Alternative harvest control rules for multi-fleet and multi-species tuna fisheries under data-poor conditions in Eastern Indonesia

Shinta Yuniarta[1,2], Rolf Groeneveld[1], Paul van Zwieten[1], Budy Wiryawan[2], Johan Verreth[1], Ekko van Ierland[1].

1)Wageningen University and Research, Netherland
2)Bogor Agricultural University, Bogor, Indonesia

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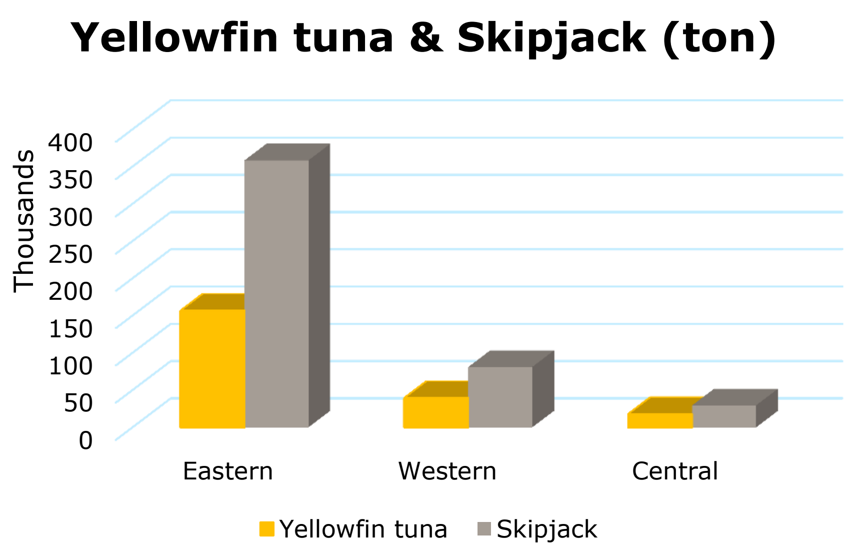
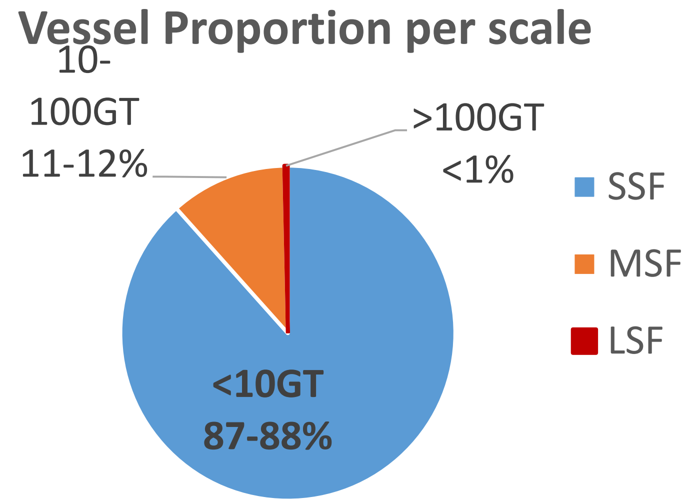
Tuna Fisheries in Indonesia and challenges on its fisheries management





Source: Fisheries Statistics Indonesia 2016

- **Gears**: longline, handline, pole-and-line, purse-seine, troll-line
- **Lack of good data**: identified in 1980, major changes logbook(2002&2010), Indonesian catch was 38% higher in 1950-2010
- **Multiple species**: yellowfin, skipjack, bigeye, small pelagic
- **Open-access system** in vessel <5GT, high labour absorption

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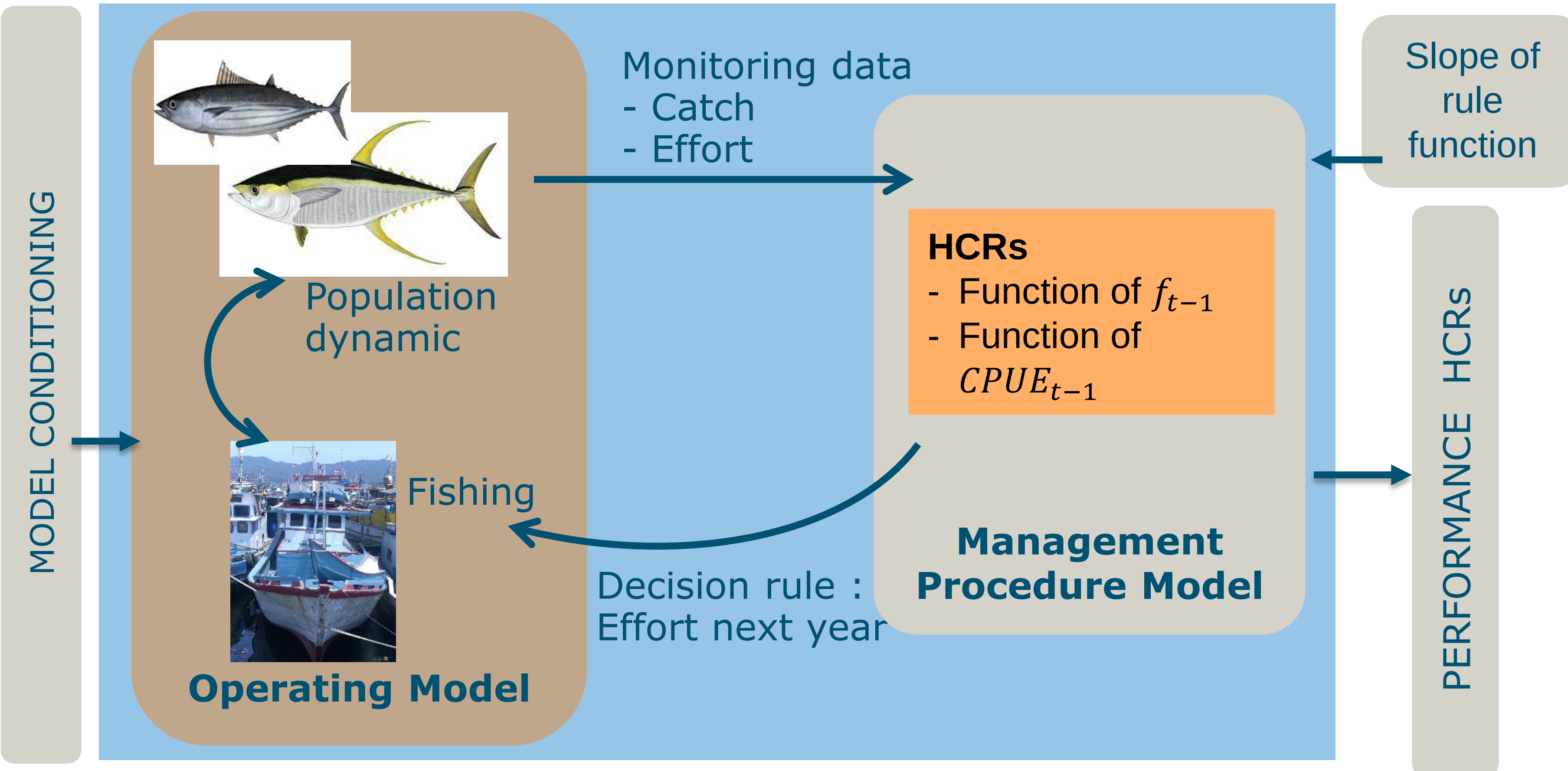
Solution (Alternative HCRs?)

- Demand for HS from stakeholders (industries & NGOs)
- Adopting HCRs by considering: data-poor, multi-scale, multi-species and social impacts
  - **HCRs & data-poor fisheries:** Dichmont & Brown (2010), Carruthers et al. (2014), etc.
  - **HCRs & multi-fleet, multi-species:** Smith et al. (2009), Little et al. (2011)
  - **MS & multi-species, economics :** Dichmont et al. (2008)
- HCR evaluations considering all challenges together are scarce

Objective of this study:

Develop alternative harvest control rules by taking into account: data poor, multiple species and fisheries, social impacts

Management Strategy Evaluation (Non-model based)



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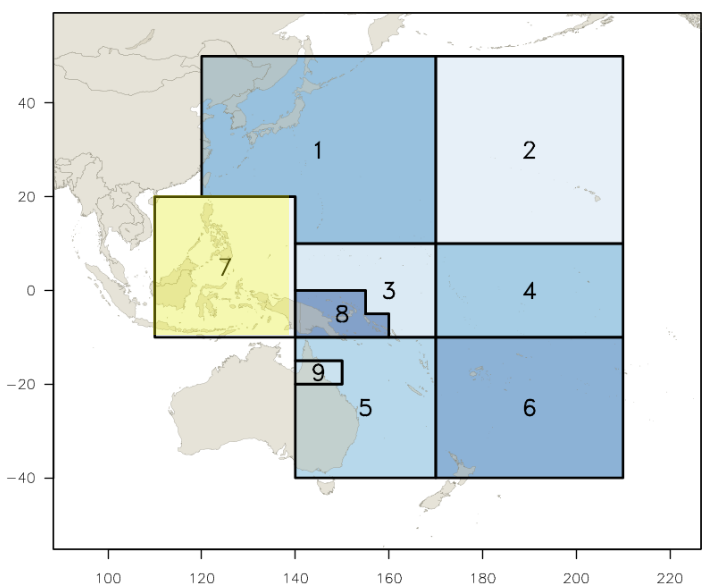
Operating Model

- An Age Structured Model;
- Beverton-Holt SRR;
- Baranov Catch Function



Parameter	Source
Age	WCPFC (2016); (WCPFC 2017)
Weight per age	Estimated from WCPFC (2016); (WCPFC 2017)
Natural Mortality (M)	Estimated from Hampton and Fournier (2001), Hampton (2000)
Catchability (q)	Assumed constant
Selectivity (s)	Estimated from Hampton and Fournier (2001), Hampton (2000),WCPFC (2016); (WCPFC 2017)
recruitment parameter	Estimated from WCPFC (2016); (WCPFC 2017)
Proportion of SSB	Estimated from WCPFC (2016); (WCPFC 2017)
Immigration and Emigration	Estimated from WCPFC (2016); (WCPFC 2017)
N0	Estimated from WCPFC (2016); (WCPFC 2017)
Mean Effort	Assumed (50000 vessels)

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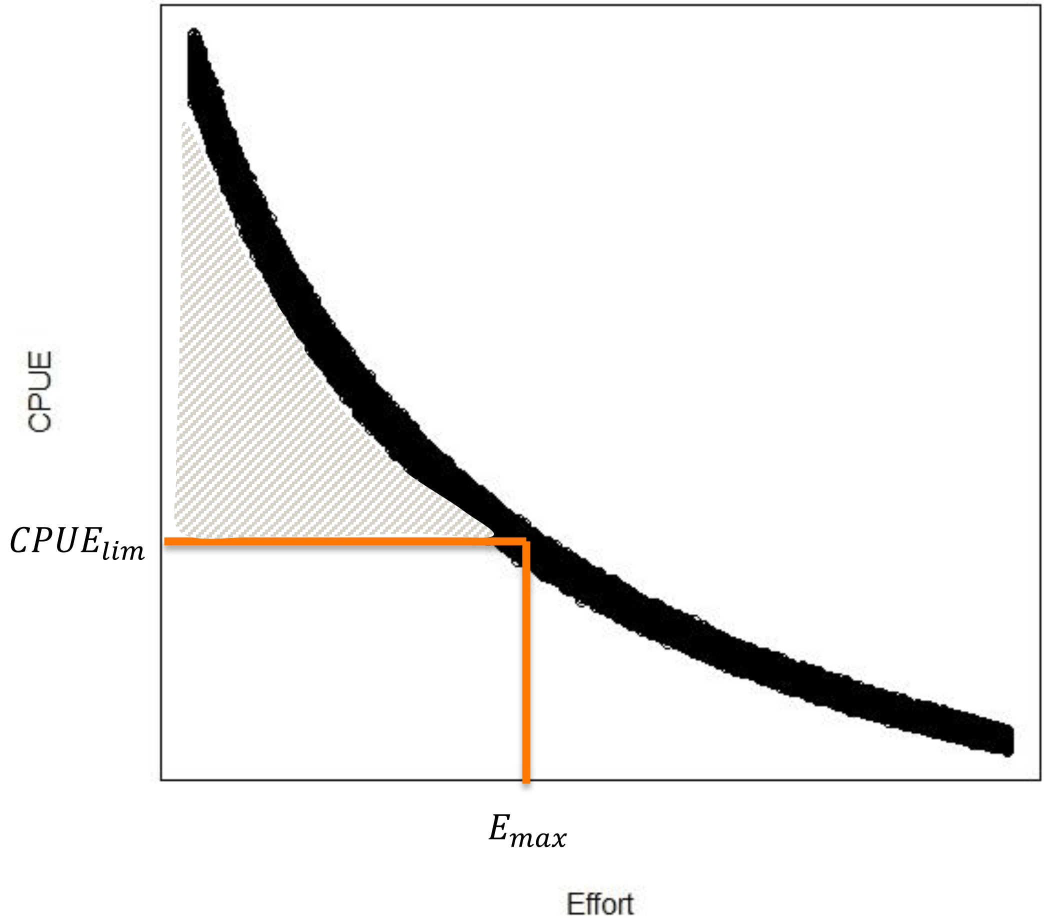
Reference Points



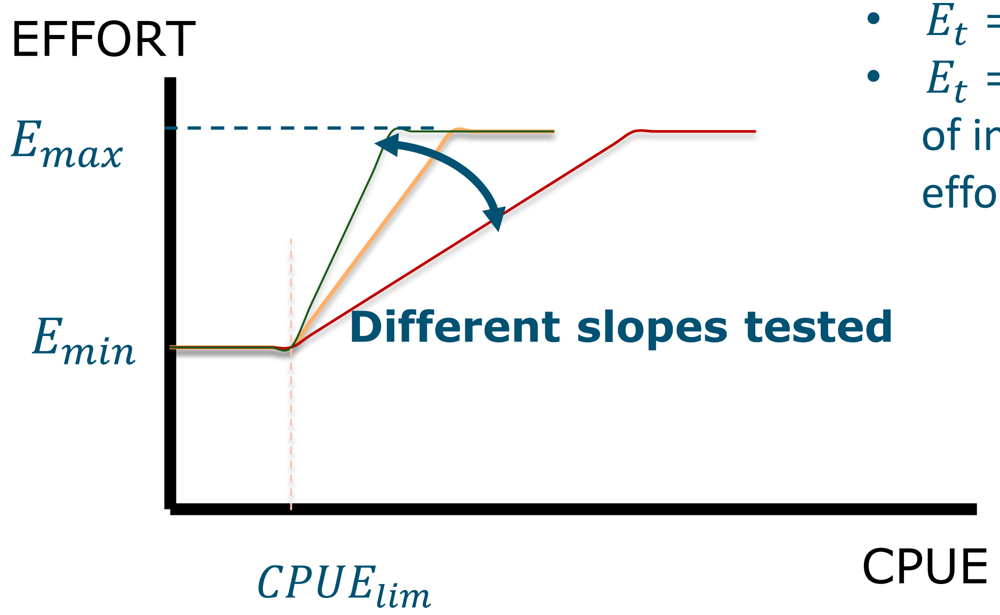
- Simulation OM: big range effort, run for 100 years,1000 draws
- $CPUE_{lim}$ at 0.4$CPUE_{max}$
- E_{max} is an effort that associated with $CPUE_{lim}$
- $E_{min} = 1000$
  a social policy rule of the fisheries.

Alternative Harvest Control Rules

HCR1) Effort is a function of last year's effort

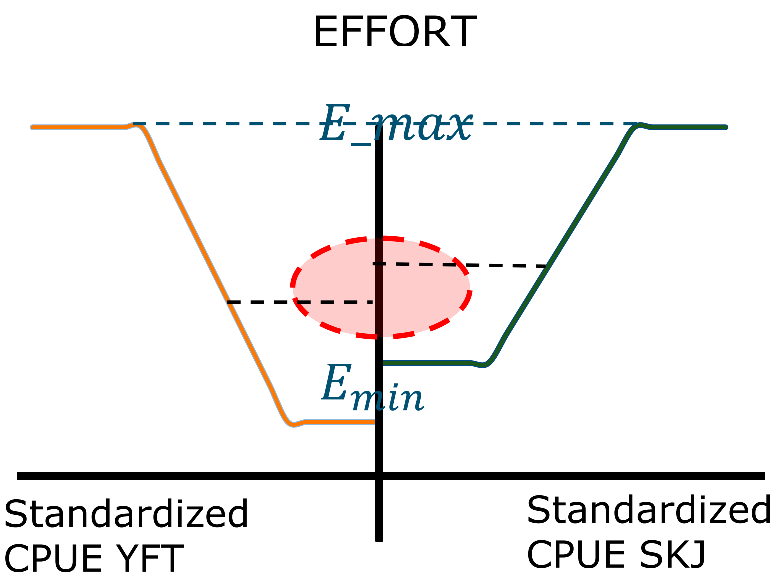
- $E_t = E_{t-1}$
- 1st year of projection $E_t = 1.5\ E_{t-1}$, after that constant
- $E_t = 1.01\ E_{t-1}$

HCR2) Effort is a function of CPUE



- $E_t = f(CPUE_{t-1})$, **without threshold**
- $E_t = f(CPUE_{t-1})$, **with threshold** 20% of increasing and decreasing effort from last year's

Alternative Harvest Control Rules



For HCRs of mixed species, we use precautionary approach to determine effort in the rule

HCR3) HCR2 with a minimum effort available to SSF
to limit social impacts

Performance Evaluation

- **Present Value of Profit**;

  consequences on the fishing rent

- **Minimum Effort**;

  - consequences on the effort stability
  - risk of effort reach E_{min}

- **Income earned by the poorest fishers**;

  - consequences on the proportion of the poorest
  - risk of fisher's income < $25x10^6$ rupiah/year

- **Status stock ;**

  - Consequences on the stock
  - risk of $B_t < 0.4B\_v_t$

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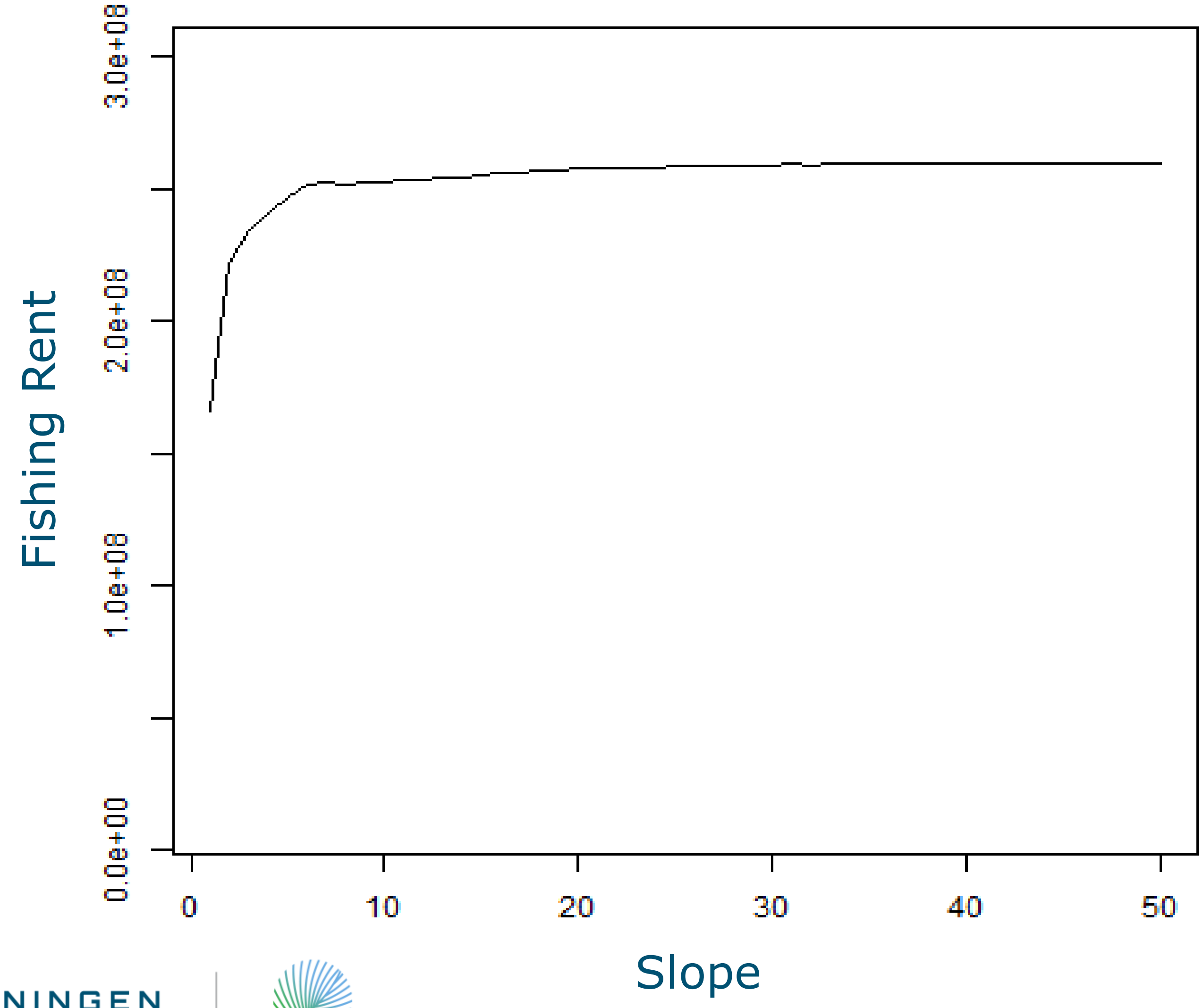
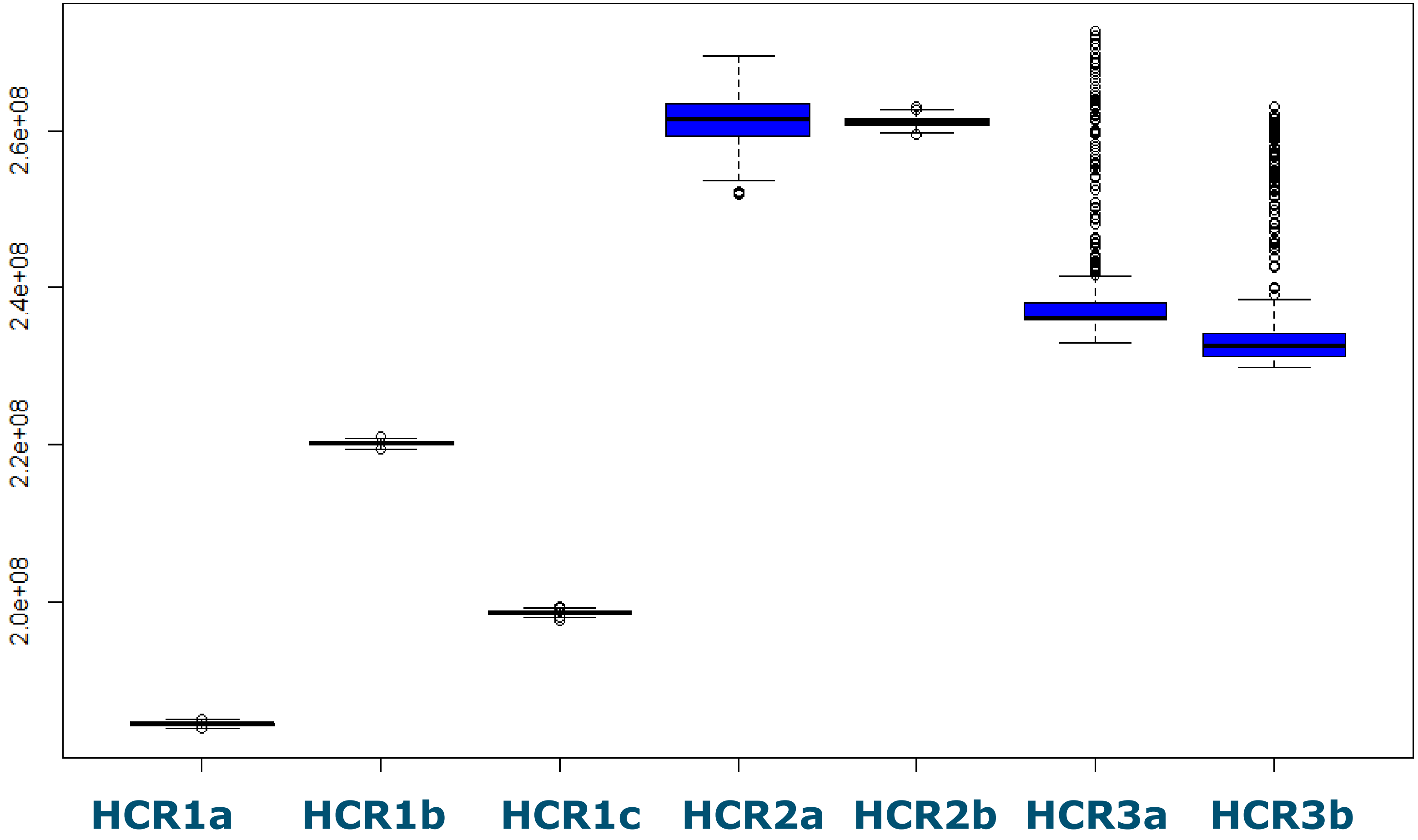
Slope and Present Value of Profit

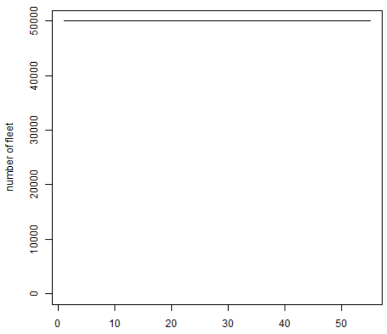


Performance of HCRs on Fishing Rents (in 10^6 rupiah)

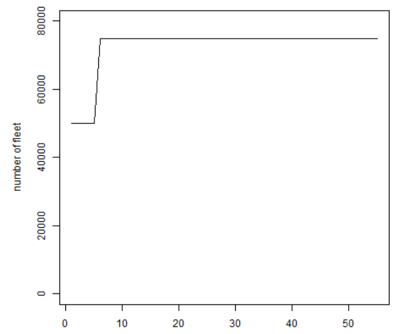


Performance of HCRs on Minimum Effort

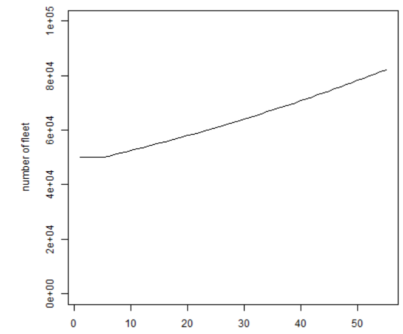
HCR 1a (0%)



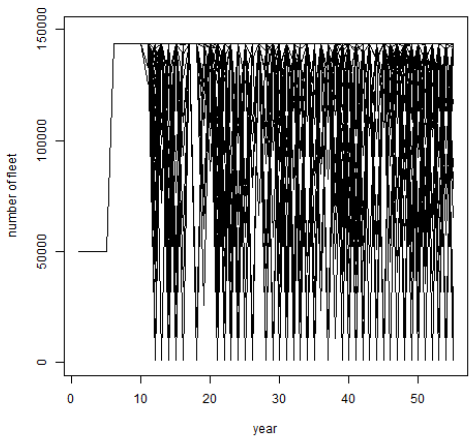
HCR 1b (0%)



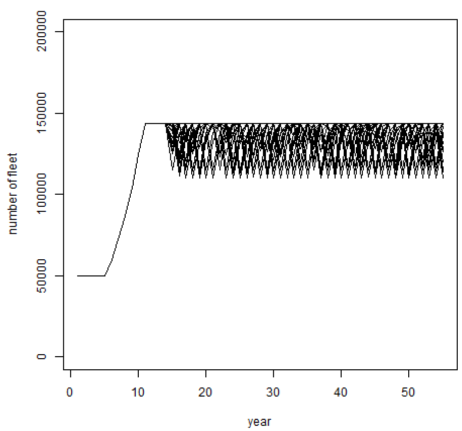
HCR 1c (0%)



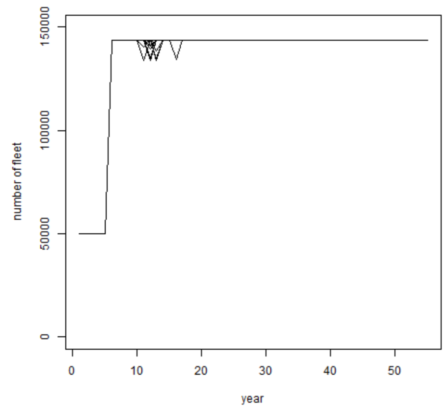
HCR 2a (4%)



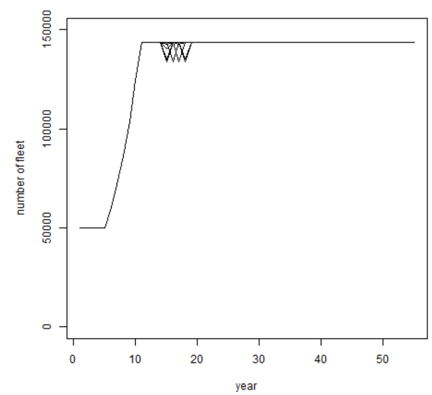
HCR 2b (0%)



HCR 3a (82%)



HCR 3b (90%)



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Performance of HCRs on income earned by the poorest (Risk fishers earn <25 10^6 Rupiah/year)

HCRs	Risk		
	SSF	MSF	LSF
HCR1a	96%	2%	0%
HCR1b	96%	89%	0%
HCR1c	96%	51%	0%
HCR2a	94%	2%	0%
HCR2b	94%	2%	0%
HCR3a	4%	40%	90%
HCR3b	4%	40%	91%

Performance on Status Stock (Risk of $B_t < 0.4B\_v_t$)

Management Strategy	Risk	
	Skipjack	Yellowfin tuna
MS1a	<2%	<2%
MS1b	>90%	<2%
MS1c	>40%	<2%
MS2a	>80%	<2%
MS2b	>90%	<2%
MS3a	>90%	<2%
MS3b	>90%	<2%

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Conclusion

- Protecting SSF would have the price of efficiency and trade-off between fisheries
- Performances on the HCR with effort is a function of CPUE → maximizes fishing rent but unrealistic (bang-bang fishery). Constant effort is less efficient but more realistic

QUESTIONS?

THANK YOU