Determination of the Optimal size of an MPA: A Bioeconomic Model with “Sasi” system in Indonesia

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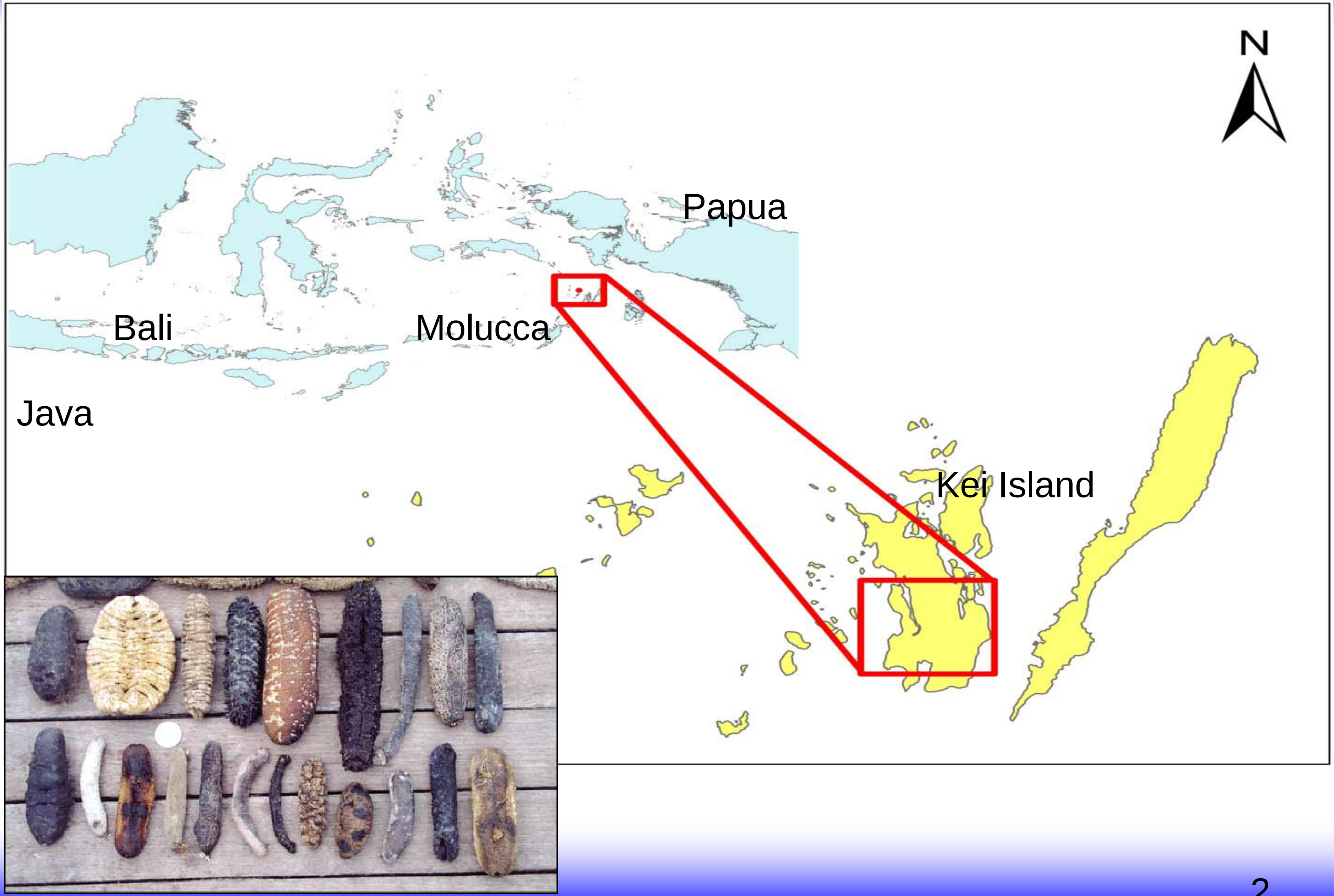
Map of Indonesia



Outline

Motivation and Objectives

Literature Review

Data and Model Development

Result and Analysis

Policy Recommendation

Motivation and Research Question

FISHERY MANAGEMENT

MPAs as a promising tool for fishery manage-ment

Biological front of MPAs

Benefits include biodiversity, age/size distribution, habitat improvement and stock recovery.

MPA acts as a mixed tool

Question: will MPA still give better economic gain compared to no MPA

"SASI"

The "SASI" system in Indonesia is basically similar to using seasonal opening in nature

RESEARCH QUESTION

Could an MPA based management system be designed so that it compares favorably in economic terms with SASI or other management systems?

Steps

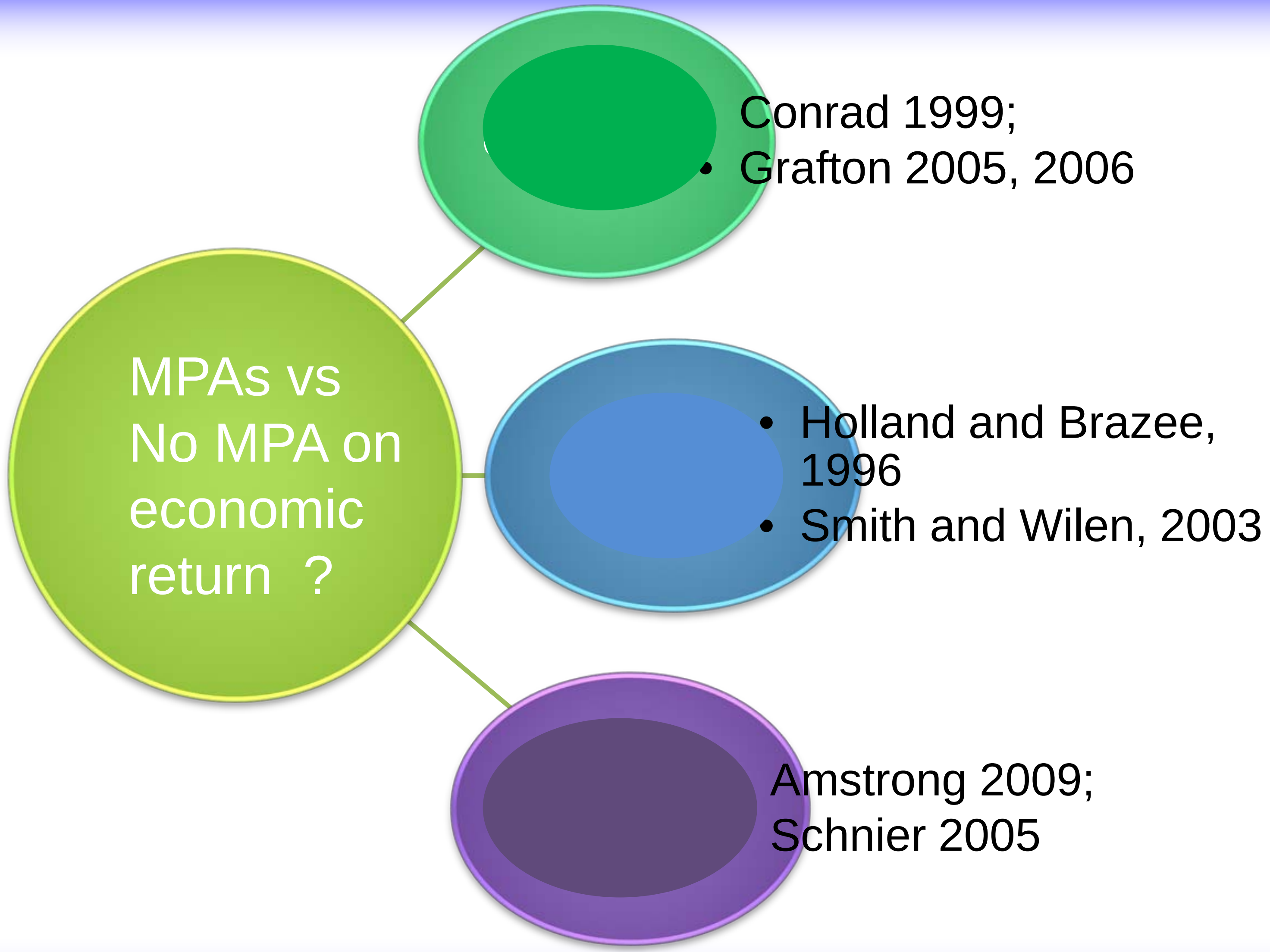
Bioeconomic Model

- MPA: two areas, fishing and no-take zone
- Fish growth model in the two areas
- Economic Model

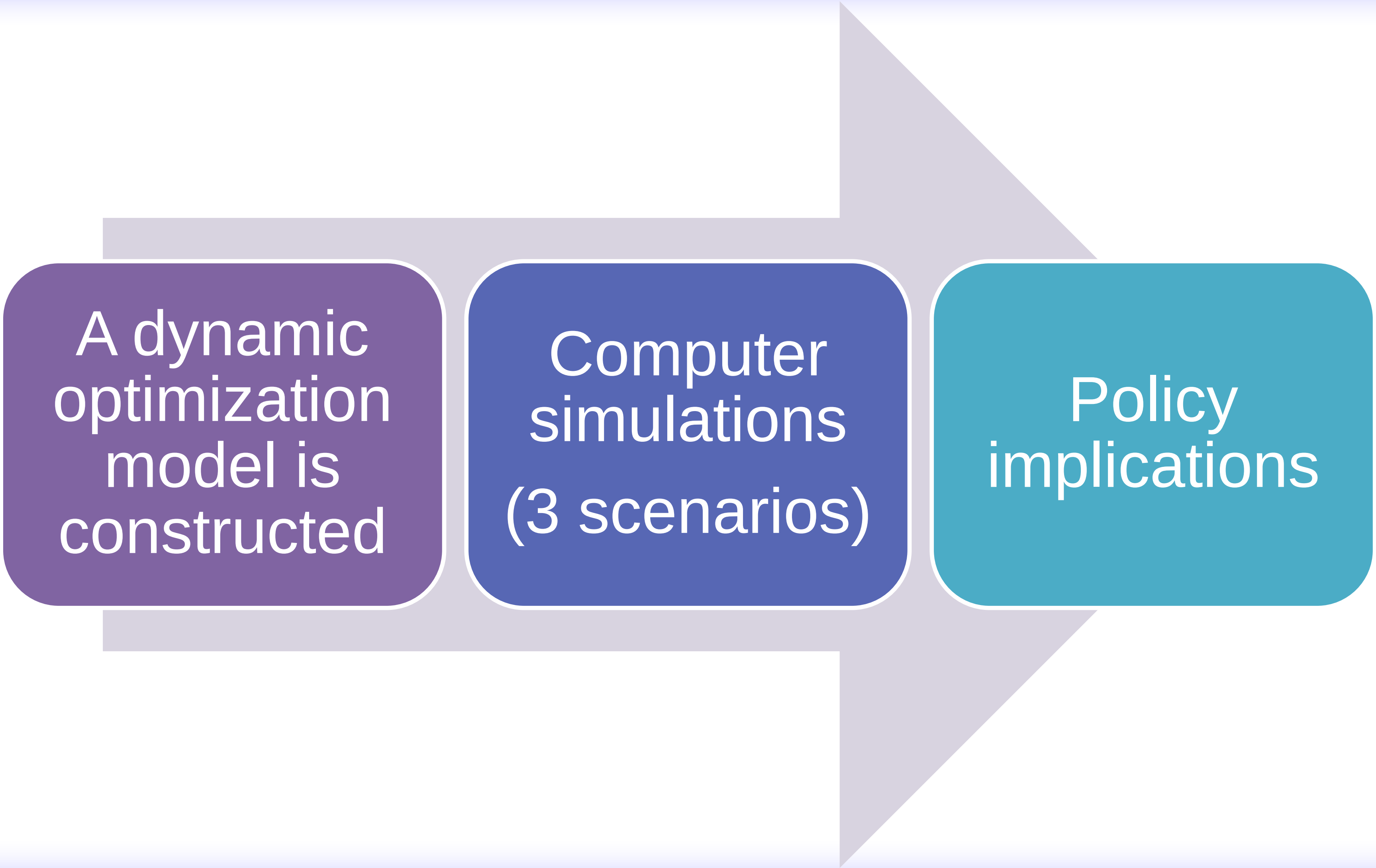
Apply to case of Indonesia

- Biological data from Molucca, Indonesia
- Policy Implication

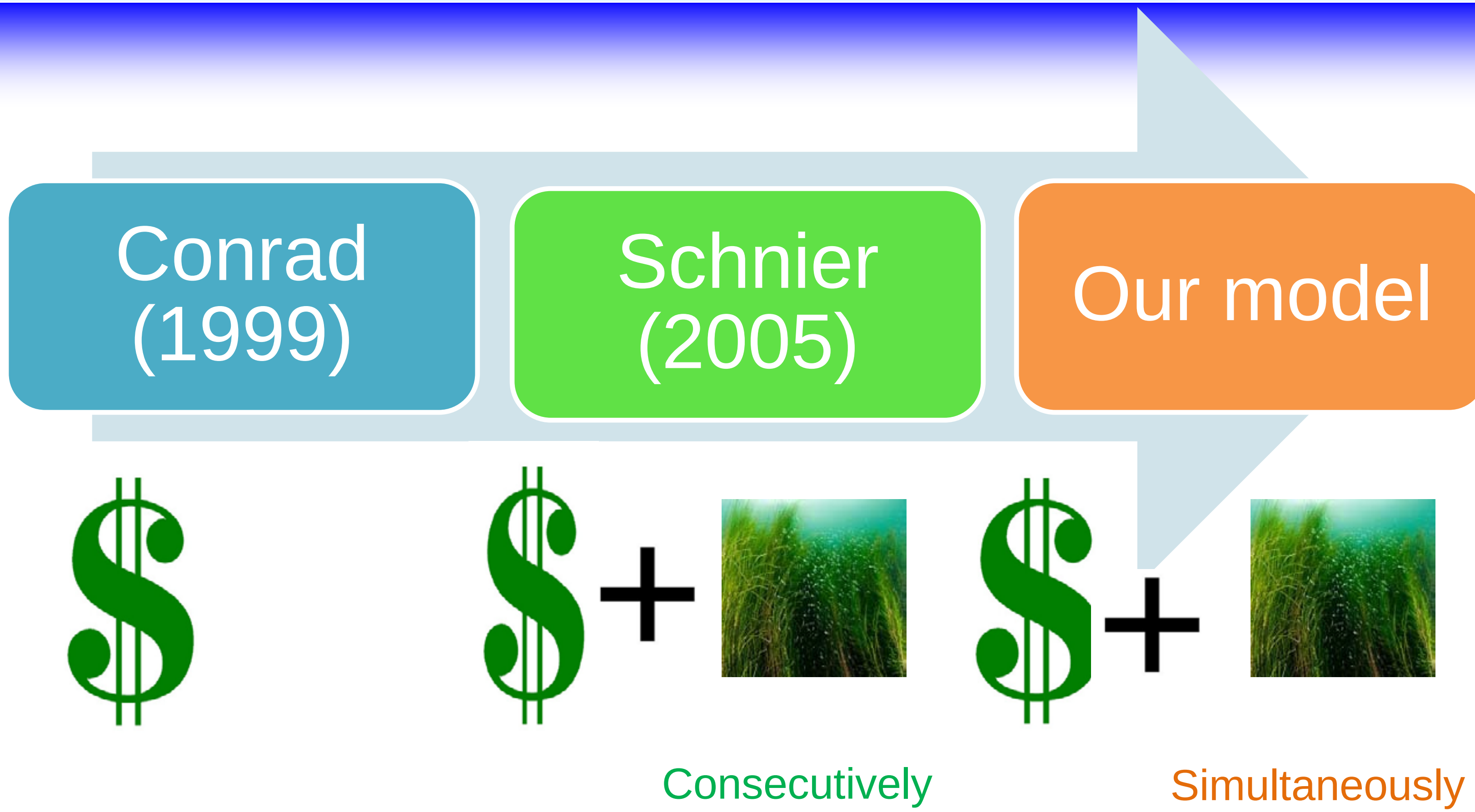
Literature on Bioeconomics of MPAs



Methodology



Model Development



Mathematical Formulation

$$\max_{H_t,m,T} = \int_0^T \left(P.H(t) - \frac{C}{X_o(t)} H(t) \right) e^{-\delta t} dt + \int_T^\infty \left(P.H(T) - \frac{C}{X_o(T)} H(T) \right) e^{-\delta t} dt$$

subject to :

growth | migration | harvest

$$\frac{dX_o(t)}{dt} = r_o.X_o(t)\left(1 - \frac{X_o(t)}{(1-m)K}\right) + z\left(\frac{X_m(t)}{m.K + g(m)} - \frac{X_o(t)}{(1-m)K}\right) - H(t)$$

$$\frac{dX_m(t)}{dt} = r_m.X_m(t)\left(1 - \frac{X_m(t)}{m.K + g(m)}\right) - z\left(\frac{X_m(t)}{m.K + g(m)} - \frac{X_o(t)}{(1-m)K}\right)$$

$X_o(0)$ and $X_m(0)$ given

Data

When and Where?

- Summer 2009
- Molucca Island, Indonesia

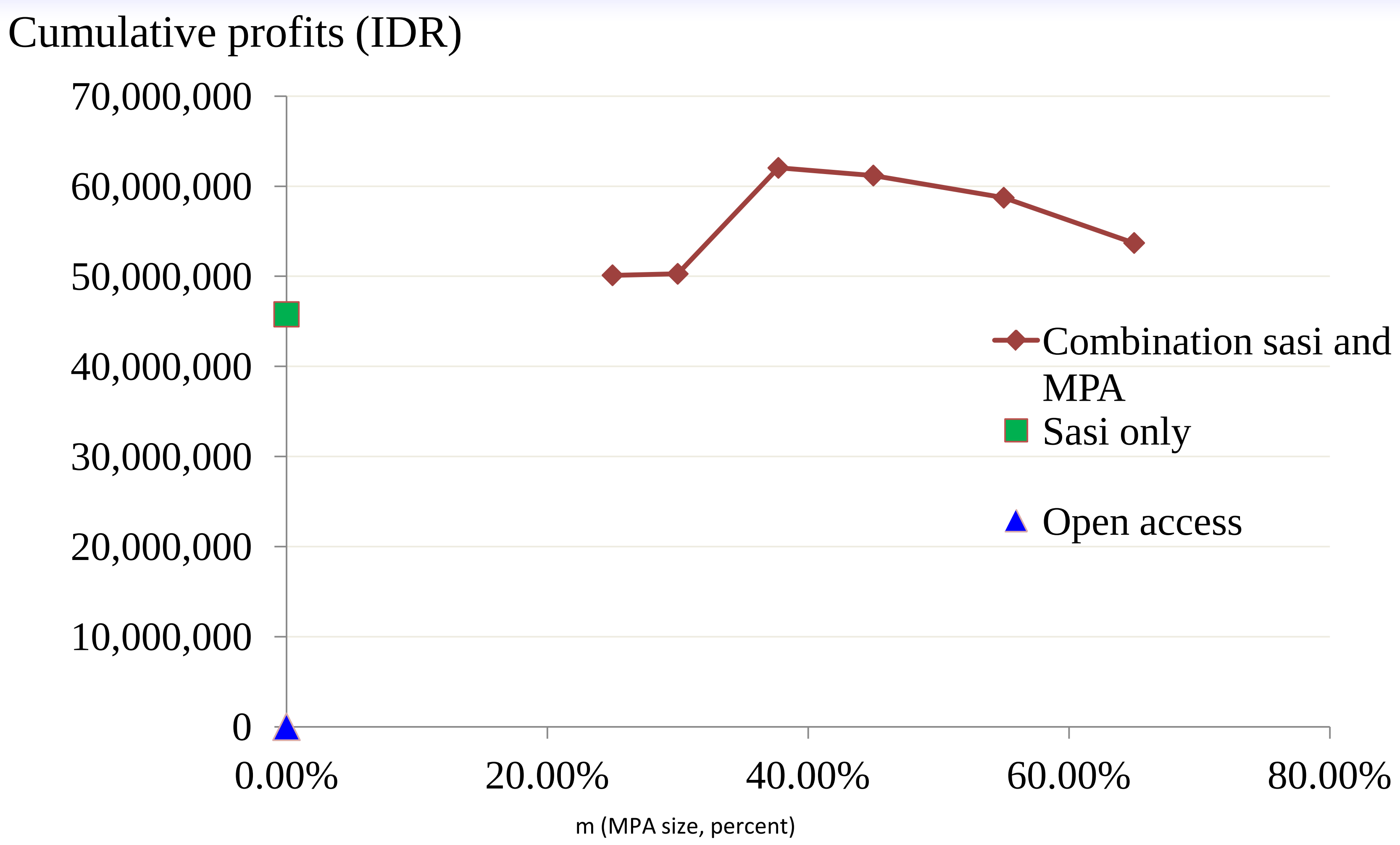
Biology

- Catch and monitoring data for open area and MPA from 2005-2009 for sea cucumber fishery.

Economy

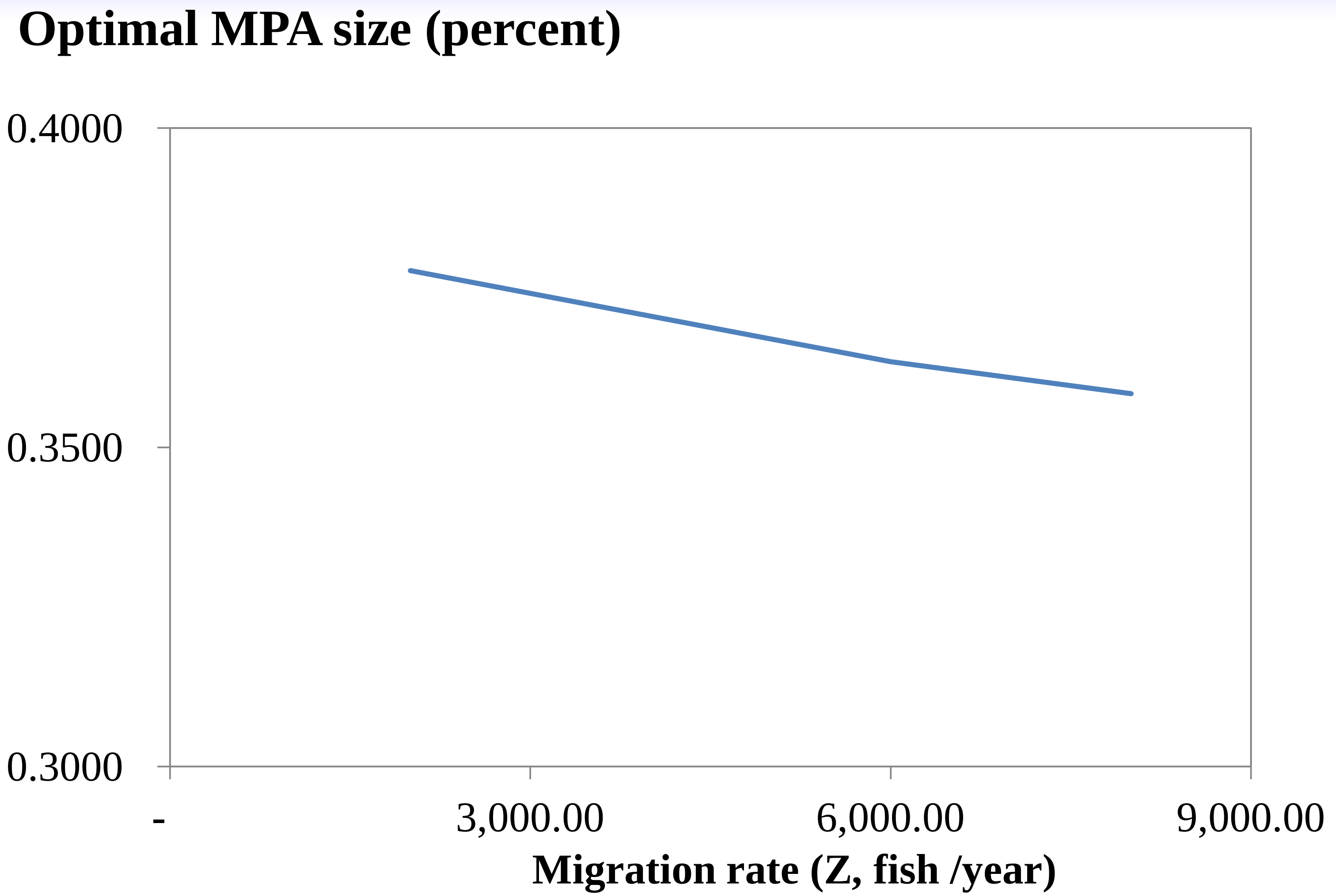
- Fish price and unit cost of fishing

Photo credit: Joshdick

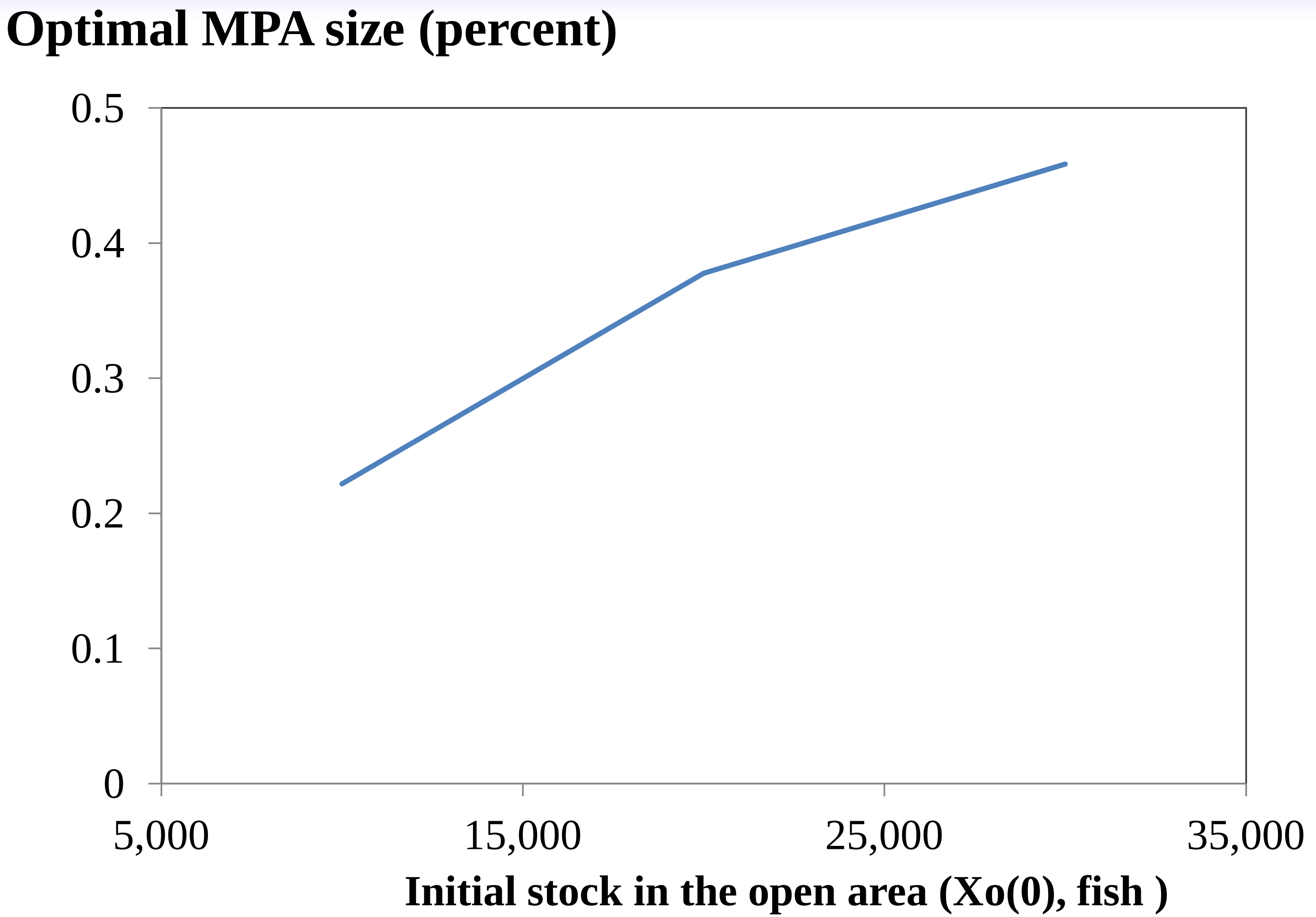


Cumulative profits (IDR)
70,000,000
60,000,000
50,000,000
40,000,000
30,000,000
20,000,000
10,000,000
0
0.00%
20.00%
40.00%
60.00%
80.00%
m (MPA size, percent)
Combination sasi and MPA
Sasi only
Open access

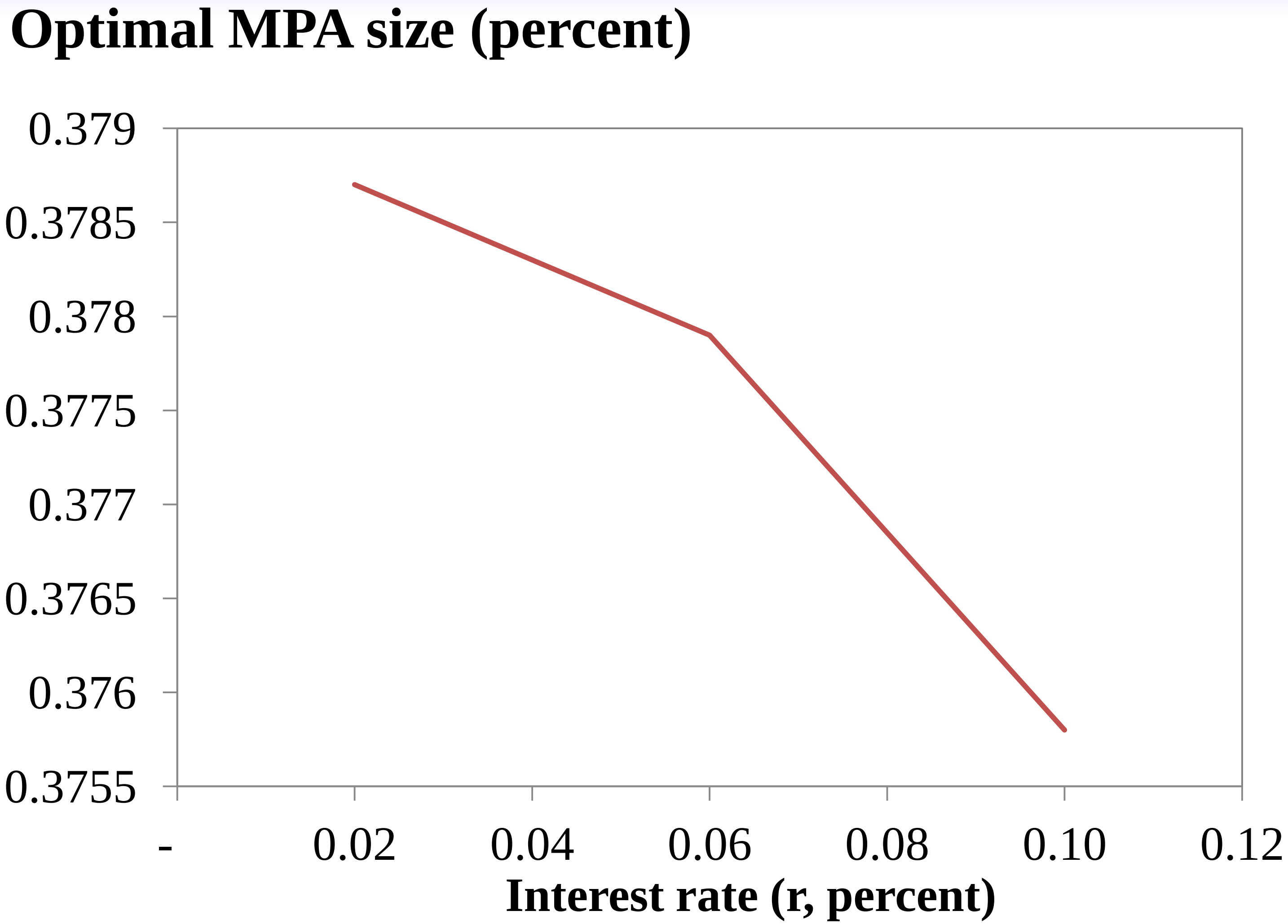
Sensitivity analysis with respect to migration rates



Sensitivity Analysis with respect initial stock sizes



Sensitivity analysis with respect to interest rate



Results

- Extend the theoretical literature
- Optimal MPA (m*) : 37.77 %
- Combination of SASI and MPA
- m* not is sensitive to interest rates (r)
- m* is not sensitive to initial stock, X(0)
- m* is not sensitive to migration rates (Z)

Policy Implications:

- An integrated and mixed approach is an option for fishery management reform in Indonesia
- MPA and traditional management measures → community-based MPA and fishery management, decentralization efforts
- Policies on "sasi" revitalization in the Eastern part of Indonesia.

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