

Marine Conservation and Fishing Effort Markets¹

NCEAS-Future Earth Working Group

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¹This is work in progress developed for the NCEAS working group. Please do not share externally. Results are yet to be refined and peer-reviewed.

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Outline

- Background and motivation
- Scope of the project
- Approach
 - Model and assumptions
 - Phoenix Island Protected Area*
- Generalizability to Palau

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Background and motivation

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Motivation

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Motivation

Effort displacement by large-scale MPAs

- Where was effort displaced to?
- Does effort displacement imply revenue losses from VDS?
- Does a 30% closure mean a 30% loss in revenue?

Scope and Approach

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Scope

Can economic instruments incentivize conservation?

- For the countries:
 - What are the costs associated to establishing an MPA?
 - What factors drive these costs?
 - Can these costs be reduced or eliminated?
- For the fishing vessels:
 - How do they respond?
 - Where do they go?

Approach

- 10-patch model of the tuna purse-seine fishery
 - 9 patches under VDS
 - one patch under Open Access
- Profits from fishing in patch i are:

$$\Pi_i(E_i, X_i, R) = pqE_iX_i\Omega_i - cE_i^\beta$$

$$\Omega_1 = \theta + (1 - \theta)(1 - R)$$

- Vessel-day price must equate the marginal profits from the last unit of effort in patches $i = (1, 9)$

$$\pi_i(E_i) = pqX_i\Omega_i - \beta cE_i^{\beta-1}$$

Approach

- Patch-level effort is then

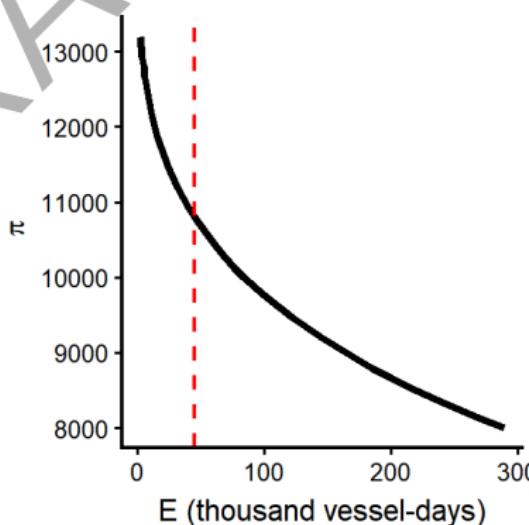
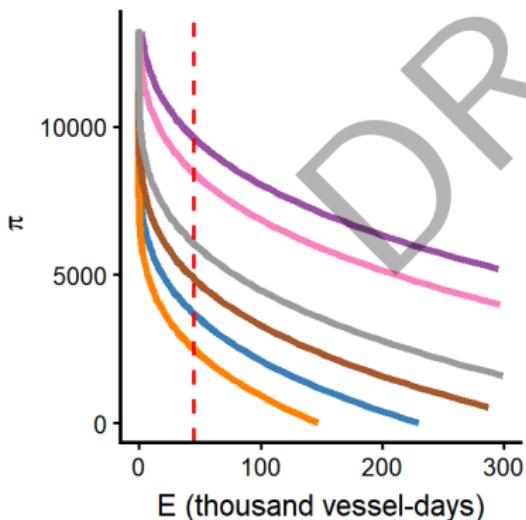
$$E_i = \left(\frac{pq\chi_i\Omega_i - \pi_i}{\beta c} \right)^{\frac{1}{\beta-1}}$$

- Effort is capped at 45,000 vessel-days (\bar{E})

$$\bar{E} = \sum_{i=1}^9 \left(\frac{pq\chi_i\Omega_i - \pi_i}{\beta c} \right)^{\frac{1}{\beta-1}}$$

Approach

- Measure country-level demand curves
 - No trading: price is patch-specific
 - Trading: price is the same for all patches



Model predictions

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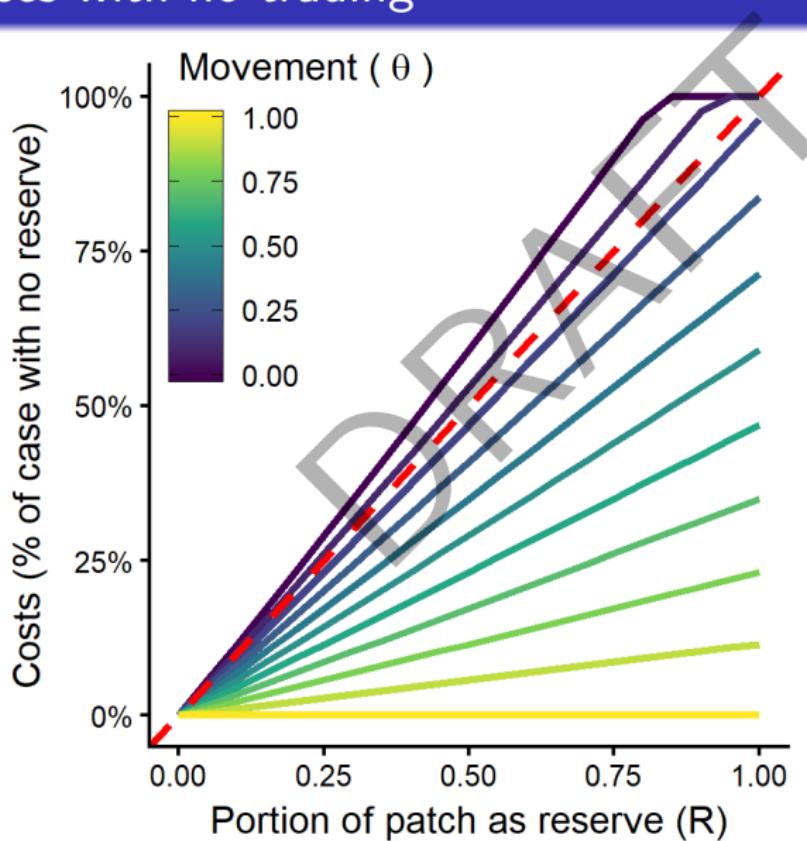
Model predictions

Relationship between closure size and losses

Does a 30% closure mean a 30% loss in revenue?

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Losses with no trading

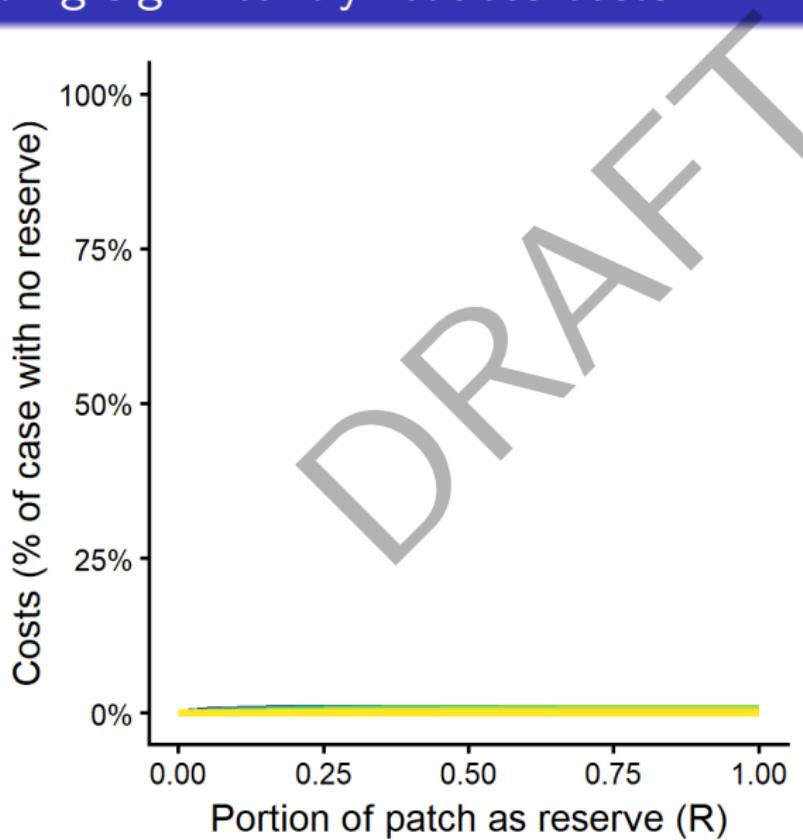


Model predictions

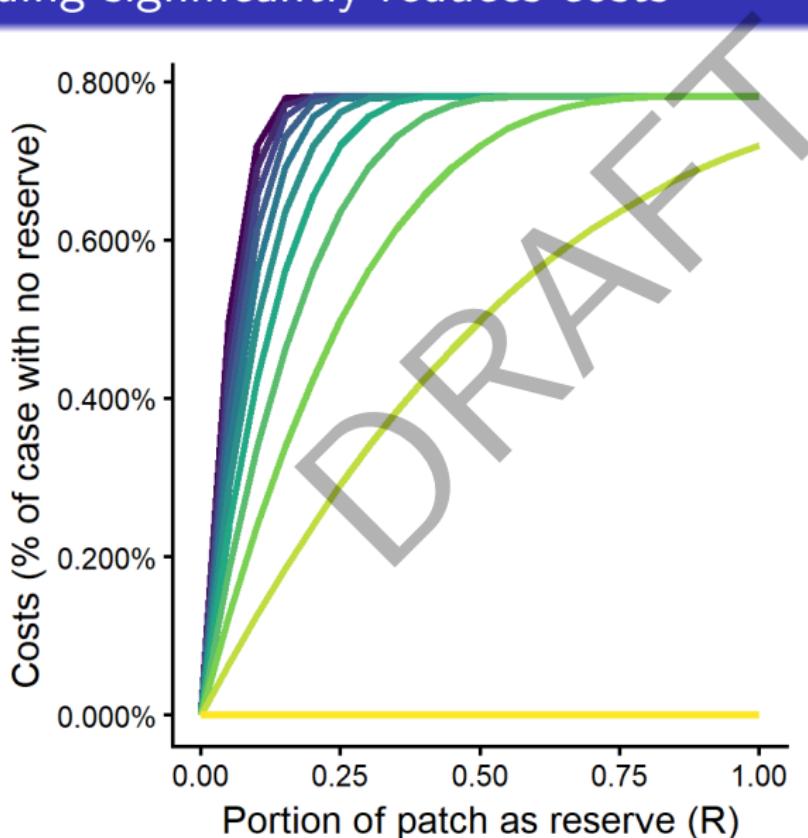
A market for fishing efforts

- What is the effect of trading?
- Can costs be reduced?

Trading significantly reduces costs



Trading significantly reduces costs



Allocation rules matter

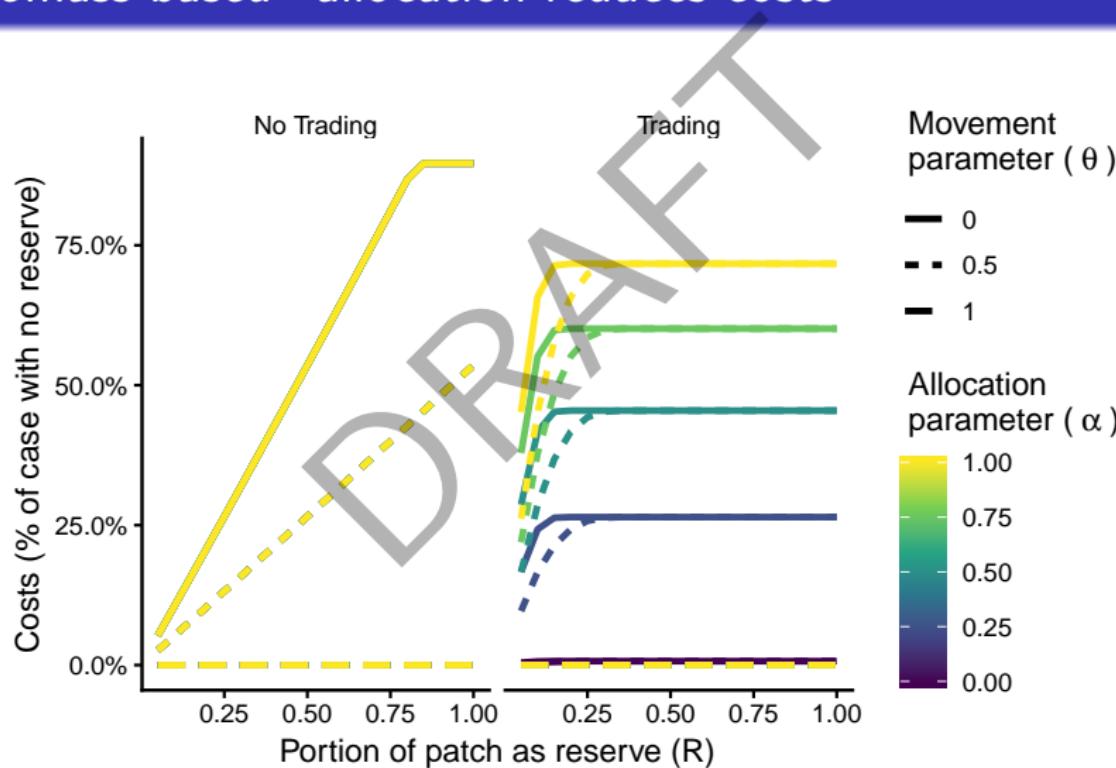
- Vessel-days are allocated to countries each year
- Combination of biomass and in-EEZ usage

$$E_i^* = \alpha \left(\frac{\sum_{\tau=0}^{\hat{\tau}} E_{i,t-\tau}}{\bar{E}^{\hat{\tau}}} \right) + (1 - \alpha) \left(\frac{\sum_{\tau=0}^{\hat{\tau}} X_{i,t-\tau}}{\bar{X}^{\hat{\tau}}} \right)$$

- α is a weight on historical effort (E_i) and historical biomass (B_i)

What is the importance of allocation rules?

“Biomass-based” allocation reduces costs



Generalizability to Palau

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Palau Vessel-day schemes

- Purse seine vessel-days
 - 700 purse seine vessel-days
 - \$5.60 - \$8.75 Million USD
 - Tradable
 - Trading might reduce costs, but allocation rules matter
- Longline vessel-days
 - 10,500 longline vessel-days
 - \$2.10 Million USD
 - Non-tradable

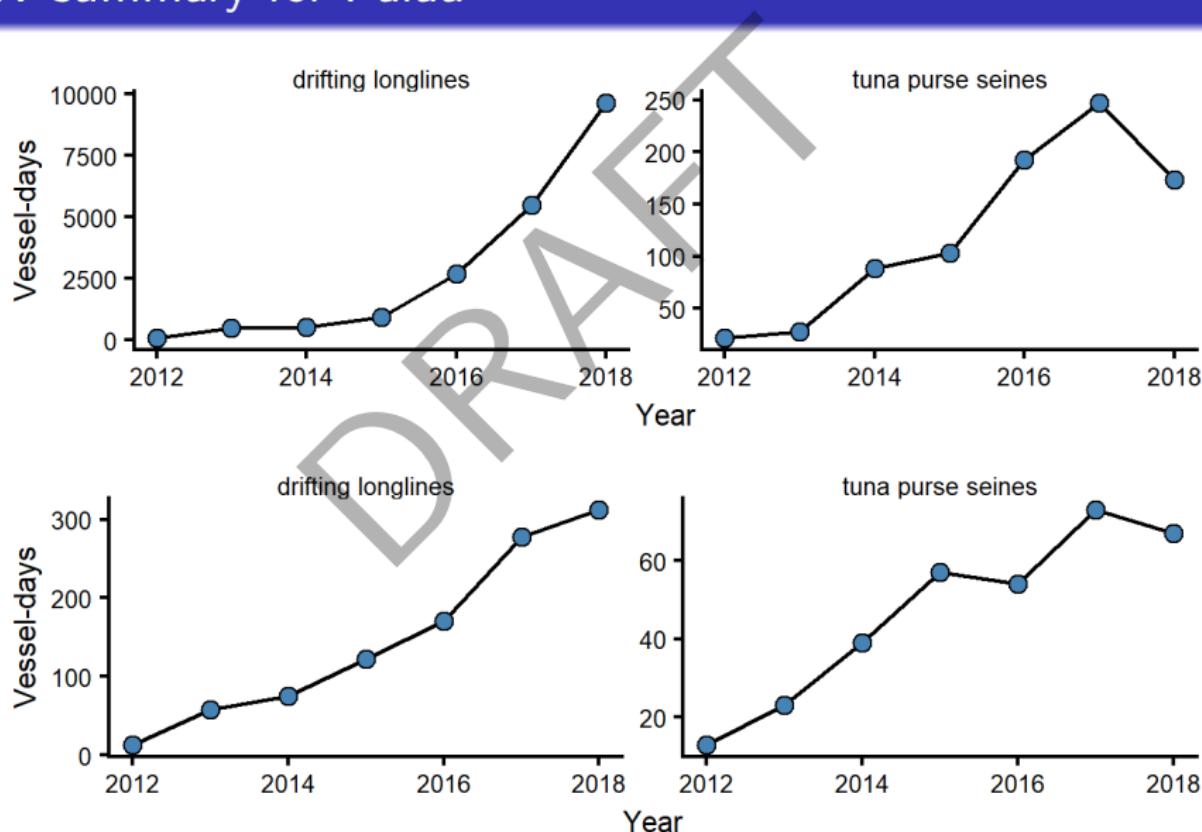
Conclusions

- Under no trading, implementing a reserve is costly
 - More fish movement reduces costs
- Trading lessens the blow of a spatial closure
 - % costs avoided by trading decrease as biomass in implementing patch increases
- Allocation rules matter
 - A biomass-based allocation ($\alpha = 0$) reduces long-term costs



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GFW summary for Palau



What can we learn from PIPA?

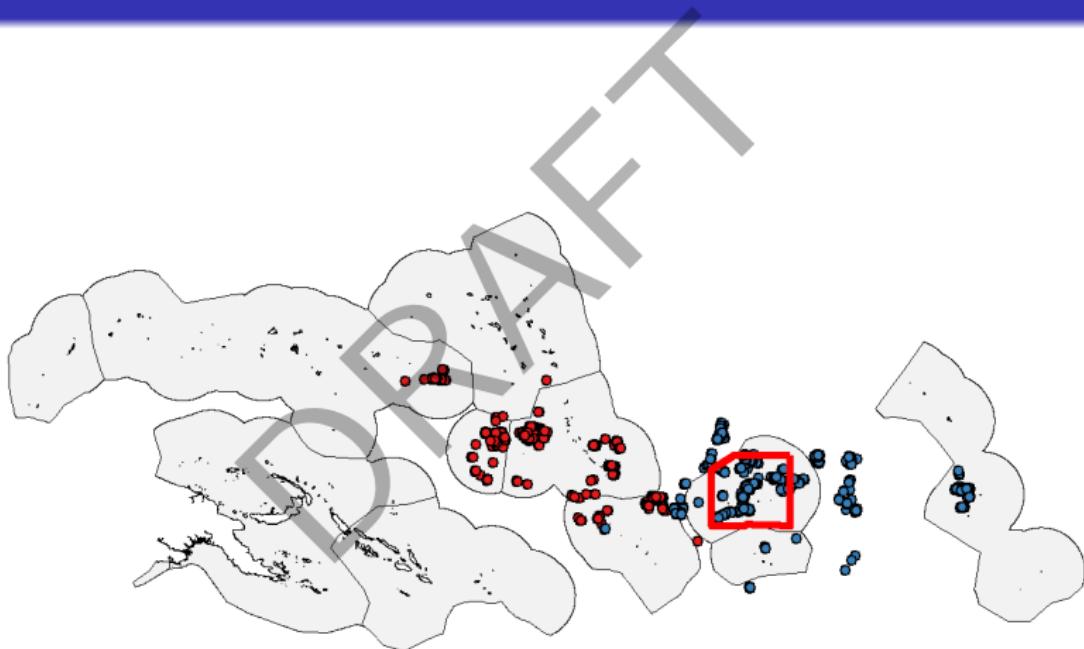
PIPA:

- Implemented in January, 2015
- 397,447 Km²
- 2.7% of total PNA area
- 11% of Kiribati EEZ
- 22% of Kiribati EEZ (excluding Line Islands)

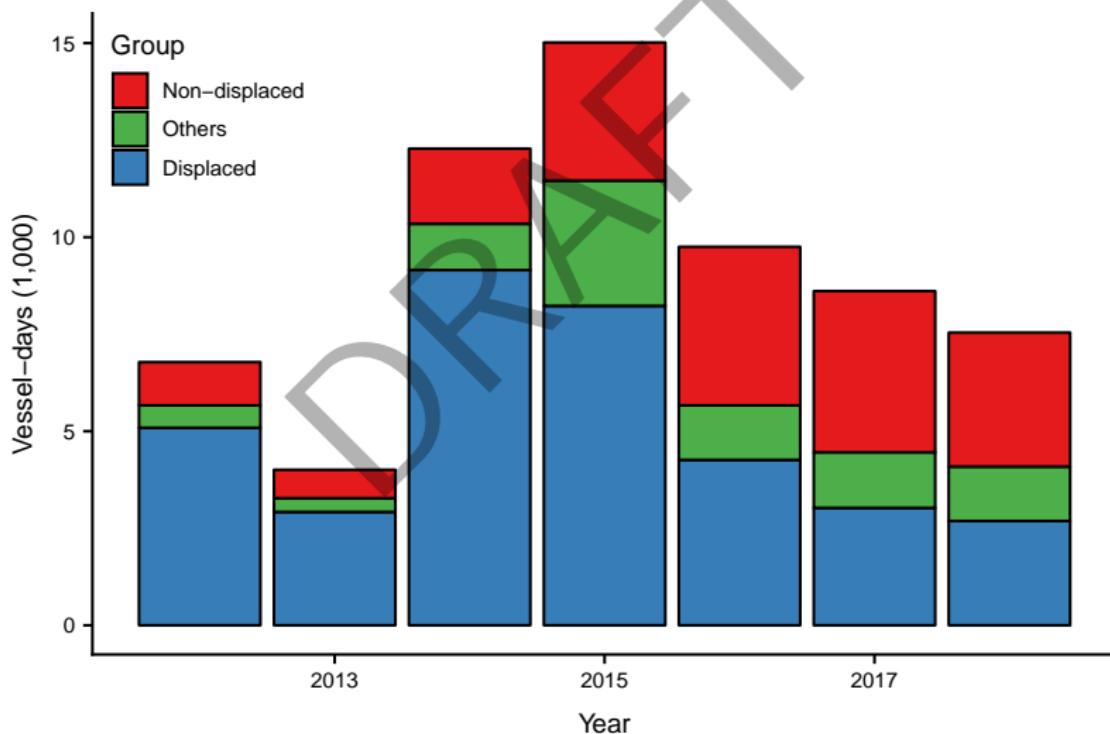
GFW data:

- 313 tuna purse seine vessels that fished in PNA
- 92 Fished both before and after PIPA implementation:
 - 64 Fished within PIPA before implementation
- 2012 - Present

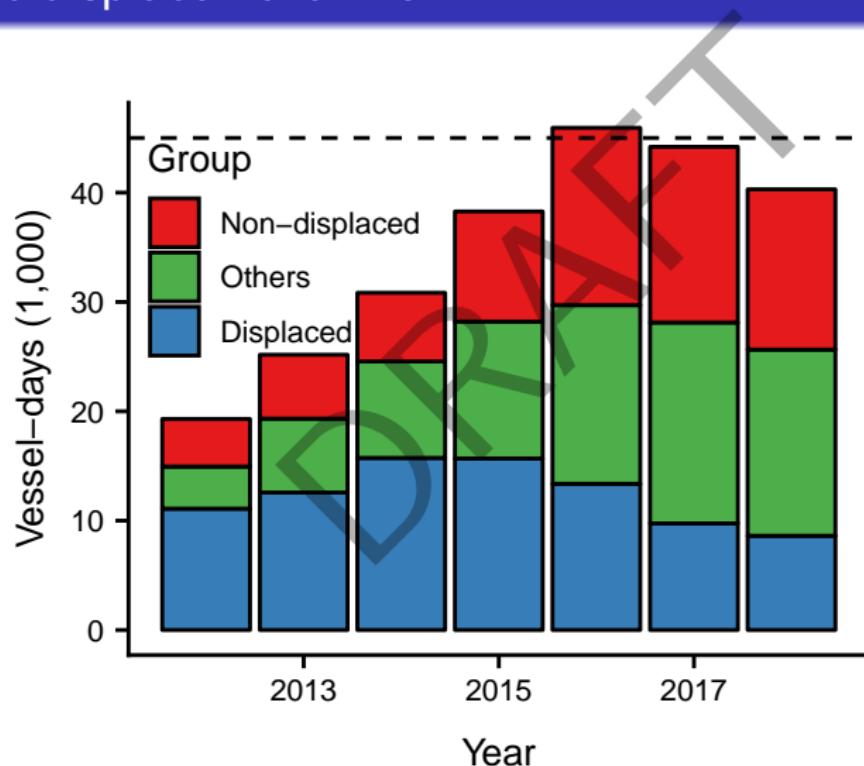
Two “fleets”



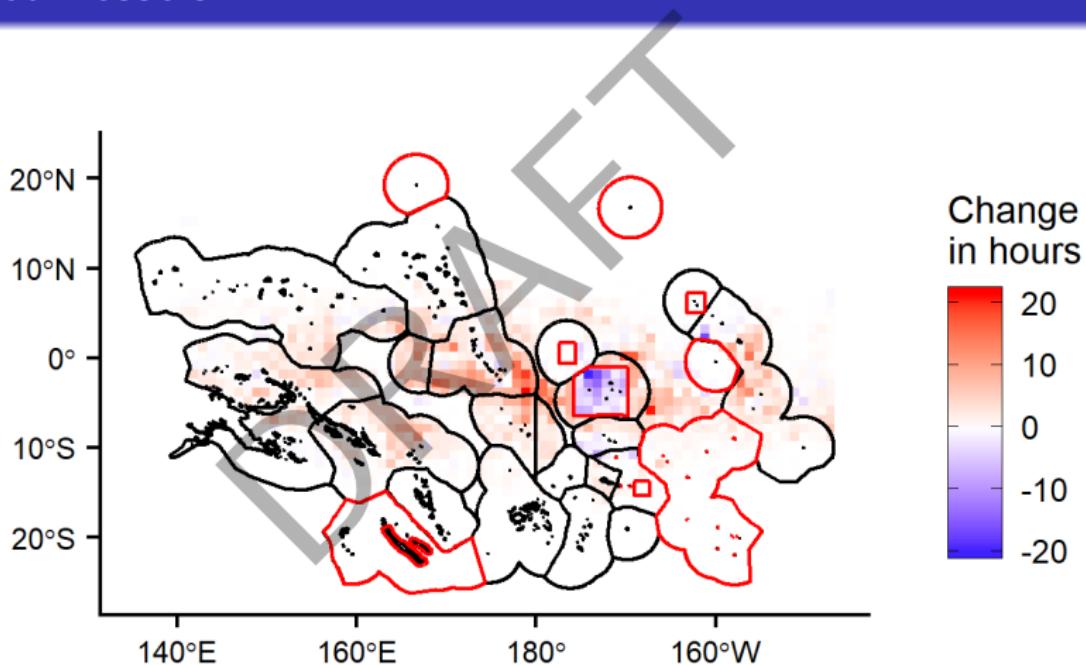
Effort displacement in Kiribati



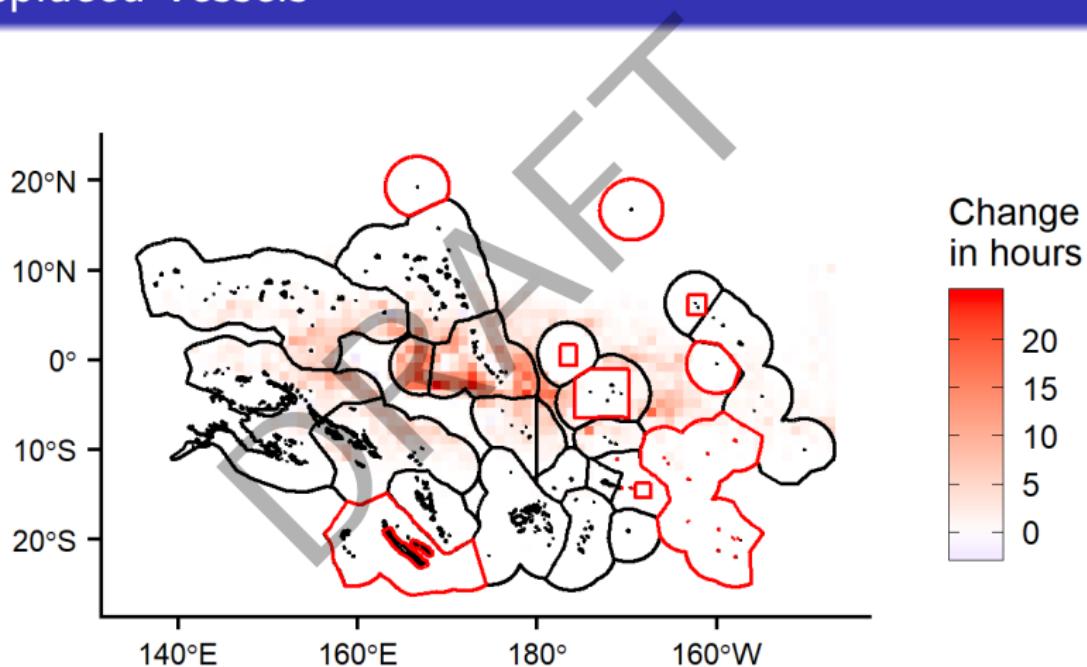
Effort displacement in all PNA



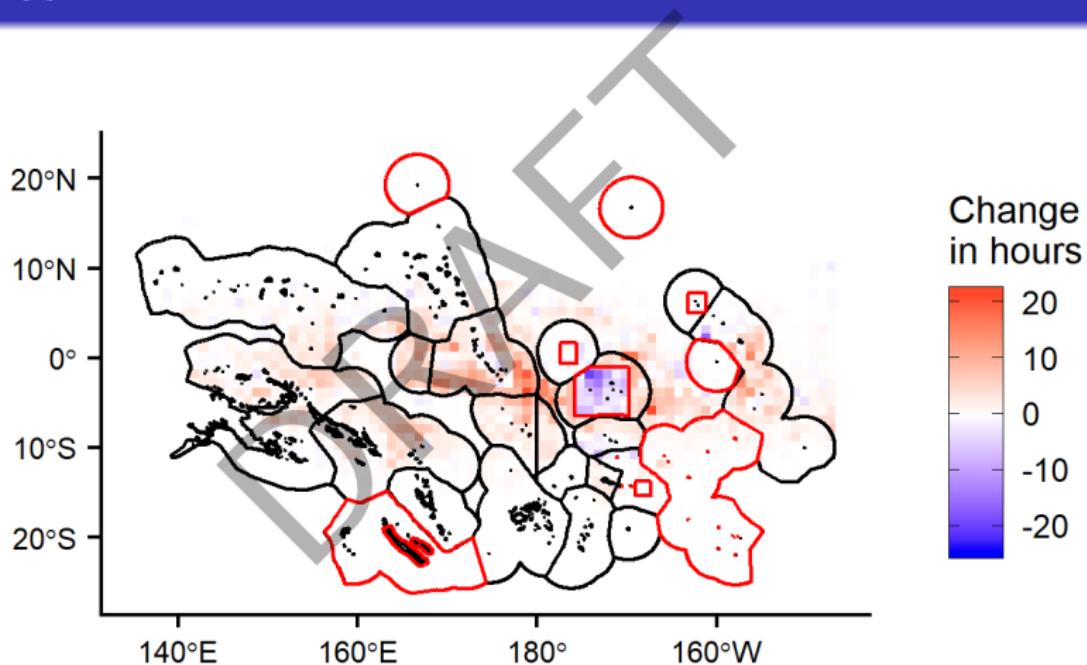
Displaced vessels



Non-displaced vessels

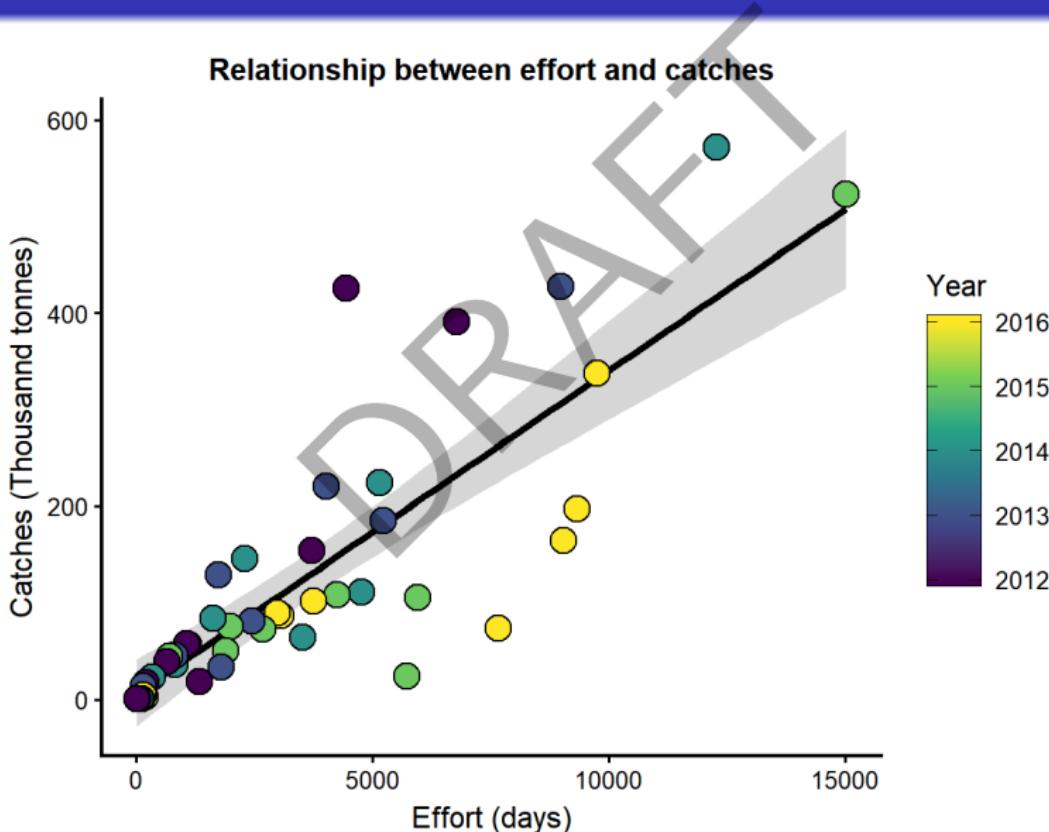


Difference





Effort vs catches



Effort and revenues

