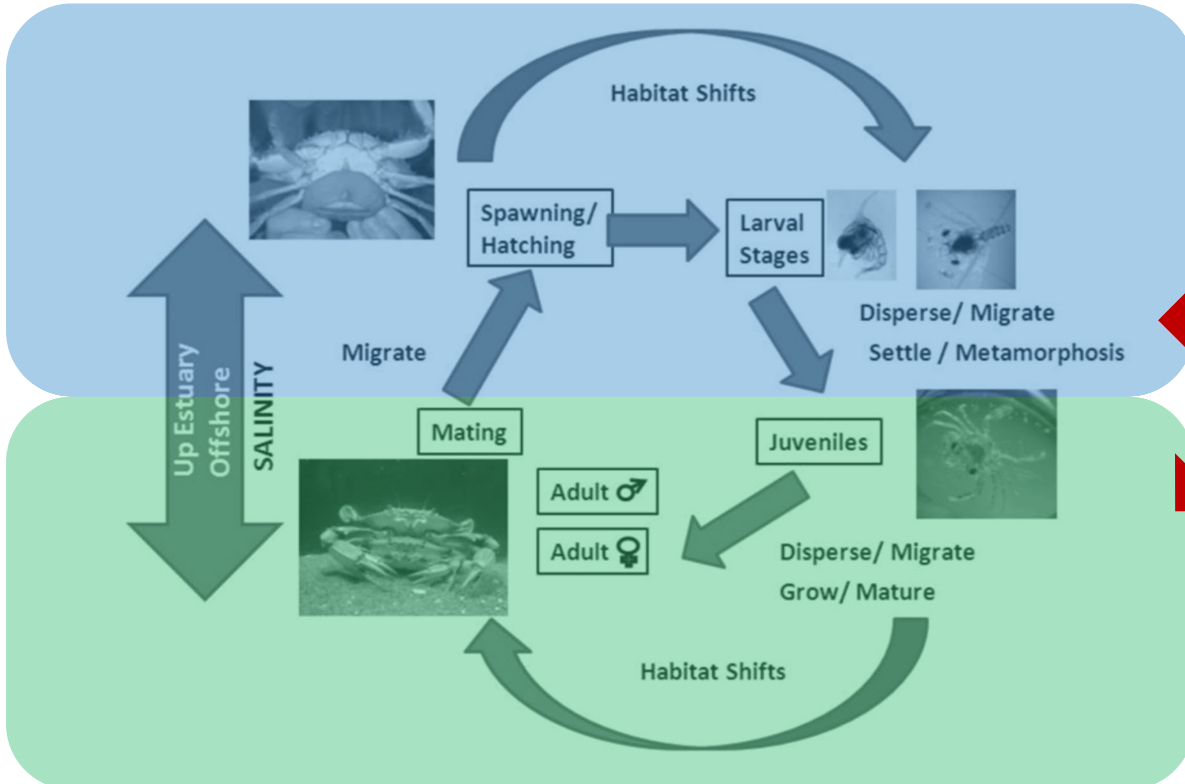


Figure 1. Schematic of blue crab life cycle showing life history stages and events, emphasizing habitat shifts and migration.

Johnson et al. 2011

Coastal habitat (larval stage)

Physical and biological transport processes

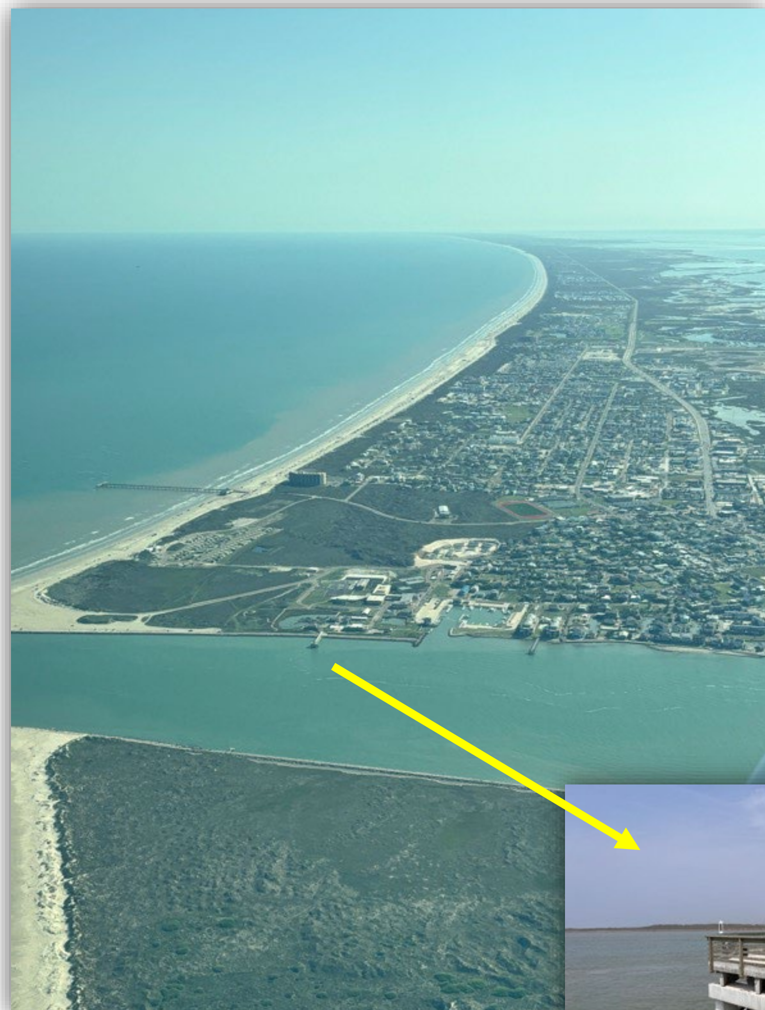
Estuarine habitat (early juveniles)

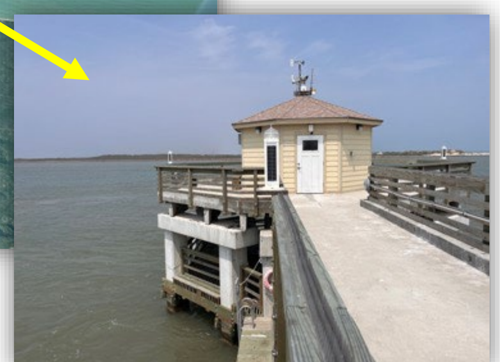
Is estuarine ingress and recruitment a bottleneck to population size?

Early juveniles
Pile et al. 1996

Instar	CW (mm)†
First	2.2–3.0
Second	3.1–4.2
Third	4.3–5.9
Fourth	6.0–7.4
Fifth	7.5–9.1
Sixth	9.2–10.6
Seventh	10.7–12.6
Eighth	12.7–14.1
Ninth	14.2–16.1

Aransas Pass





Lydia Ann Channel and Aransas Bay

Objectives

(1) Quantify the daily ingress (i.e., post-larval supply) of blue crab by sampling in the Aransas Pass

Net sampling

Settlement collectors

High-speed shadowgraph imaging

(2) Evaluate the density and size distribution of early-stage juvenile recruits at five seagrass habitat sites located as a function of distance from Aransas Pass

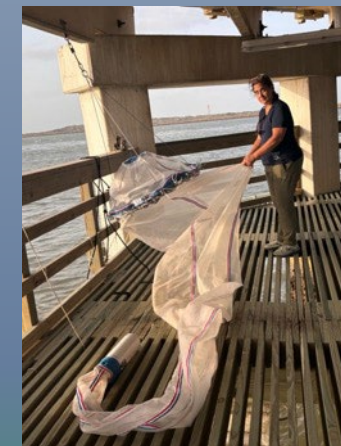
(3) Employ stable isotope ratios to track recent estuarine immigration at the individual level and fine-tune the detection of recruitment pulses

(4) Examine the relationship between larval supply and the abundance of recruits

Pier sampling

500 um mesh net 20 cm diameter

Deployed **diurnal flood tides (maximum tidal excursion)** for 3 days preceding seagrass sampling



Settlement collectors

N=3 with cages

N= 3 without cages

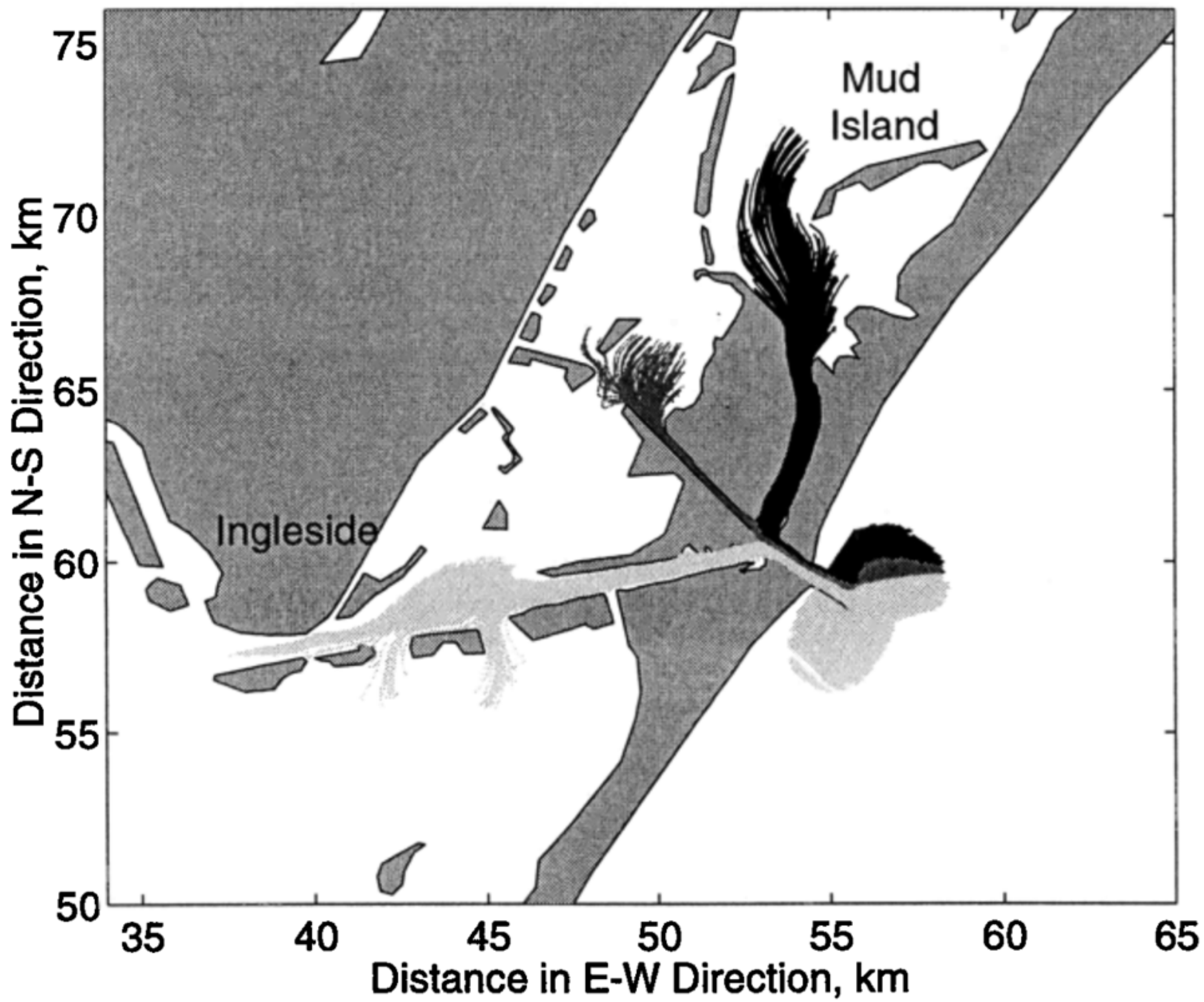


Figure 11. Maximum particle excursions at the end of initial flood tide for particles released at the beginning of flood tide under $K_1 + O_1 + P_1$ forcing. The maximum excursion of particles into the bays extends approximately 10-15 km beyond the confluence of the three channels.

Brown at al. 2000 Journal of Geophysical Research 105:24,141-24,156

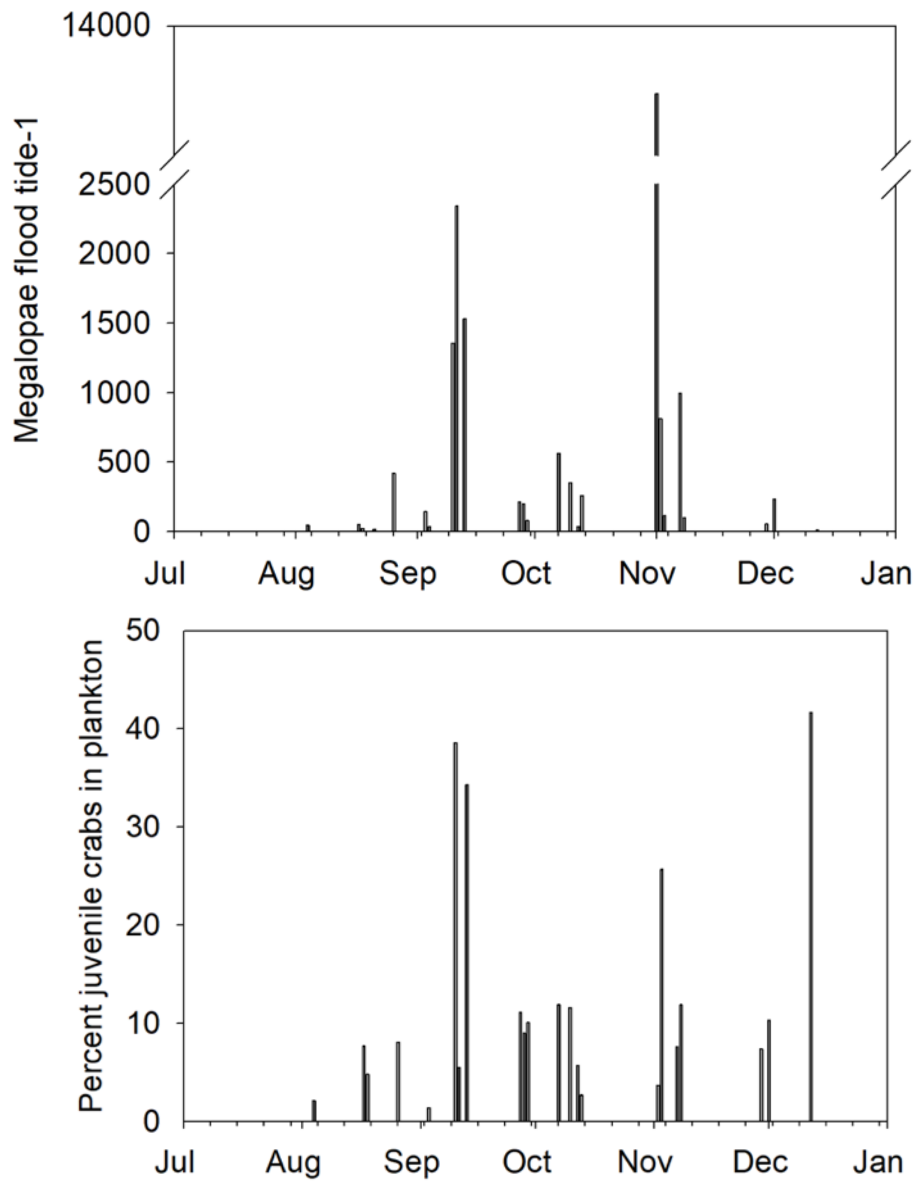
Seagrass sampling sites
Halodule wrightii

Enclosures sampled with dip nets and pumps (n =3)

Individuals m^{-2}

Monthly (Sept-Dec) fall 2024

Plankton net sampling: Abundance of megalopae correlated with a high percentage of early juveniles in the plankton



May partly reflect molting once caught

Pier lab settlement collectors

Mean $\pm$ SD of megalopae flood tide^{-1}

End of pier *Closer to jetty*

	C1	C2	C3	C4	C5	C6
All data	16.2±43.4	11.6± 24.5	12.7 ± 32.9	11.8 ± 23.3	24.8 ± 58.1	20.9 ± 38.1

Orange: Collectors with cages
Non-significant differences in means
(also when only considering dates with > 9 megalopae flood tide^{-1})

Pier lab settlement collectors

When megalopae are present, they are caught in all collectors

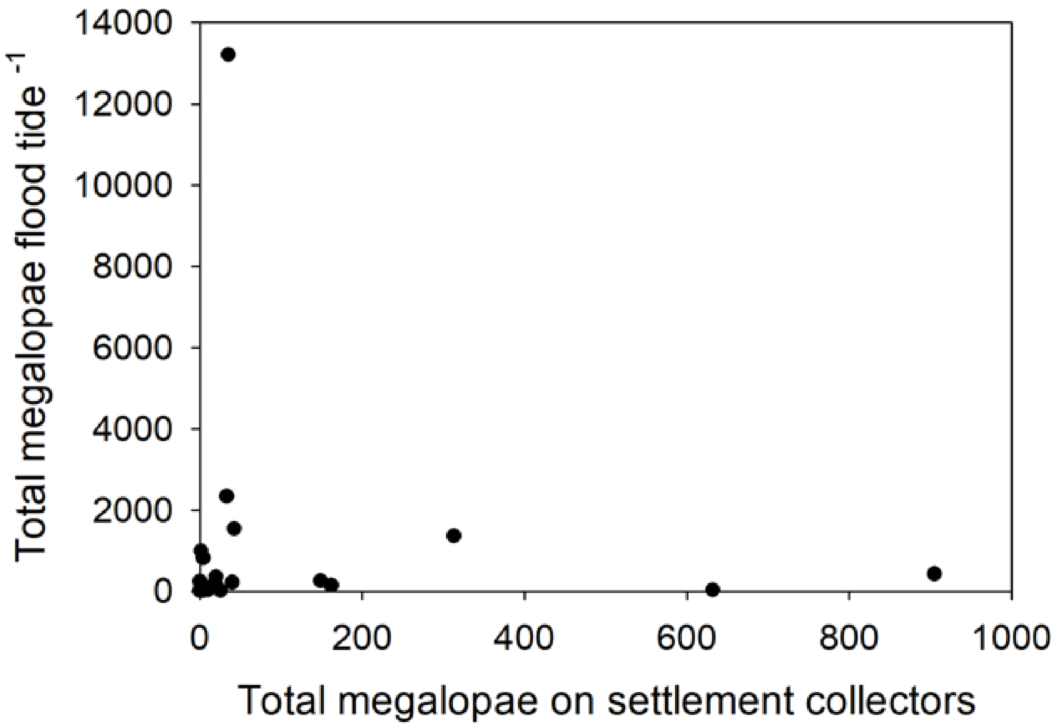
Mean ± SD of megalopae flood tide^{-1}

End of pier *Closer to jetty*

	C1	C2	C3	C4	C5	C6
All data	16.2±43.4	11.6± 24.5	12.7 ± 32.9	11.8 ± 23.3	24.8 ± 58.1	20.9 ± 38.1

Orange: Collectors with cages
Non-significant differences in means
(also when only considering dates with > 9 megalopae flood tide^{-1})

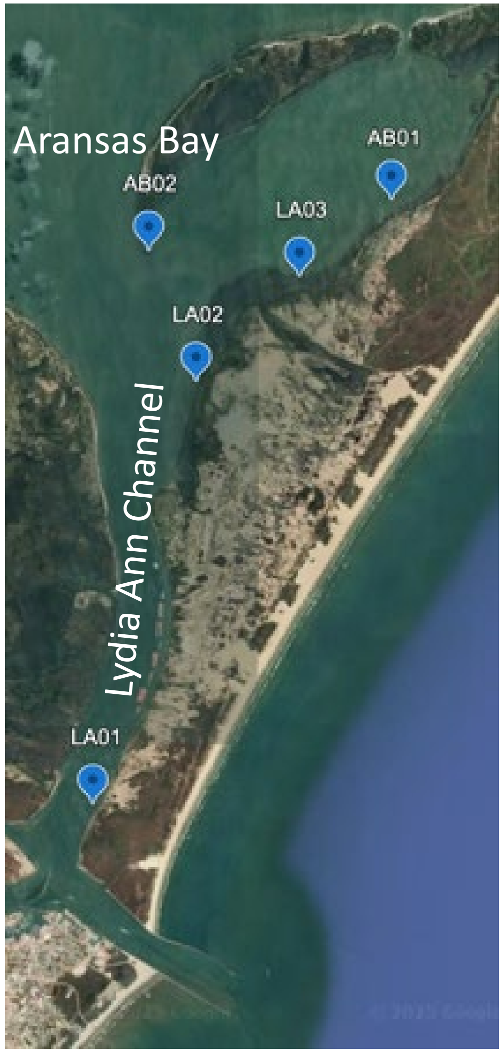
No correlation between megalopae caught in the plankton net and retrieved from settlement collectors

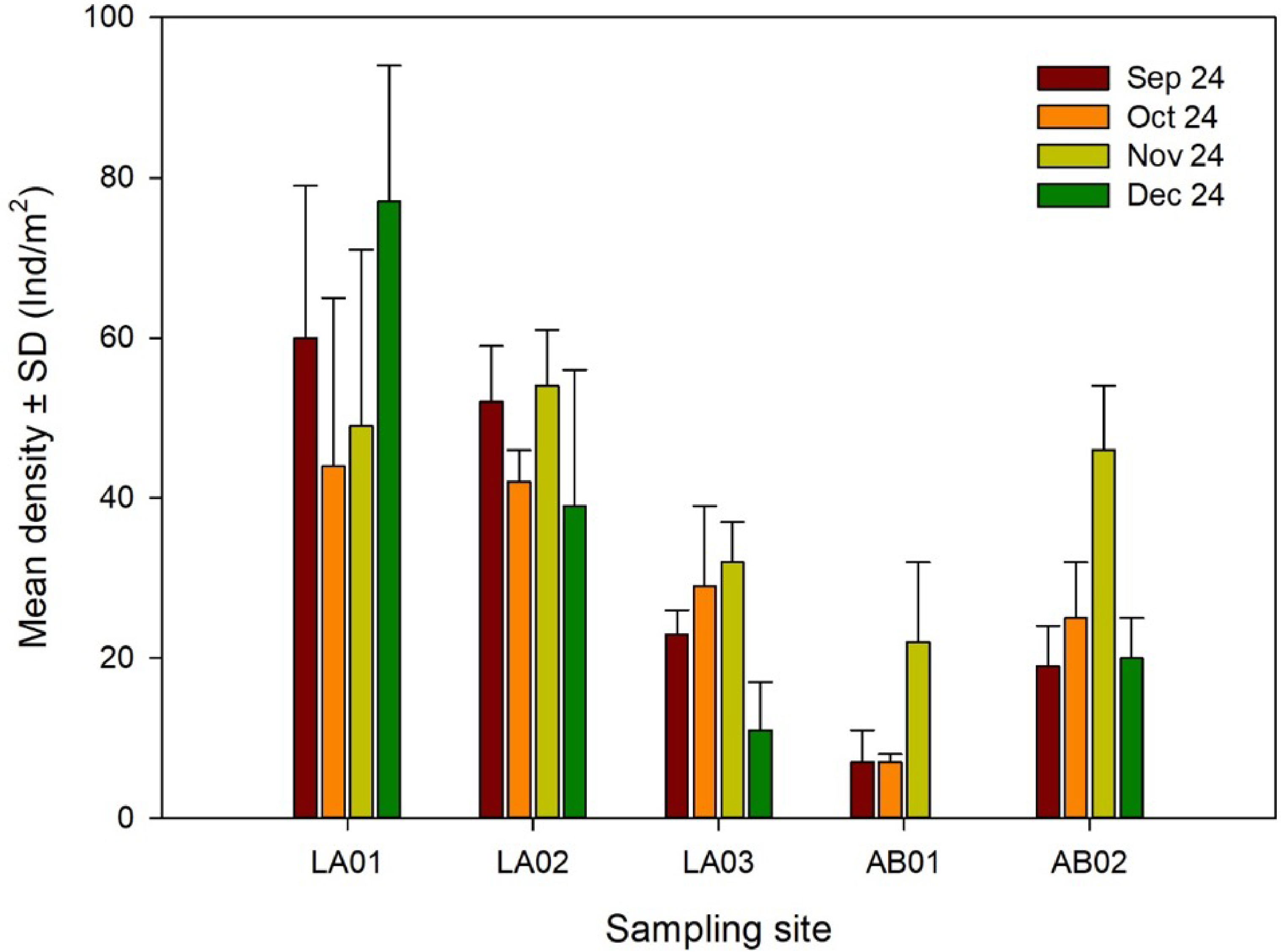


Plankton net. vs. settlement collector abundances

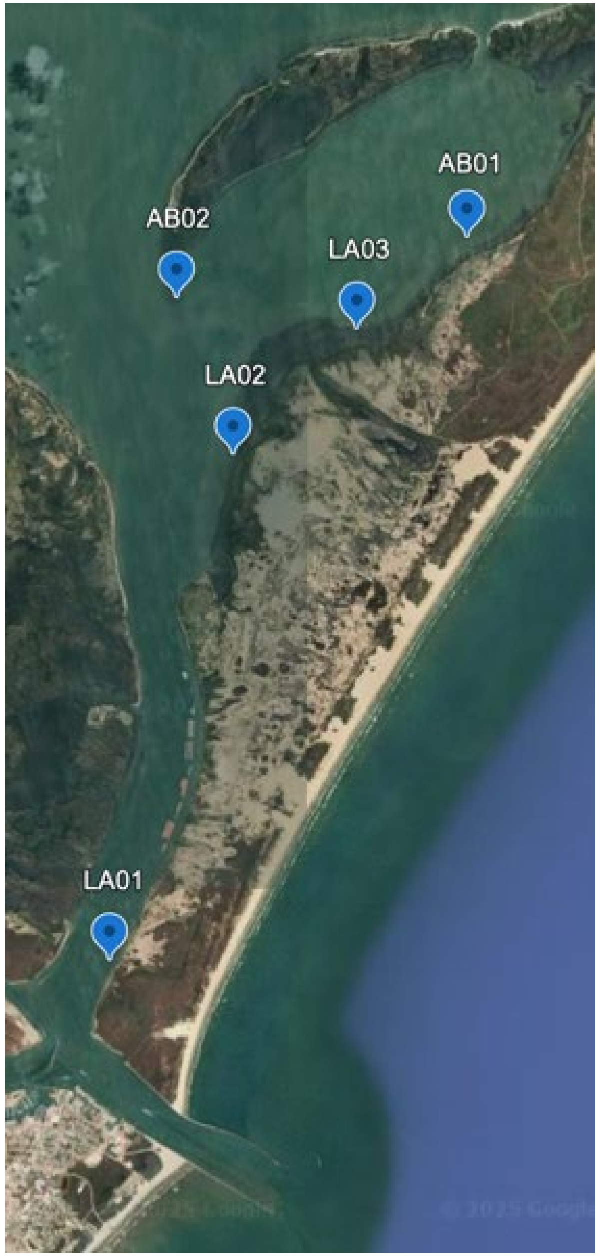
Differences in developmental stage? Influence of current speed on the ability to settle? Gear selectivity? Plankton patchiness?

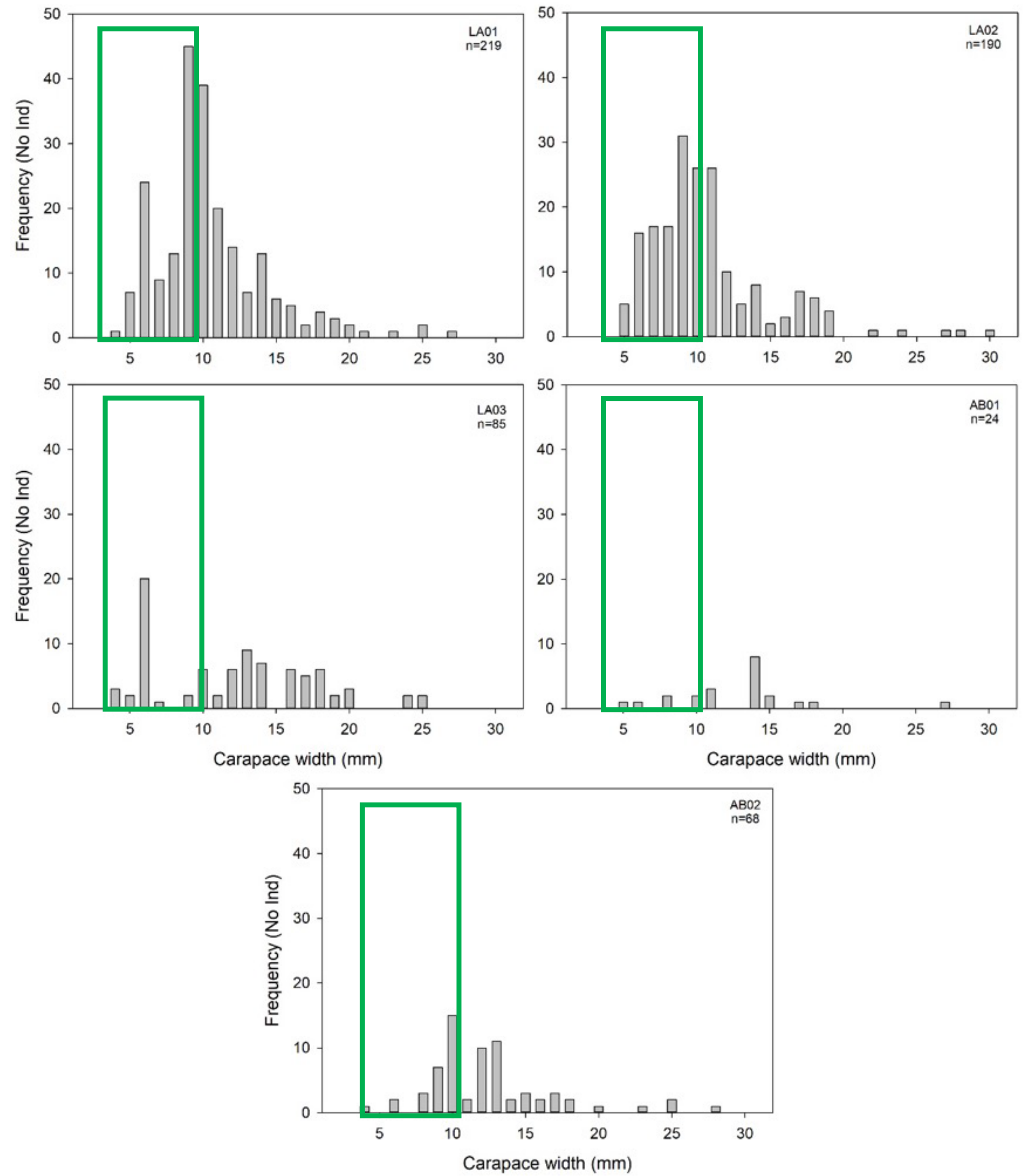
Higher abundance of early juveniles (< 30 mm CW) in Lydia Ann Channel reflects higher settlement rates





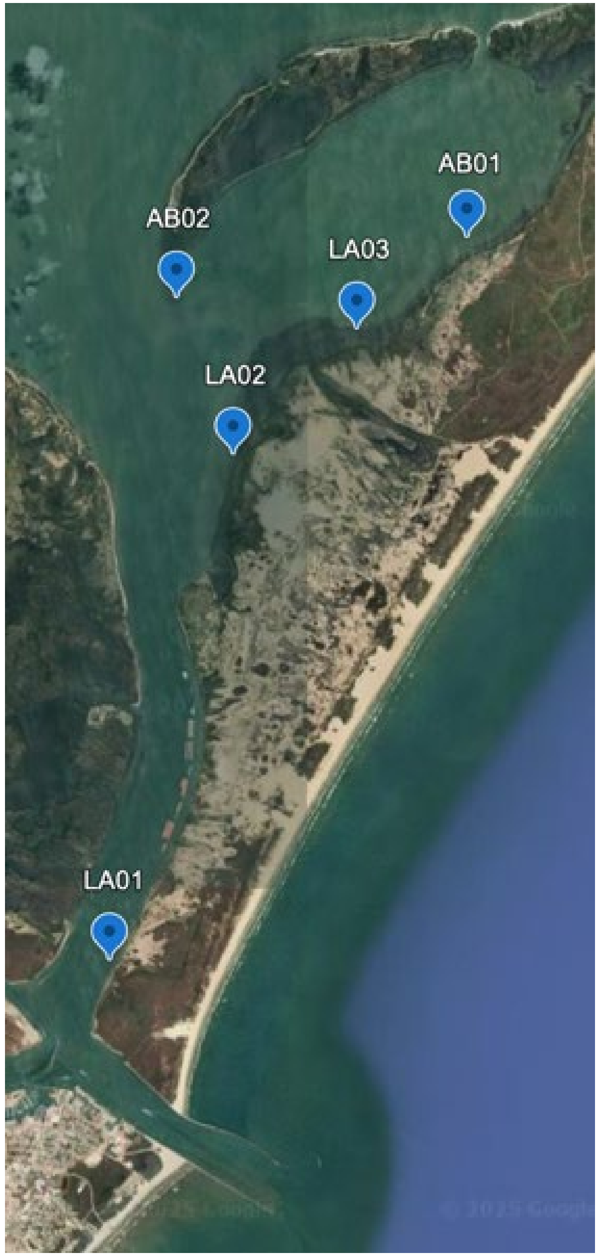
September 2024

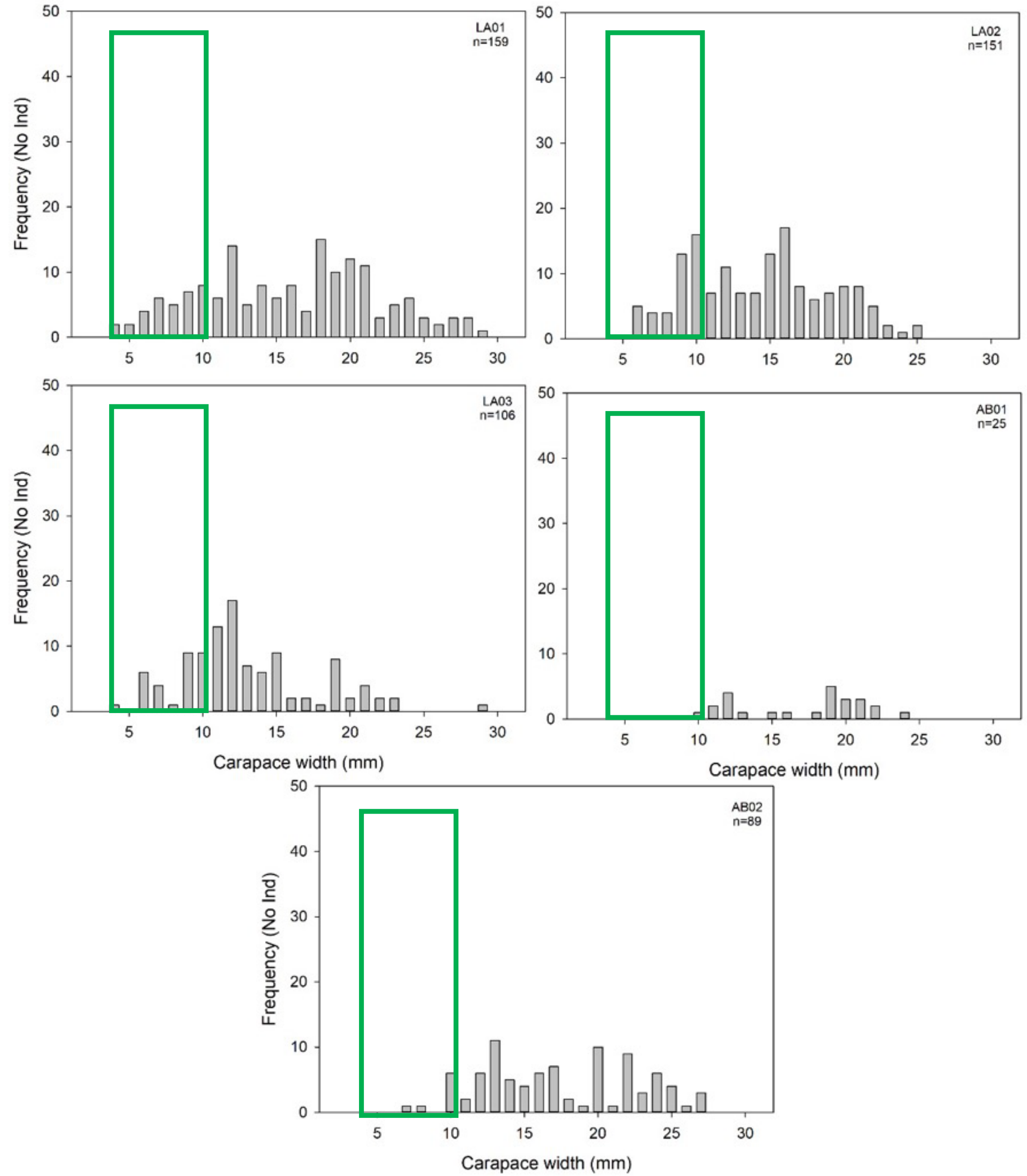




Higher density of early juveniles (≤ 10 mm CW) in Lydia Ann Channel

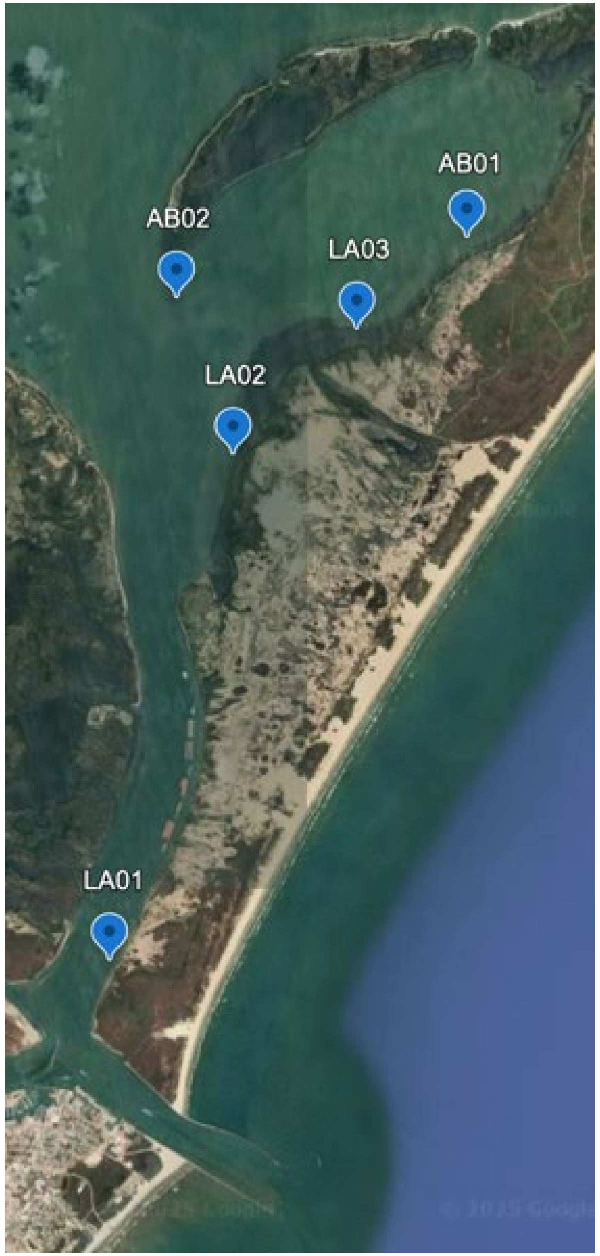
October 2024

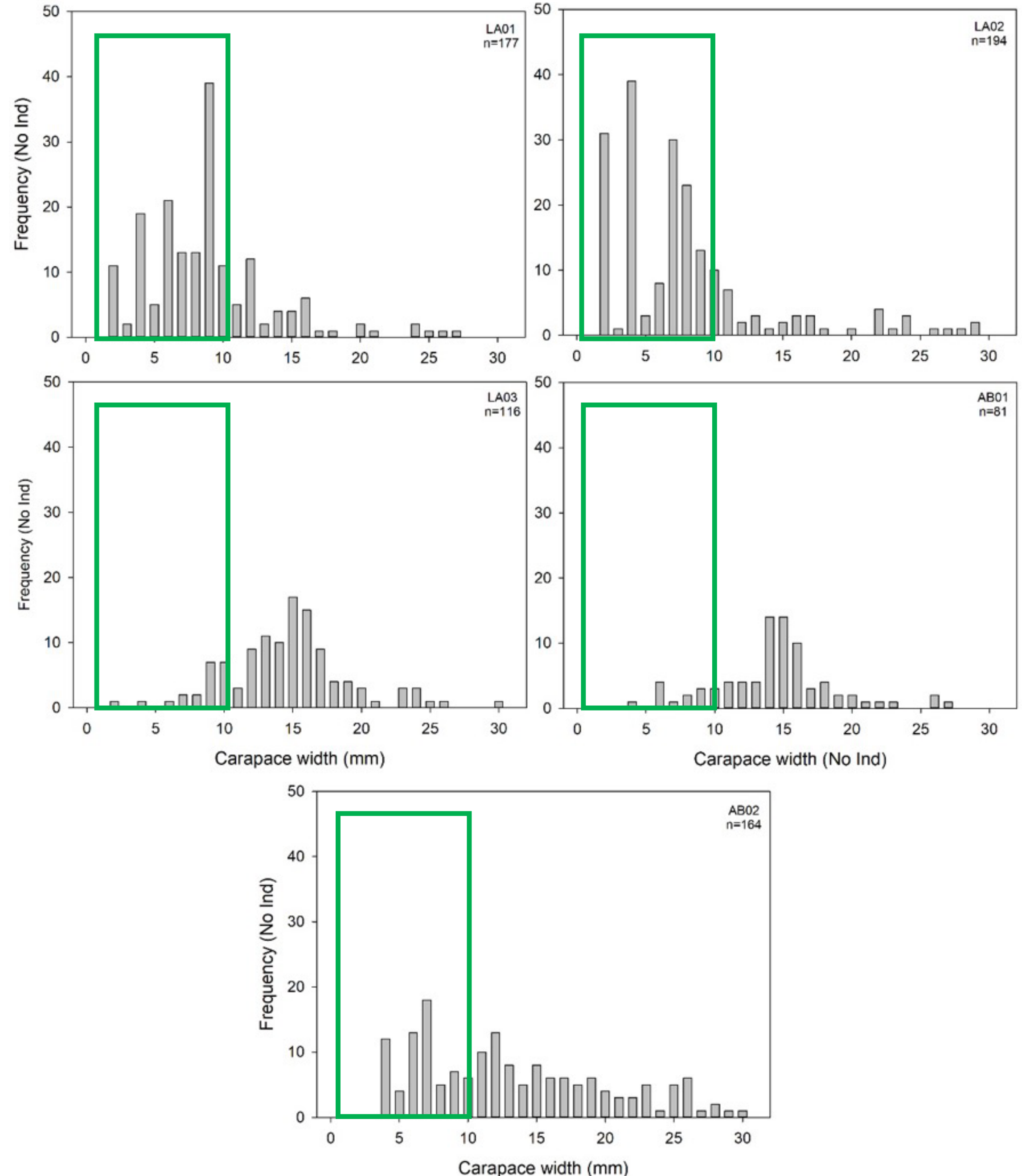




Higher density of early juveniles (≤ 10 mm CW) in Lydia Ann Channel

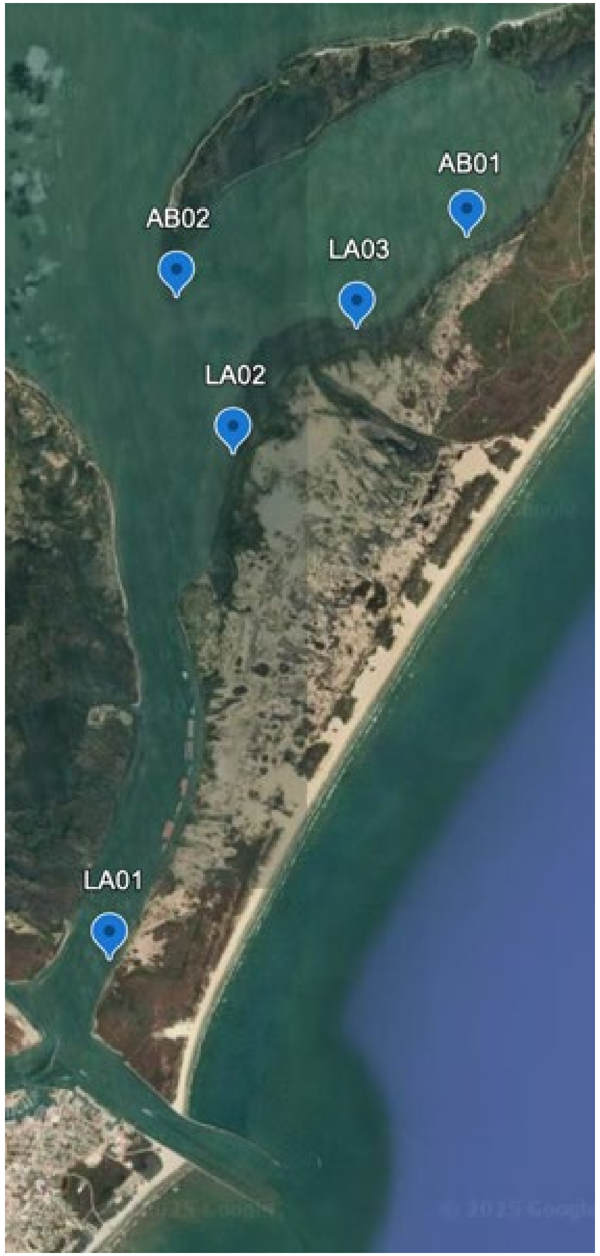
November 2024

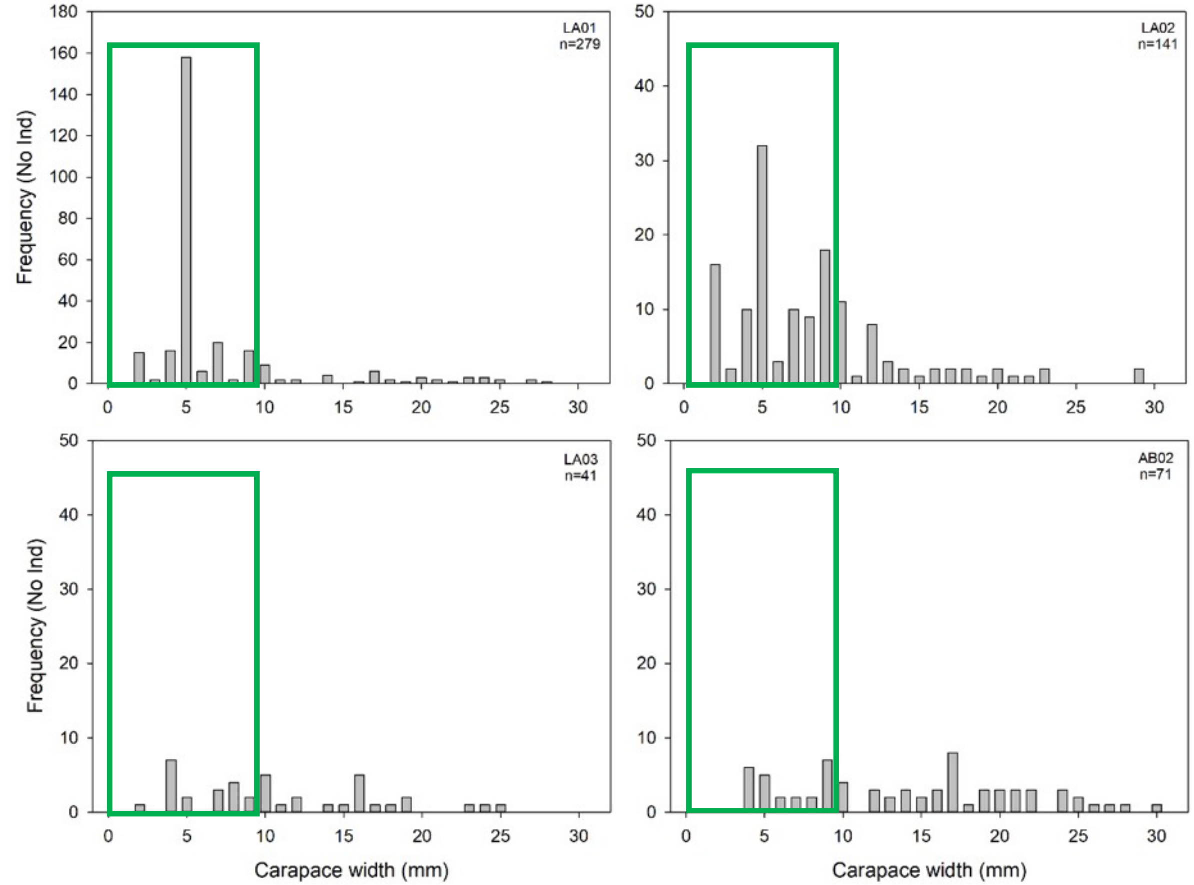




Higher density of early juveniles ($\leq$ 10 mm CW) in Lydia Ann Channel

October 2024



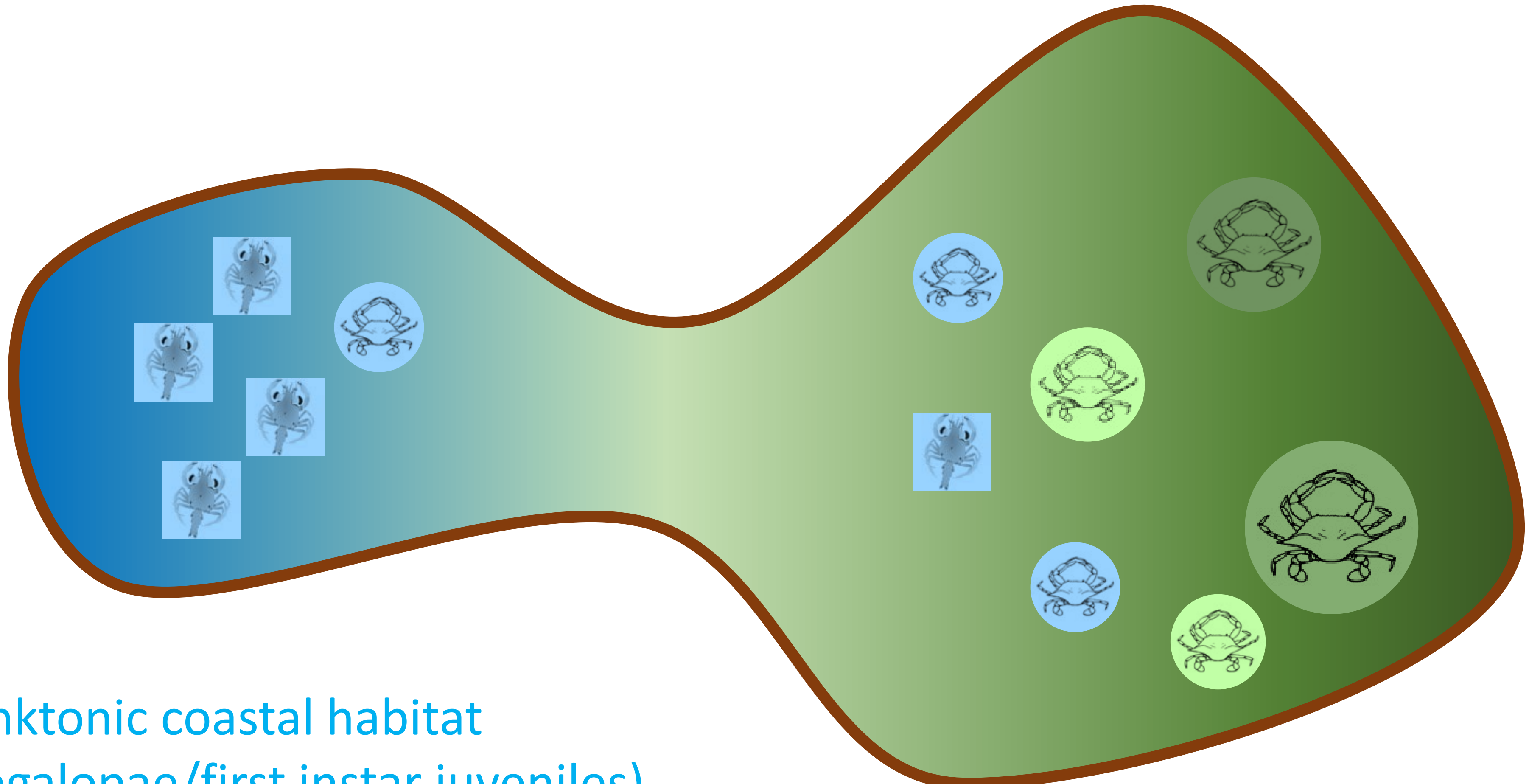


Higher density of early juveniles ($\leq$ 10 mm CW) in Lydia Ann Channel

How can we differentiate the settlement of megalopae to seagrass habitat from up-estuarine movement of early juveniles following settlement?

Which nursery areas are critical for settlement and early juveniles?

Stable isotope ratios as tracers of individual recent settlement

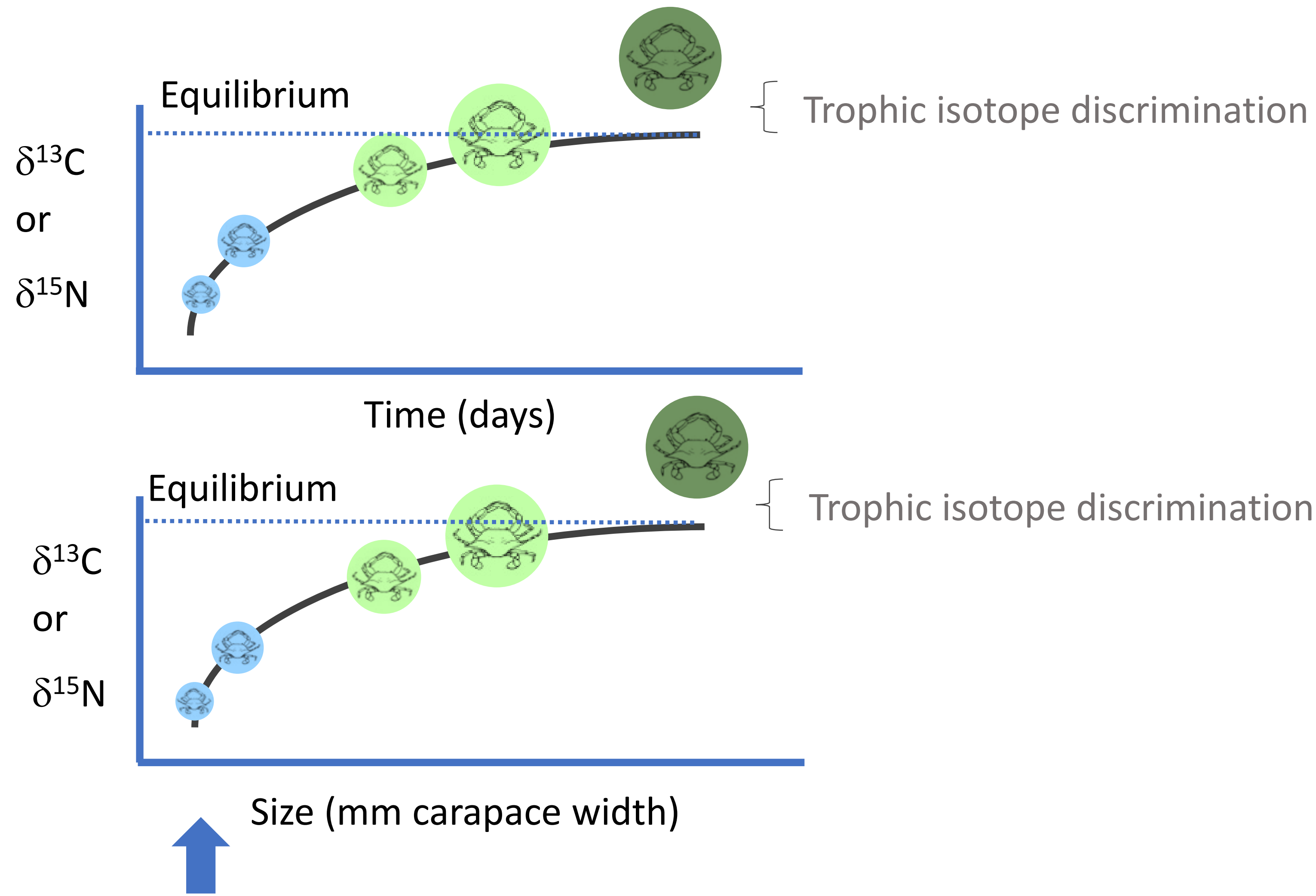


Planktonic coastal habitat
(megalopae/first instar juveniles)

Seagrass nursery habitat
(early juveniles)

Empirical estimates of stable isotope turnover rates

Megalopae caught in Aransas Pass



Simulate habitat/dietary shift

Isotope turnover rates
Experiment # 1

18 Sept – 3 Oct 2024

Mean temp: 26.6 ± 0.5°C

Mean salinity: 32.4 ± 1.8

Feed: Freshly hatched Artemia

$\delta^{15}N$ = 11.7 ‰

$\delta^{13}C$ = -22.4 ‰

Crabs analyzed whole

Isotope turnover rates
Experiment # 1

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Mean temp: 26.6 ± 0.5°C
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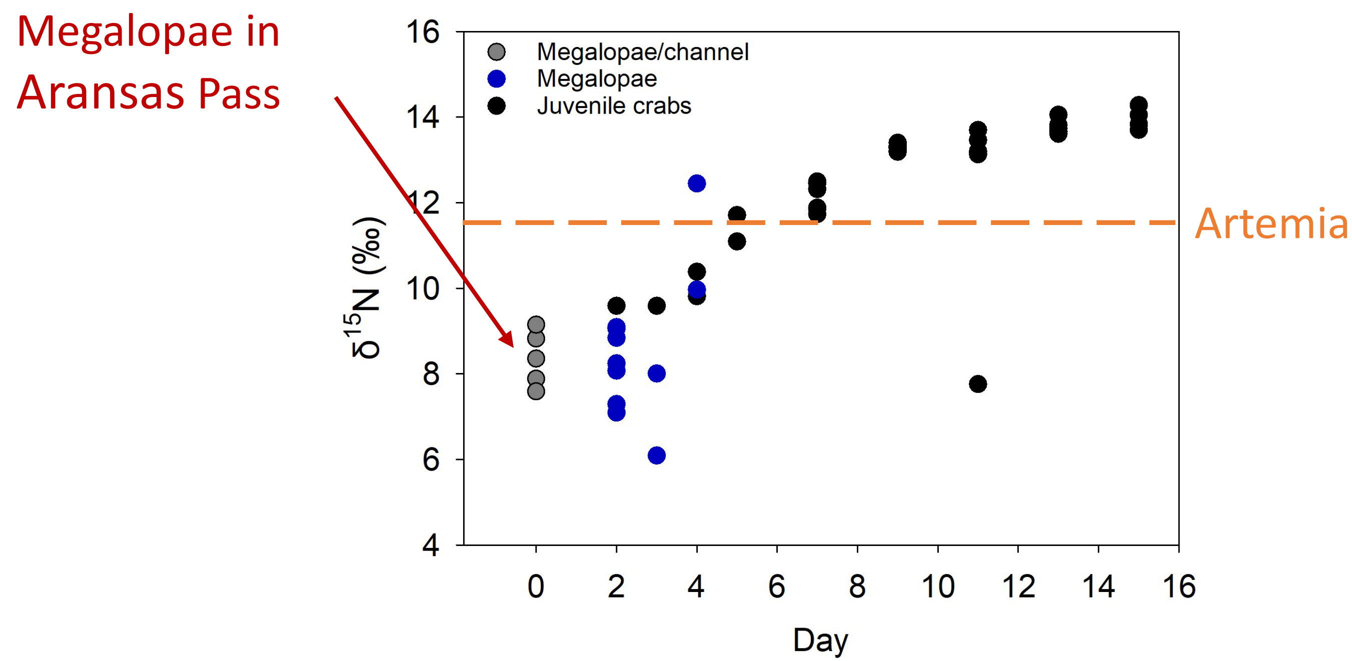

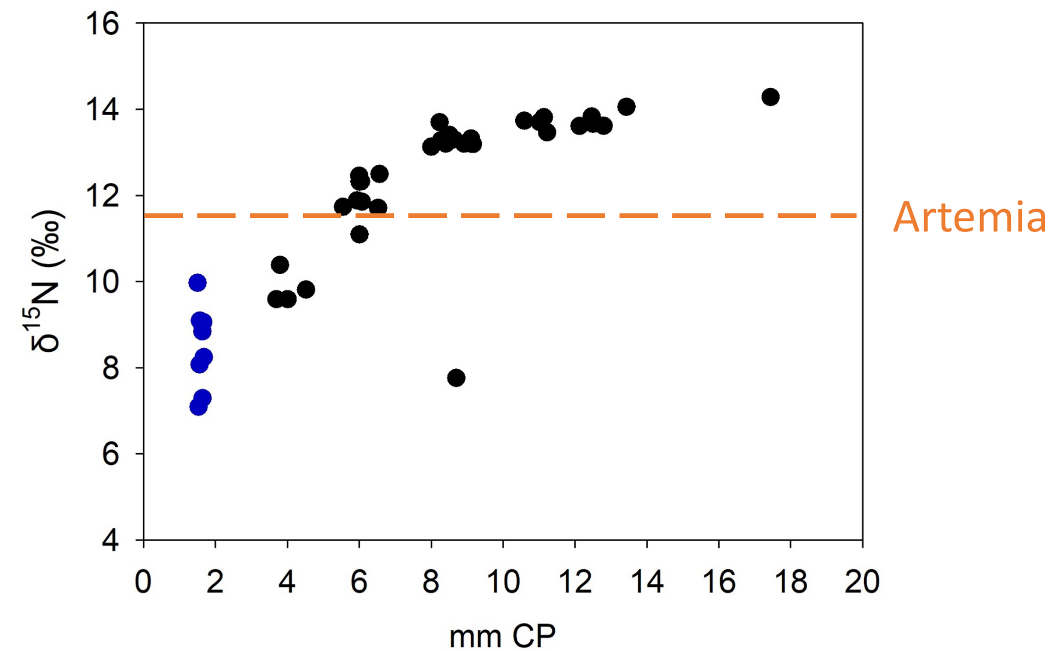

Isotope turnover rates
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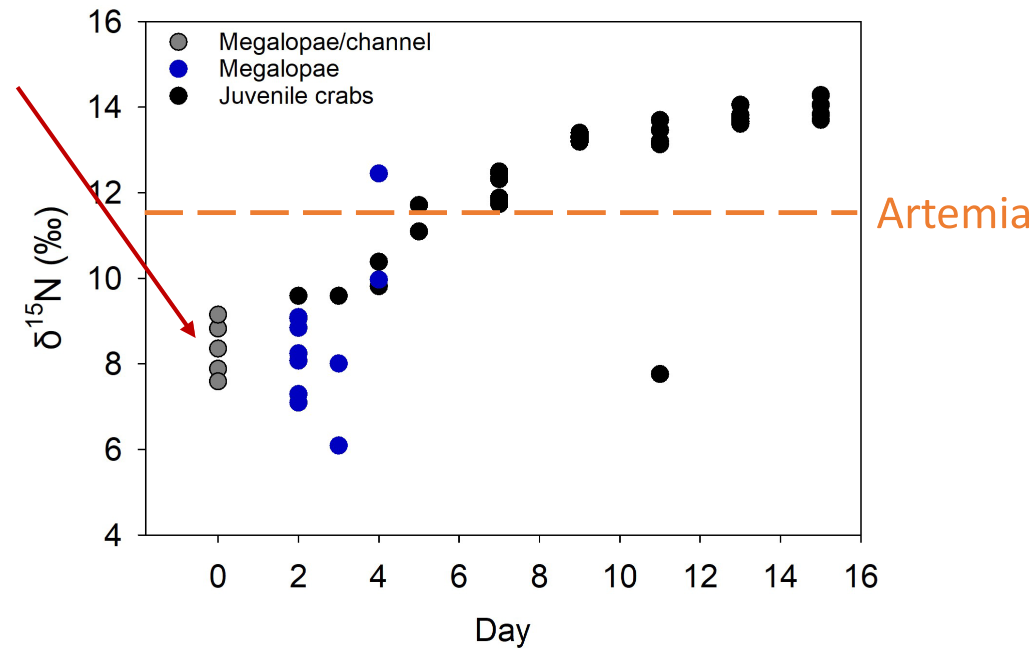
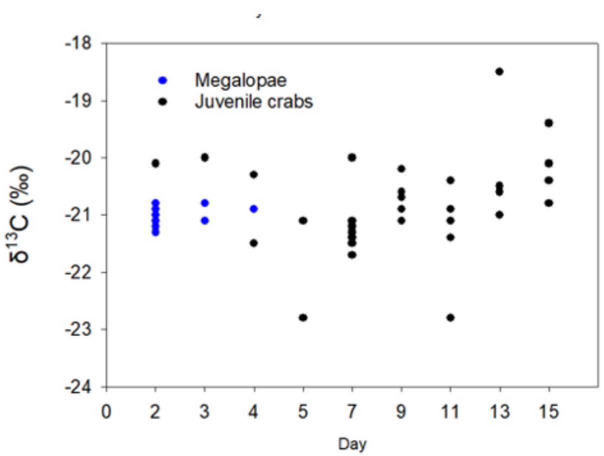
Crabs analyzed whole

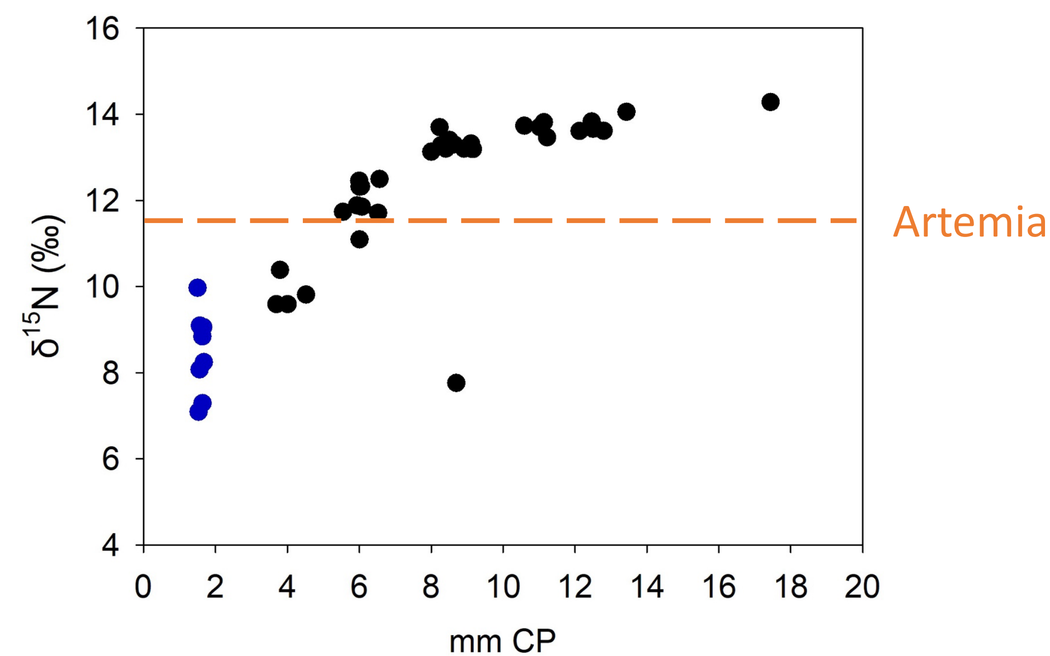
Megalopae in Aransas Pass

Nitrogen SIR indicate isotopic turnover to new diet occurs over about 10 days and 3-4 molts





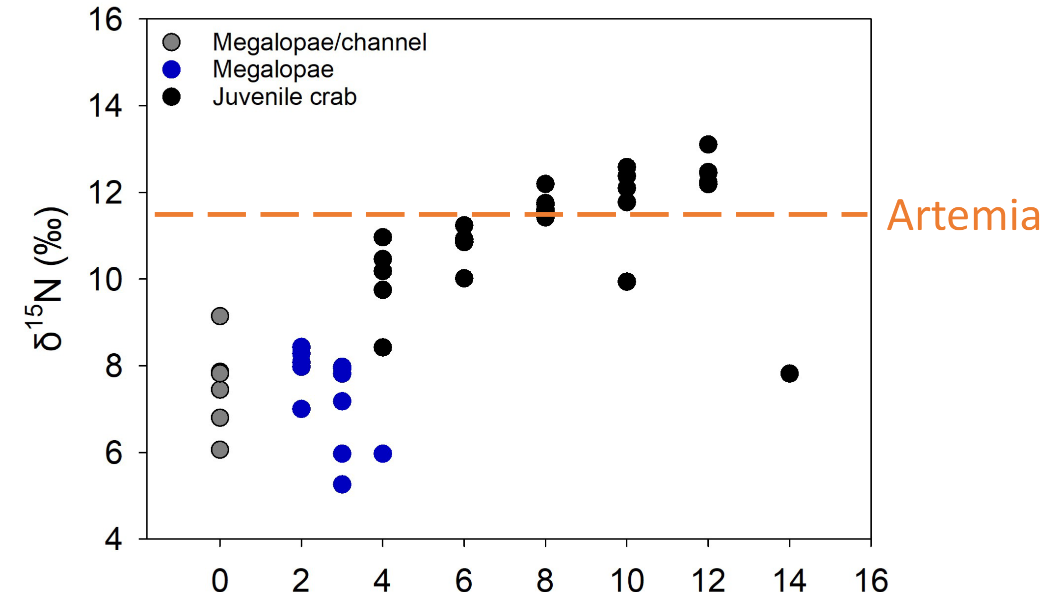
Carbon SIR not useful due to lack of isotopic differences between megalopae (coastal signature) and Artemia diet

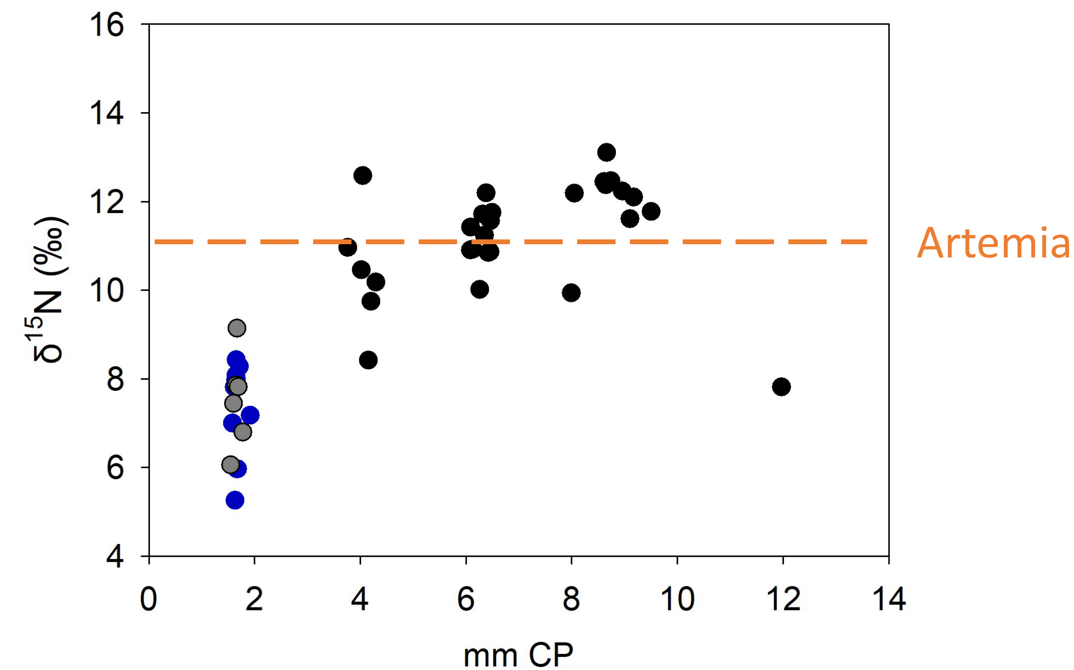


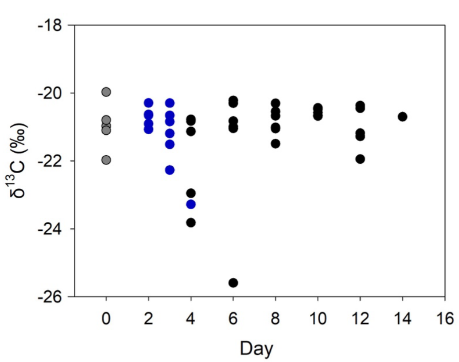
Isotope turnover rates
Experiment # 2

06 Nov– 20 Nov 2024
Mean temp: 25.0 ± 0.8°C
Mean salinity: 36.7 ± 0.2
Feed: Freshly hatched Artemia
$\delta^{15}N$ = 11.7 ‰
$\delta^{13}C$ = -22.4 ‰
Crabs analyzed whole

Nitrogen SIR indicate isotopic turnover to new diet occurs over about 10 days and 3-4 molts







Carbon SIR not useful due to lack of isotopic differences between megalopae (coastal signature) and Artemia diet

Isotope turnover rates
Experiment # 3

05 Feb– 20 Feb 2025

Mean temp: 24.7 ± 0.6°C

Mean salinity: 36.0 ± 1.0

Feed: Frozen mysid shrimp

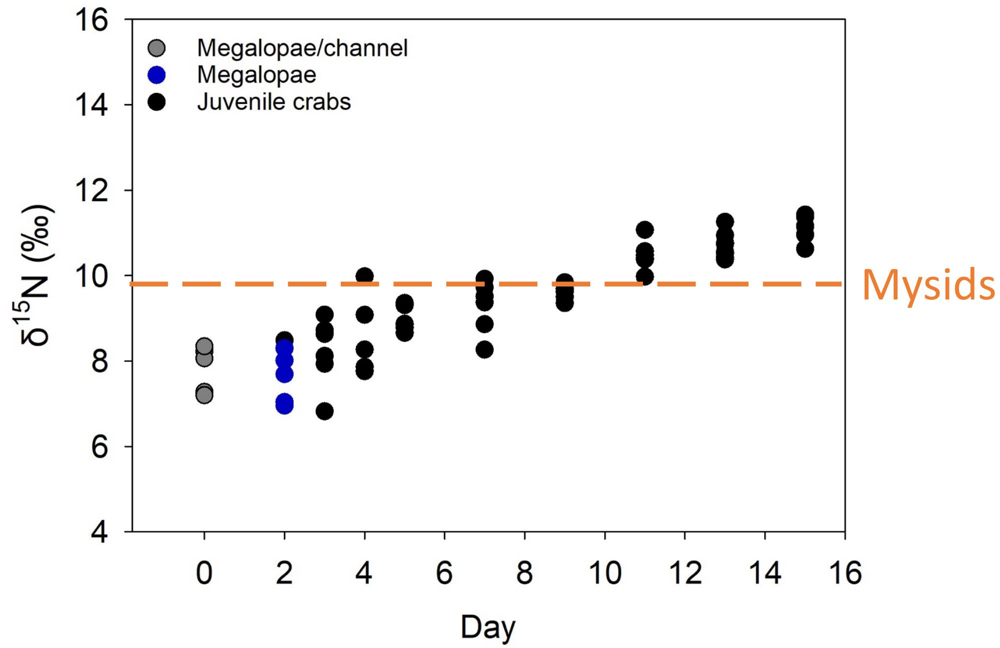
$\delta^{15}N$ = 9.9 ‰

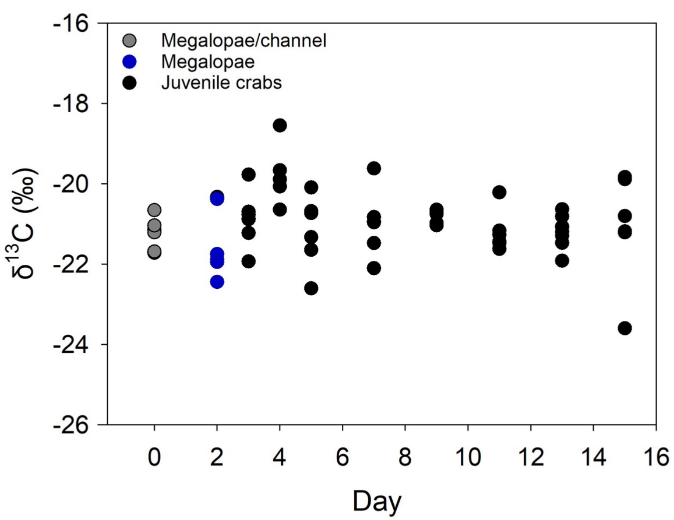
$\delta^{13}C$ =-22.9 ‰

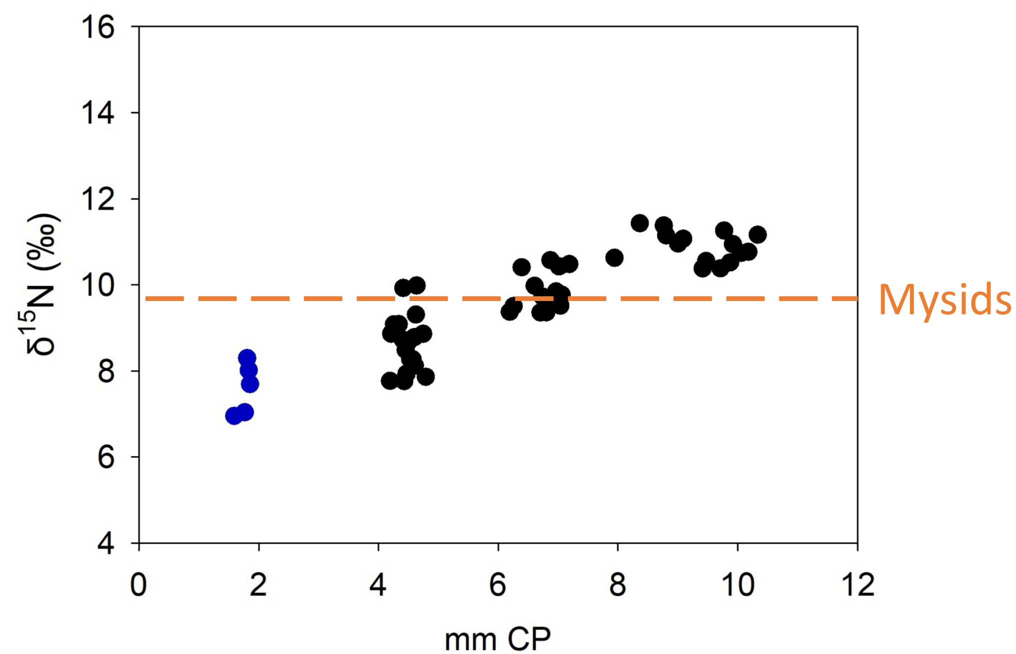
Crabs analyzed whole

(May be *Callinectes similis*)

Nitrogen SIR indicate isotopic turnover to new diet occurs over about 10-12 days and several molts







Isotope turnover rates
Experiment # 4

05 March– 03 Apr

Mean temp: 16.2°C

Mean salinity: 34.4

Feed: Frozen mysid shrimp

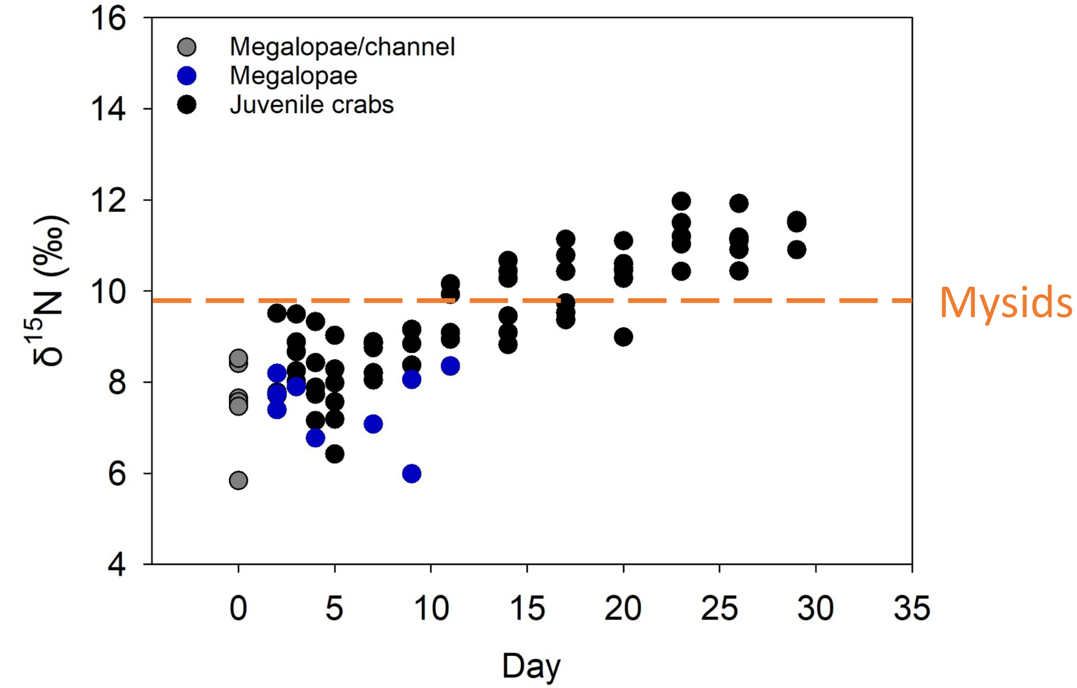
$\delta^{15}N$ = 9.9 ‰

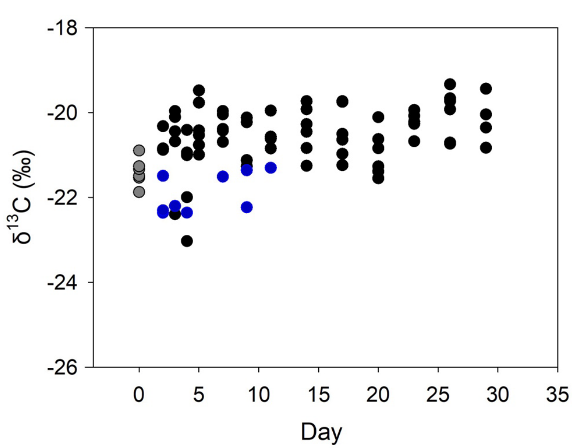
$\delta^{13}C$ =-22.9 ‰

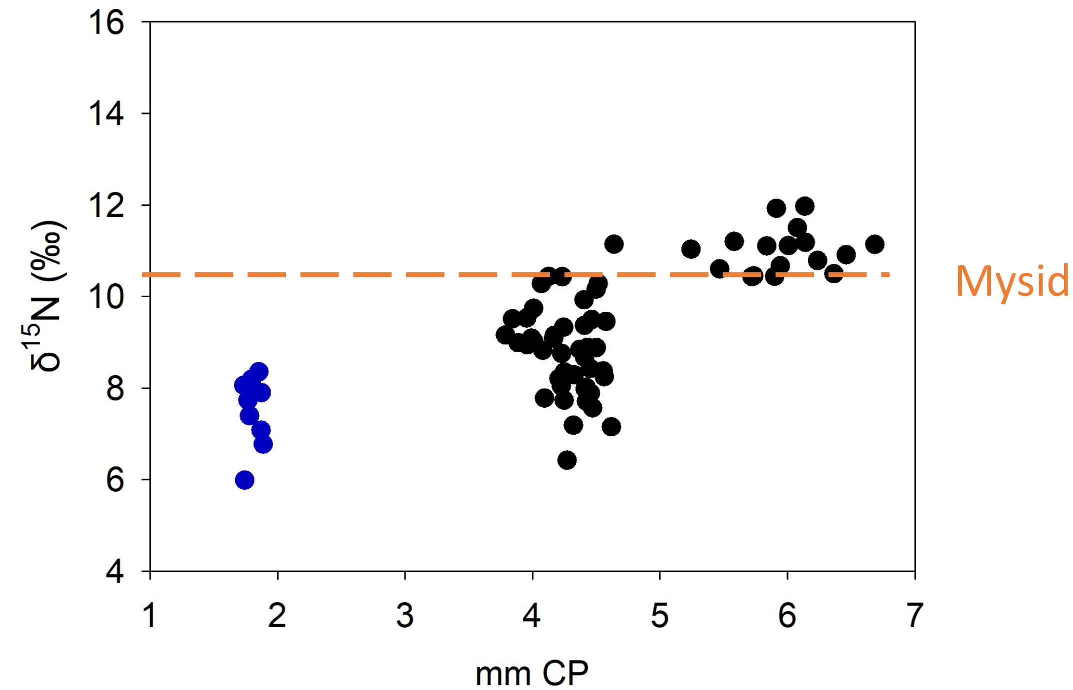
Crabs analyzed whole

(May be *Callinectes similis*)

Nitrogen SIR indicate isotopic turnover to a new diet occurs over <u>about 20-25 days and several molts at lower temperatures</u>

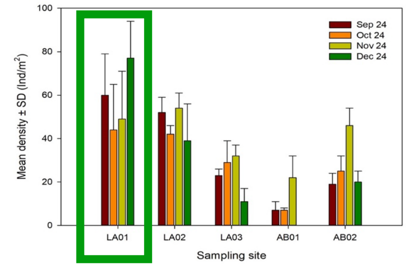






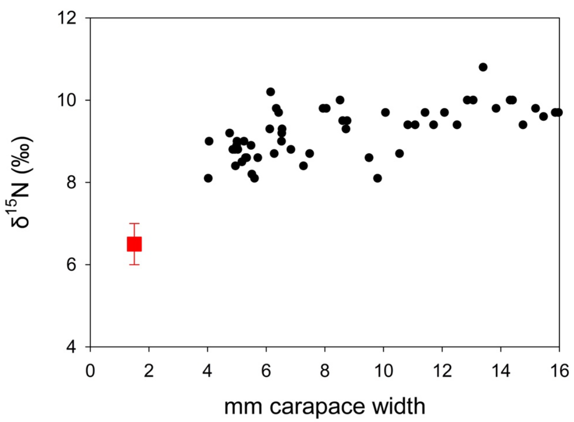
LA01

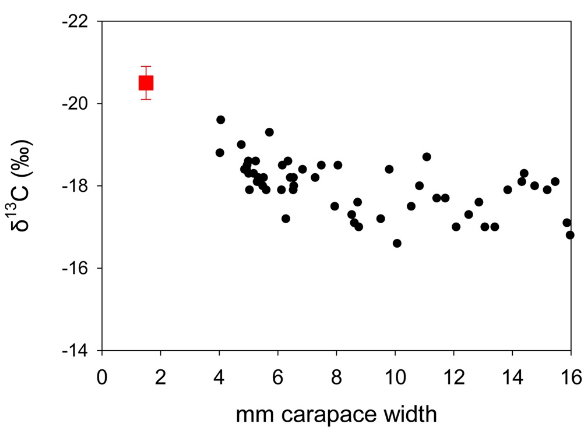
Closest to Aransas Pass
Juveniles < 15 mm CW



Mean ± SD Megalopae

September





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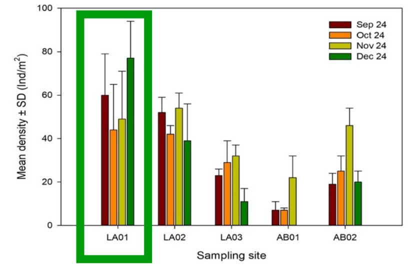
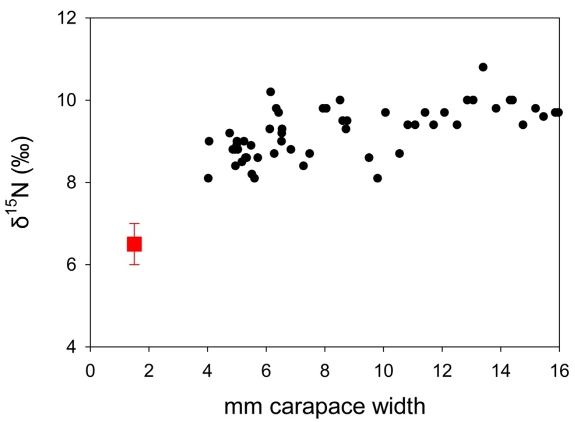
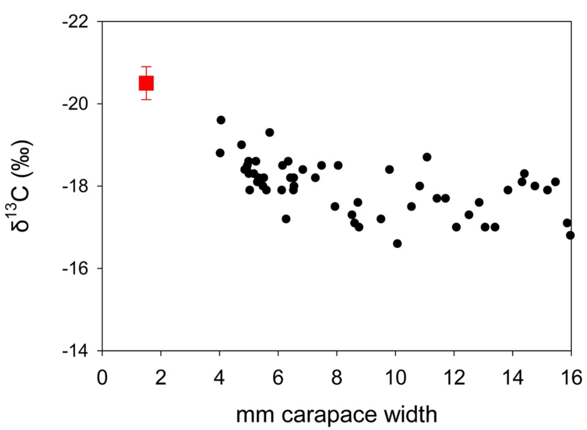


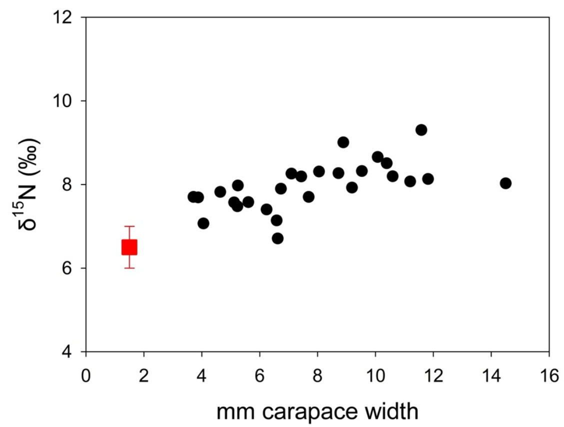
Mean ± SD Megalopae

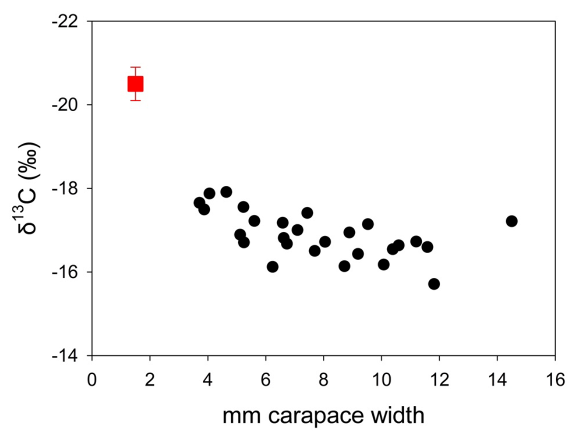
September



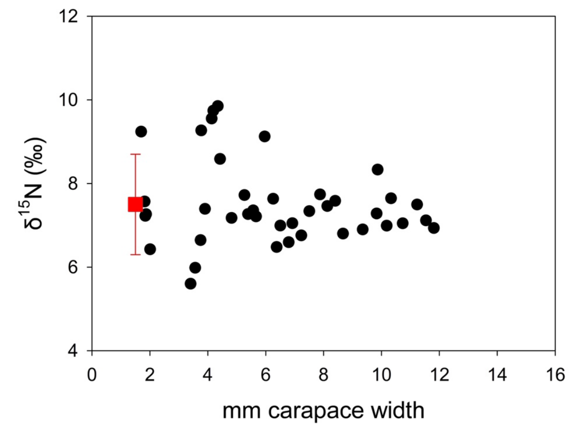


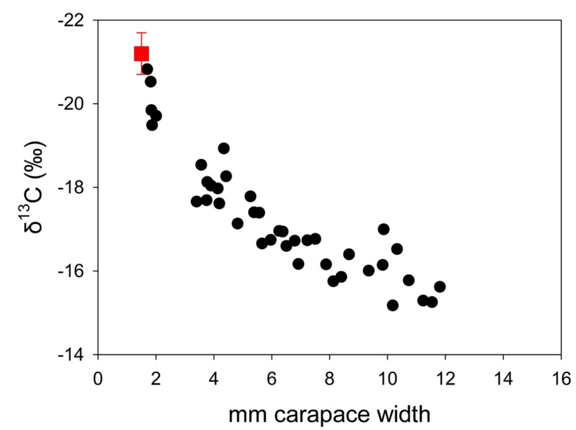
October



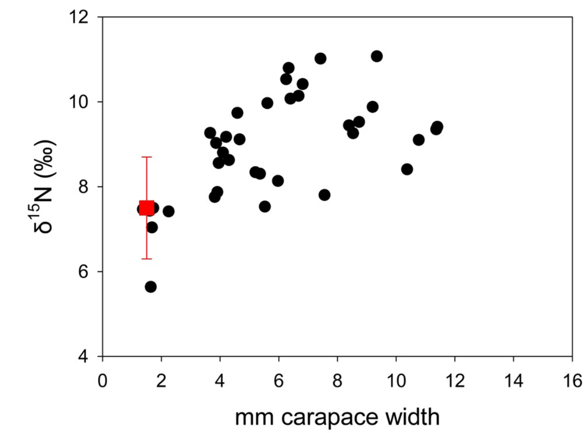


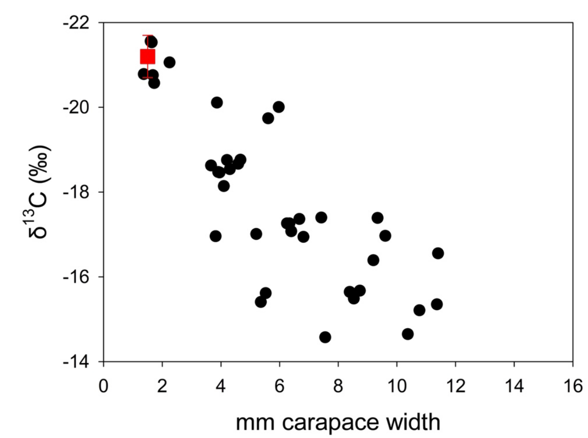
November





December

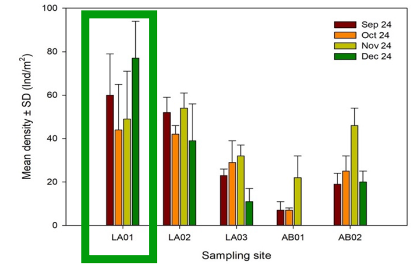




LA01

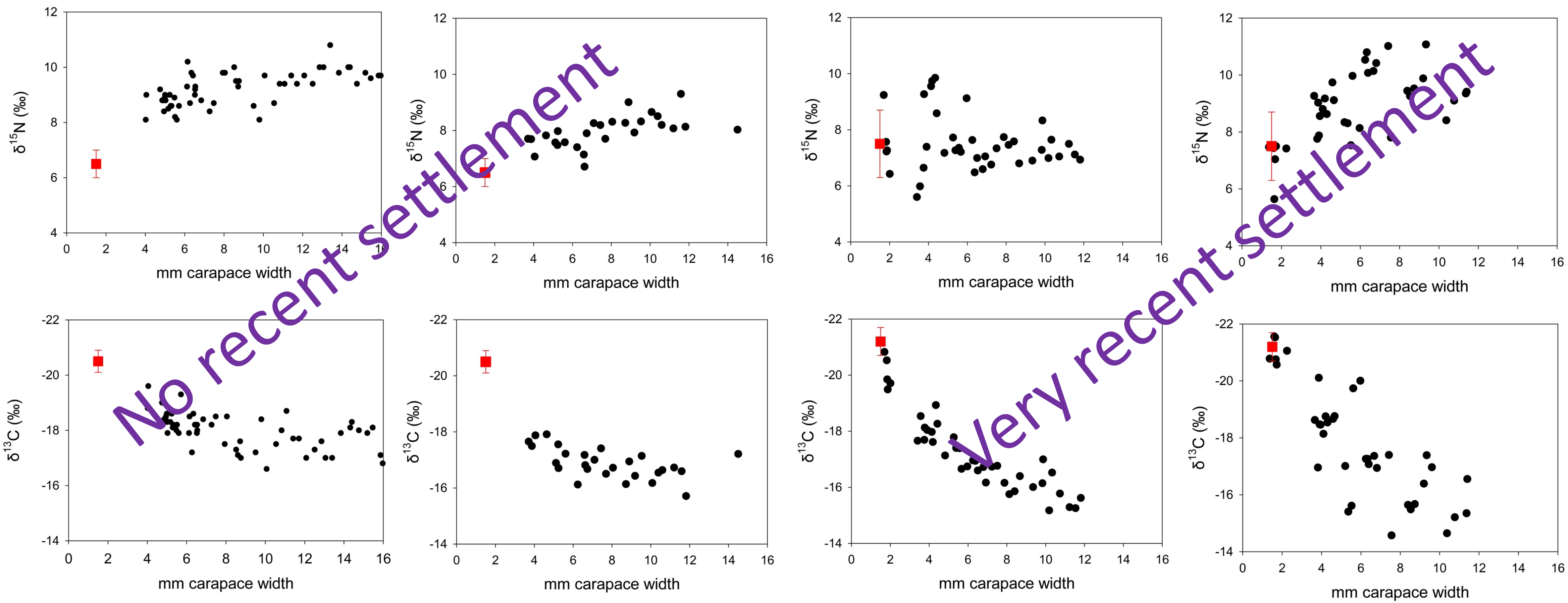
Closest to Aransas Pass

Juveniles < 15 mm CW



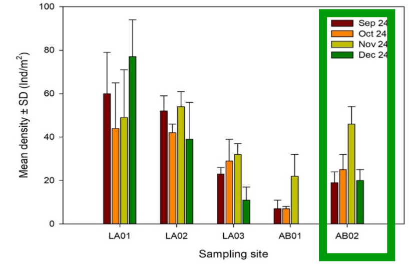
Mean ± SD Megalopae

September | October | November | December



AB02

furthest from Aransas Pass
Juveniles < 15 mm CW



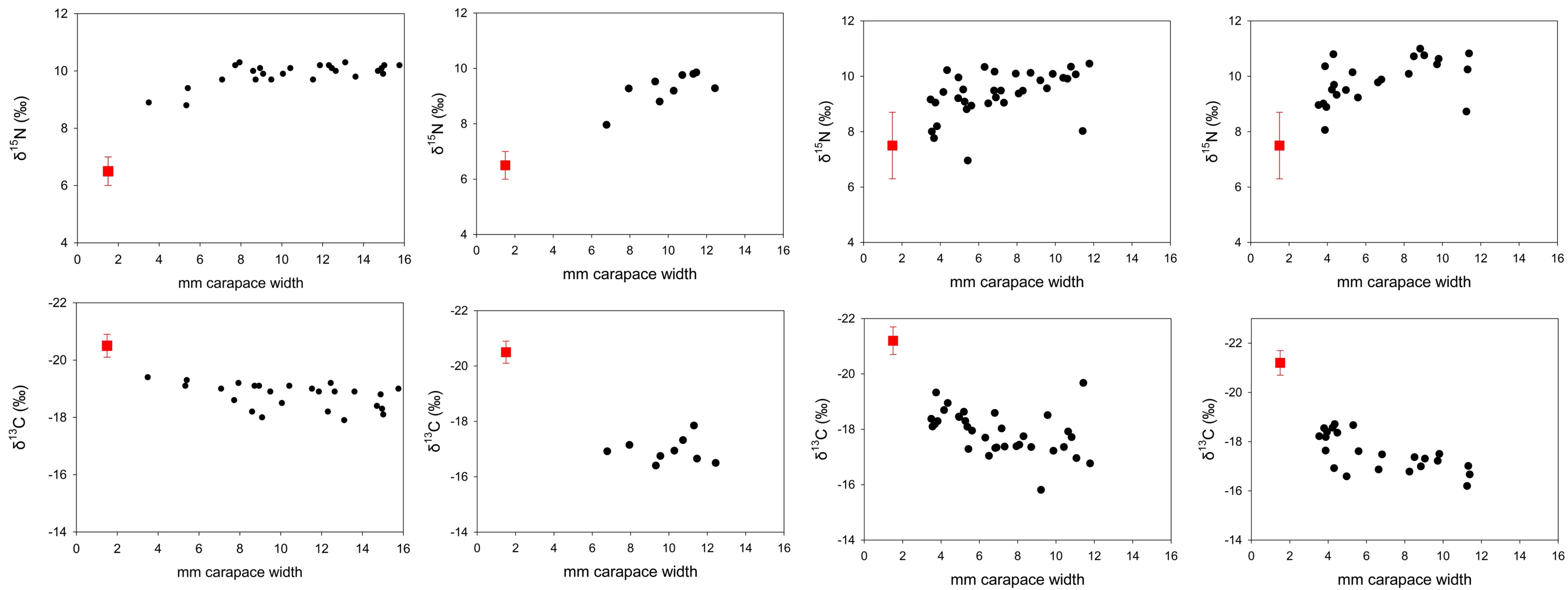
Mean ± SD Megalopae

September

October

November

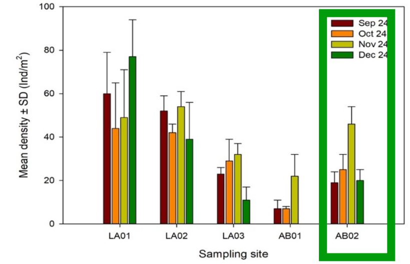
December



AB02

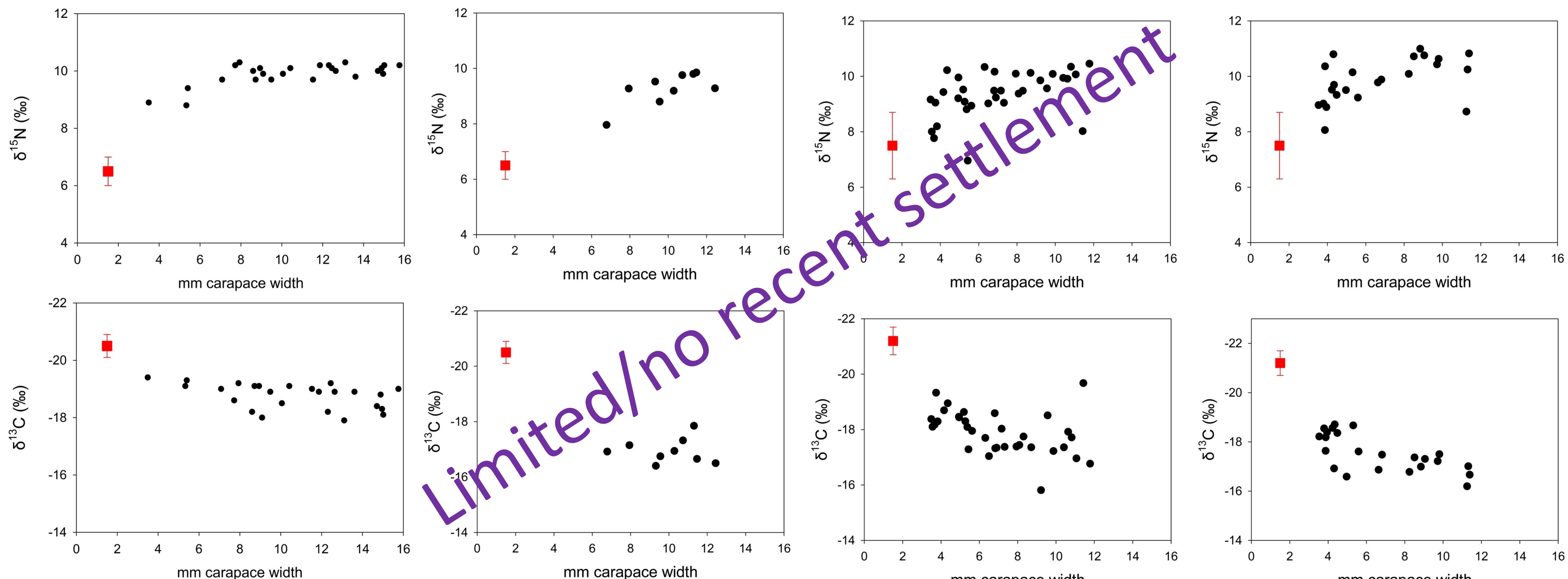
furthest from Aransas Pass

Juveniles < 15 mm CW



Mean ± SD Megalopae

September   October   November   December



Conclusions

Higher densities of early juveniles closer to Aransas Pass are consistent with current-mediated transport

Seagrass habitat closer to the pass provides key nurseries for new settlers

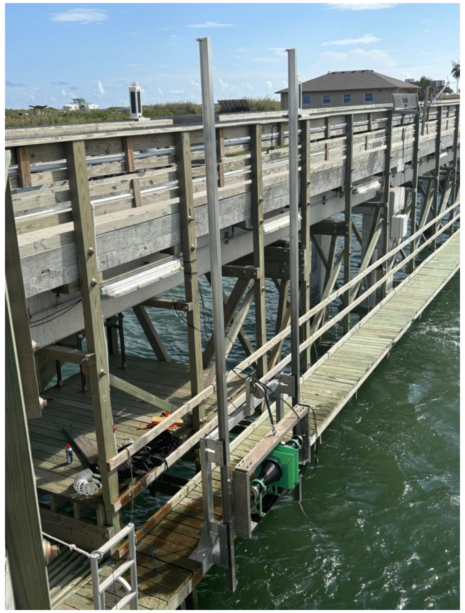
Early juveniles move up estuary following settlement into seagrass habitat

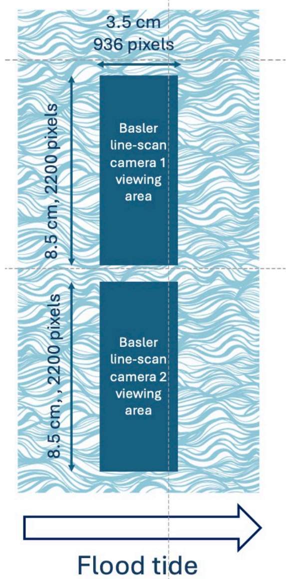
Stable isotope ratios of whole crabs can be used to detect recent settlement, despite molting

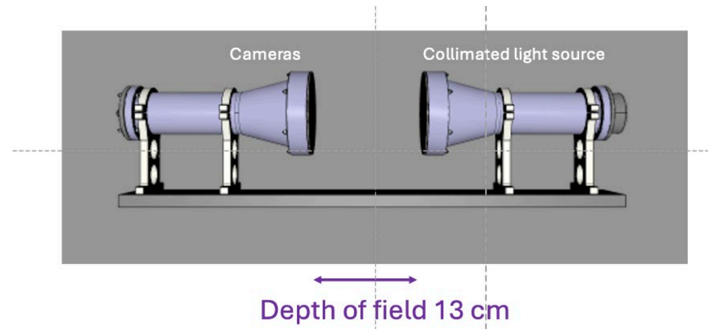
Thank you to sampling volunteers Nichole Dopp and Sebastian Quintanilla

High-frequency shadowgraph imaging as an innovative approach to researching fine-scale dynamics of the ingress of blue crab megalopae into a turbid estuarine system

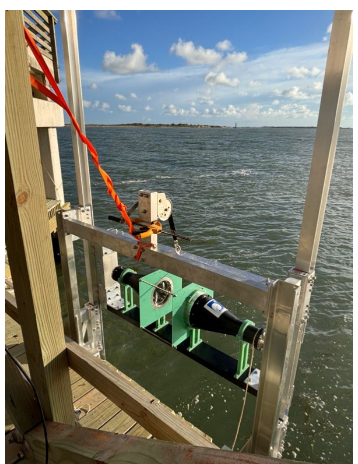
Sharon Z. Herzka (UT Austin Marine Science Institute) and Charles Cousin (Bellamare)





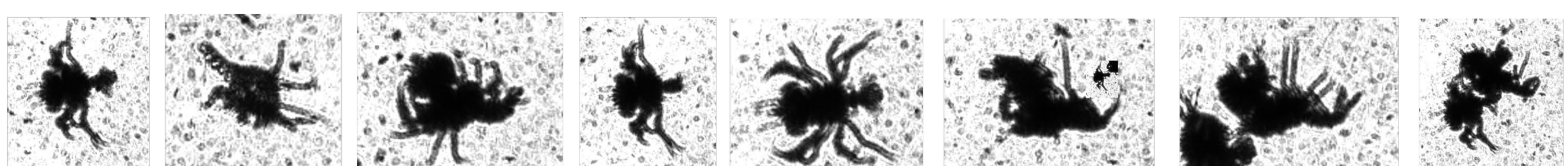


- Can provide high-resolution imaging of relatively high volumes (large depth of field and depth of view) at high current speeds
- Detection of taxa at low densities
- Telecentric lens system and collimated light source yield in-focus particles throughout the depth-of-field, allowing for precise two-dimensional observation and measurements
- Requires machine learning



Segmented images of blue crab megalopae

Wild-caught megalopae were held in a transparent flask positioned within the field of view of the ISIIS-DPI deployed at the UTMSI Pier Laboratory 0.5 m below the surface during the incoming flood tide.



Isotope turnover rates Experiment # 5

Juveniles reared from megalopae on Artemia and switched to tilapia

8 Apr – 5 May

Mean temp: 22.1°C

Mean salinity: 35.6

Feed: Tilapia

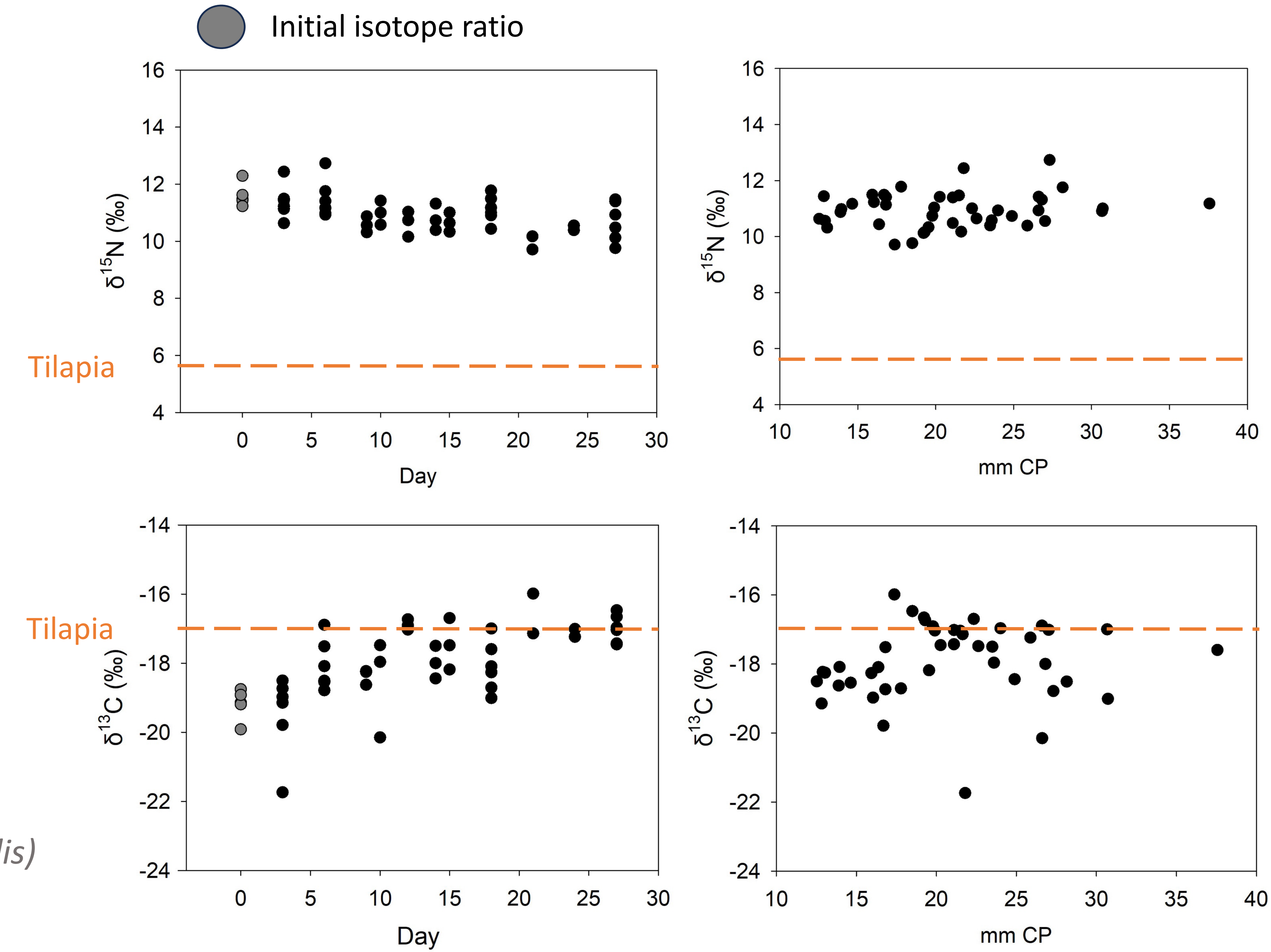
Tilapia

$\delta^{15}N$ = 5.6 ‰

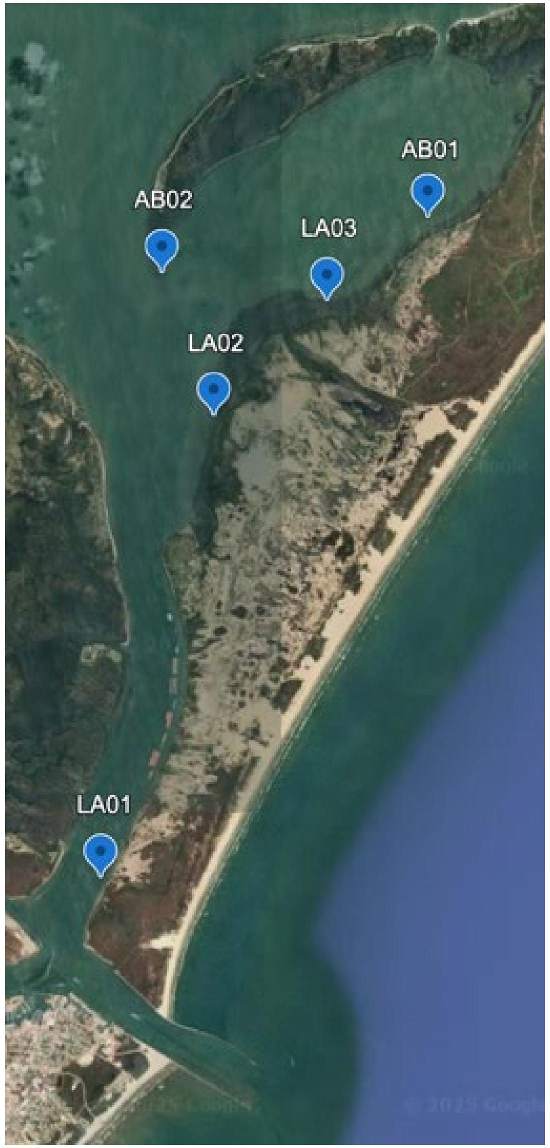
$\delta^{13}C$ = -17.5 ‰

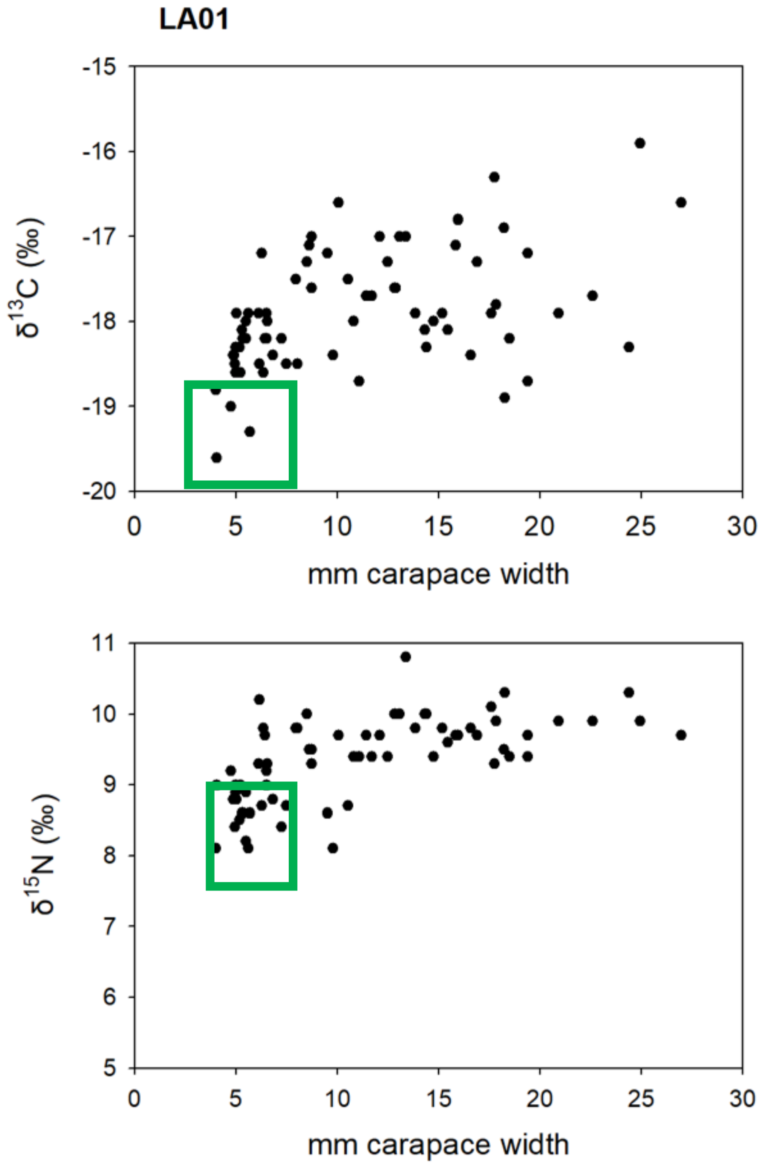
Crabs analyzed whole

(May be *Callinectes similis*)



Sept 16-17 seagrass sampling SIR



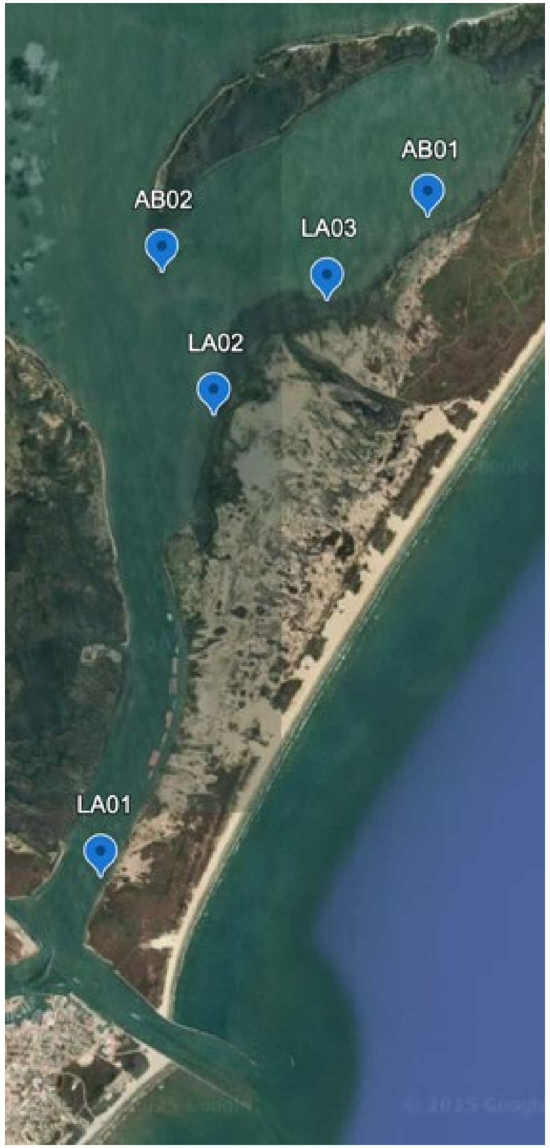


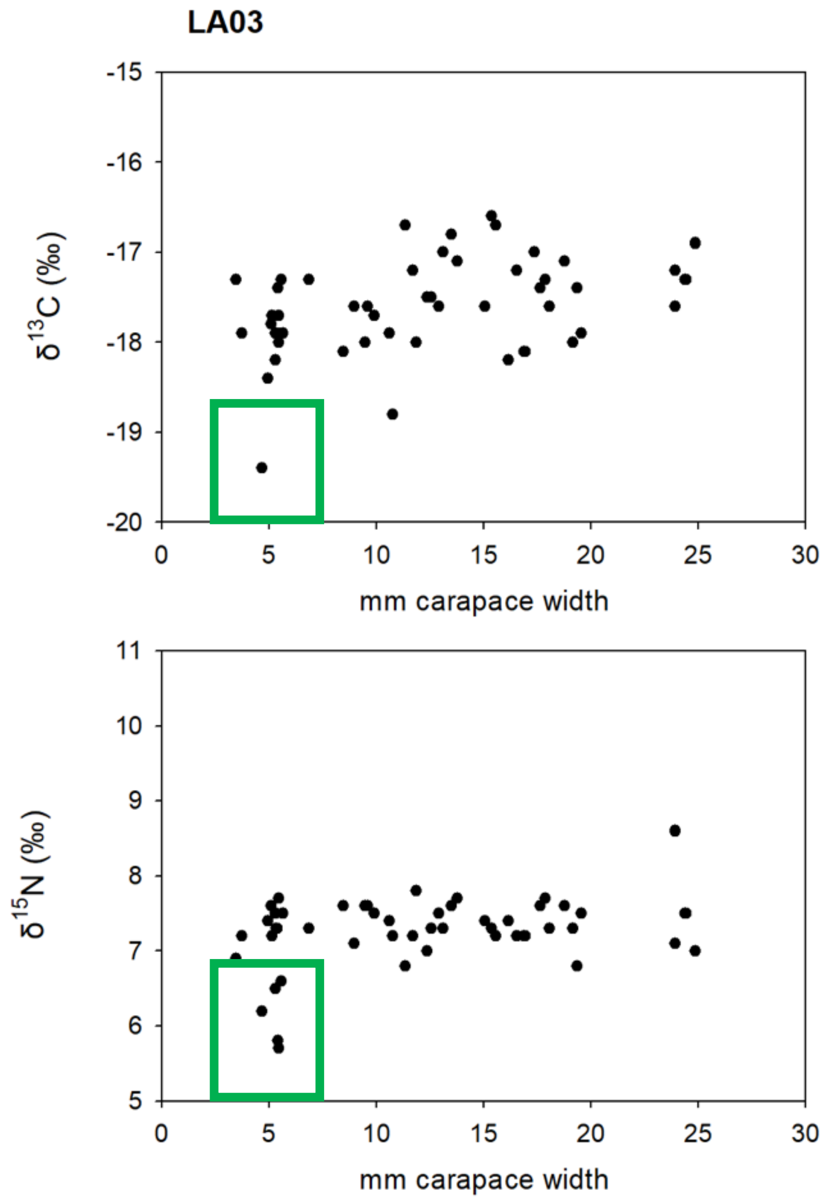
Analyzed 5 crabs per mm size class < 7 mm carapace width

Analyzed 3 crabs per mm size class > 7 mm

Smallest early juveniles reflect planktonic feeding prior to settlement

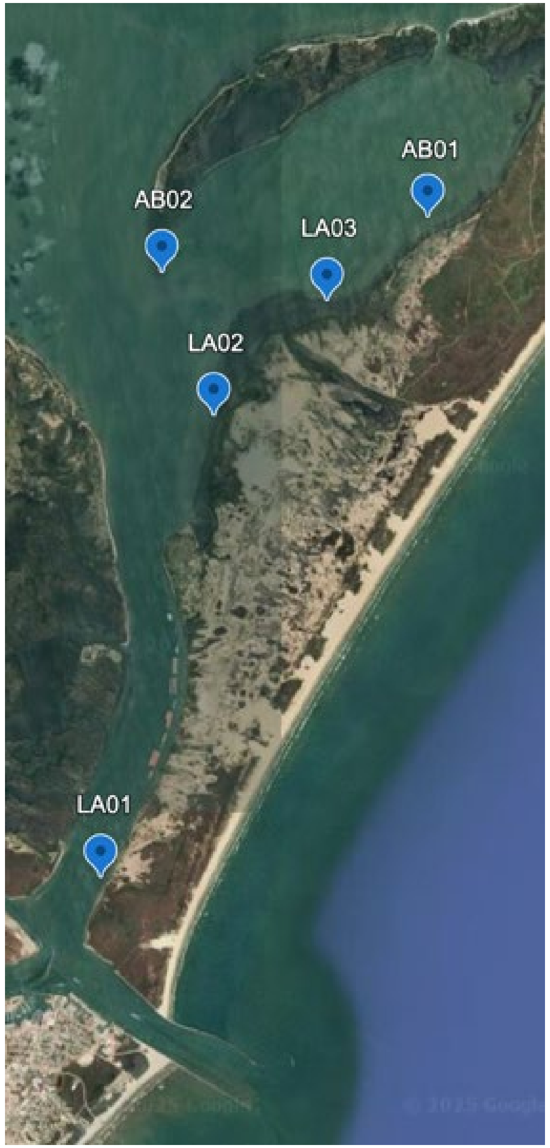
Sept 16-17 seagrass sampling SIR

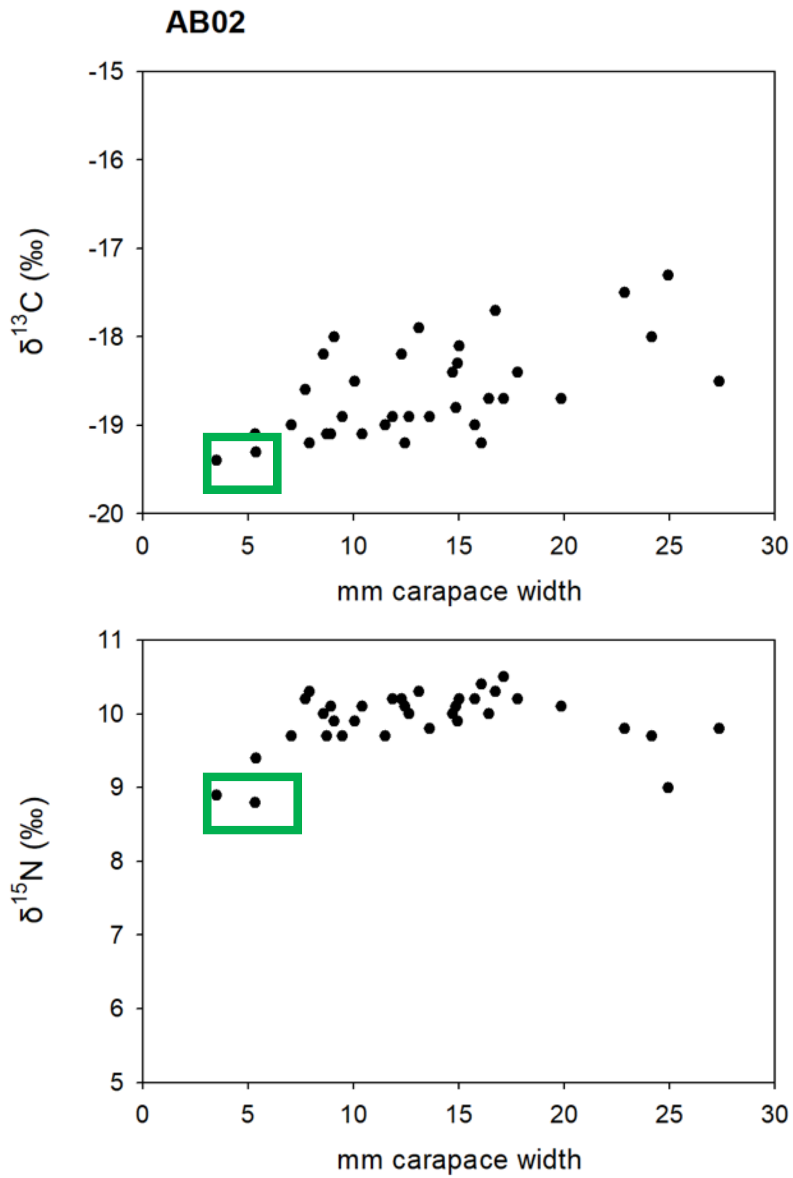




Smallest early juveniles reflect planktonic feeding prior to settlement

Sept 16-17 seagrass sampling SIR





Smallest early juveniles reflect planktonic feeding prior to settlement