Spatiotemporal bio-economic performance of artificial shelters in a small scale rights-based managed Caribbean spiny lobster (*Panulirus argus*) fishery

Maren Headley, Juan Carlos Seijo, Álvaro Hernández,

Alfonso Cuevas Jiménez, Raúl Villanueva Poot

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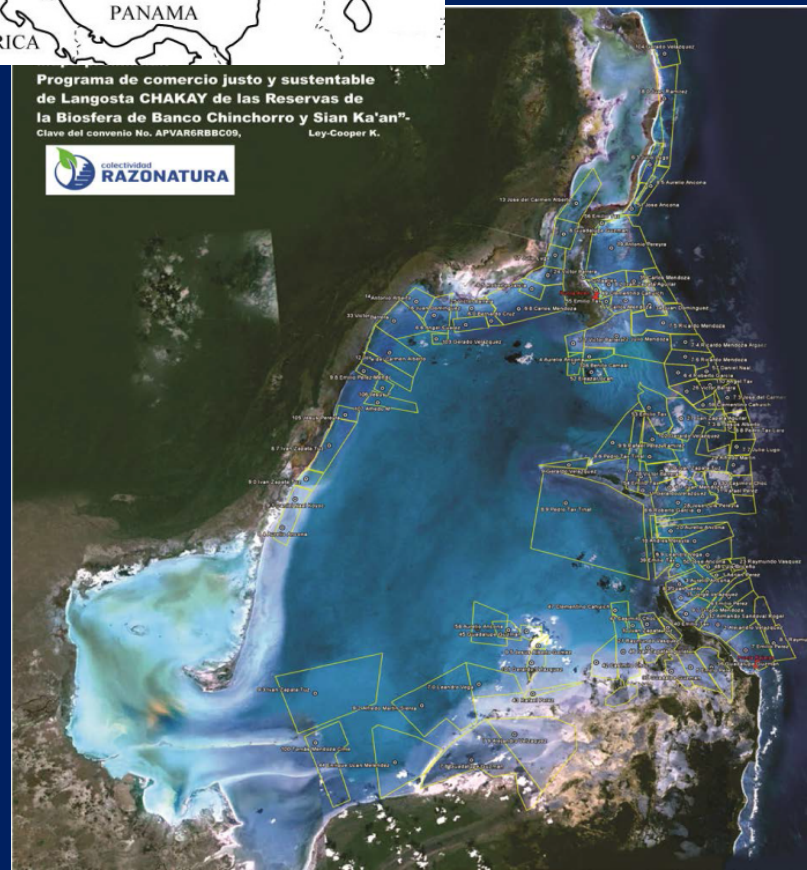
Spiny lobster

- Distributed and fished throughout the Wider Caribbean
- High market value - $ 620 million USD (FAO 2016)
- Main source of income for a large number of coastal communities (Seijo 2007)
- Targeted using a variety of gears
- Regulated open access (Gardner et al. 2013)
  - Limited number of vessels
- TURFs
  - Individual transferrable fishing grounds (IFGs)

The fishery

- Community of Punta Allen, Mexico
- Concession granted to the Vigia Chico Cooperative
- Bahia de la Ascension (~850 km^2)
- IFGs vary in size from 3 km^2 to 20 km^2 (Ley-Cooper 2016)
- This system has been in place since 1969 (Sosa-Cordero et al. 2008)
- Free diving, hand-held nets, artificial shelters

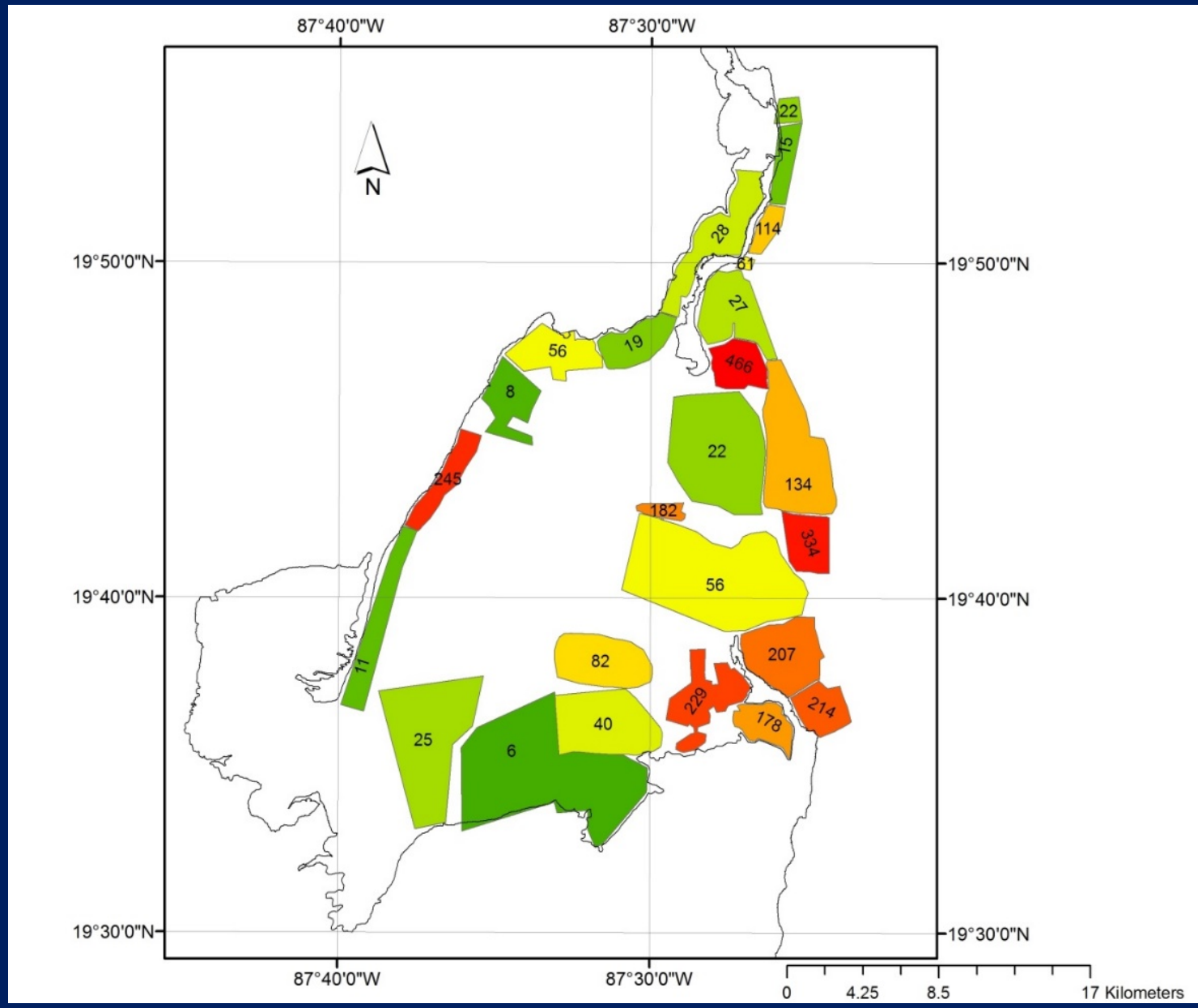


Research question

- Are there significant differences in the spatiotemporal bioeconomic performance of artificial shelters located in different fishing areas with exclusive property rights in benthic fishing grounds?

Fishing areas & density of artificial shelters

- Fishing areas polygons
- Fisher interviews
- IFGs-115
- Artificial shelter density
- Current estimate of 27000 artificial shelters
- Historical peak
  - 26500 shelters in 1988 (Cesar-Dáchary and Arnaiz-Burne 1989



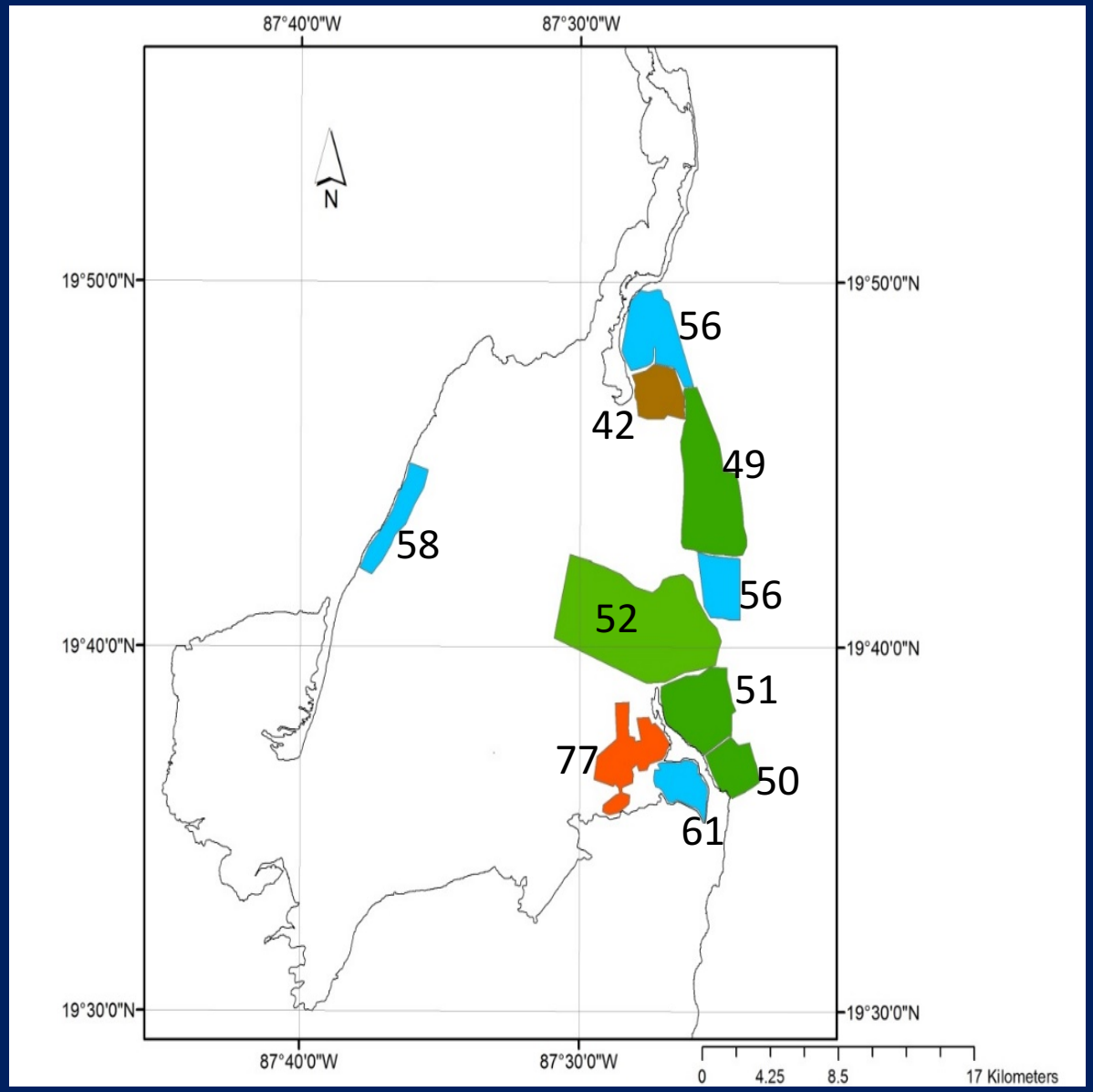
Calculations

- Four fishing seasons-2010-2014
- Ten fishing areas-93% total landings
- Variable costs (C_{st})of fishing per daily trip to alternative fishing areas were calculated, using the following equation (Anderson 2002):
- $C_{st} = \frac{\frac{D_s}{v}C_1 + (L - \frac{D_s}{v})C_2}{L}$
  - D_s - round trip distance between port of origin (Punta Allen) and fishing area (s)
  - v - steaming speed of the boat (km/h)
  - C_1 - cost of operating the boat when steaming ($/h)
  - C_2 - cost of operating the boat when fishing ($/h)
  - L - average length of the daily trip in hours

Calculations

- Daily revenues by fishing area (s)
  - $TR_{s,t} = W * p$
    - W - kg whole weight of spiny lobster
    - p - 15.84 USD/kg
- Quasi-profits of variable costs per trip
  - $Tquasi\pi_{s,t} = TR_{s,t} - C_{s,t}$
- Quasi-profits of variable costs per artificial shelter harvested per trip
  - $Aquasi\pi_{s,t} = Tquasi\pi_{s,t}$ /no. of shelters harvested by a boat in fishing areas (s)
- Two factor ANOVAs & post-hoc Tukey test

Mean number of artificial shelters harvested per trip

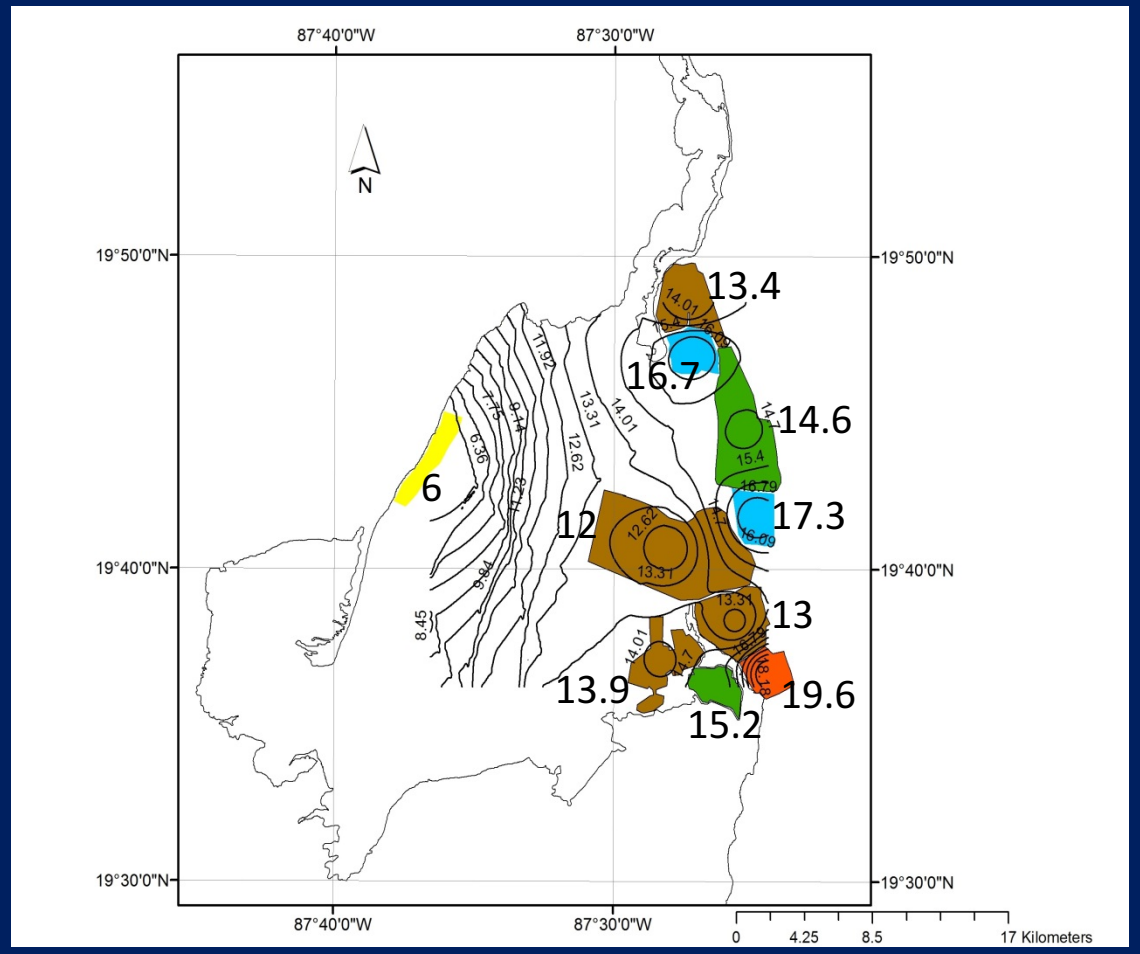


- No interactions between the fishing areas and seasons
  - Fs(27, 5209)=1.1, p =0.33

Fs(9, 5209)=65.9, p<0.05; Fs(3,5209)=4.4, p<0.05

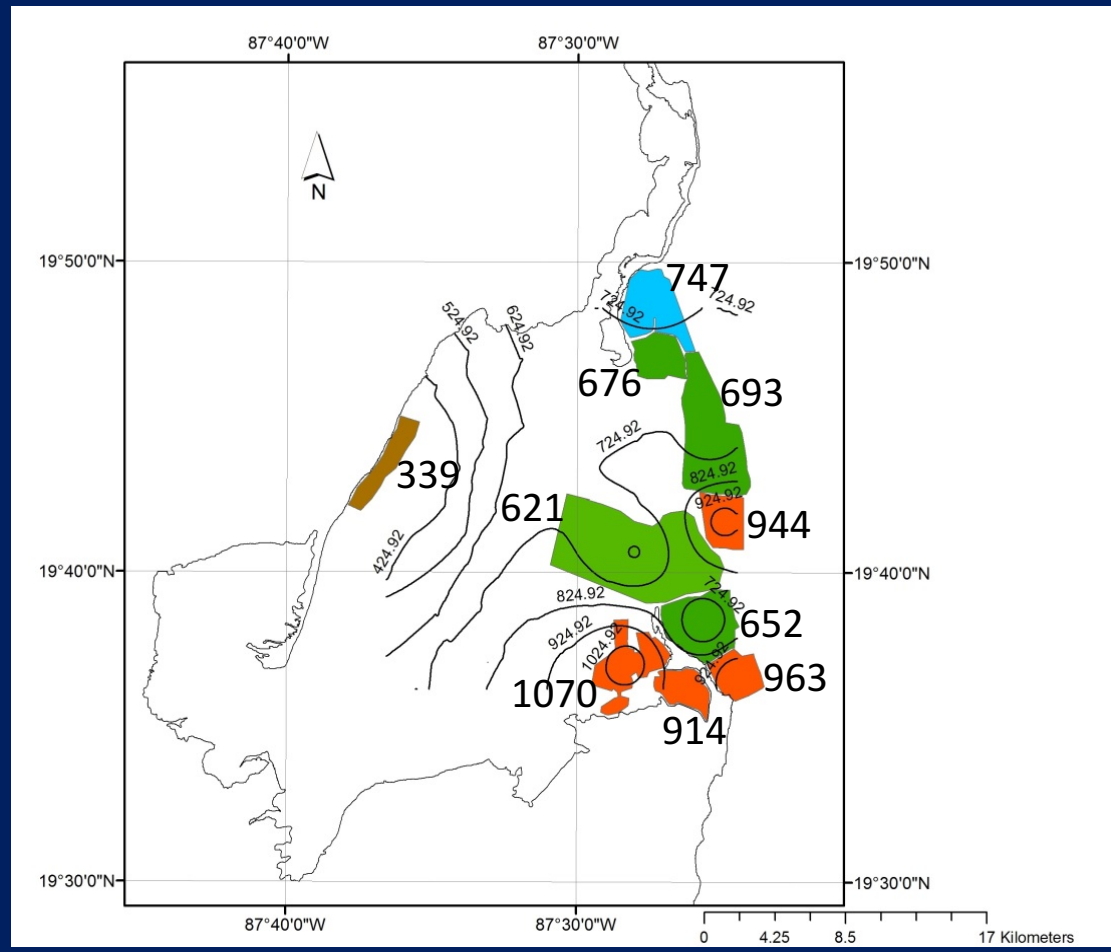
Mean quasi-profits of variable costs per shelter harvested per trip ($USD)

Fs(9,5209)=38.40, p<0.05; Fs(3,5209)=23.9, p<0.05



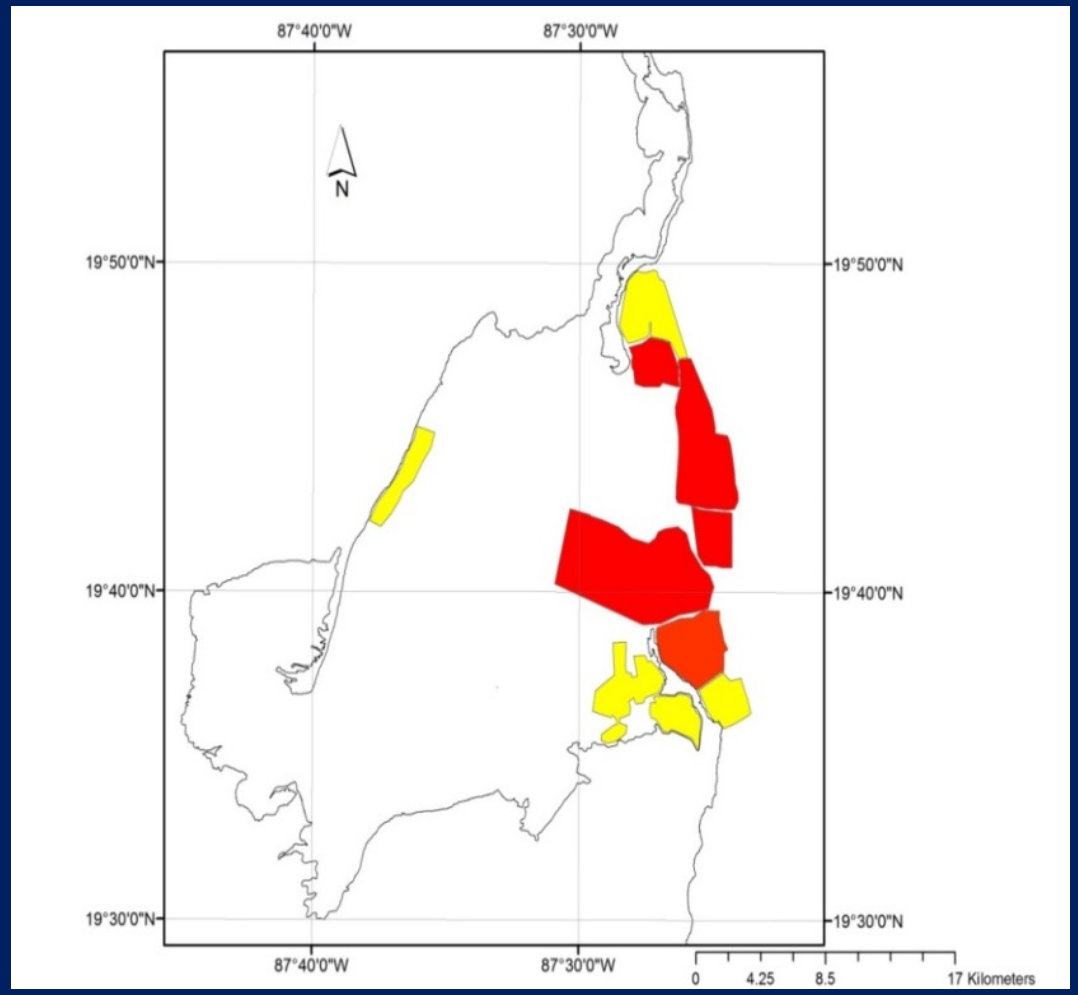
Mean quasi-profits of variable costs per trip ($USD)

Fs(9,5209)=43.67,p<0.05; Fs(3,5209)=17.18, p<0.05



Mean quasi-profits of variable costs per shelter harvested per trip ($USD)

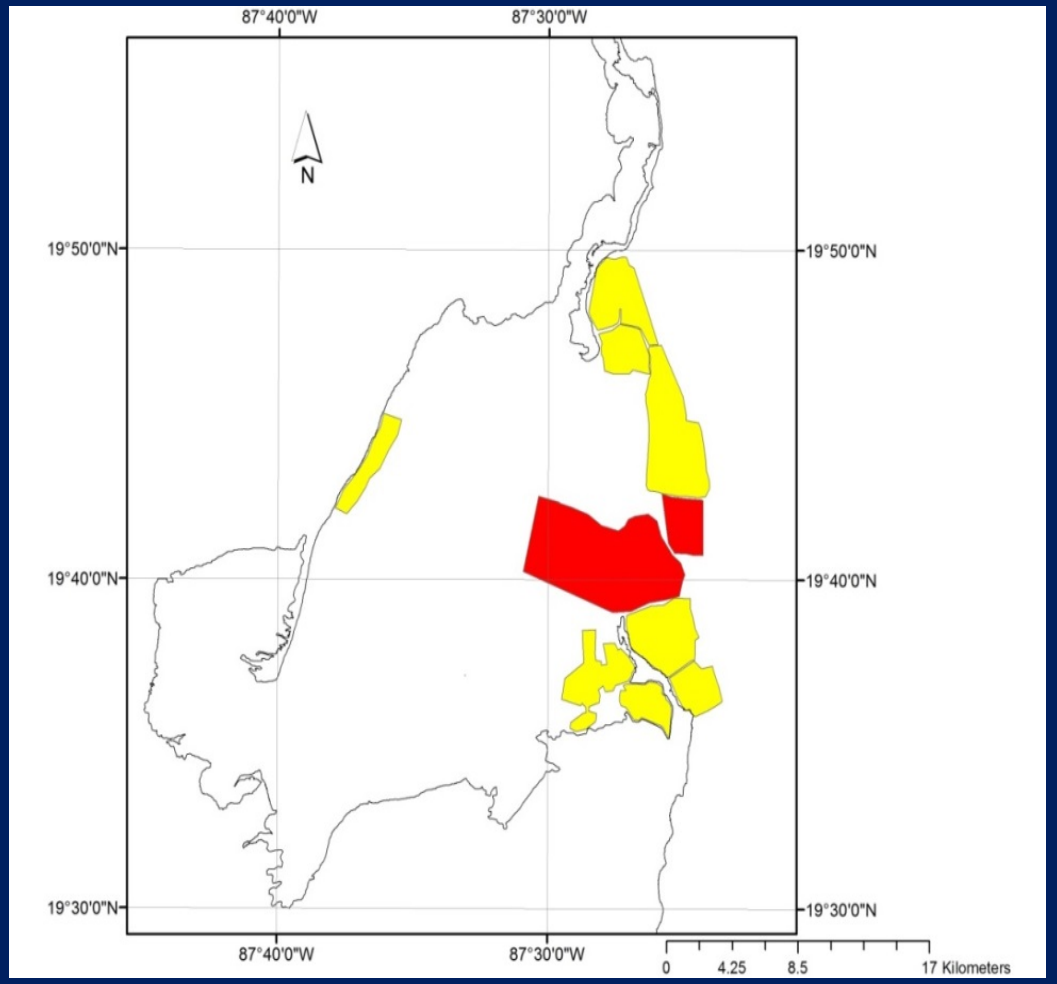
Fs(27,5209)=2.7, p<0.05



- Spiny lobster movement-salinity, water temperature, food availability, ontogenetic habitat shifts

Mean quasi-profits of variable costs per trip ($USD)

Fs(27,5209)=2.5, p<0.05



- Consistent fishing intensity
- Fishing trips in accordance to spiny lobster abundance

Correlation between CPUE and shelter density

- Positively moderate correlation
- (r=0.55; r=0.48; r=0.73;r=0.49)
- Productivity per shelter is still increasing
- Meta-population harvested by 26 countries (FAO 2016)
- Abundance and distribution is influenced by local environmental factors (Field and Butler 1994, Ley-Cooper 2016)

Conclusion & Next Steps

- Performance of the shelters between fishing areas was significantly different and influenced by:
  - Spatiotemporal distribution and abundance of the resource
  - Location of the fishing area in relation to the port
  - Shelter densities
  - Heterogeneous fishing strategies & economically rational fisher behaviour
  - Co-management
  - Rights-based management
- Other factors
  - Environmental conditions
  - Seasonal recruitment patterns
  - Sizes of spiny lobster typically present in the area
  - Micro-habitats
- Future research should take habitat types into consideration within a multivariate analysis

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