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Responses of tuna stocks to temporal closures in the Indian Ocean

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Introduction

Recent assessment models estimated the current status of tropical tunas in the Indian Ocean (IO):

- Bigeye (BET): overfished and subject to overfishing
- Yellowfin (YFT): overfished and subject to overfishing
- Skipjack (SKJ): not overfished and is not subject to overfishing

There is a need to implement measures to improve the status for BET and YFT.

Time-area closures

- Implemented to control fishing effort, to protect adults during spawning season, to allow growth of juveniles, to rebuild depleted stocks, or to protect bycatch species (IATTC, 2021).
- Seasonal closures are generally quite effective and easy to implement.
- However, effort allocation during open seasons or areas might produce negative results.

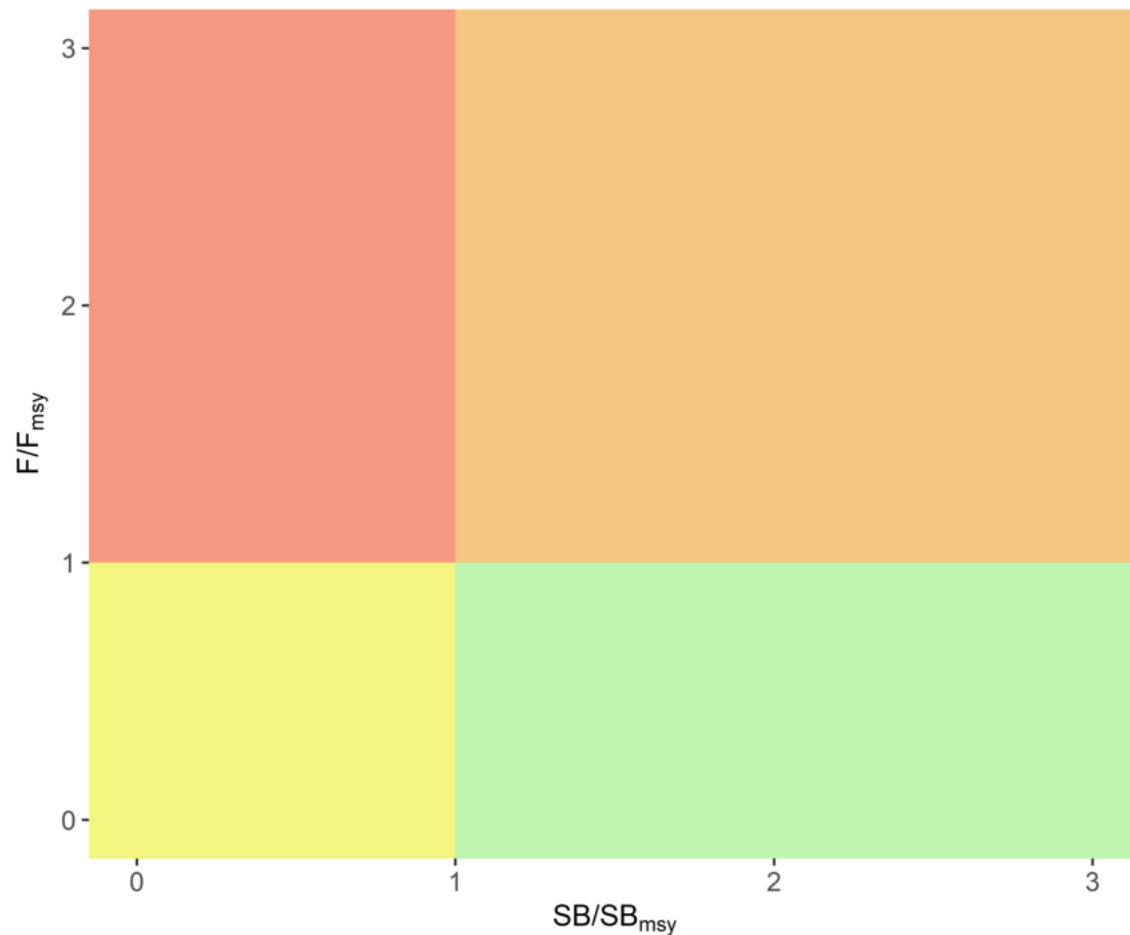
Objectives

Evaluate the impacts of temporal and time-area closures on the future status of tropical tunas in the Indian Ocean (IO).

- Status evaluated using SB/SB_{msy} and F/F_{msy} at the end of a 10-year projection.

Stock status

Kobe plot:



Not overfished and not subject to overfishing

Not overfished and subject to overfishing

Overfished and subject to overfishing

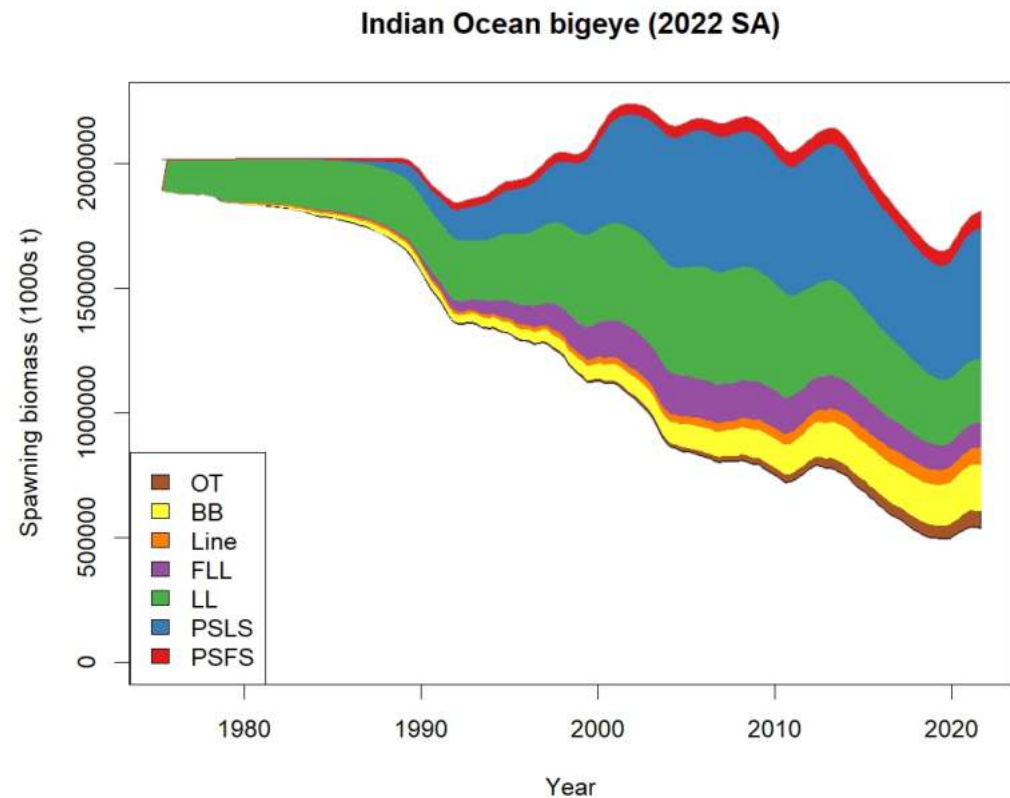
Overfished and not subject to overfishing

Assessment model

- Use Stock Synthesis (SS3) (Fu 2020, Fu et al. 2021, 2022) to make projections.
 - SS3 configuration: steepness of 0.8, base growth and natural mortality, lambda of 1.
- Projected recruitment is deterministic from the SR relationship.
- Growth, selectivity, and other model components constant during the projection period.

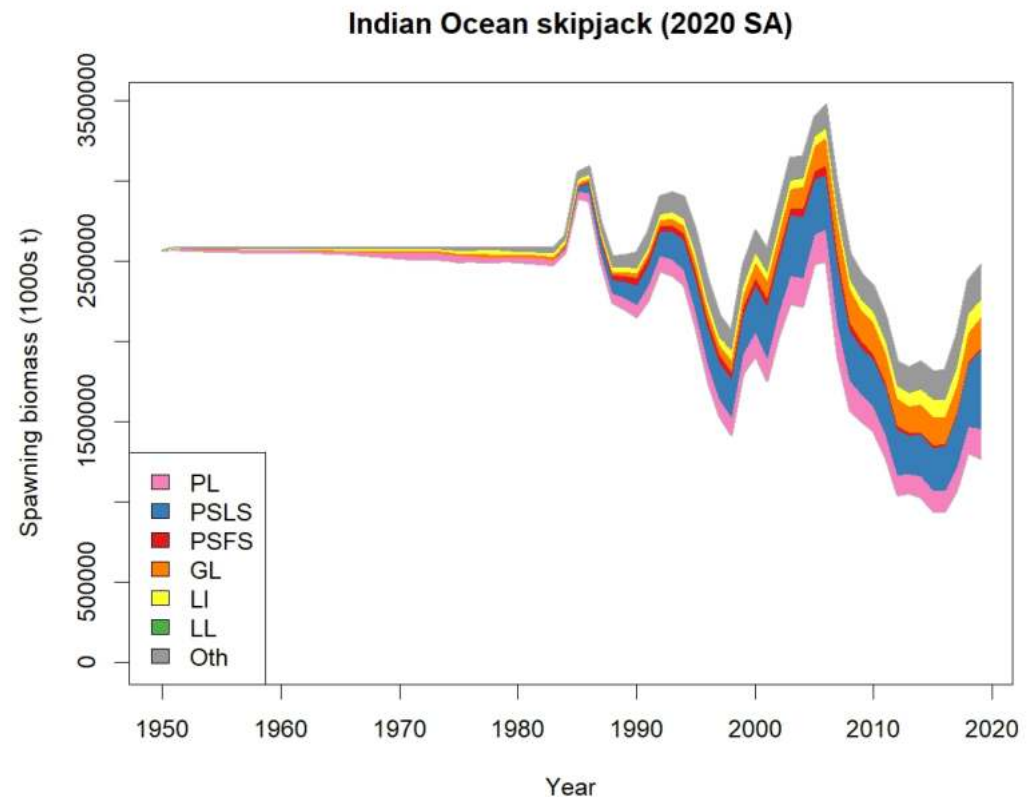
Fleet definitions

Fishery name	Fishery code
Longline (fresh tuna)	LF
Longline (distant waters)	LL
Purse-seine (free school)	FS
Purse-seine (FADs)	LS
Baitboat	BB
Mixed gears	LINE
Others	OT
All fisheries	all



Fleet definitions

Fishery name	Fishery code
Maldivian Pole and Line	LINE
Longline (distant waters)	LL
Purse-seine (free school)	FS
Purse-seine (FADs)	LS
Gillnet	GI
Line (Handline, troll)	HD
Others	OT
All fisheries	all



Catch projections

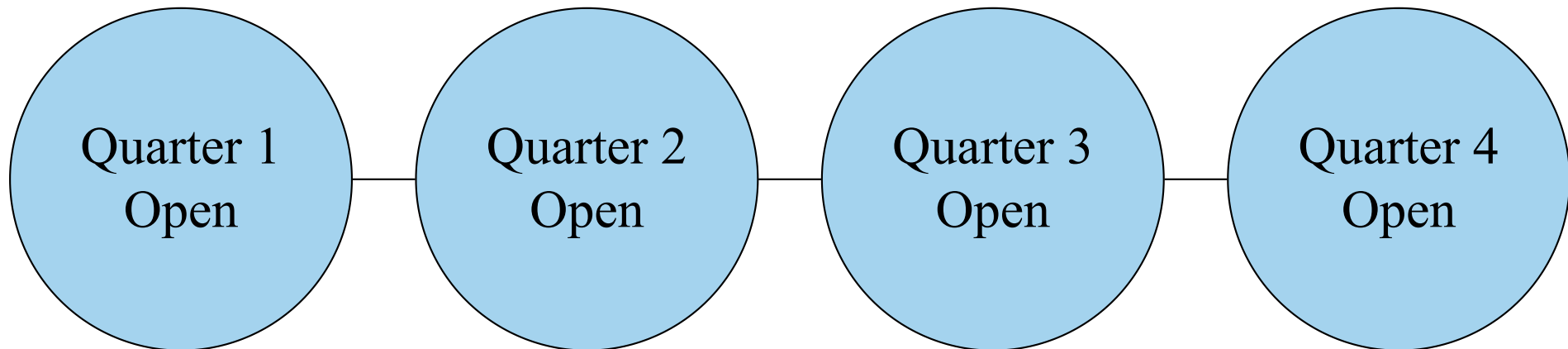
- **TAC:** projected catch from TAC recommendation (YFT) or resolution (BET and SKJ, Resolution 23/04 and 16/02).
- **Closures:** projected catch derived from *TAC* values. Then, we applied several fleet-specific temporal closures to the entire IO.
- **LS-FS:** Interaction between the FAD and free school purse seine fisheries.

Closure strategies

- Closed quarter: Q1, Q2, Q3, or Q4 could be closed.
- Closure duration: 3, 2, or 1 month.
- Catch reallocation: 100%, 50%, or 0% of the catch corresponding to the closed period could be redistributed among the open period (for fleet-specific closures).
 - For LS-FS: Catch reallocation from LS to FS during the same period.

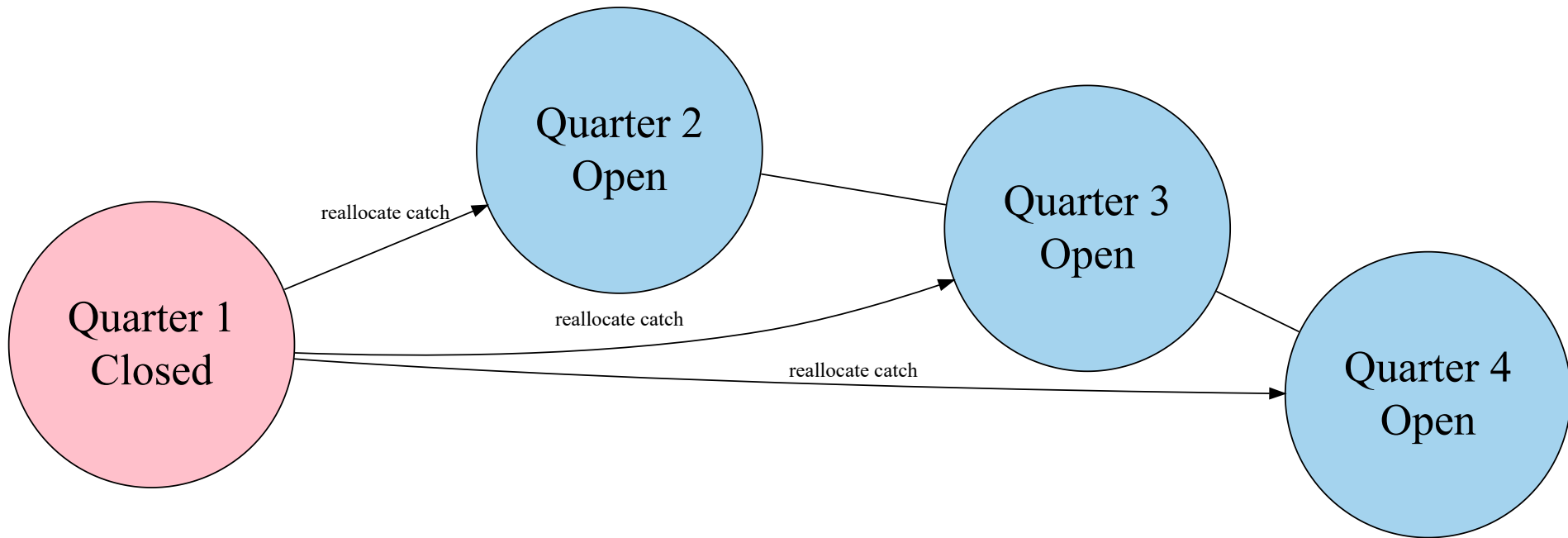
Catch reallocation

TAC



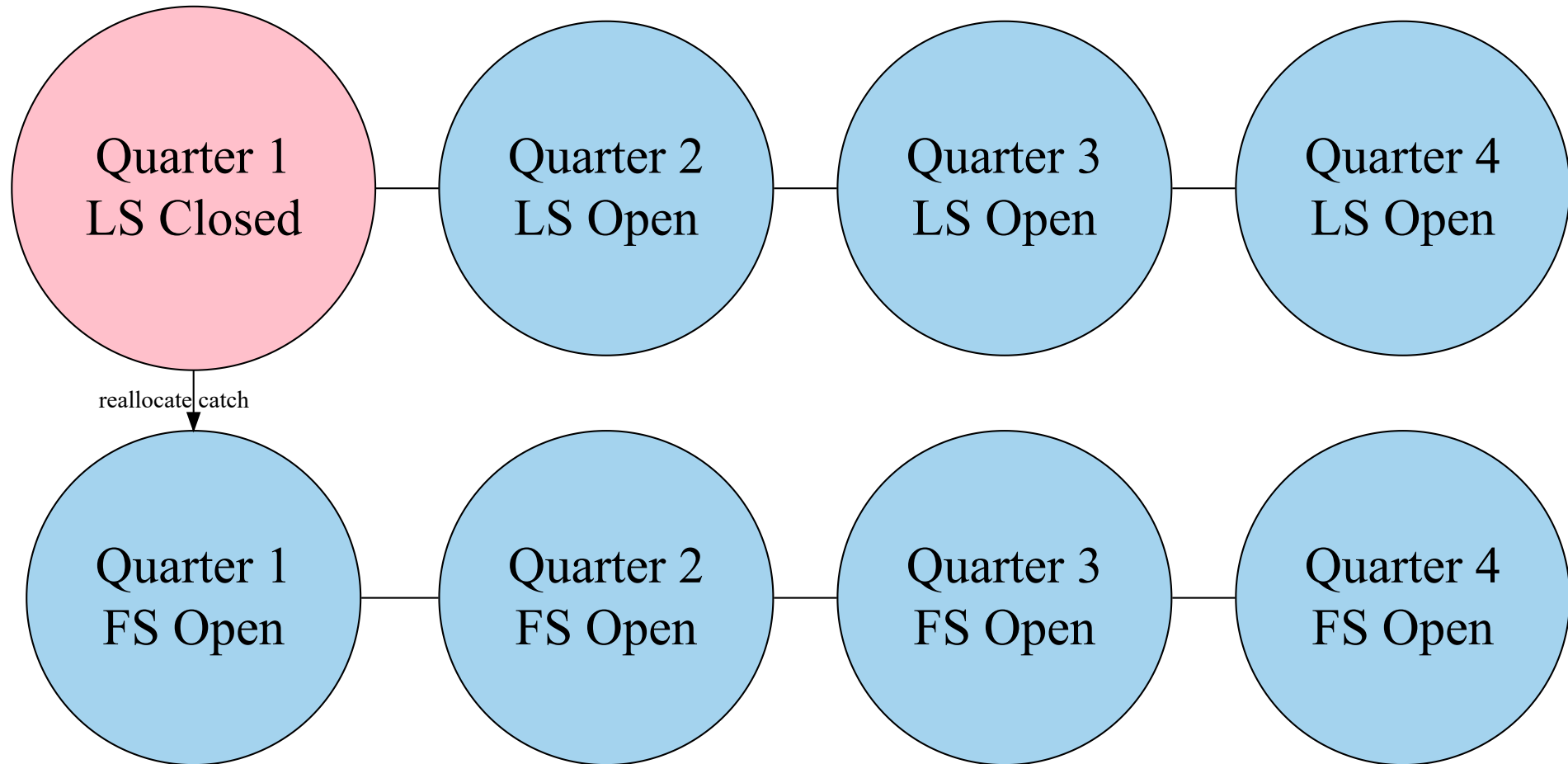
Catch reallocation

Fleet-specific closures



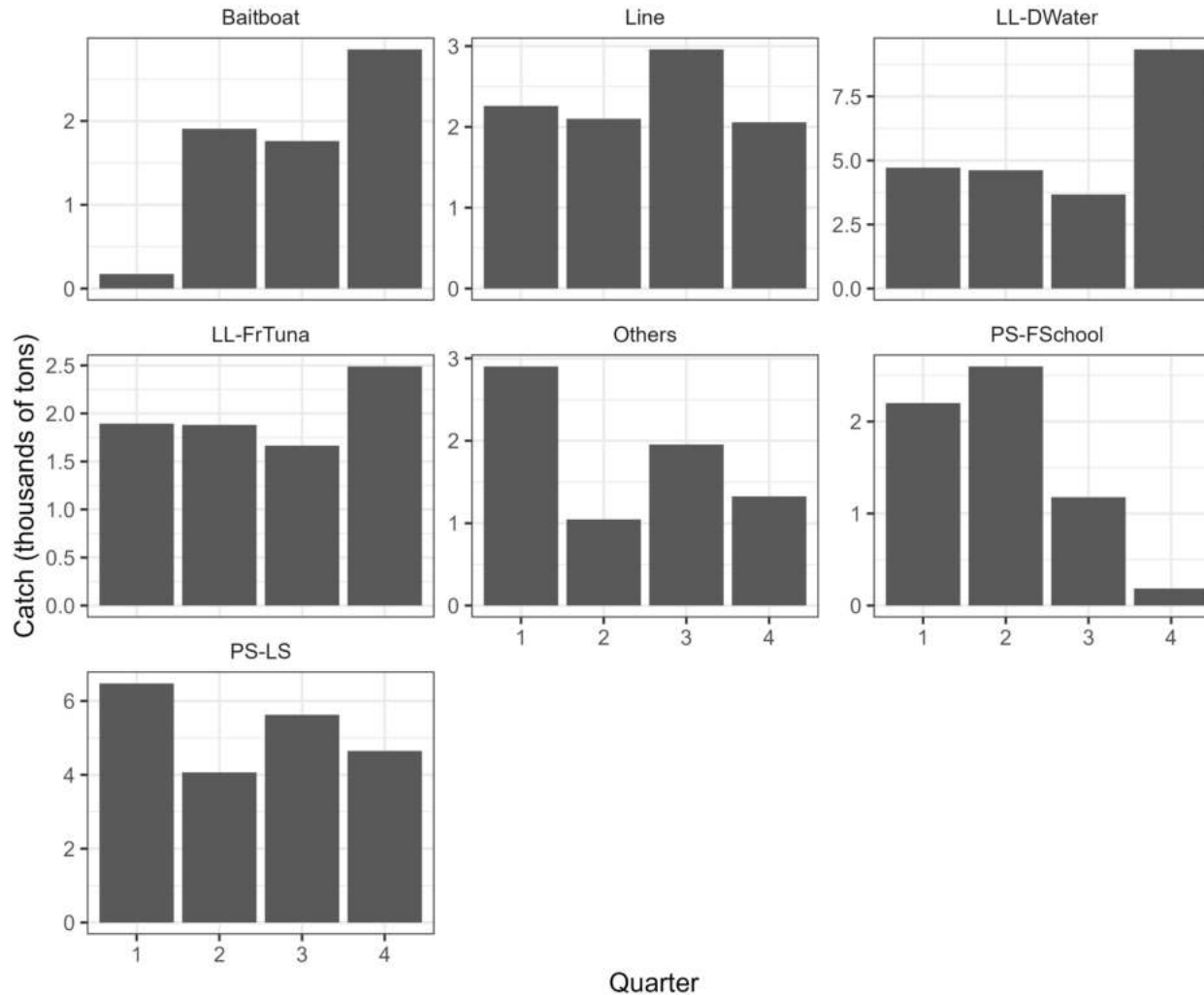
Catch reallocation

LS-FS closure interaction



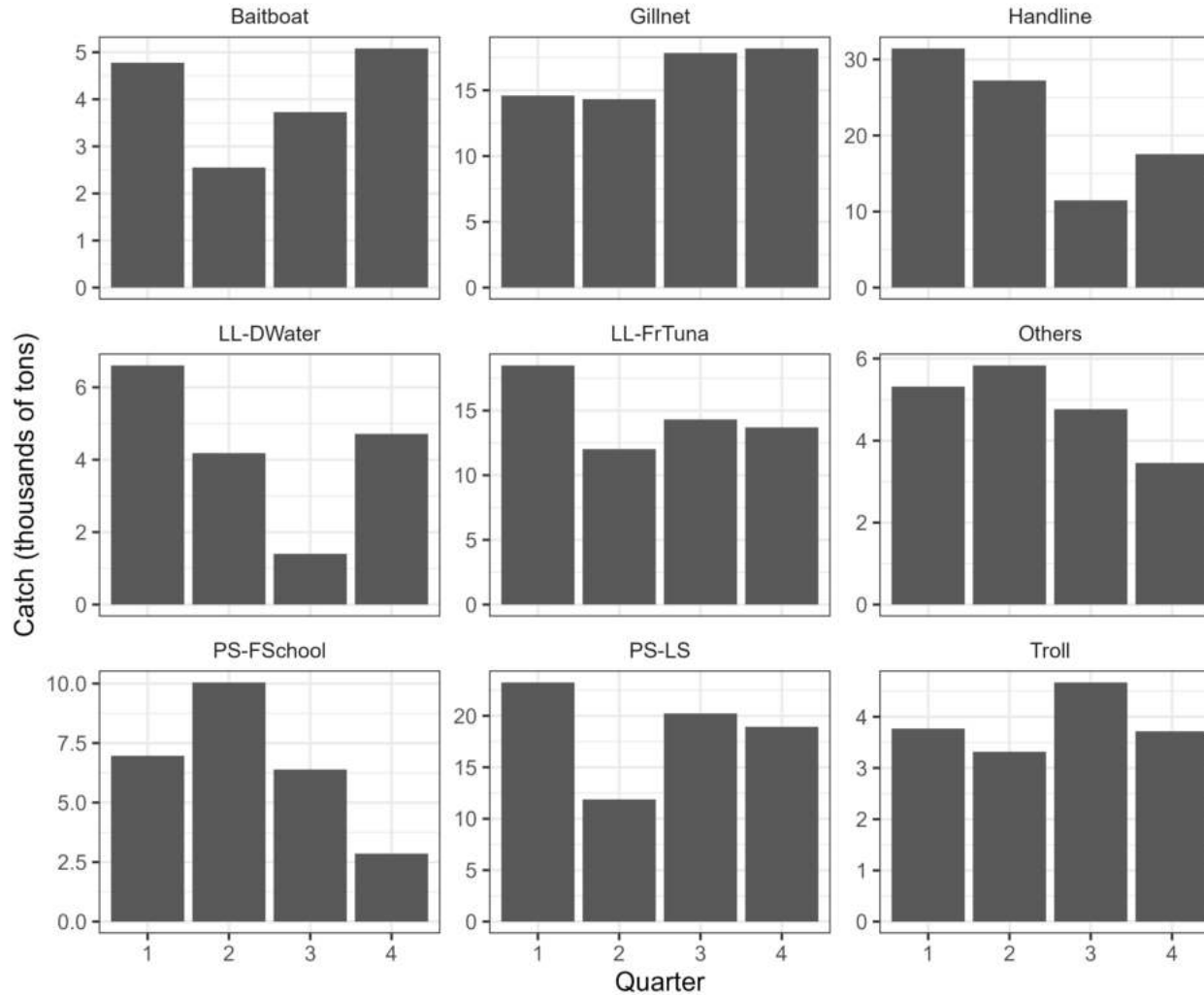
Projected catch

For BET:



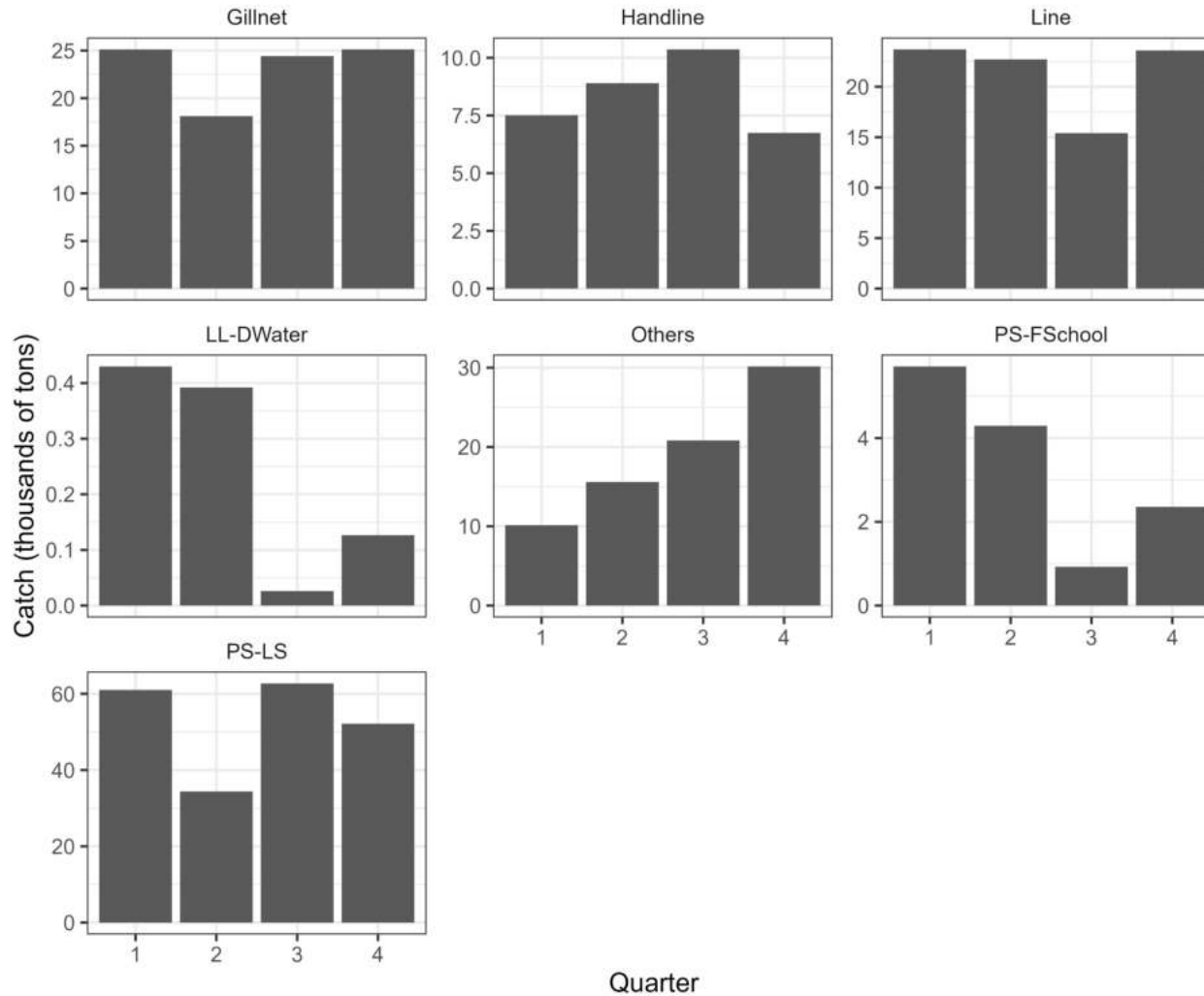
Projected catch

For YFT:



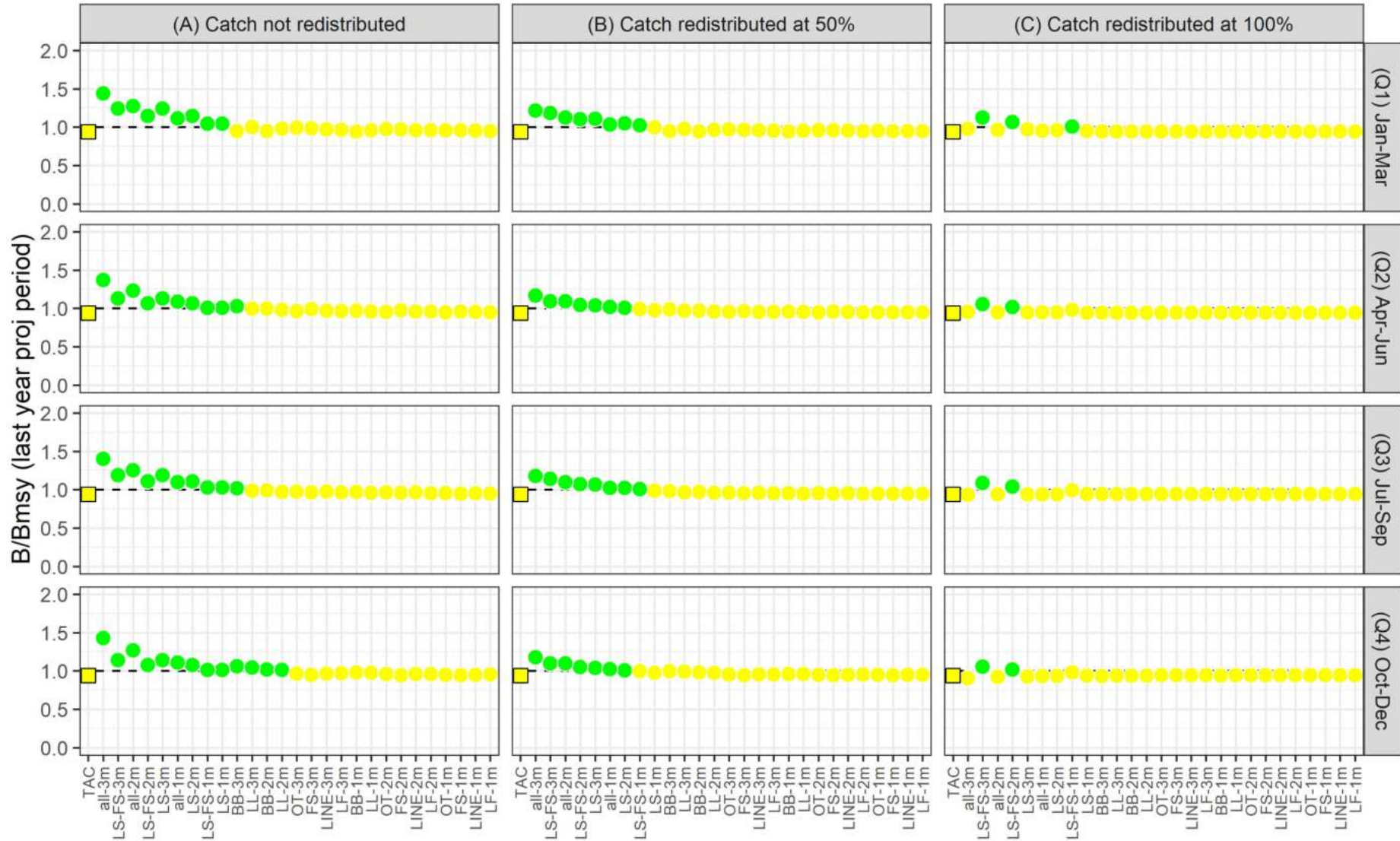
Projected catch

For SKJ:



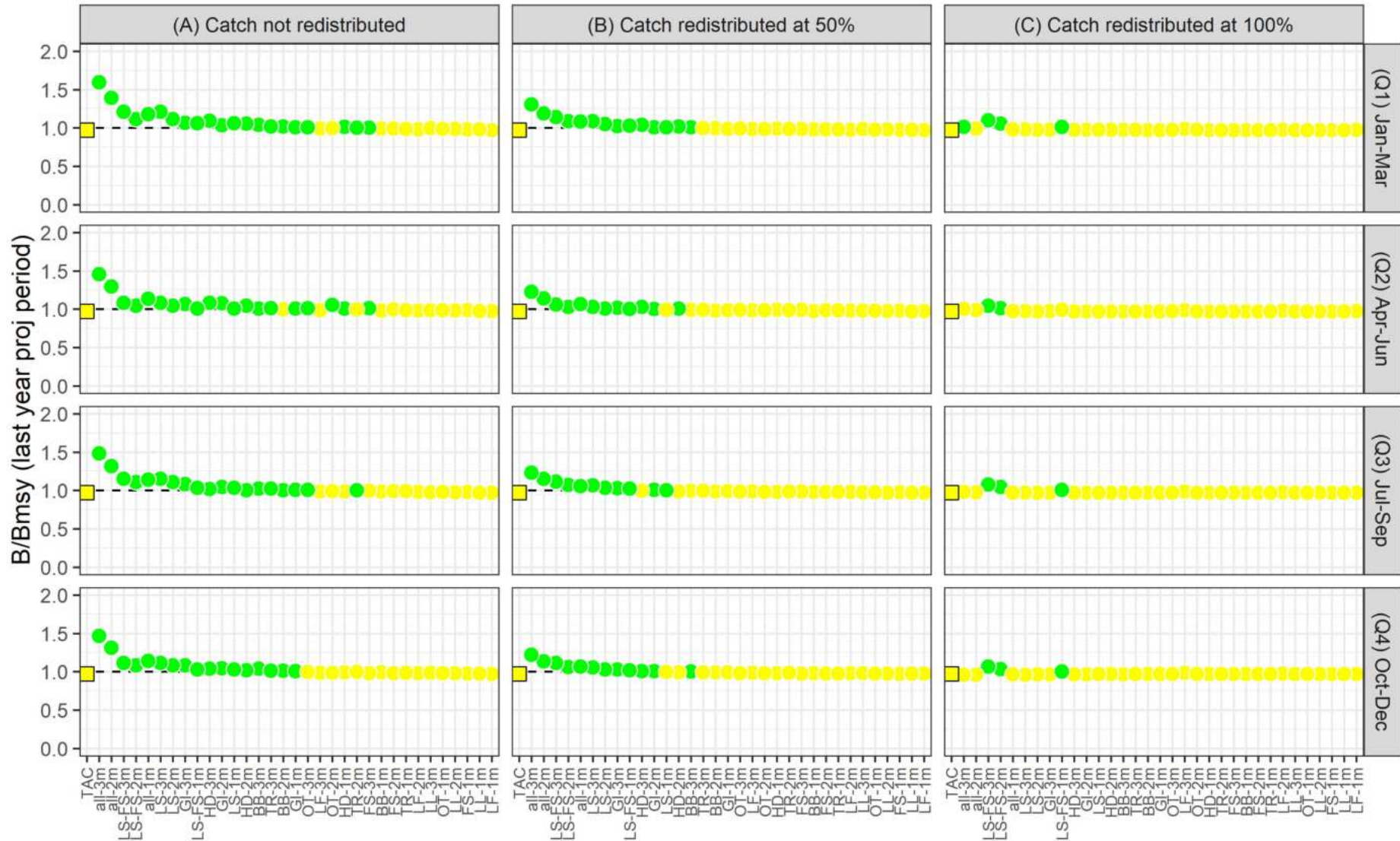
Results

IO Bigeye



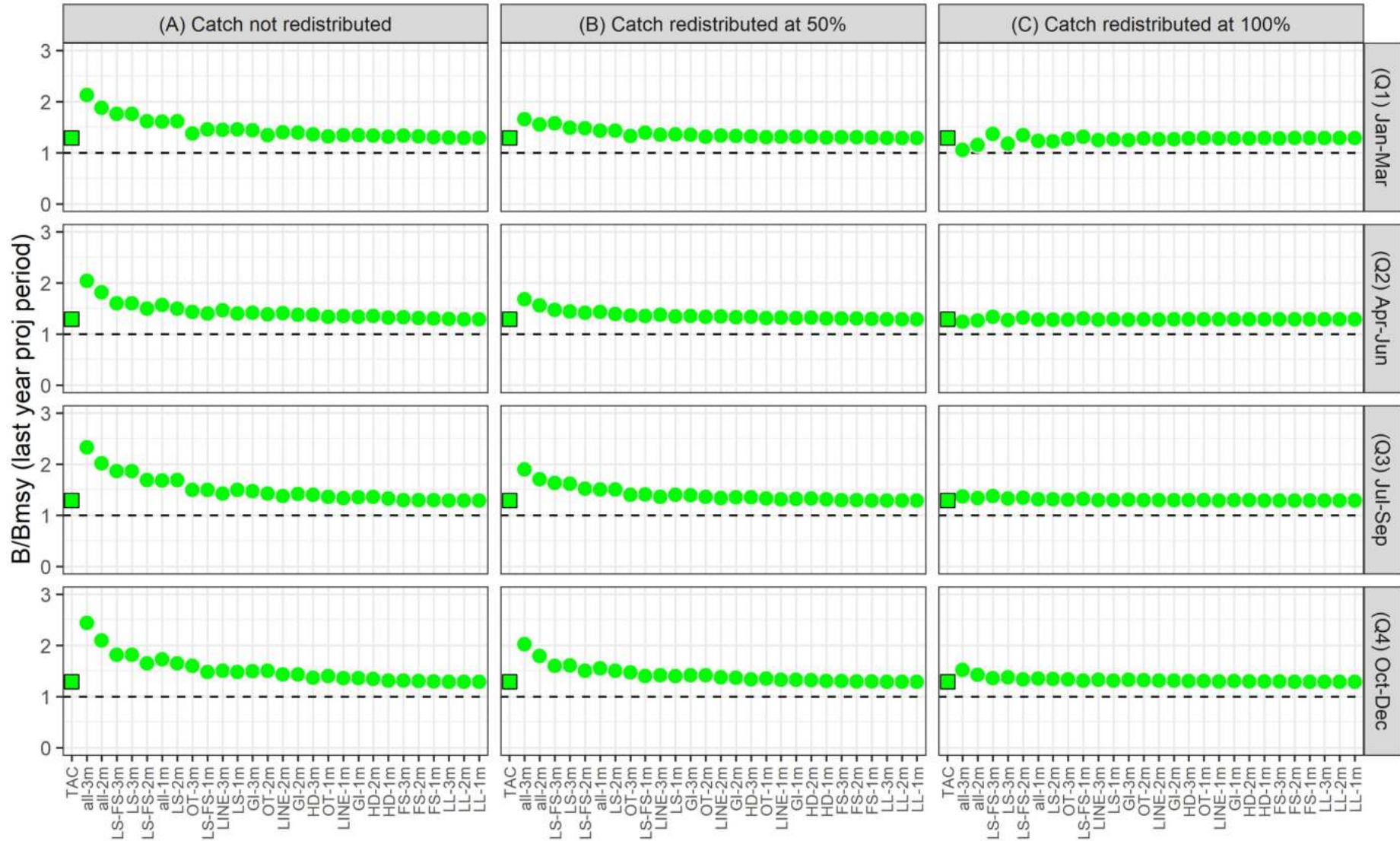
Results

IO Yellowfin



Results

IO Skipjack



Conclusions

We presented a coherent framework to assess the impacts of closure strategies on tropical tunas in the Indian Ocean.

By the terminal year of the projection period:

- The TAC scenario produced a stock status **overfished and not subject to overfishing** for BET and YFT and **not overfished and not subject to overfishing** for SKJ.

Conclusions

For closure scenarios, by the terminal year of the projection period:

- Catch reallocation of 100% always produced a stock status as in the TAC scenario.
- Closing all fleets during an entire quarter with 0% reallocation always produced a stock status not overfished and not subject to overfishing.
- Closing the PS-LS fishery produced the largest positive impact on the stock status compared to other fleet-specific closures, followed by BB (for BET) and GI and HD (for YFT).

Conclusions

For the LS-FS interaction, by the terminal year of the projection period:

- Produced even larger positive impact on the stock status compared to fleet-specific closures.
- Even considering a 100% reallocation, the stock status was not overfished and not subject to overfishing in most cases for the three tuna stocks.

Thank you



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