Marine conservation efforts and their effects on industrial fishing activity

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EfD Annual Meeting 2022

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Motivation

FAO (2020)

More than three billion people dependent on marine resources.

- 38.98 million people in the world depend for work on fishing.
- Fish consumption equivalent to 20.3 Kg/year per person.
  - The fish trade is estimated at 164 billion dollars (2018).
  - 11% of total trade in agricultural products.
- Additionally, 30% of the carbon sequestration is given by the oceans.

However, overexploitation of marine resources puts the sustainability of ecosystems at risk.

- 34.6% of fishing is done outside of sustainability standards.
- The cost of overexploitation is estimated at 32 billion dollars.

Motivation

WDPA (2020)

- Marine Protected Areas (MPAs) are a widely used control tool for fishing overexploitation around the world. **Nevertheless, what we know about its effectiveness is limited.**
- A Marine Protected Area is an area with geographical delimitation within which limits are imposed on environmental exploitation activities. **About 7% of the oceans are protected.** ◂ Table
- Industrial/commercial fishing is prohibited in all MPAs. No comply with the regulations imposed on the MPAs generates fines and sanctions in case of being caught.
- The greater restriction designation, according to the categories of MPAs, necessarily implies a greater commitment to monitoring and control.
- Although the delimitation of the MPAs is not physically visible, it is known to the vessels through the geographic location systems.

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Research question

Are industrial fishing vessels deterred by marine protected areas?

- I evaluate the effect of Marine Protected Areas as control instruments on industrial fishing activity.
- I use a non-parametric spatial RD identification strategy. Exploiting the spatial discontinuity of the MPA boundary and the variation of the distance to it.

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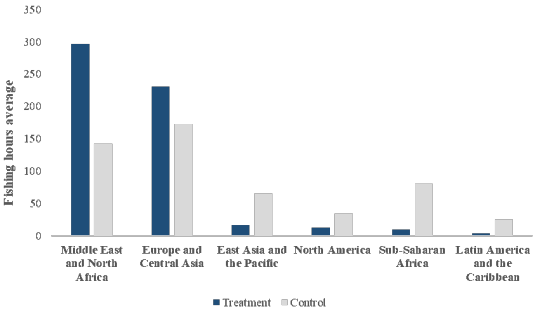
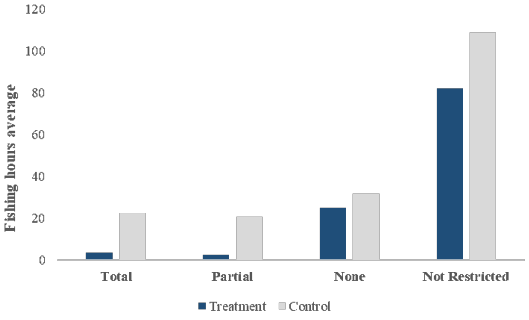
Fishing is still detected within the MPAs

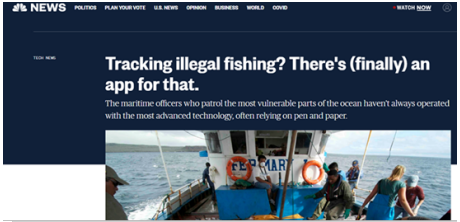


(a)



(b)

The role of monitoring



New Internationalist

HOW TO FIGHT ILLEGAL FISHING

26 September 2019

Can fishers, coastguards and marine activists see off the thieves from powerful nations plundering the seas of West Africa? **Aida Grovestins** reports.

On the shore of the Liberian fishing town, Robertsport, Wilson Weah prepares his narrow wooden canoe for a night's fishing. Pointing out to the sea, he comments: 'We used to see big trawlers on the horizon, emptying the ocean and cutting through our nets, but since our coastguard started inspections at sea we catch more fish again.'

Contribution

What do I find?

- On average, industrial fishing efforts have been reduced within MPAs by 30.5% of the total fishing hours per km^2 that were carried out in the world between 2016 - 2020.
- Fishing efforts have been reduced primarily in those protected areas with a stricter protection designation.
- **I find evidence of a strategic behavior of the vessels around the border of the MPAs.**

I contribute to the literature on the effectiveness of environmental policy instruments in the maritime sector.

- I identify causal effects of MPAs on the behavior of industrial fishing activity at a global level (Ahmadia et al., 2015; Gill et al., 2017; Harasti et al.; 2019, Davis and Harasti, 2020).
- I provide greater representativeness (Number of MPAs) in the evaluation of the effectiveness of the MPAs.

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Data

Fishing Activity ▸ Scheme

- Global Fishing Watch: Automatic Identification System (AIS) and Vessel Monitoring Systems (VMS) (Englander, 2019; Kroodsma et al., 2018).
  - It is measured in number of hours of fishing activity with a resolution of 0.1 degrees.
  - The fishing activity that is captured is **industrial** at a global level.
  - It is used for the years 2016 - 2020.

Marine Protected Areas ▸ Map

- World Database Protected Areas: Contains information on the characteristics of the MPAs in the world.
  - 434 marine protected areas
  - 47 (total protection), 60 (Partial protection), 49 (multipurpose) y 278 (Not Reported).
  - On average, MPAs are 28 years old.

Global Fishing Watch: Monitoring System

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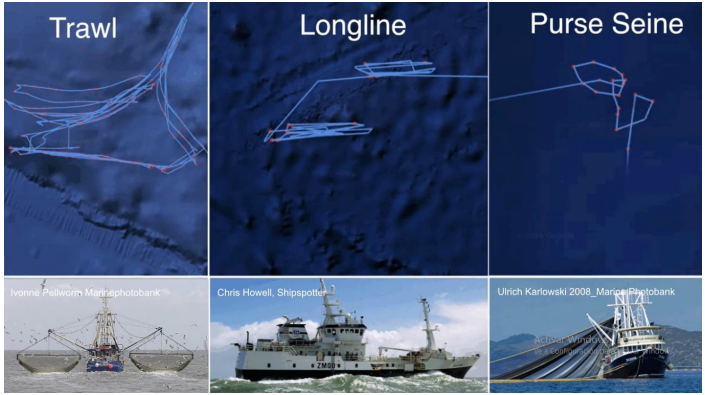
Global Fishing Watch: Monitoring System



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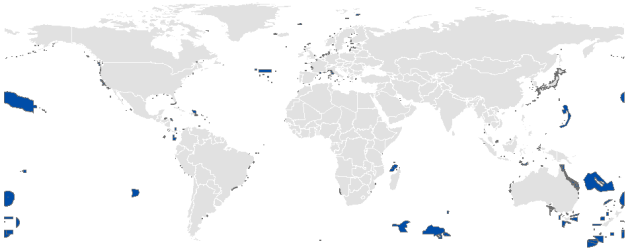
Conservation and fishing efforts



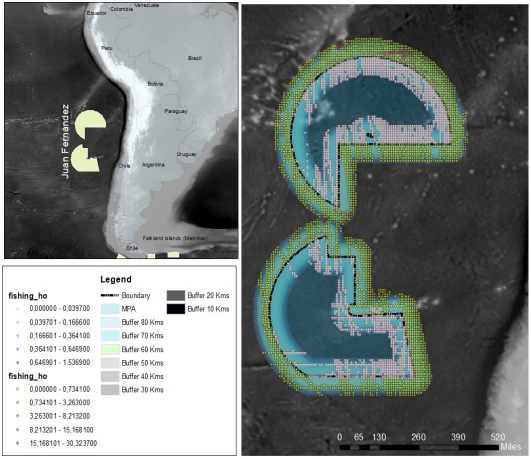


Figure 2: Assignment of treatment and control

Empirical Framework

Spatial Regression discontinuity (Calonico et al., 2014)

$$Y_{ji} = \alpha + \tau_{RD_0} D_{ji} + \sum_{k=1}^{k} \beta_k X_{ji}^k + D_{ji} \sum_{k=1}^{k} \gamma_k X_{ji}^k + \Gamma_{ji} + \theta_j + \mu_{ji} \quad (1)$$

Where Y_{ji} denotes the fishing effort, measured by the number of hours of activity, at a given pixel, denoted by i, at MPA j. D_{ji} is an indicative variable that takes the value of 1 if the observation is inside the MPA or 0 if it is outside. The variable X_{ji} indicates the minimum distance to the MPA border by the cells. Controls such as depth, distance to the coast and phytoplankton concentration Γ_{ji} are included, and it is also controlled by a polynomial of order k of the distance to the MPA border. Finally, fixed effects per MPA and region θ_j are added.

The parameter of interest is τ_{RD_0} which captures the total average effect of MPAs on the number of hours of fishing activity in the period 2016 - 2020.

Identification

Assumptions

- Discontinuity of the variable of interest (Y_i).
- **Continuity of covariates at the cutoff point** (Canay & Kamat, 2018).
  - Depth
  - Phytoplankton concentration
  - Distance to the coast

▸ Permutation test ▸ Figures

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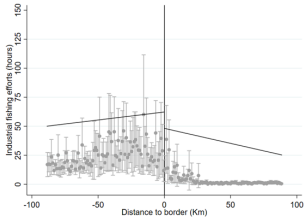
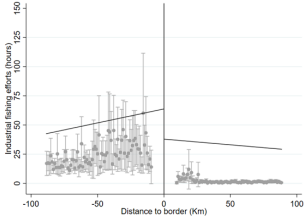
Effects of marine protected areas on industrial fishing activity

Average effect of marine protected areas



All obs.



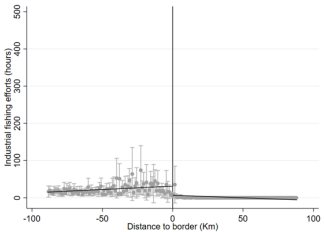
Donut hole

	All Obs.		Donut Hole	
	Optimal (1)	80kms (2)	Optimal (3)	80kms (4)
MPAs	0.26	-7.69**	-10.8**	-14.9***
	(5.73)	(3.19)	(4.30)	(3.42)
Mean (Yi)	27.2	23.8	26.8	23.9
Bandwidth	26.05	80	61.09	80
% of mean	0.9	32.3	40.3	62.3
Observations	39673	39673	35263	35263

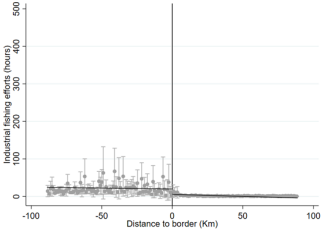
▸ Robustness checks

Effects of marine protected areas on industrial fishing activity

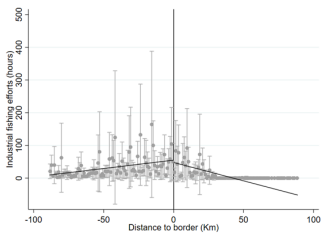
Restriction levels and conservation objectives



Total



Partial



None

	Total Restriction (1)	Partial Restriction (2)	No Restriction (3)	Not Reported (4)
MPAs	-13.22***	-10.46***	11.98	85.42***
	(5.05)	(3.20)	(23.28)	(19.9)
Mean (Yi)	23.1	21.33	31.56	110.6
Bandwidth	80	80	80	80
% of mean	57.2	49	37.9	77.2
Observations	11654	23491	4528	39764

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Discussion

1. On average, industrial fishing efforts have been reduced within MPAs in 94.796 hours, which represents a reduction of 30.5% of the total fishing hours per km^2 that were carried out in the world between 2016 - 2020.
2. I find evidence that the greater restriction reported, the greater reductions will be obtained.
3. The results seem to indicate that the lack of clarity in the designation of the MPAs generates incentives to not comply with the regulations of the MPAs. (Gill et al., 2017).
4. As a result of the lack of clarity, I find evidence of a local effect on the border that suggests a negative use by vessels of the *spillover* generated by MPAs.

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Coverage of Marine Protected Areas

Table A1: Coverage of marine protected areas 2010 - 2020

	2010		2020	
	No.	*Coverage (km^2)*	*No.*	*Coverage (km^2)*
A. Regions				
East Asia and the Pacific	99	1.432.023	153	3.021.285
Europe and Central Asia	81	76.043	115	215.248
Latin America and the Caribbean	42	279.514	47	331.012
Middle East and North Africa	4	560	5	1124
North America	57	1.949.358	70	1.953.872
Sub-Saharan Africa	9	16.718	9	16.718
B. Protection Designation *"No Take"*				
Total (%)	31	725.479 (100%)	47	725.118 (100%)
Partial (%)	54	1.317.552 (46.8%)	60	1.377.580 (32.8%)
None	34	312.250 (0%)	42	347.782 (0%)
Not Reported	187	1.497.332 (0%)	264	1.815.278 (0%)
Total	316	5.356.191	434	7.213.431

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Identification

Table A2: Continuous distribution of baseline ocean characteristics at MPAs borders by "*no-take*" restriction level

	Treatment		Control		Permutation test	
	Mean	Standard Deviation	Media	Standard Deviation	t-Test	p-value
A. Total						
Depth (m)	-2789	1913	-1223	1641	0.01	0.8
Phytoplankton Concentration Index	144.03	37.24	136.4	47.65	0.05	0.22
Distance to the coast (km)	367	300.8	155.9	250.7	0.02	0.57
B. Partial						
Depth (m)	-3443	1629	-3110	1861	0.27	0.00***
Phytoplankton Concentration Index	124.6	54.6	124.9	52.44	0.05	0.18
Distance to the coast (km)	483.8	417.8	442.6	401.6	0.03	0.34
C. None						
Depth (m)	-3484	2736	-2114	2229	0.09	0.06
Phytoplankton Concentration Index	123.3	60.46	141.8	52.91	0.06	0.12
Distance to the coast (km)	284.6	254	140.8	170.9	0.13	0.02**
D. Not Reported						
Depth (m)	-2316	2127	-1360	1507	0.16	0.00***
Phytoplankton Concentration Index	124.1	48.86	132.6	51.93	0.14	0.01**
Distance to the coast (km)	277.1	266.7	144.4	206.6	0.34	0.00***

Source: Own calculations with NOAA database. Note: * p<.10, * p<.05, ** p<.01. The first two columns present the descriptive statistics of the observations within the 88 km buffer around the border of the MPAs. The last two columns show the results of the continuous distribution test of the covariates proposed by Canay & Kamat (2018) with 1,000 permutations. The null hypothesis is that there is continuity of the baseline covariates at the cutoff point.

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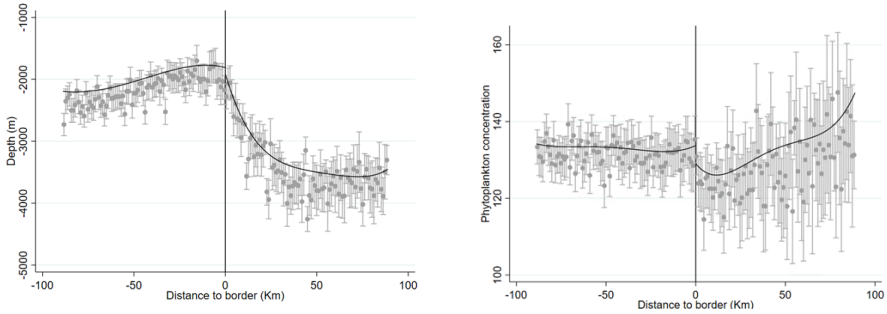
Identification



(a) (b)

Figure A1: Depth and productivity in MPAs. Note: Observations are clustered at 1-km intervals and smoothed with a covariate-adjusted linear polynomial. The observations to the left of the cut-off point are those that are outside the protected area, while those to the right are those that are inside. The bars represent the confidence intervals at the 95% confidence level. Panel (a) Depth, and (b) Phytoplankton concentration.

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Robustness check

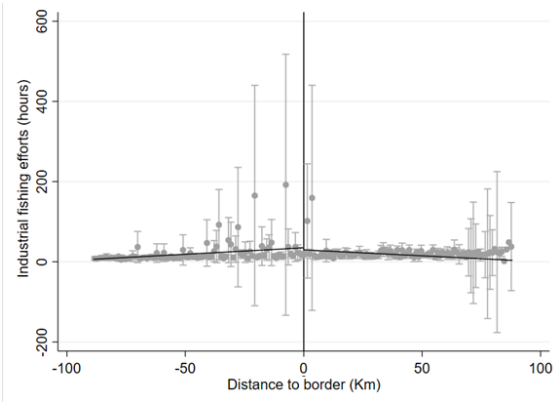

Figure A2: Effects of MPAs on fishing effort for MPAs created in 2020. Note: Placebo test for pre-treatment. Observations are clustered at 1-km intervals and smoothed with a covariate-adjusted linear polynomial. The observations to the left of the cut-off point are those that are outside the protected area, while those to the right are those that are inside. The bars represent the confidence intervals at the 95% confidence level.

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