Marine Reserve Creation and Interactions between Fisheries and Aquaculture: A Bio-economic Model Analysis

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Content

- Study’s objectives
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- Management regimes
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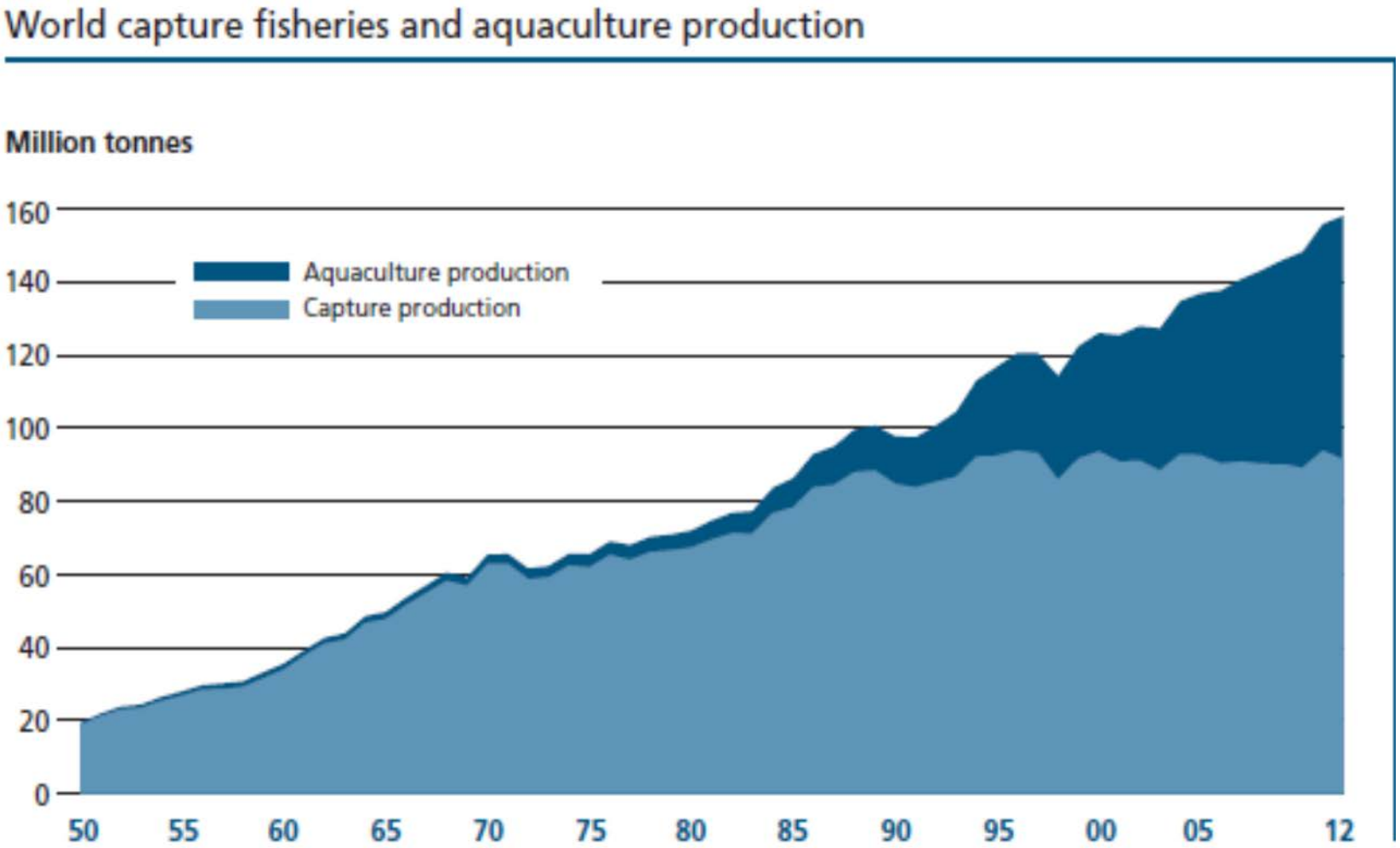
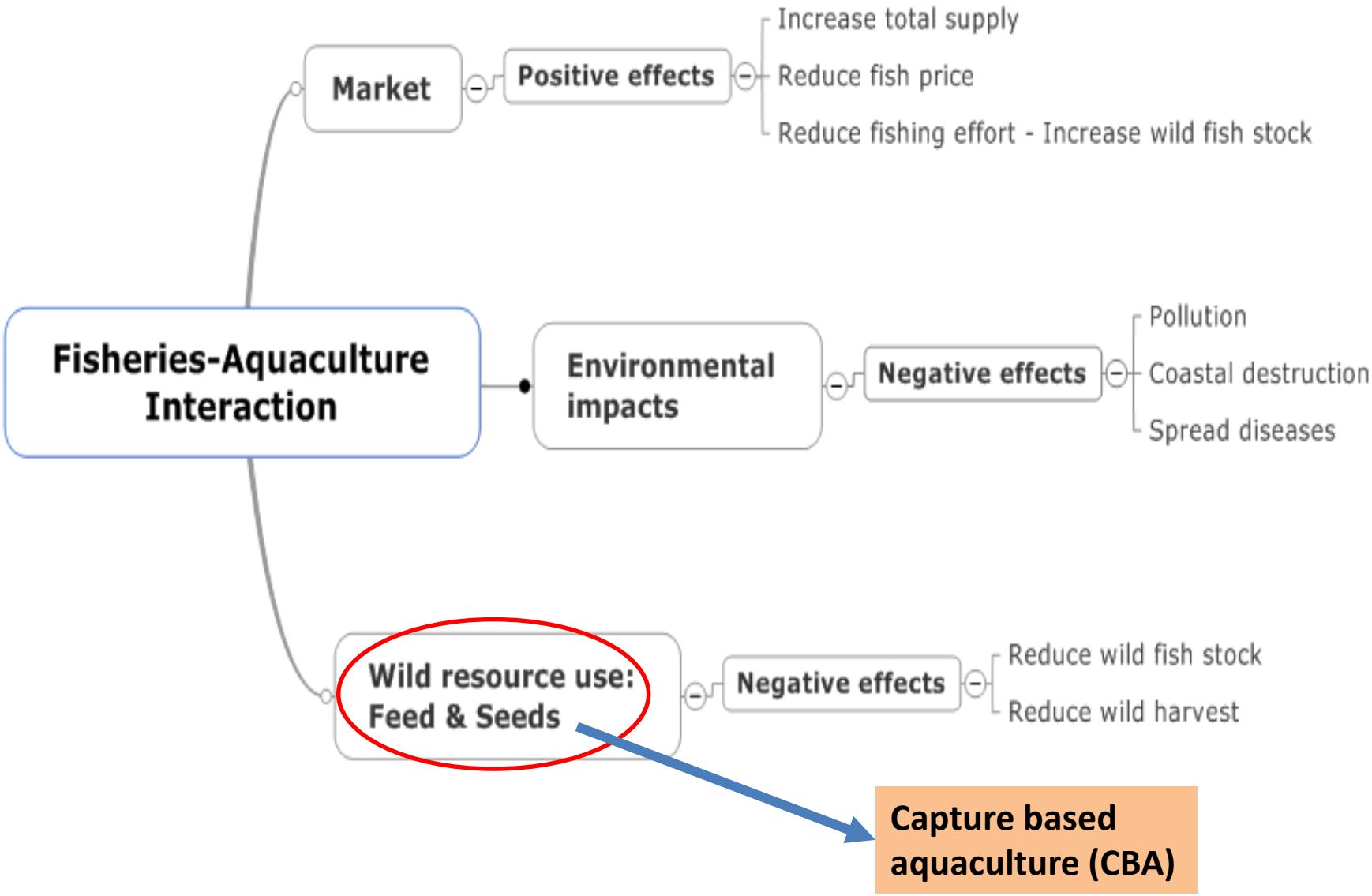
- Discussion & Conclusion

World fish production

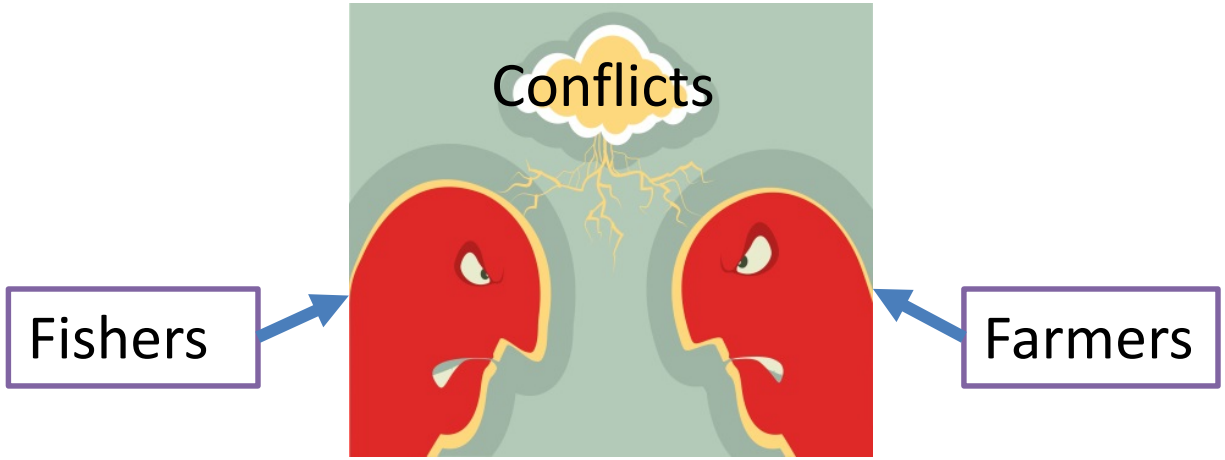


Source: FAO, 2014

Fisheries and Aquaculture Interactions



Interest Conflicts



- Ocean space
- Production

Can MPA help?

CBA and Reduction in Fish Stock

Collecting wild juveniles for CBA

Increase

Natural mortality of pre-recruitment

Reduce

Intrinsic population growth rate

Reduce

Natural growth rate of the fish stock

Reduce

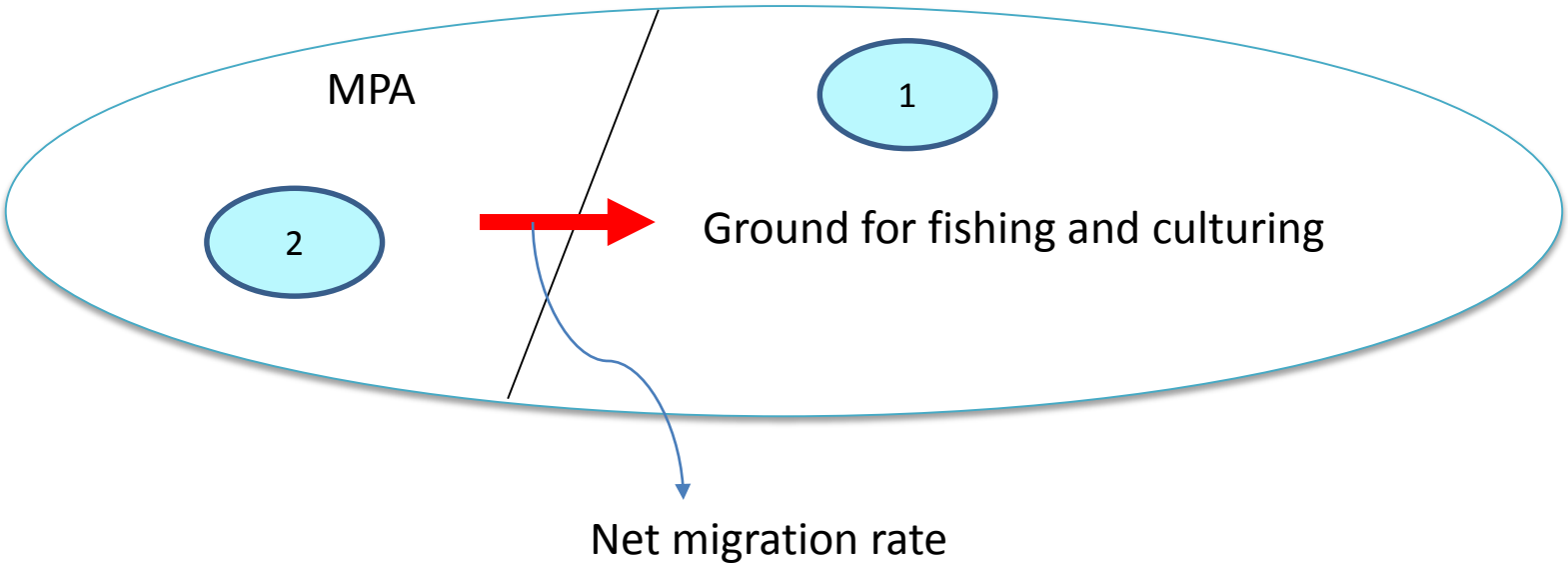
Source: corlorbox

Simon et al. (2012)

Research questions

- What is trade-off between wild fishery and CBA?
- Can MPA help to reduce conflicts of interests among users in both management regimes: open access and optimum?

Division in Ocean space



Bioeconomic models

Sub-population net growths in the fishing ground and the MPA

$$\dot{X}_1 = r\left(1 - \exp\left(-\frac{X_1}{\alpha N}\right)\right)X_1\left(1 - \frac{X_1}{(1-m)}\right) + \gamma\left(\frac{X_2}{m} - \frac{X_1}{(1-m)}\right) - Y_{1f}$$

$$\dot{X}_2 = rX_2\left(1 - \frac{X_2}{m}\right) - \gamma\left(\frac{X_2}{m} - \frac{X_1}{(1-m)}\right)$$

Total net benefits from the wild fishery and aquaculture

$$V(X_1, N) = \left[\left(p_f - \frac{c}{qX_1}\right)Y_{1f}\right] + [p_a N - \nu N^2 - bz]$$

Flaaten and Mjølhus (2010)

X_1: nomalized stock in fishing ground
X_2: nomalized stock in the MPA
m: MPA size (0<m<1)
γ: migration coefficient
r: intrinsic growth rate of the fish stock
q: catchability
p_f: unit price of wild fish

N: produced volume of farmed fish
α: sensitivity aquaculture coefficient
ν: unit operating cost of aquaculture
b: cost of investment for a unit of produced volume of farmed fish
z: increment to the total aquaculture production
p_a: unit price of farmed fish

Management regimes

- Open access (OA)
  - Pure open access
  - Open access outside MPA
- Optimal management
  - Pure optimal management
  - Optimal management outside MPA

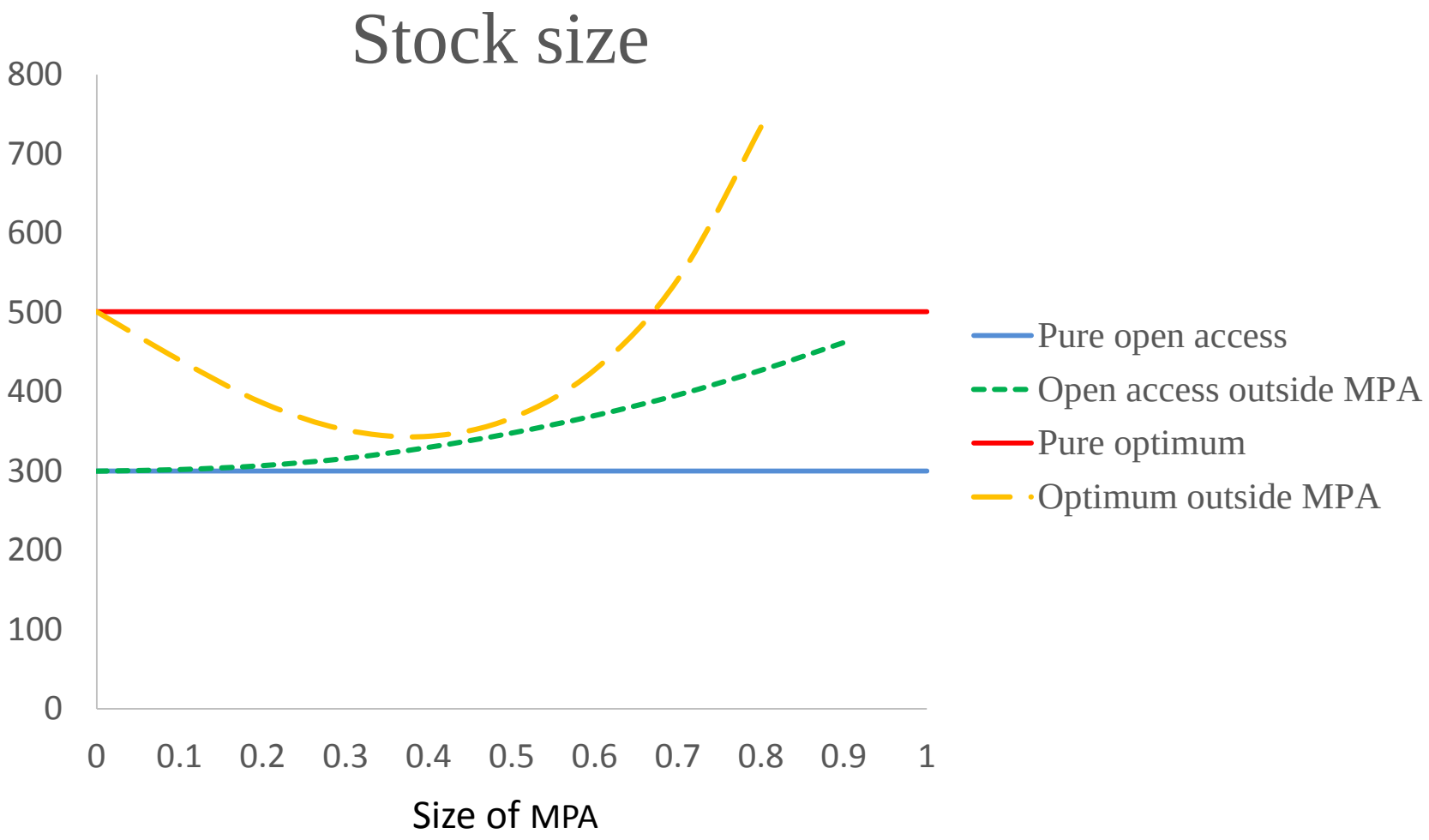
Numerical Simulation

Table 1. Parameters for Wild Fishery and Aquaculture

Variable	Description	Unit	Value
α	Aquaculture sensitivity coefficient	(farm x time)$^{-1}$	100
ν	Aquaculture production operating cost	USD/year/area	0,4
c	Unit cost of fishing effort	USD/day	0,3
q	Catchability coefficient	day^{-1}	1
p_f	Unit price of wild fish	USD/volume	1.2
p_a	Unit price of farmed fish	USD/volume	1
r	Intrinsic growth rate	time^{-1}	0,4
b	Investment cost	USD/year/area	0,2
γ	Migration coefficient		0,5
δ	Discount rate		0.07

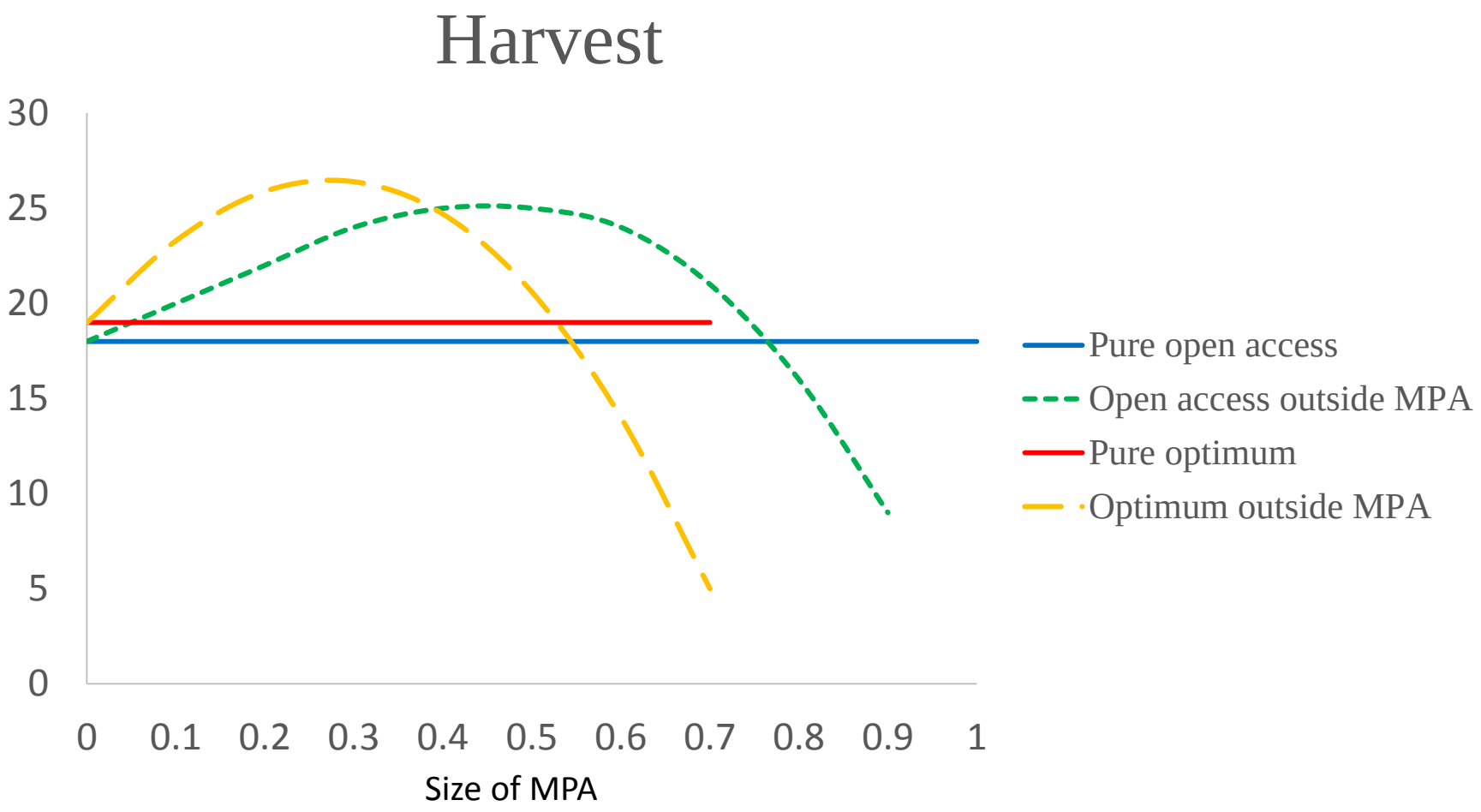
What did we find?

Effect of varying size of MPA (*m*) on wild fish stock under OA and Optimal Management



What did we find? (cont.)

Effect of varying size of MPA (*m*) on wild harvest under OA and Optimal Management



What did we find? (cont.)

Simulation results for the steady-state equilibria in the bioeconomic optimum

Output variable	Description	Unit	Without MPA	With MPA (m)			
				0.1	0.3	0.5	0.7
S_1^*	Stock size in fishing ground	volume		434.4	293.3	174.4	81.6
S_2^*	Stock size in MPA	volume		5.6	58.8	192.3	460.0
S^*	Total stock size	volume	501.0	440.0	352.1	366.7	541.6
N^*	Amount of CBA	volume	1222.2	1223.9	1227.7	1230.7	1232.4
y_f^*, y_{1f}^*	Harvest in tons	volume	18.5	23.3	26.4	20.6	5.1
V^*	Total NPV	currency	8838.9	8893.9	8941.2	8880.1	8704.1
V_f^*	NPV from wild fishery	currency	159.2	214.0	261.0	199.8	23.8
V_N^*	NPV from aquaculture	currency	8679.7	8679.9	8680.2	8680.3	8680.3

So what?

- What is trade off between wild fishery and CBA?
  - More aquaculture production, less commercial wild catch.
- Introduce MPA can help?
  - Yes. MPA may mitigate economic conflicts among fishers and farmers
  - At certain size of MPA, production of wild and farmed fish is higher than without MPA, for both open access and optimal management regimes.

So what?


What drives model's results?
Heterogeneous intrinsic growth rate between MPA and fishing ground

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Thank you !!!