Transboundary Marine Protected Areas

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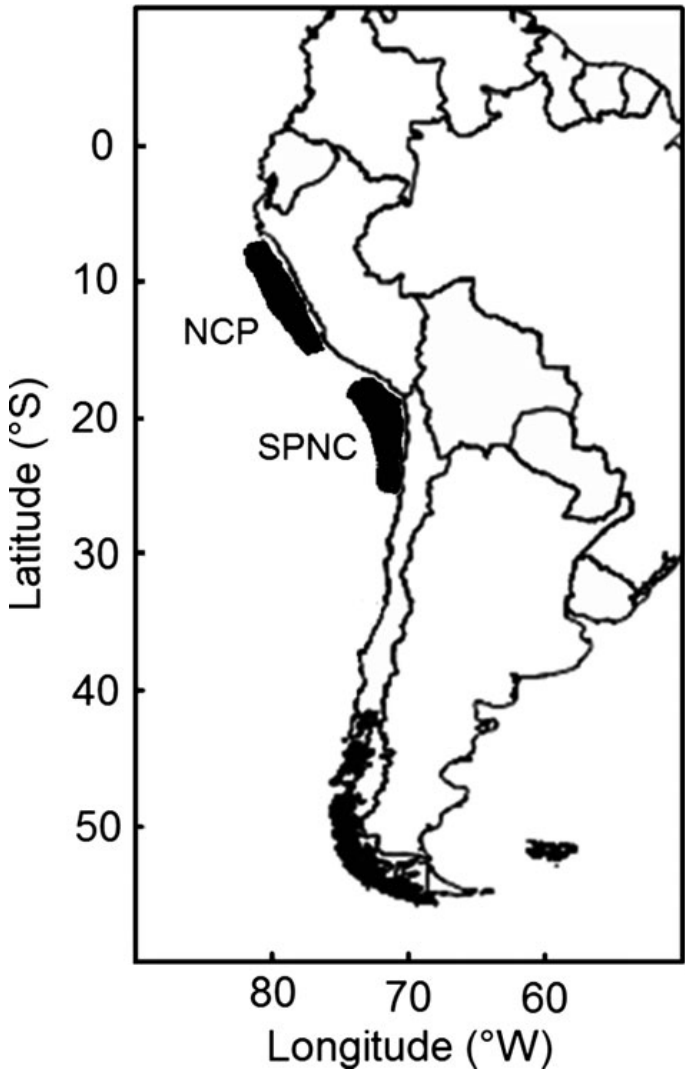
Transboundary Fisheries

- Fishing stocks distributed across two or more EEZs (Hayashi 1993; McWhinnie 2009)
- Usually in worse shape than stocks contained in just one jurisdiction (McWhinnie 2009)
- Underlying incentives for countries to fish over-aggressively (Bailey, Sumailam & Lindroos 2010)
- Fishing agreements, despite being recommended, usually fail to achieve desired performance goals (Bjorndal, Kaitala, Lindroos & Munro 2000)

Southern Peru - Northern Chile Anchoveta Stock



Research Question

Can transboundary marine protected areas be used as an alternative management scheme to fishing agreements?

Model assumptions

- One stock that spans two jurisdictions
- Countries seek to maximize benefits
- Both countries have the required individual institutions to enforce catch limits
- There are two seasons, reproduction and harvest
- Stock distributed homogeneously once it has reproduced

Timing

1. At time t, country i observes the stock available for harvest, x_{it}, and decides its level of escapement, e_{it}
2. Harvest is given by $h_{it} = x_{it} - e_{it}$, with harvest benefits $\log[h_{it}]$ and discount factor β_i
3. Escapements, e_{it} and e_{-it}, plus the stock that is protected in the TMPA, e_{mt}, retreat for reproduction and distributes across jurisdictions and the reserve proportional to their sizes, $\gamma_i(\lambda_i)$, $\gamma_{-i}(\lambda_{-i})$, and the size of the TMPA, $\boldsymbol{\lambda} = \lambda_i + \lambda_{-i}$
4. At time $t+1$, country i's stock available for harvest is given by $x_{it+1} = \gamma_i(\lambda_i)(e_{it} + e_{-it} + e_{mt})^{\alpha}$

Problem

Each country seeks to maximize its own total discounted harvest benefits acting non-cooperatively, taking into account both countries' characteristics and the size of the TMPA

Existence of an optimal TMPA

Corollary

An optimal TMPA exists if there is a combination of spatial fishing exclusion in each country that matches the cooperative individual escapement in the transboundary fishery.

TMPAs as a management tool

To illustrate how TMPAs can achieve different management objectives, we require a couple of additional assumptions:

1. Stock if fully contained in both countries' jurisdictions ($\gamma_i(0) + \gamma_{-i}(0) = 1$)
2. The TMPA is proportionally distributed across across jurisdictions ($\gamma_i(\boldsymbol{\lambda}) = (1 - \boldsymbol{\lambda})\gamma_i(0)$)

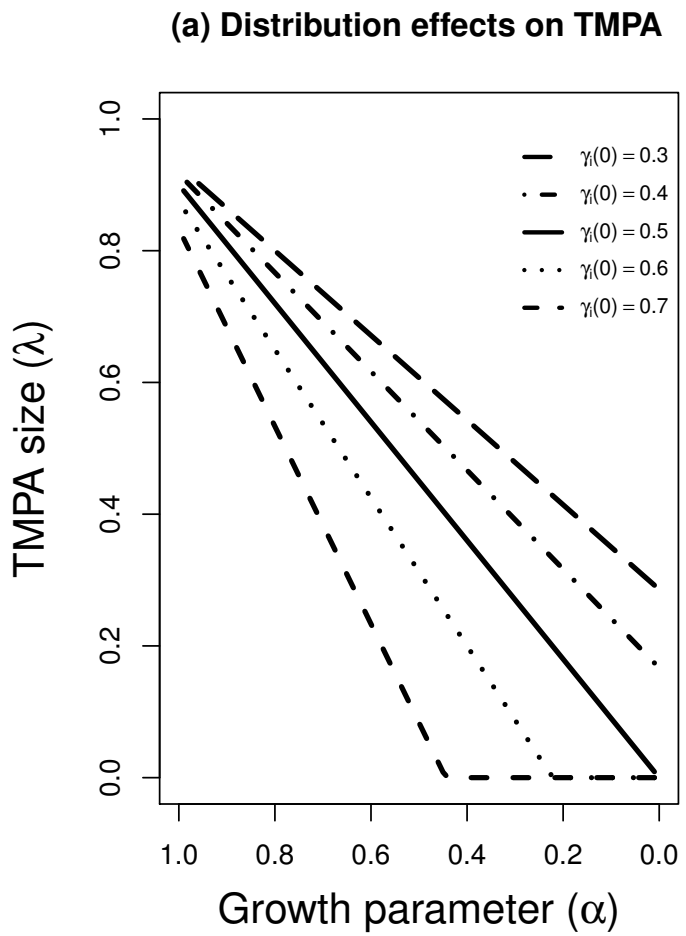
Optimal proportional TMPA

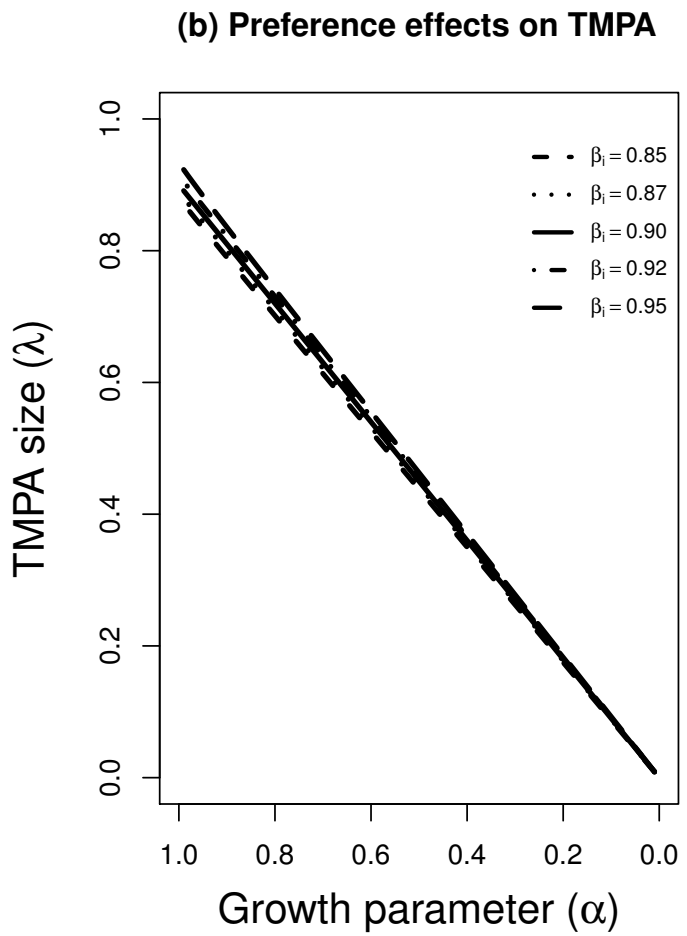
Lemma

The transboundary marine protected area that achieves optimal dynamic cooperative escapement in country i in a non-cooperative scenario is inversely proportional to the country's original fishing grounds, $\gamma_i(0)$, and is given by:

$$\lambda^* = \frac{\hat{f}_i}{\gamma_i(0)}$$

Optimal proportional TMPA





Fishing agreements

Suppose the two countries engage in a bilateral negotiation over a common fishing mortality, θ, in their jurisdictions.

Proposition

Individual dynamic agreed upon escapement in country i's jurisdiction is a fixed fraction of the total level of stock, X_t, and is given by:

$$\tilde{e}_{it} = X_t \, \tilde{f}_i(\theta)$$

where

$$\tilde{f}_i(\theta) = \gamma_i(0)(1-\theta)$$

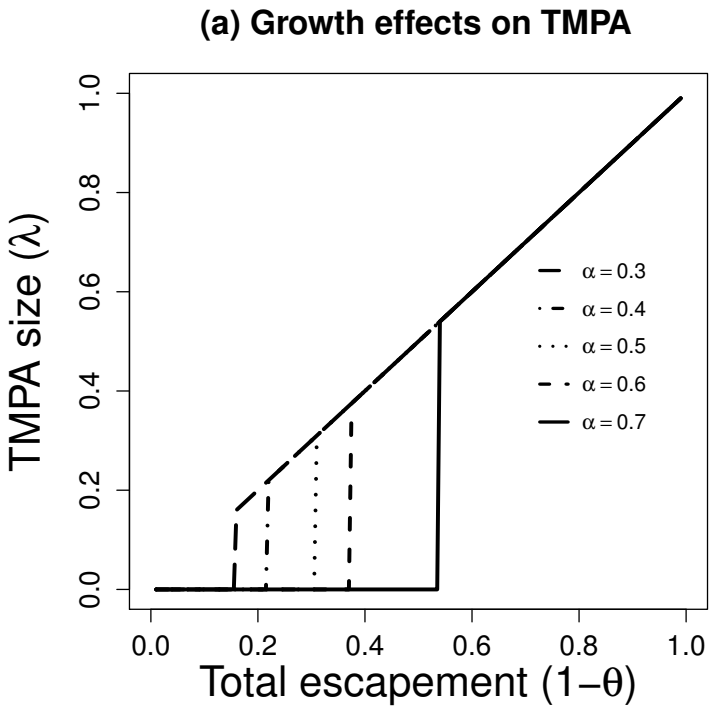
Duality between TMPAs and fishing agreements

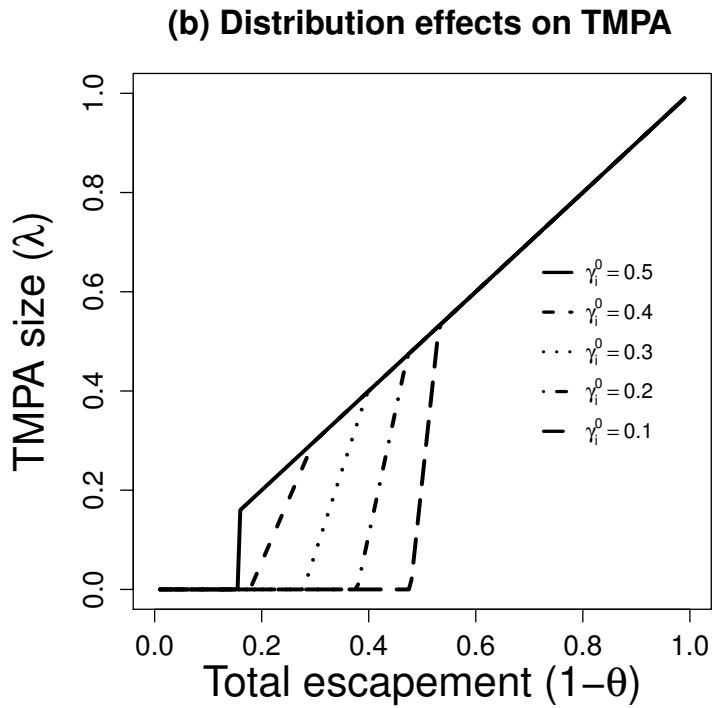
Lemma

A proportional transboundary marine protected area achieves the same total dynamic escapement levels as any fishing agreement if it satisfies the equality:

$$\boldsymbol{\lambda}^{**} + \bar{f}_i(\boldsymbol{\lambda}^{**}) + \bar{f}_{-i}(\boldsymbol{\lambda}^{**}) = \tilde{f}_i(\theta) + \tilde{f}_{-i}(\theta)$$

TMPA - Fishing agreements





Conclusions

According to our results, we can say that:

- Strategic behavior allows for TMPAs to be used as a management tool for transboundary fisheries, sometimes even replicating the first best
- When designed properly, a TMPA can be analogous to a bilateral fishing agreement
- Results are robust when including cost-dependent profit functions

Thank you!