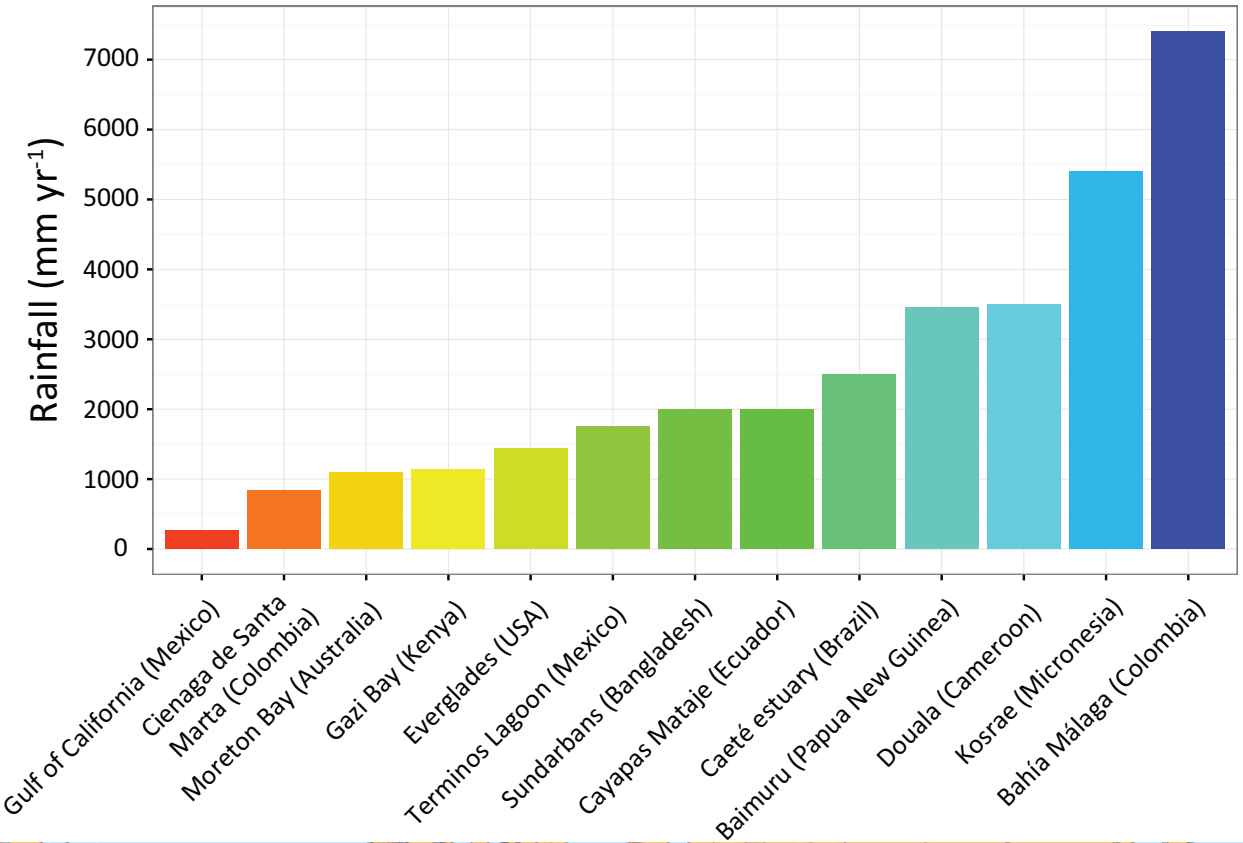
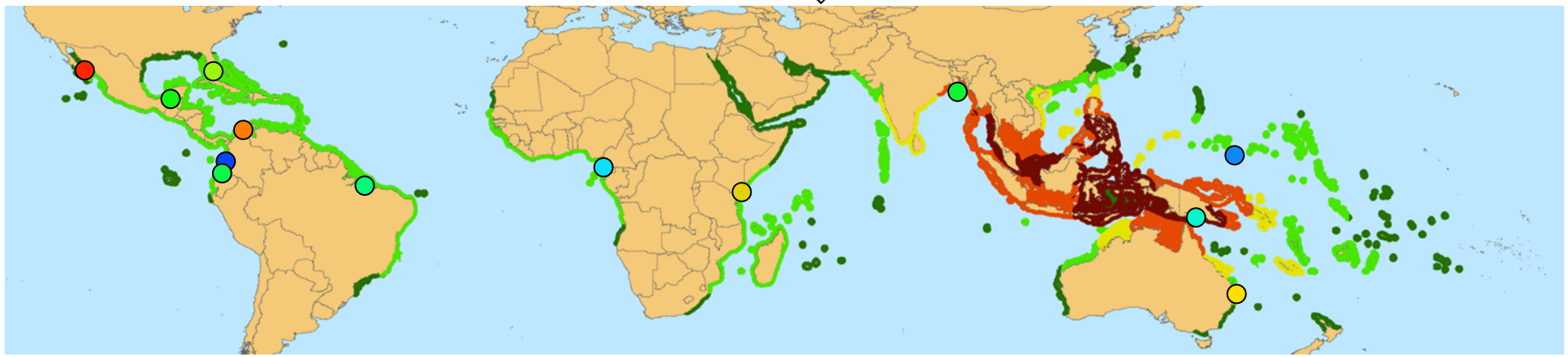
Modeling trophic flows in the wettest mangroves of the tropical Eastern Pacific region

G.A. Castellanos-Galindo, J. Cantera, N. Valencia, S. Giraldo, E. Peña, L.C. Kluger & M. Wolff

St. Augustine, July 19th 2016, MMM4

Mangroves & precipitation regimes





Polidoro et al. (2010) *PLoS ONE* 5(4)

Modeling trophic flows in the **wettest mangroves of the world**

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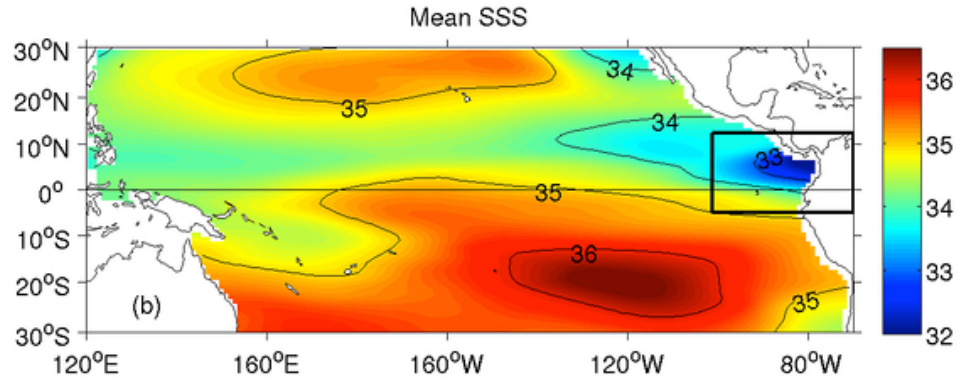
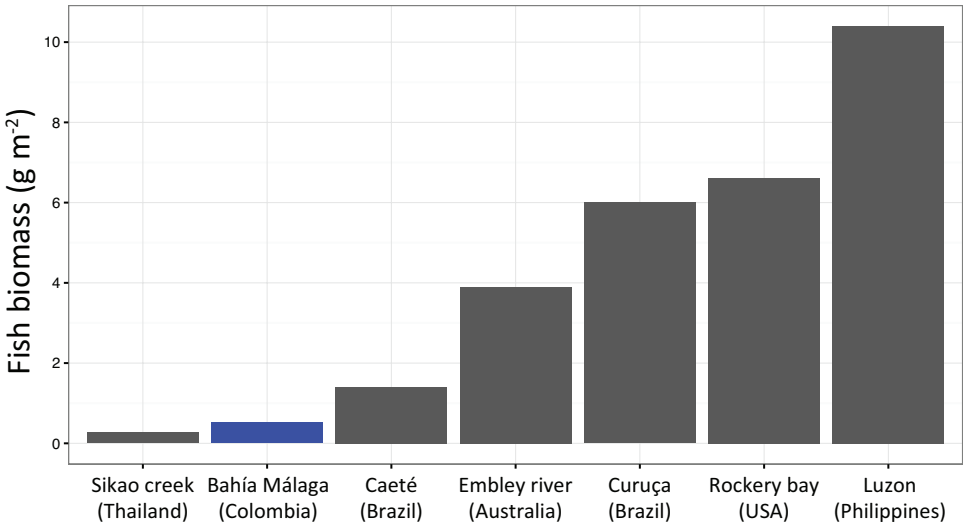
What can these mangroves tell us?



The far Eastern Pacific Fresh Pool - salinity is permanently lower than 33 (< 30 in estuarine areas)

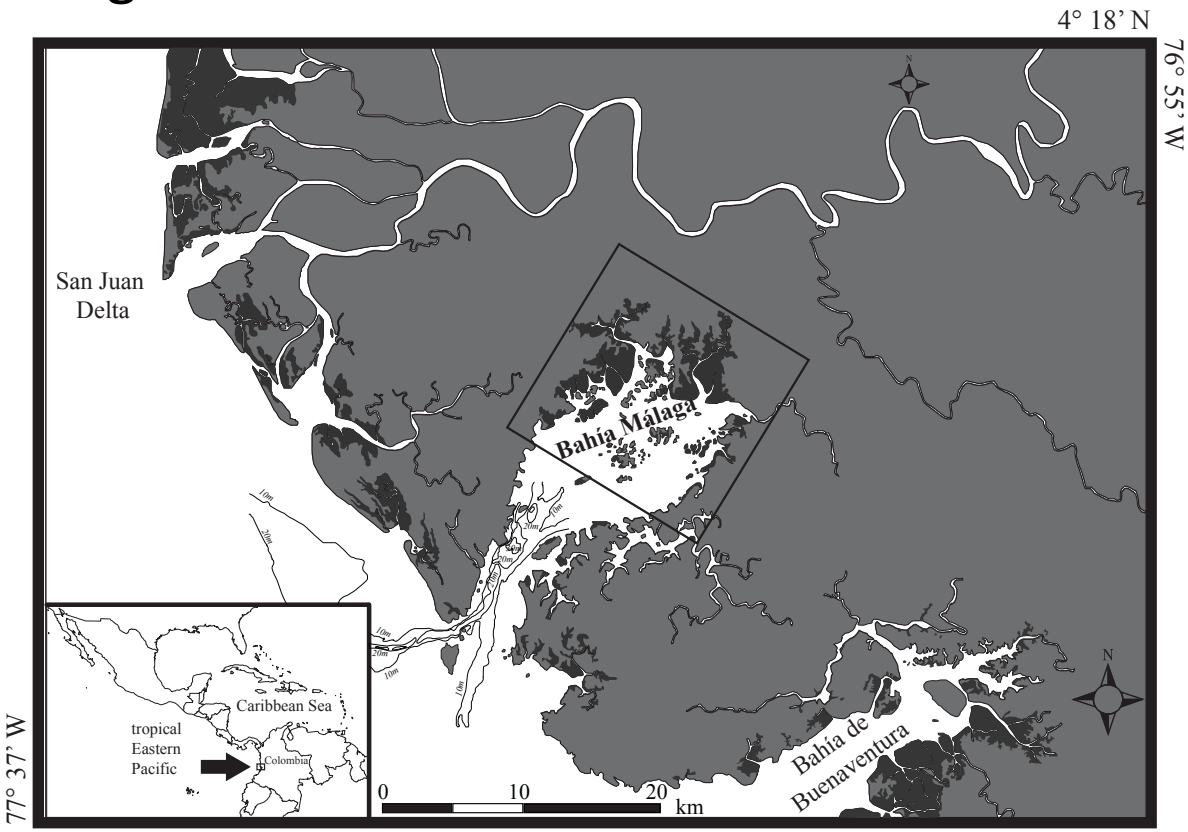
- Great mangrove development (above-ground biomass)
- But, poor fish and macrobenthic biomass



Alori et al. (2012) *Journal of Geophysical Research: Oceans*; Castellanos-Galindo & Krumme *(2015) Ecosystems*

Bahía Málaga, tropical Eastern Pacific

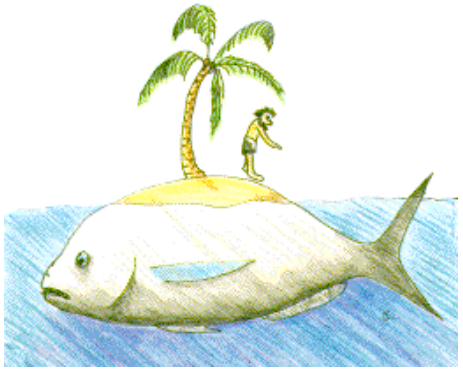
- Estuarine system (4 m tidal range)
- ca. 160 km^2 (1/3 mangroves)
- Low salinities (< 23) throughout the year
- Low human population density (1.5 persons km^{-2})
- One of the best studied mangroves in the Colombian Pacific



Bahía Málaga in the central coast of The Colombian Pacific, tropical Eastern Pacific Ocean. Mangrove areas in dark grey color

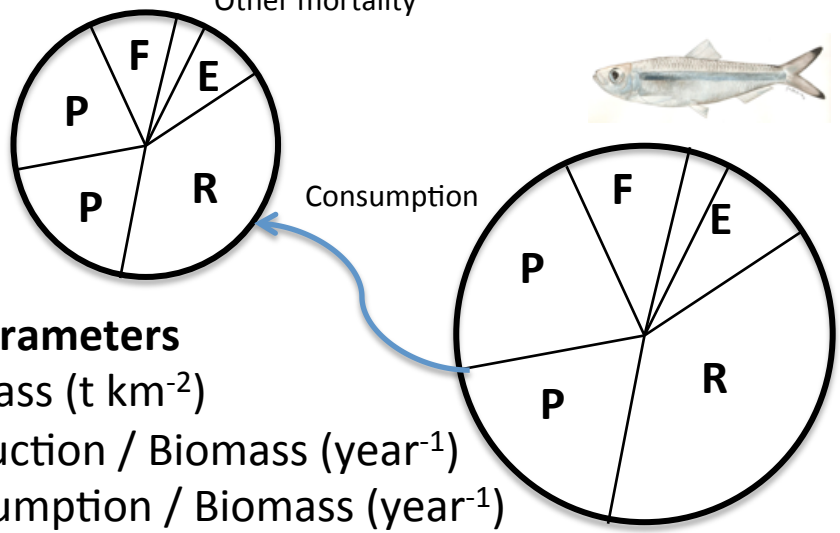
How does this system function?

- Mass balance models (*Ecopath with Ecosim*, EwE)
- Why? - easily comparable with other mangrove and coastal ecosystem models



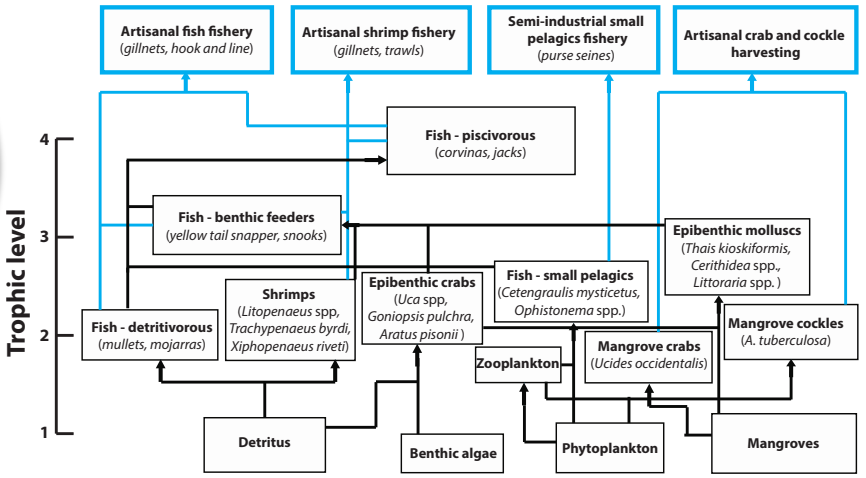
Production = **P**redation + **F**ishery + Biomass accumulation
+ net migration + other mortality (Eq 1)

Consumption = **P**roduction + unassimilated food + **R**espiration (Eq 2)



Input parameters

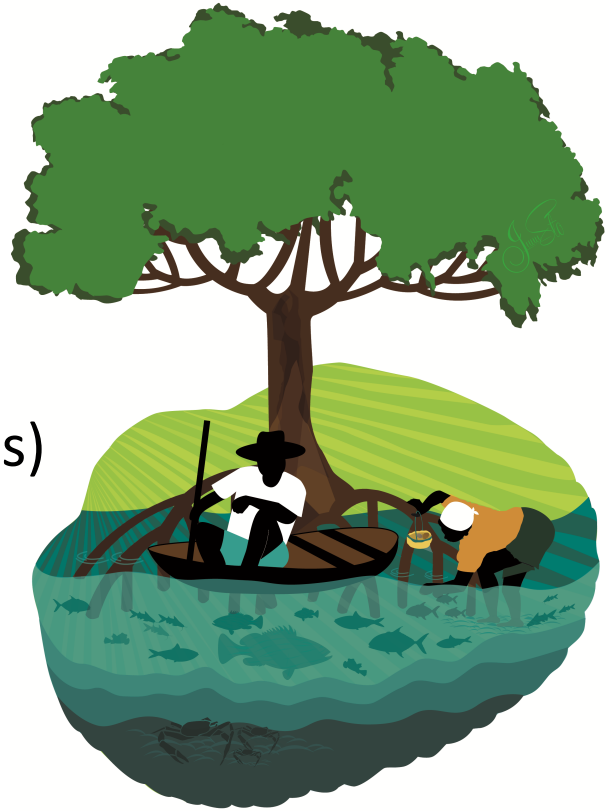
- Biomass (t km^{-2})
- Production / Biomass (year^{-1})
- Consumption / Biomass (year^{-1})
- Ecotrophic efficiency (proportion)
- Diets (proportions)
- Catches (t km^{-2} year^{-1})

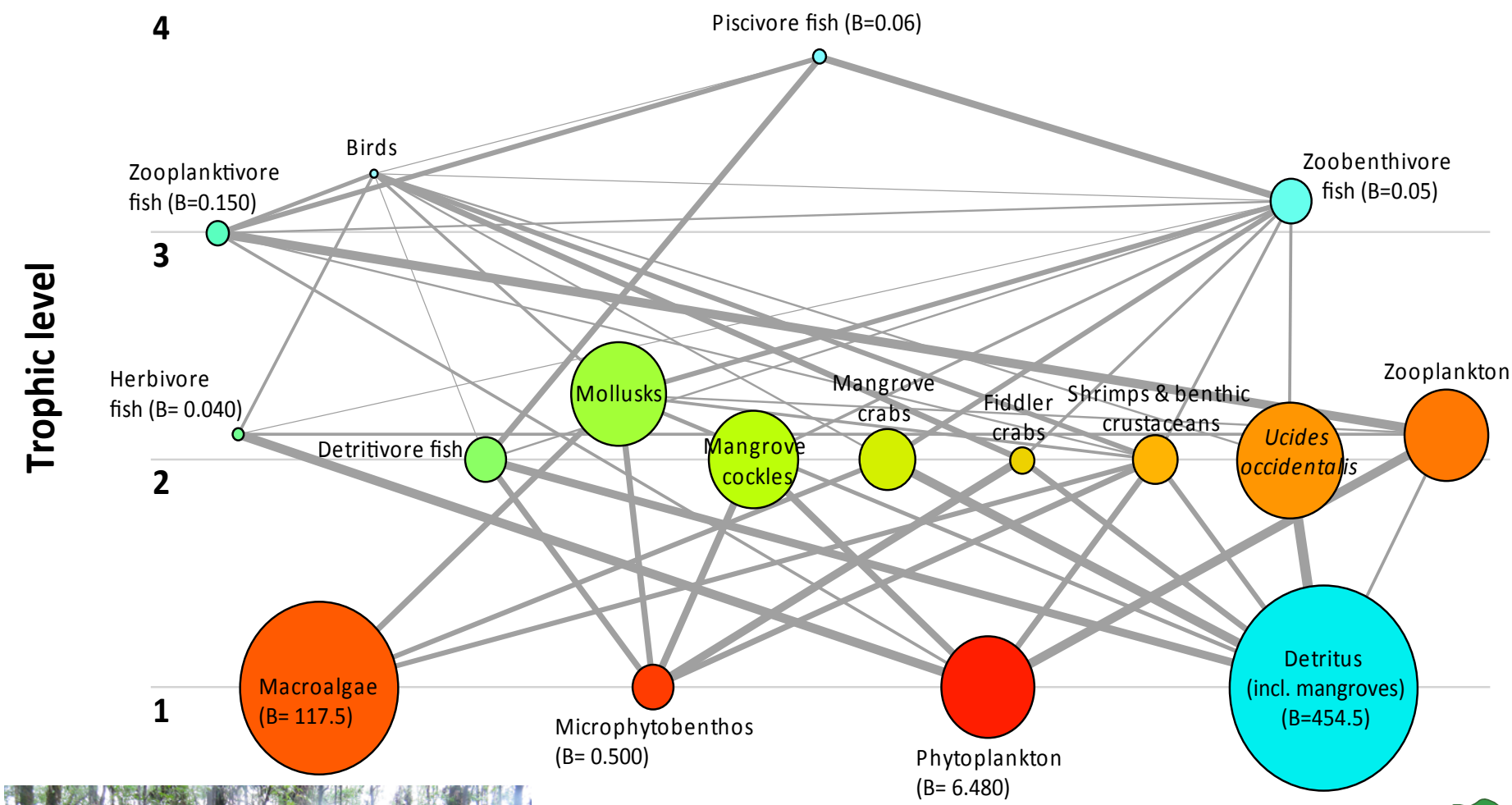


Christensen & Walters (2004) *Ecological Modelling*

The Bahía Málaga Ecopath Model

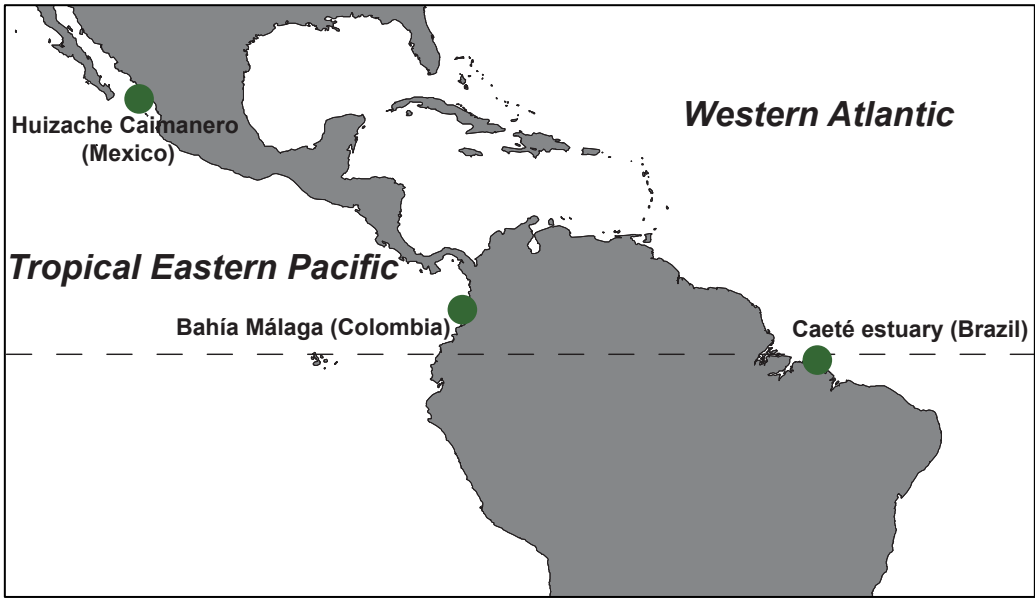
- 17 functional groups
- Detritus group includes mangrove litter fall
- Three primary producers
- 12 consumer groups
- Two main fisheries:
  - Mangrove cockles
  - Finfish (mainly detritivores and zoobenthivores)
  - *Ucides occidentalis* rarely exploited
- Most biomass concentrated in detritus and macroalgae (94%)
- Extremely low macrobenthic (e.g. fiddler crabs) and fish biomass




Trophic level
4
3
2
1
Piscivore fish (B=0.06)
Birds
Zooplanktivore fish (B=0.150)
Zoobenthivore fish (B=0.05)
Herbivore fish (B= 0.040)
Detritivore fish
Mollusks
Mangrove cockles
Mangrove crabs
Fiddler crabs
Shrimps & benthic crustaceans
Ucides occidentalis
Zooplankton
Macroalgae (B= 117.5)
Microphytobenthos (B= 0.500)
Phytoplankton (B= 6.480)
Detritus (incl. mangroves) (B=454.5)

Comparison to other models in the Neotropics

- At least three more Ecopath mangrove models:
  - Caeté estuary (Wolff et al. 2000)
  - Huizache-Caimanero (Zetina-Rejon et al. 2003)
  - Gulf of Nicoya (Wolff et al. 1998)
  - Celestun Lagoon (Vega-Cendejas & Arreguin-Sanchez 2001)



Parameter	Bahía Málaga, Colombia	Caeté estuary, Brazil	Huizache Caimanero, Mexico
Functional groups	17	20	26
Mean trophic level of the catch	2.16	2.08	2.5
Total system biomass (t km^{-2})	155.4	13132.2	486.33
Total system throughput (t km^{-2} yr^{-1})	6490	10559	6658

Outlook

- A very rainy area with high above-ground mangrove biomass does not necessarily translates into a high productivity ecosystem
- Other factors (e.g. salinity) may play important roles determining mangrove system productivity
- Existing EwE mangrove models in the Neotropics can provide insights about generalities in the functioning of these ecosystems
- Further EwE simulations will look at the ecosystem-level effects of projected changes in these mangroves (increased fishing pressure, ENSO)

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Thanks!

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