

# A Framework to Understand Interactions between Large- and Small-Scale Fisheries

Collaborative project between Duke, IHH, Global Fishing Watch, and Conservation International

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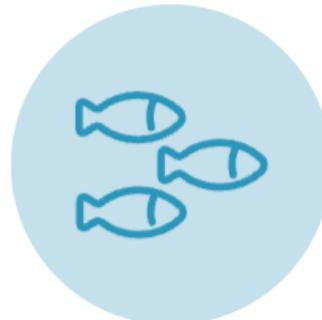
Workshop with University of Liberia, 10.23.23

# Small-scale fisheries provide benefits for:



LIVELIHOODS

- 492 million people at least partially dependent on SSFs
- 90% of capture fisheries employment



FOOD

- 37 million tonnes of catch
- 40% of global fisheries catch



WOMEN

- 44 million women participate in SSFs
- 4 in 10 people in SSF are women

# Large-scale fisheries may operate in small-scale fishing areas



# Harmful interactions between LSF and SSF anecdotally reported

## GULF OF GUINEA: artisanal fishermen accuse trawlers of IUU fishing

By Boris Ngounou - Published on July 5 2023 / Modified on July 5 2023

### The African Coastline Is a Battleground for Foreign Fleets and Artisanal Fishers

It's illegal and dangerous for industrial boats to encroach on fishing zones reserved for local communities.

Evidence of spatial competition, over  
resource scarcity, as a primary driver of  
conflicts between small-scale and industrial  
fishers

<https://doi.org/10.5751/ES-13650-280106>

Conflicts at sea between artisanal and industrial fishers: Inter-sectoral interactions and dispute resolution in Senegal

Jean DuBois  , Christos Zografos 

Fishing groups in West Africa, Latin America fighting back against Chinese incursions

By Mark Godfrey  
November 20, 2020

SHARE    

Mongabay Series: [Sea Change](#)

### Illegal industrial fishing hampers small-scale African fisheries

by John Cannon on 3 February 2020

# Project questions

**1. What kinds of LSF-SSF interaction occur, and what are documented impacts in the literature?**

- Conceptual framework of LSF-SSF interactions based on literature review

**2. Where are probable interactions?**

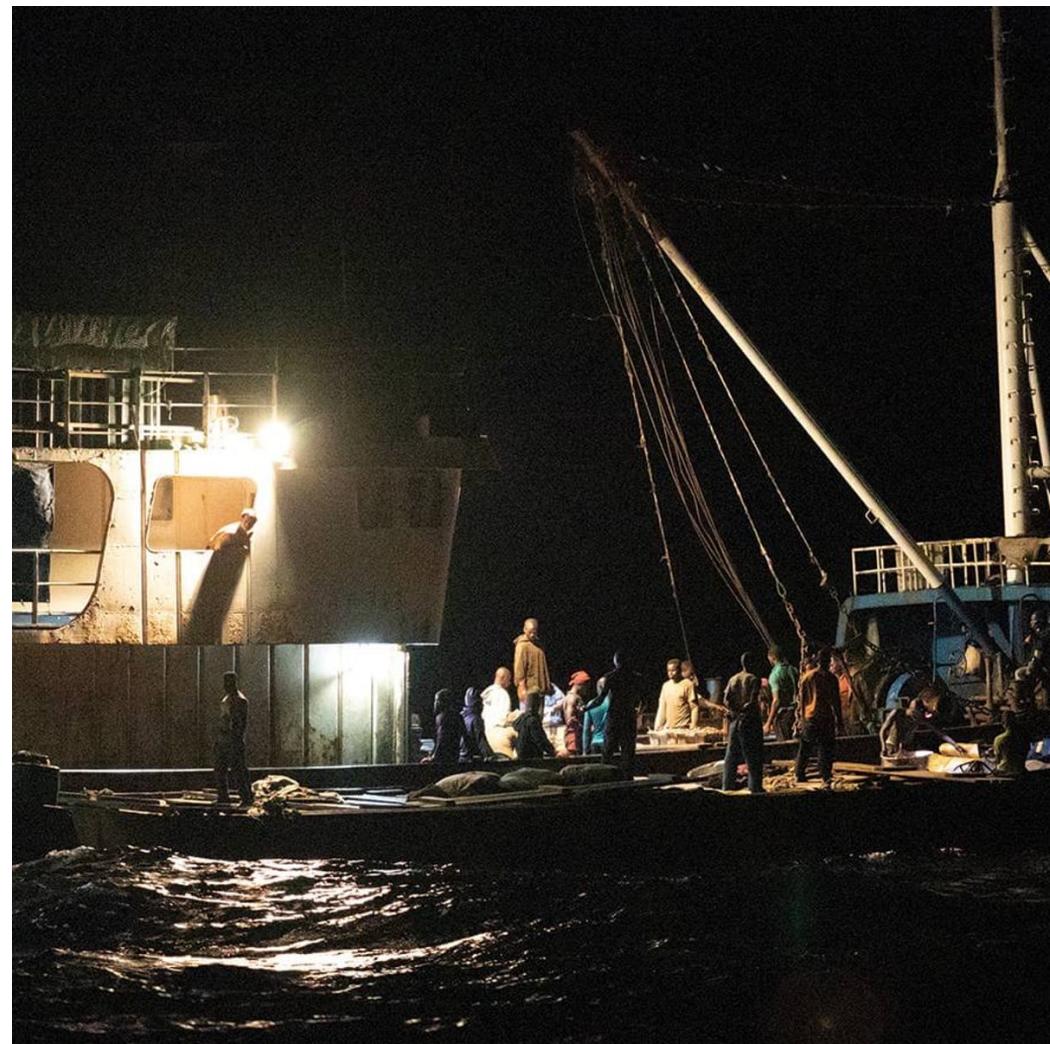
- Global vulnerability assessment using IHH and GFW data
- For IHH countries with geo-referenced fishery locations, mapping focal case studies and conduct point-density analysis to LSF activity

# Where are interactions likely to occur?

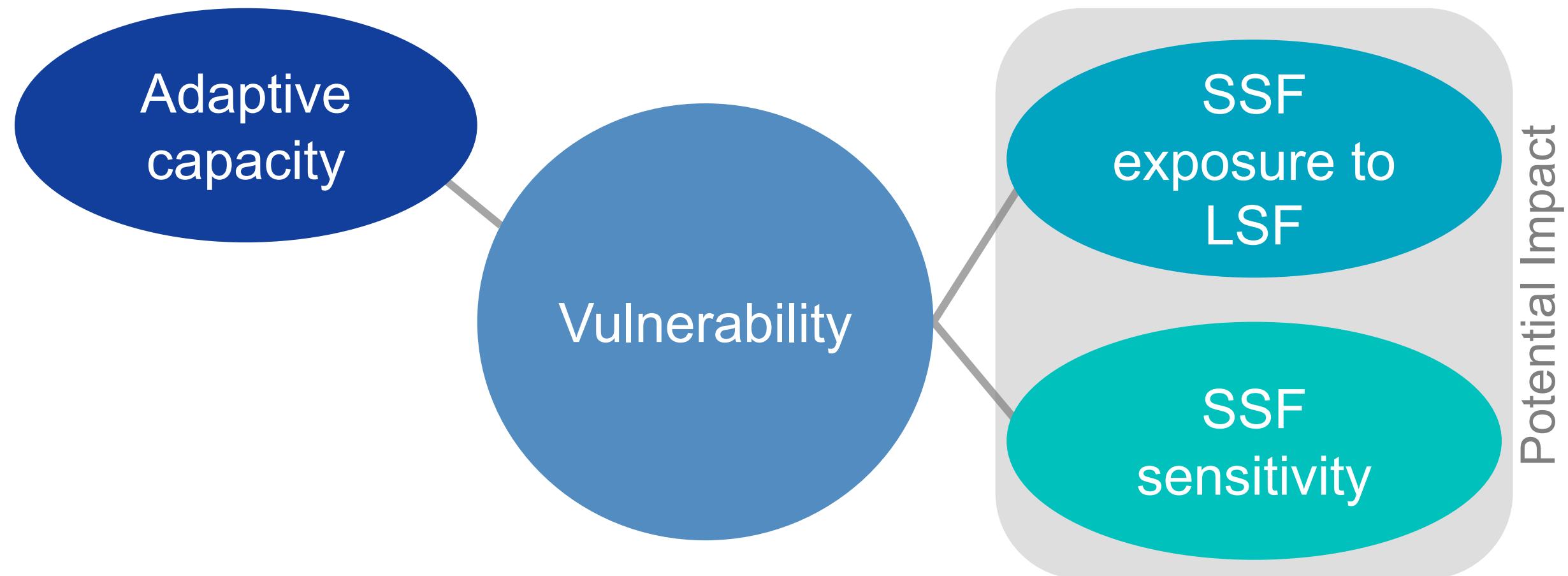
- 83.7% of SSF catch occurs <20km from shore (IHH)

## Questions:

1. Within this spatial area, which countries have high vulnerability to LSF-SSF interactions?
2. How much nearshore LSF activity occurs in proximity to SSF locations?



# Assessing national vulnerability of small-scale fisheries to LSF interactions



# Main data sources :

1. Global Fishing Watch (GFW) **industrial fishing effort** (AIS, VMS)
2. Illuminating Hidden Harvests (IHH) **small-scale fisheries data**:
  - Relative “importance” (prioritization) of SSF at country level for ~200 countries
  - Fishery-level data (**ecological, economic, food security**)
  - Geospatial location of fishery-level data for 16 countries [9,094 fishing units, of variable spatial precision, from exact port to regional]
3. **National indicators** – governance scores, WorldBank data, HDI, etc.

# Primary data sources



Food and Agriculture  
Organization of the  
United Nations

Duke  
UNIVERSITY



Component	Indicator	Variable	Source
<b>1. Exposure</b> <i>Degree to which LSF activities could interact with SSF activities</i>  <u>Methods:</u> normalized and standardized two indices, averaged them to produce the composite index	1.1 Composite index of intensity of nearshore large-scale fishing activity scaled to nearshore area	A. Annual LSF hours within 25 km / country nearshore area B. Annual LSF fishing hours fishing within 25 km / country nearshore area C. Annual Count of LSF vessels present within 25 km of shore / country nearshore area D. Annual Count of LSF vessels fishing within 25 km / country nearshore area	GFW
	1.2 Indicator of SSF activity scaled to nearshore area	A. Marine SSF production / country nearshore area	IHH
<b>2. Sensitivity</b>  <i>Nation's small-scale fisheries dependence, i.e., the importance of fisheries to national economies, employment, and food security.</i>  <u>Methods:</u> normalized and standardized two indices, averaged them to produce the composite index	2.1 Composite index of employment and economic dependence on the small-scale fisheries sector	A. Contribution to SSF global marine fisheries landed value (% of global landed value) B. Contribution to SSF global marine fisheries employment (% of global marine SSF employment) C. Contribution of marine SSF employment in fisheries to total employment (% of country's labor force) D. Contribution to marine subsistence employment (work for own consumption) (% of global subsistence workers)	IHH WorldBank
	2.2 Composite index of coastal nutritional dependence on SSFs	A. Quantity: Contribution to marine SSF production within country (kg / capita /year for coastal population within 100 km to shore] B. Quality: Nutrient supply of catch (iron, zinc, calcium, vitamin A) for coastal residents [in progress]	IHH WHO GADM 3.6 Beale et al 2017; Hicks et al 2019
	2.3 Composite index of nutritional need that could be met by SSFs	A. Hunger: WHO undernourishment indicator (share of population with insufficient caloric intake) B. Hunger that could be addressed by SSFs: Prevalence of inadequate micronutrient intake (PMII) for 6 micronutrients	
<b>3. Adaptive capacity</b>  <i>Nation's ability to effectively and resiliently manage the impacts of large- and small-scale fisheries interactions</i>	3.1 Level of development	A. HDI (which includes: Health: Measured by life expectancy at birth; Education: Measured by a combination of mean years of schooling for adults aged 25 and older and expected years of schooling for children entering school; Standard of Living: Measured by Gross National Income (GNI) per capita, adjusted for purchasing power parity (PPP))	

# Methods

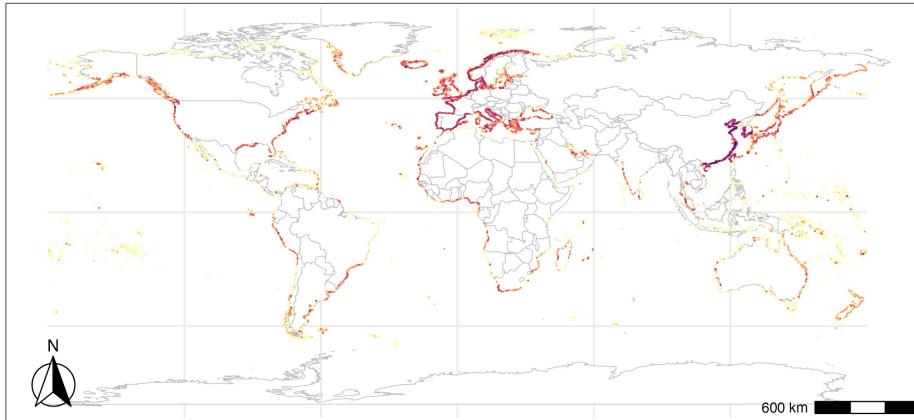
- Used logged data for some variables, then min-max scaling subindex variables to scale on 0-1 and to reduce the impact of outliers:
  - $X_{normalized} = (X - X_{min}) / (X_{max} - X_{min})$
- Sensitivity analysis between subindices
  - PCA, correlation analysis, Monte Carlo simulations
- Resilience analysis within each subindex
  - Correlation analysis

# LSF effort fishing hours in nearshore zone (<25 km from shore)

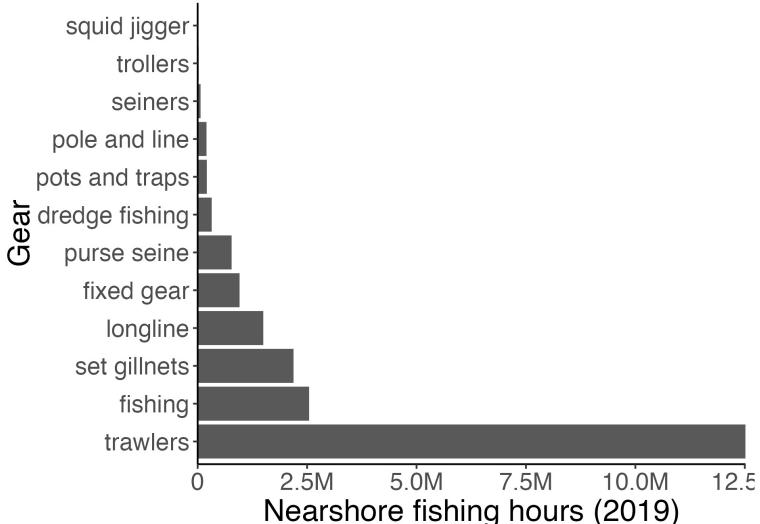
A

Fishing Hours

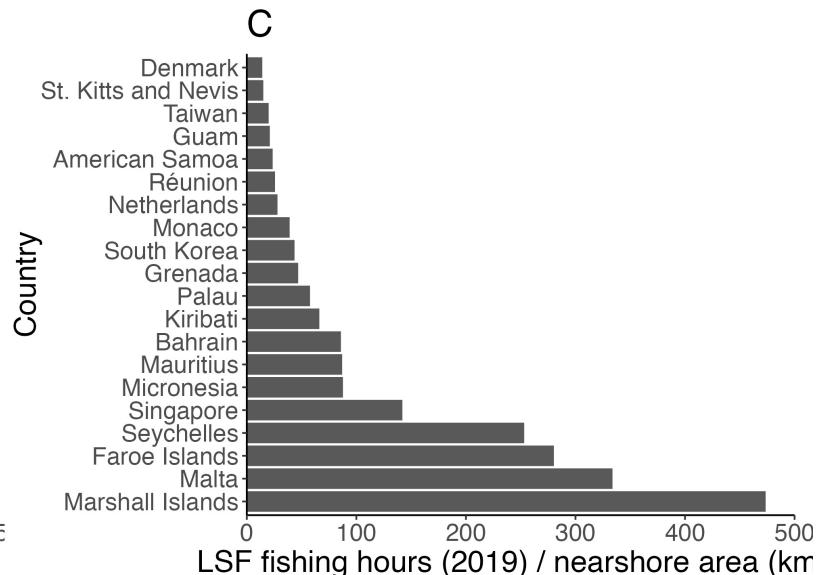
<100	<10,000	<500,000
<1,000	<100,000	700,000+



B



C

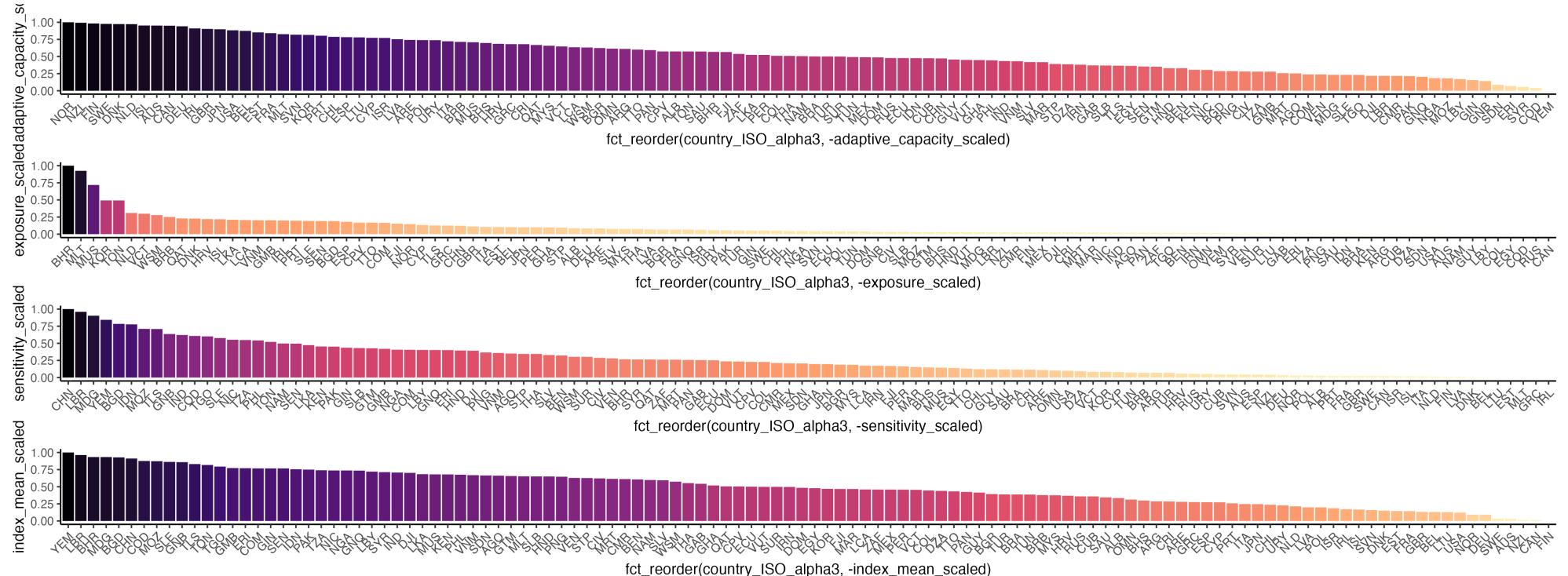
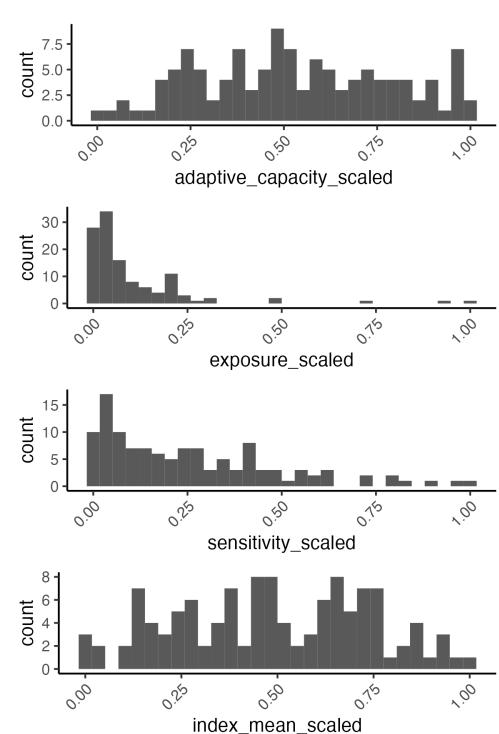


# Index calculation – trying different methods

- Tried sum, average and product (using exponent to deal w decimal )
  - Correlation between Mean and Sum indices: 0.9988877
  - Correlation between **Mean and Product** indices: 0.5603
  - Correlation between Sum and Product indices: 0.5461841

*Allison et al: Similarly, averaging or multiplying the variables produced highly correlated vulnerability scores (A1FI, Spearman's  $q = 0.96$ ; B2, Spearman's  $q = 0.95$ ). Indices were therefore calculated as an **unweighted mean** of the standardized indices of the three components of vulnerability.*

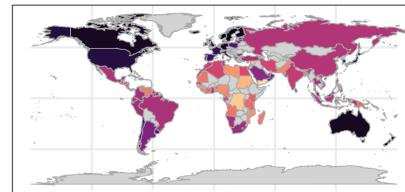
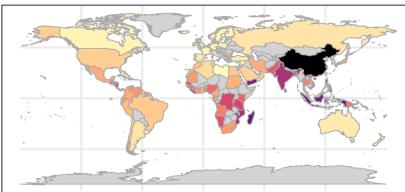
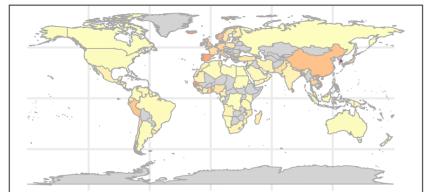
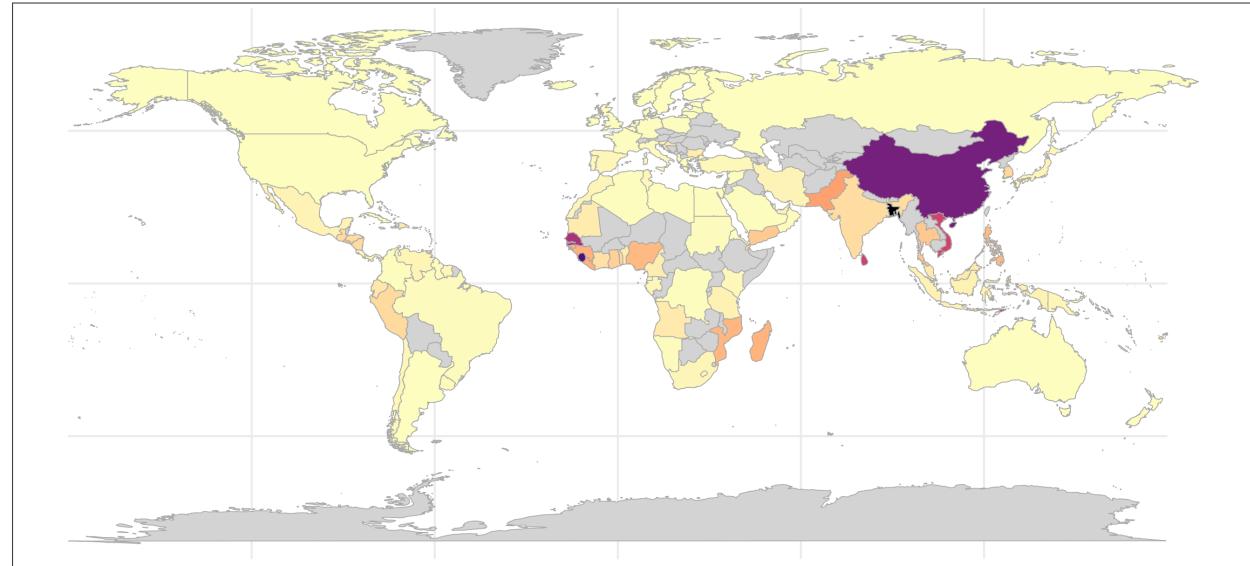
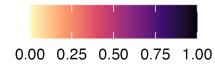
# Subindex distribution of scores



# National vulnerability of small-scale fisheries to LSF interactions

A

Vulnerability

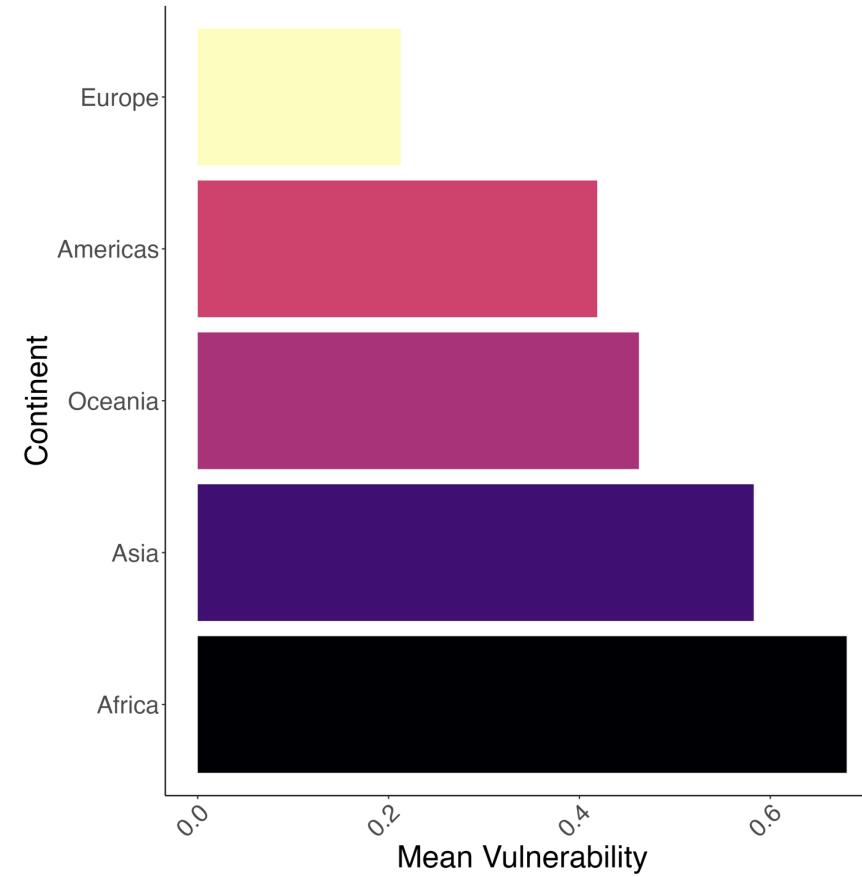


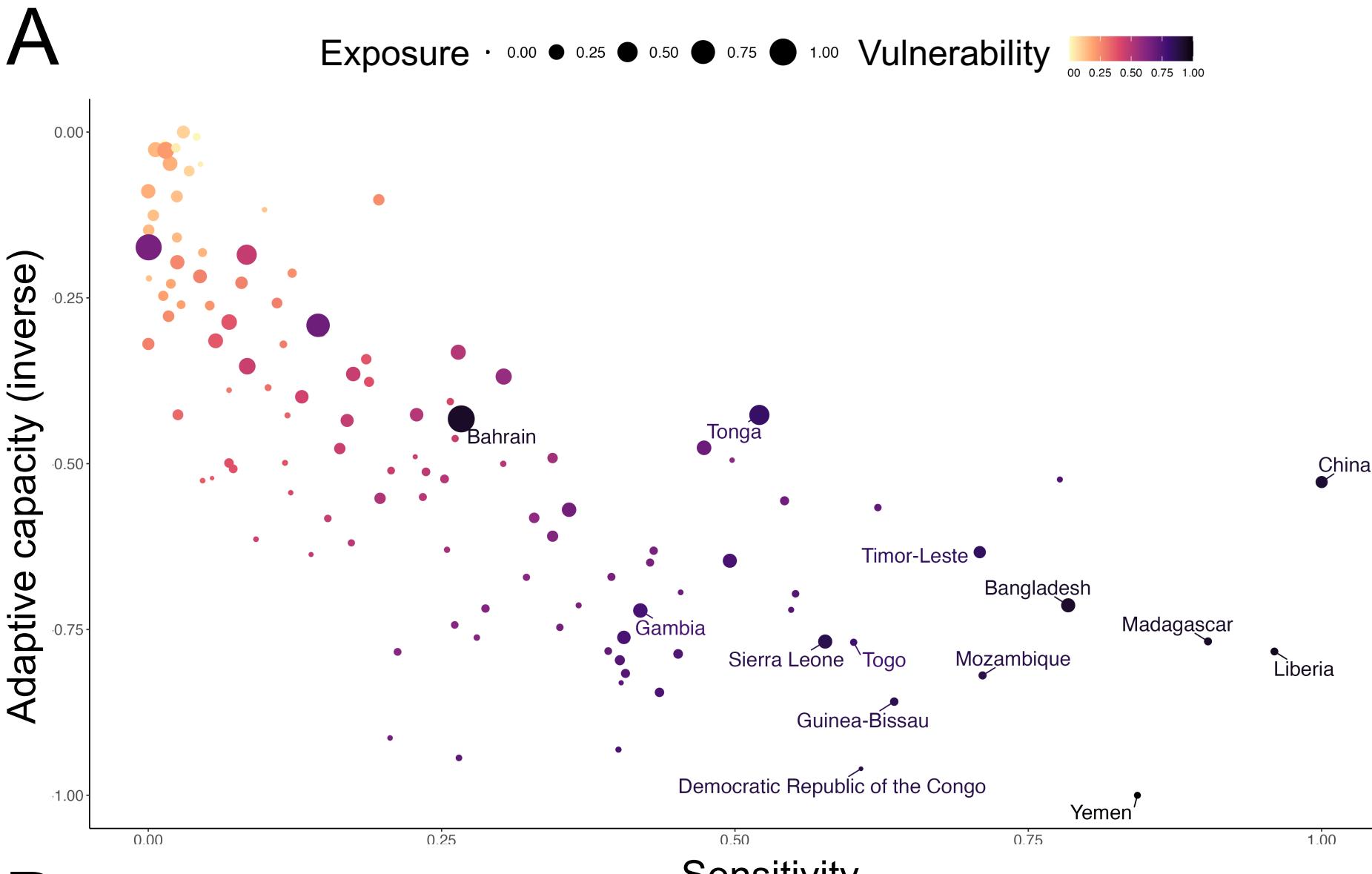
Exposure

Sensitivity

Adaptive capacity

B



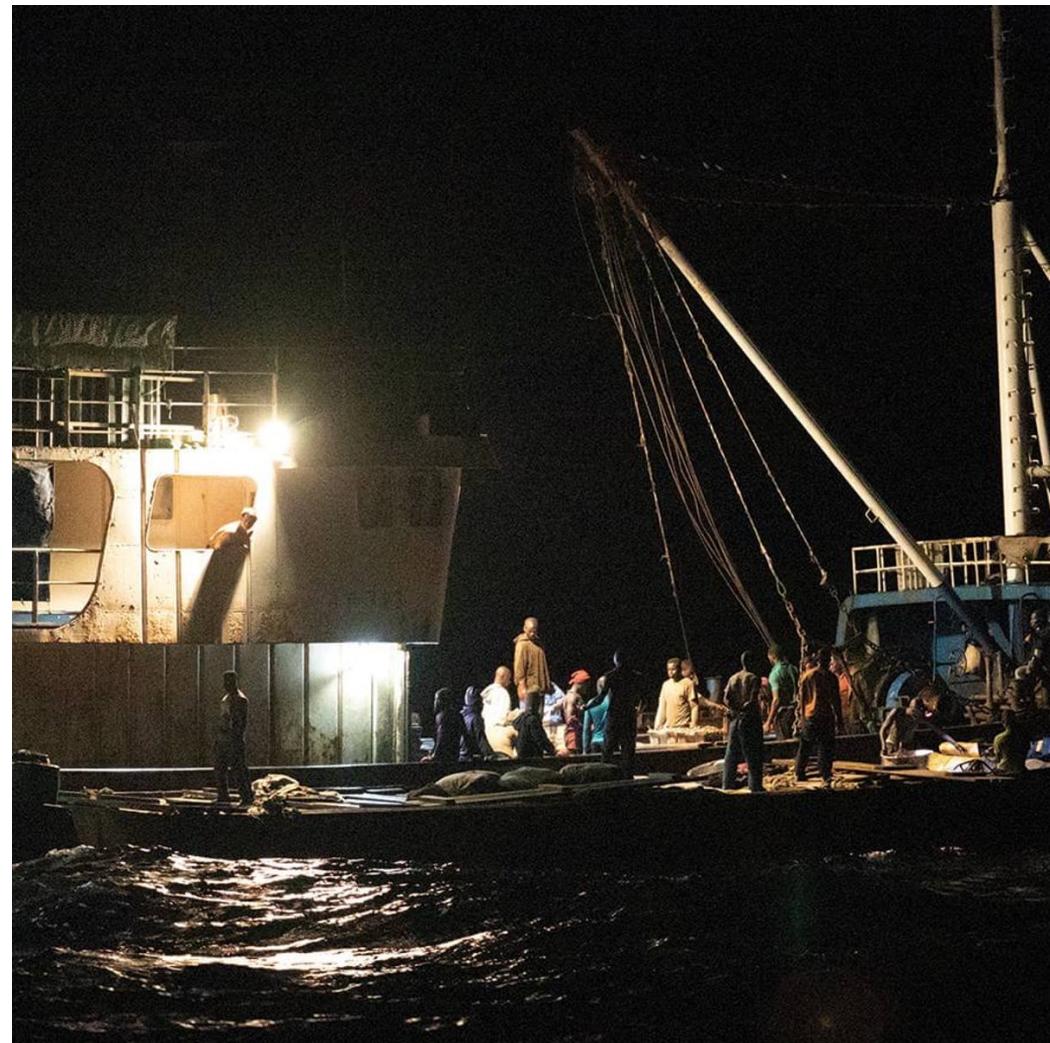


# Where are interactions likely to occur?

- 83.7% of SSF catch occurs <20km from shore (IHH)

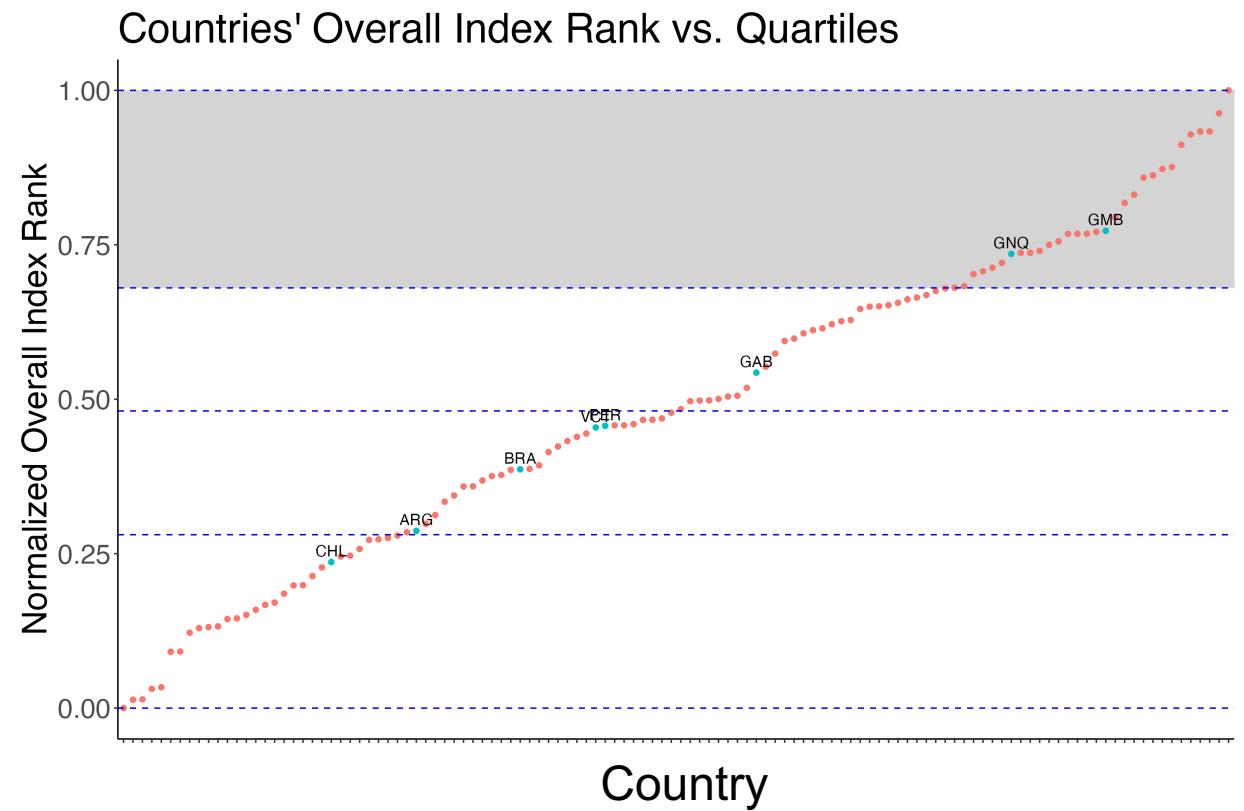
## Questions:

1. Within this spatial area, which countries have high vulnerability to LSF-SSF interactions?
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# SSF-LSF Interaction Case Studies

- Selected countries with:
  - Index value in the top half of scores
  - $\geq 5$  unique SSF fishing sites in IHH data
  - Within these, we chose three countries with varying income level (high, middle, low)
- Extracted LSF fishing effort data within 25km buffer to coastline
  - Point-density analysis for LSF fishing hours [all gears] within 25 km radius of SSF (IHH reported site)



# Guinea

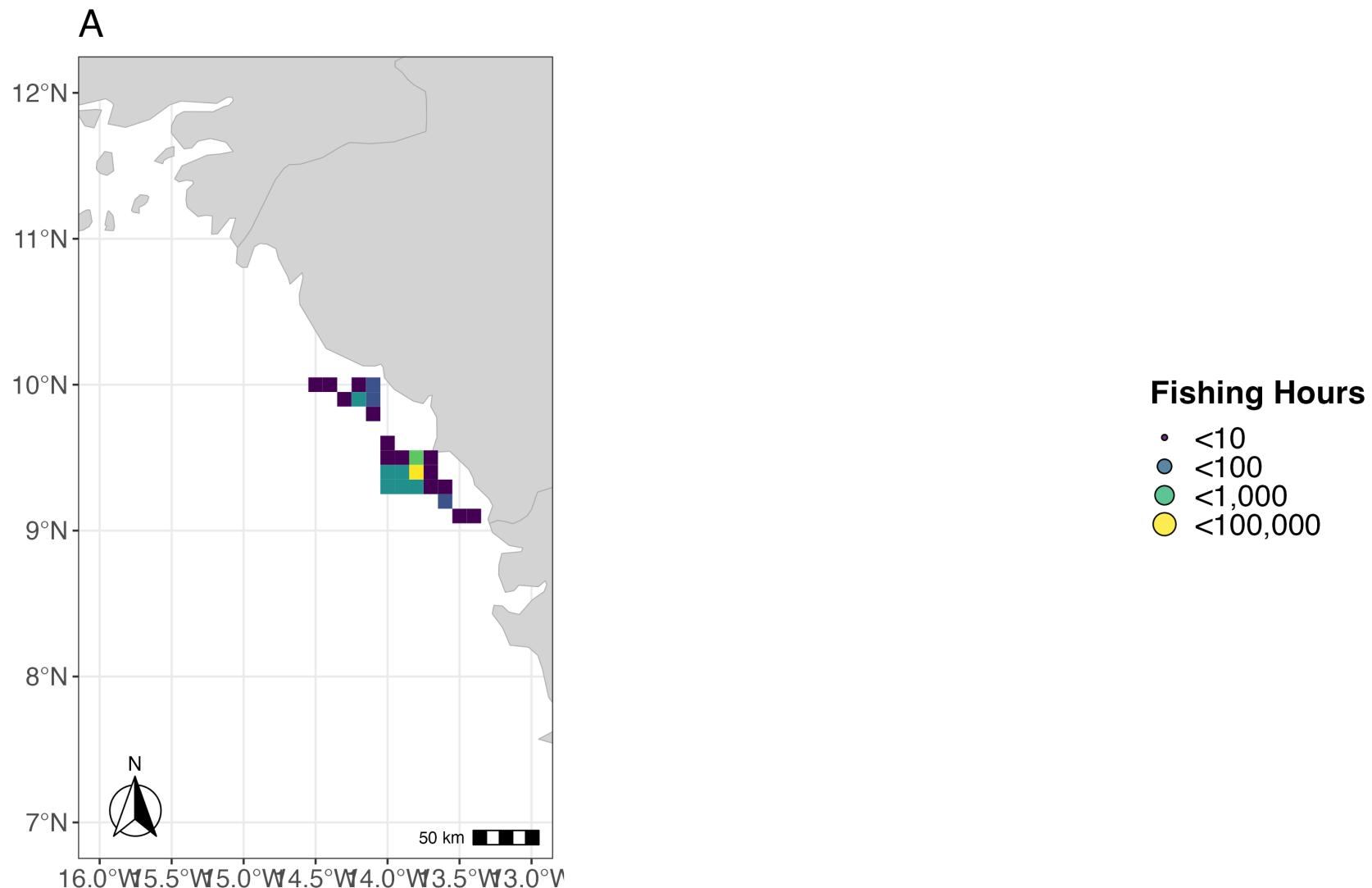
- Good SSF data resolution
- Relatively low LSF hours but high concentration in some SSF locations
- Domestic and foreign LSF fishing

## LSF activity:

- 39 vessels
- 3,579 hours; 1,624 fishing hours
- **Most hours by Guinea (60%)** followed China (19%)
- Most trawlers (92%), set longliners (2%)

## SSF activity:

- 42 fishing units
- 7 fishery locations



# Gabon

- Upper middle income
- good SSF data resolution
- No domestic nearshore fishing
- Low fishing hours comparatively but relatively concentrated compared to others

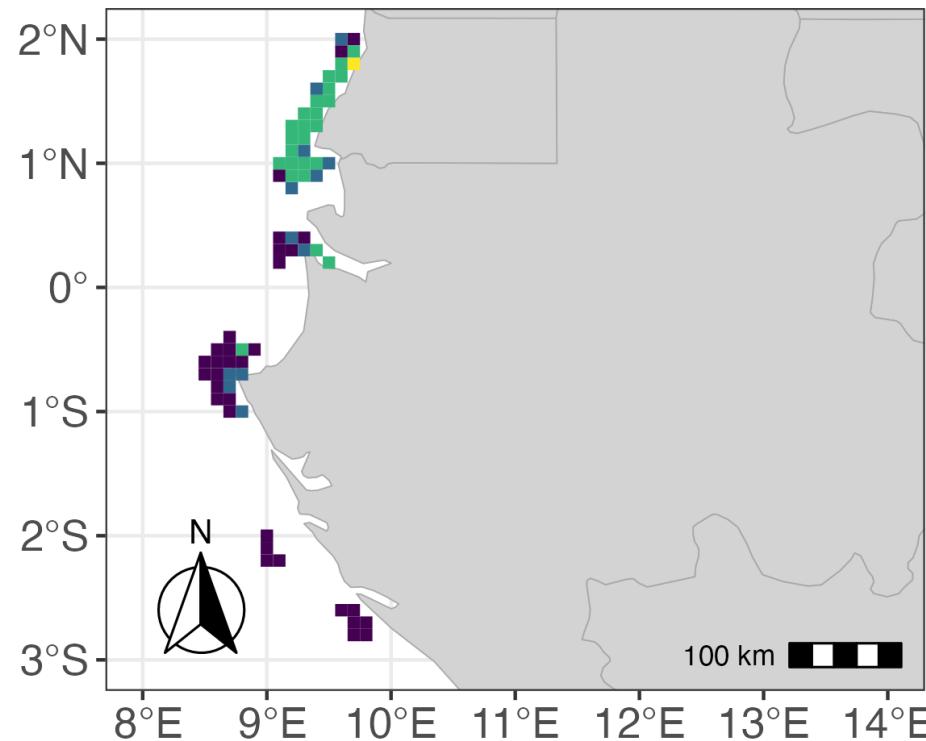
## LSF activity:

- 19 vessels
- 4496.5 hours
- **Most hours by China (90%),** followed by unknown and Nigeria; no Gabon flagged vessels
- Most trawlers (88%), drifting longliners (12%)

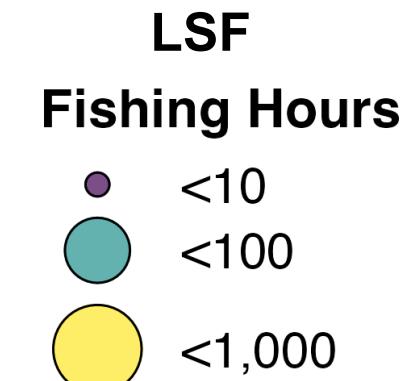
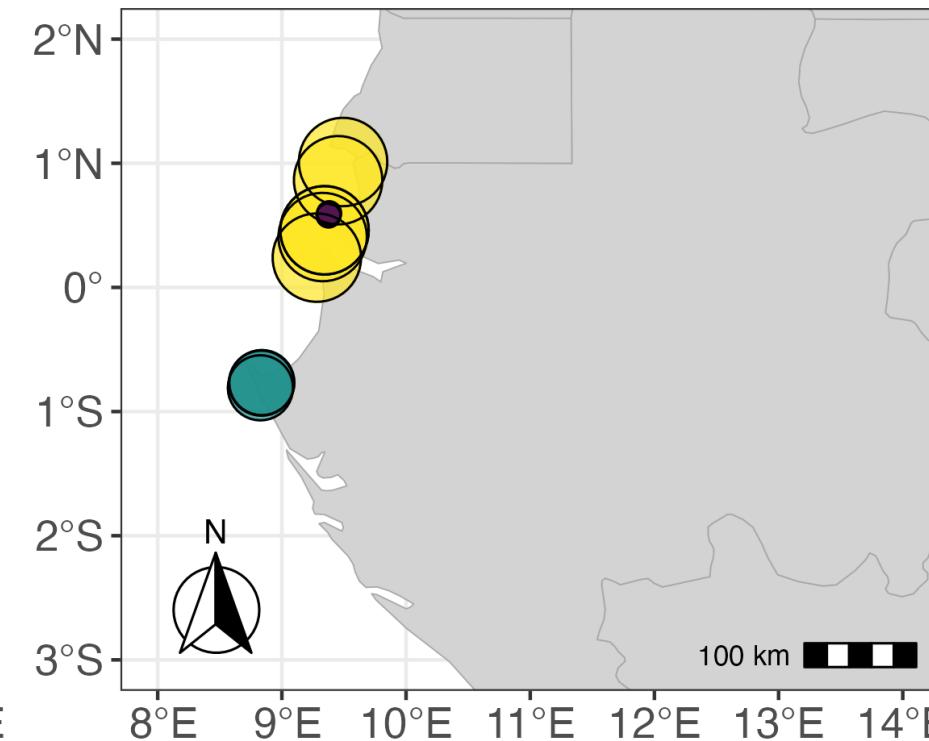
## SSF activity:

- 89 fishing units
- 20 fishery locations

A



B



# Next steps

- Refine and test vulnerability assessments
  - Some are normally distributed (between 0 and 1), and some are not. Is this ok?
- Conduct sensitivity analysis – not sure about how to do this!
- Refine case study selections
- Elicit feedback on results with country and subject experts