



tafi

Tasmanian Aquaculture
and Fisheries Institute



UTAS



Tasmania
Explore the possibilities

No-Take MPAs and Sustainability

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TAFI is a joint venture between the State Government and the University of Tasmania

The Problem:

- On-going interest in the establishment of no-take MPAs.
- Original claims were that 10% of coastline needed to be in MPAs.
- Then 20%.
- Now up to 30%!
- Often touted as the solution to all marine resource management issues.

Objectives of Talk

- Outline the MPA debate in relation to their effects on fisheries.
- Describe the approach used in our investigations of MPAs and fisheries (FRDC 1999/162).
- Characterize some effects of MPAs on fisheries (according to our models).
- Draw conclusions in relation to Fisheries and MPAs.

Marine Protected Areas

An area of sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means

after IUCN 1994

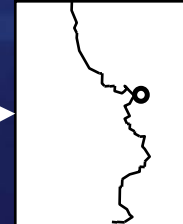
Lots of Claims/Intuitions

- **Large areas, closed to fishing, will act as reproductive centers and replenish areas both outside and inside the reserves (& spillover).**
- **MPAs are an alternative when fisheries management or information is absent.**
- **Migratory species would not benefit.**
- **No fisheries benefit for sedentary, benthic species, with limited larval dispersal (e.g abalone).**
- **MPAs can only be optimized for single species (compromises multi-species diversity objective).**

Tasmanian Marine Protected Areas



Tasmania



Governor Island



Maria Island

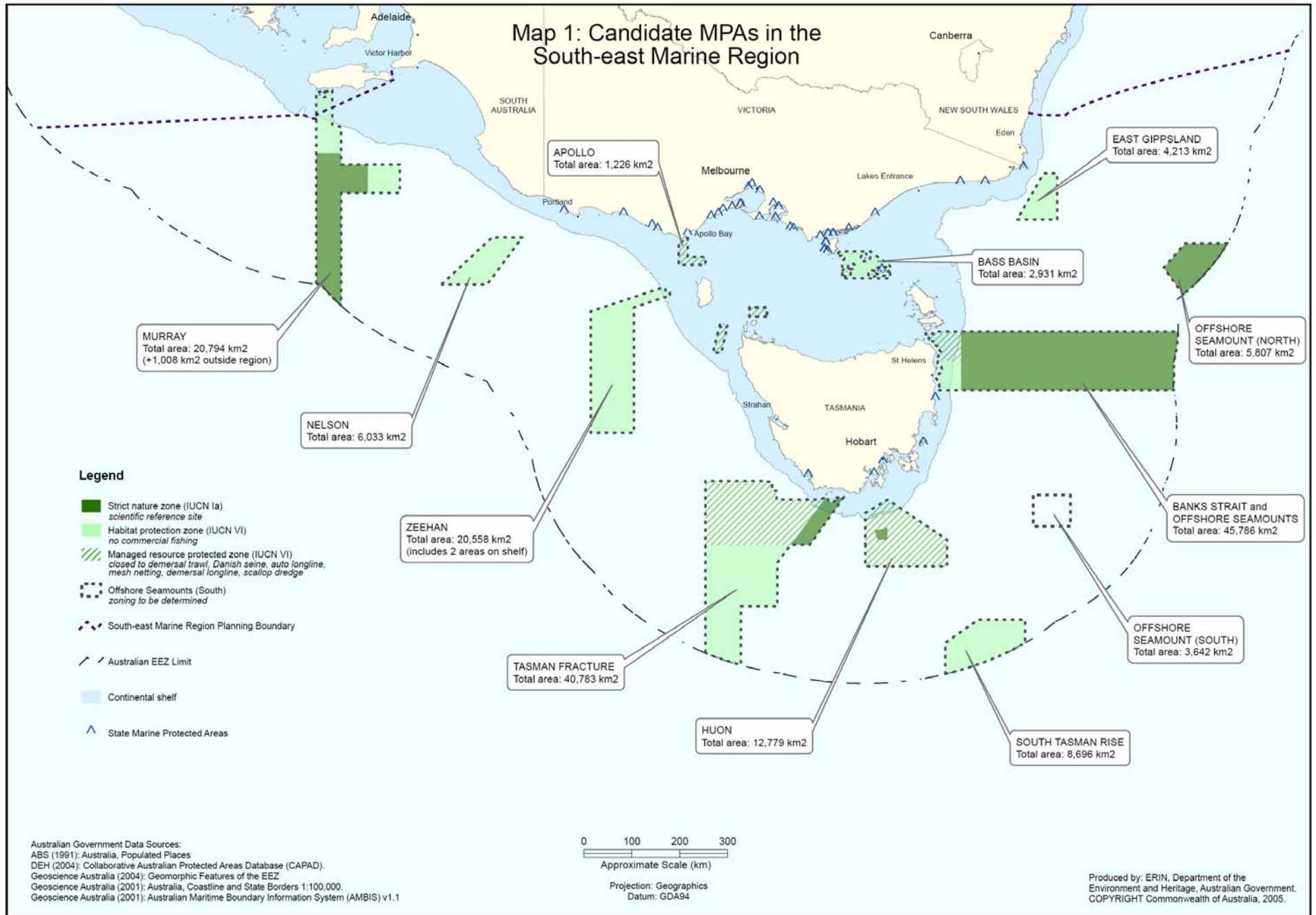
Tinderbox



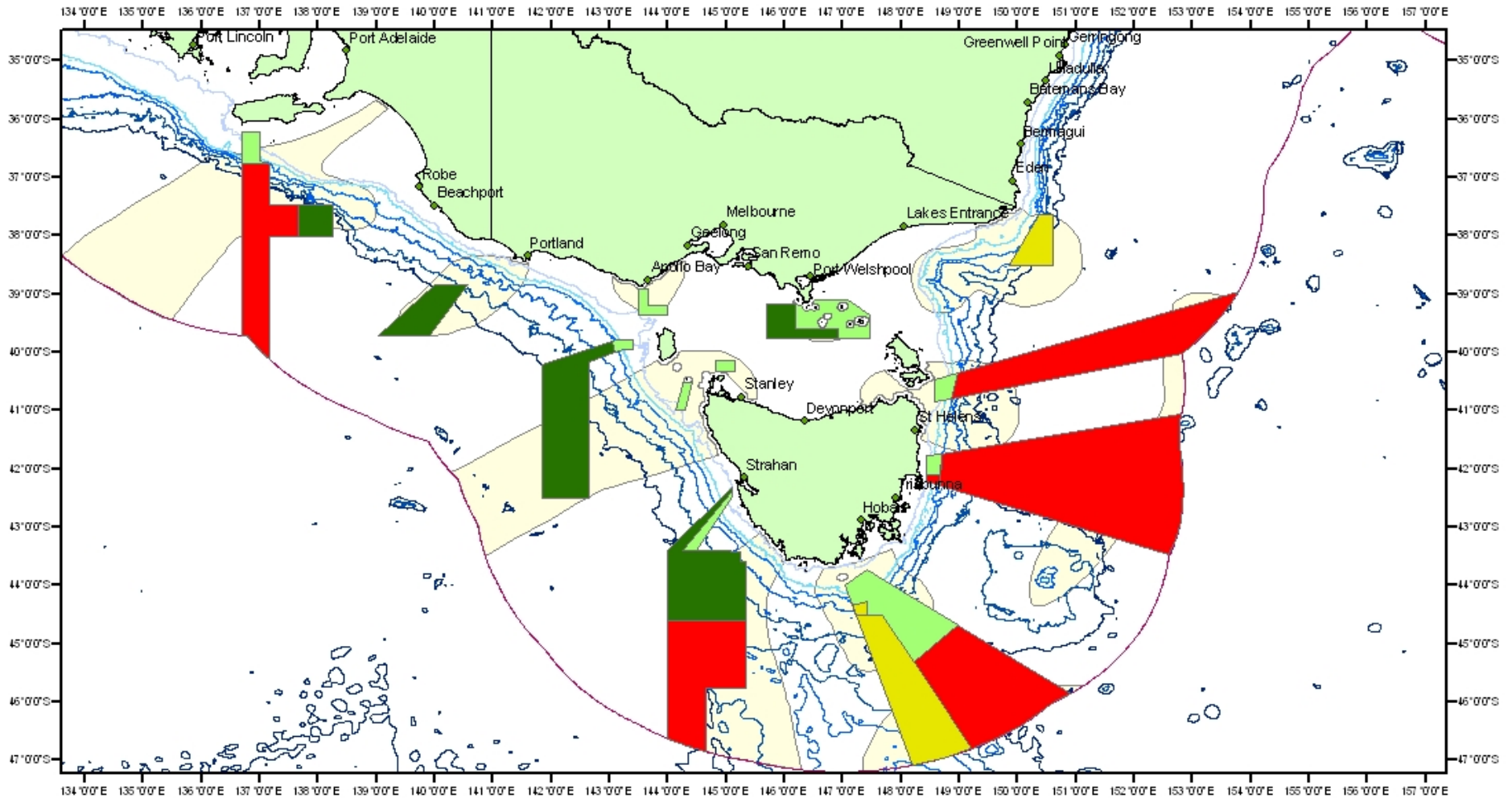
Ninepin

Proposed Commonwealth MPAs



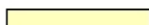

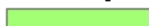







Map 1: Candidate MPAs in the South-east Marine Region

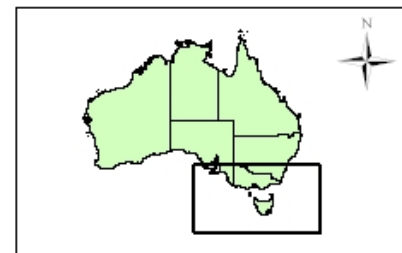


Final Commonwealth MPAs



LEGEND

	Australian EEZ Limit		100
	Broad Areas of Interest		200
IUCN Zoning and protection			
	Managed resource protection zone (IUCN VI)		1000
	Managed benthic protection zone (IUCN VI)		2000
	Habitat protection zone (IUCN VI)		3000
	Strict nature zone (IUCN Ia)		4000



Threats to Marine Ecosystems

- **Fishing**
- **Habitat loss**
- **Pollution**
- **Introduced species**

Threats to Fishing

- **Habitat degradation or modification**
- **Pollution from urban and industrial development**
- **Introduced species**
- **Over-fishing and effects of fishing**
- **Resource use and allocation conflict (displacement of effort from MPAs)**

Potential MPA benefits

- **Conservation of biodiversity**
- **Fishery enhancement**
- **Scientific observation**
- **Community value**
 - **recreation**
 - **historical significance**
 - **cultural significance**
 - **education**

Potential Benefits of MPAs

- **Protection of biodiversity**
- **Restoring ecosystem balance**
- **Protection of spawner biomass**
- **Natural population age structure**
- **Recruitment source**
- **Source of surplus adults**
- **Insurance against stock collapse**

How to Investigate Impacts of MPAs?

- Long term field studies comparing status inside MPAs relative to similar areas outside MPAs.
- Use computer modelling to simulate the effects of introducing MPAs.
- In Tasmania we have used both these approaches – but I will focus on the simulation studies.

Simple Message but Complex Model!

Initial response -

You want me to do **WHAT!**

Second response -

Immerse in Detail

Detailed models of Tasmanian Rock Lobster and Abalone

Final Strategy -

Simplify

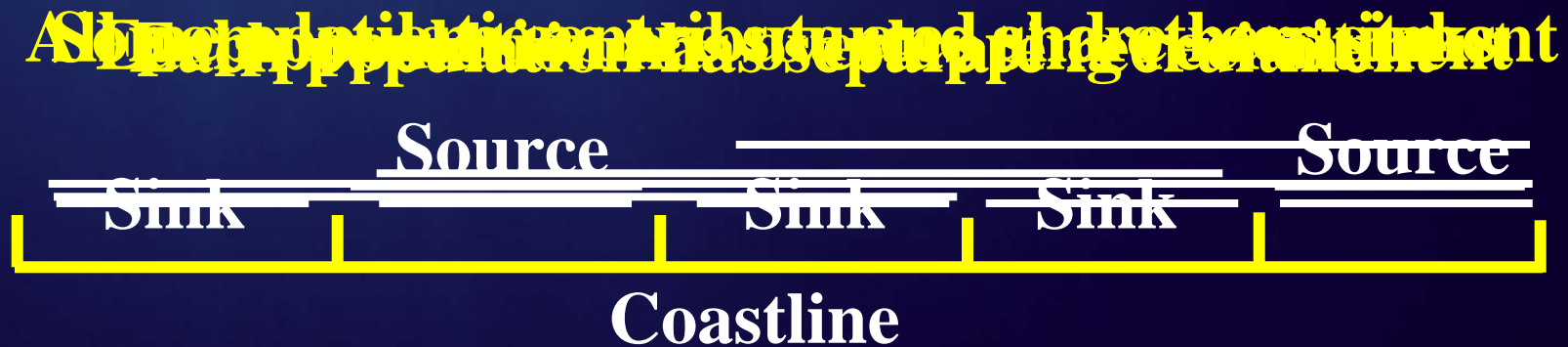
Base case – multiple identical populations

You're All Individuals

- Most systems have unique:
 - catch histories,
 - distribution of source and sink areas of recruitment (usually unknown),
 - different areas wildly different.
- Effect of MPA idiosyncratic to the studied system (e.g. Tasmanian RL).
- How best, therefore, to achieve generalized conclusions?

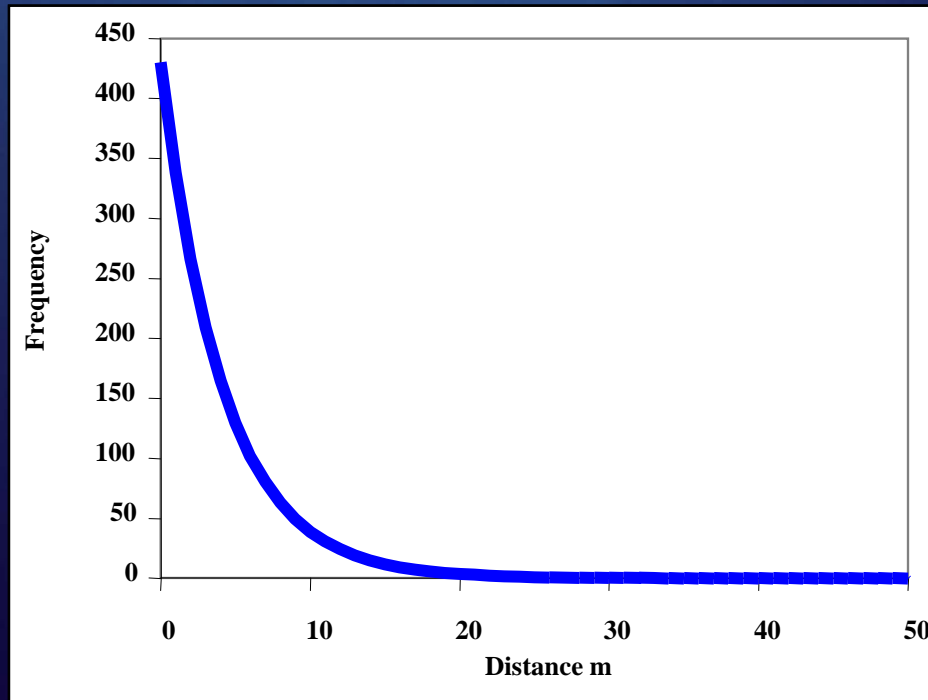
Recruitment Dynamics

With Tasmanian Rock Lobster and Abalone, assumptions have to be made about scales of recruitment.



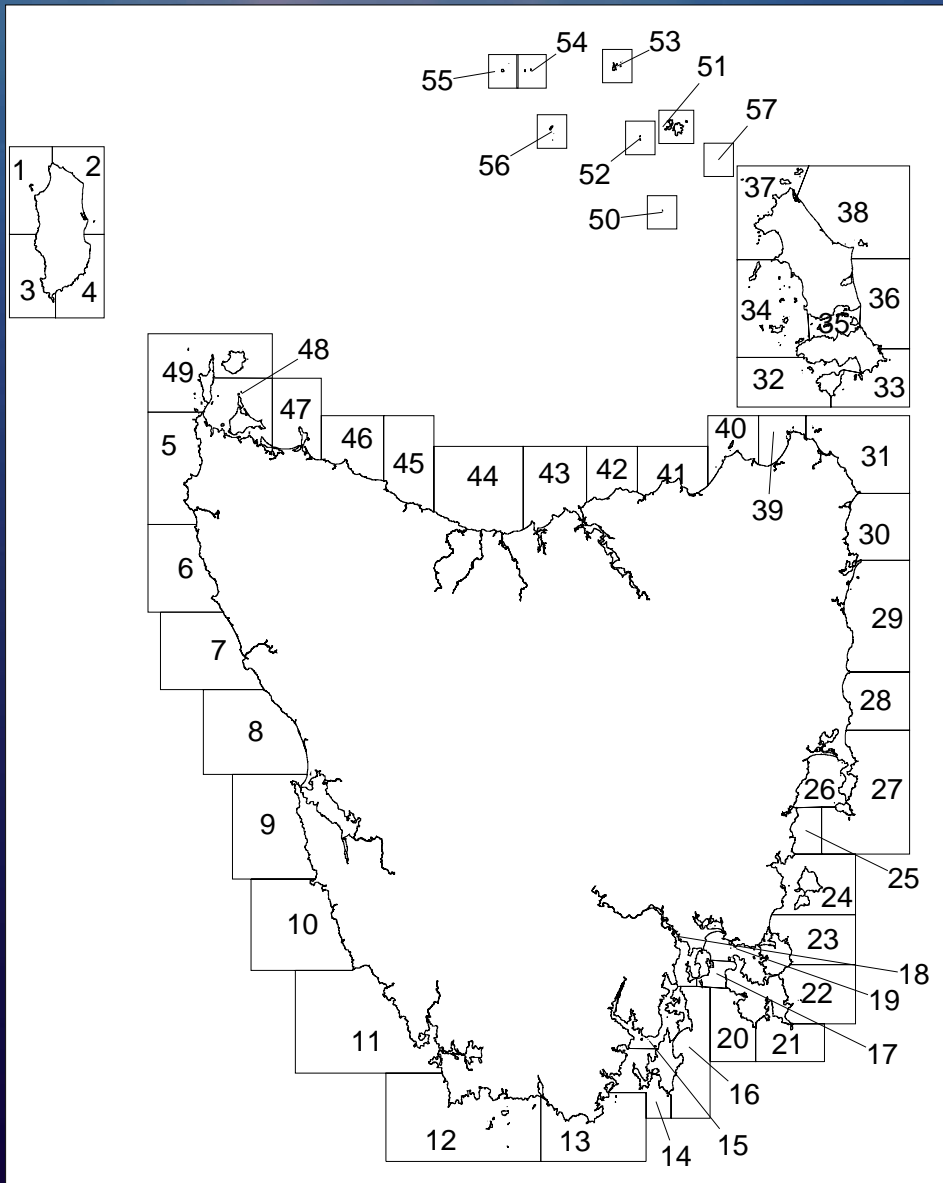
Abalone Movement

Larval drift is generally taken to be on the scale of a few km (McShane et al., 1988). Larval export from MPAs would be low.



Adults, once settled tend not to move more than 100 m (Dixon et al. 1998)

Impact of MPAs on a Fishery



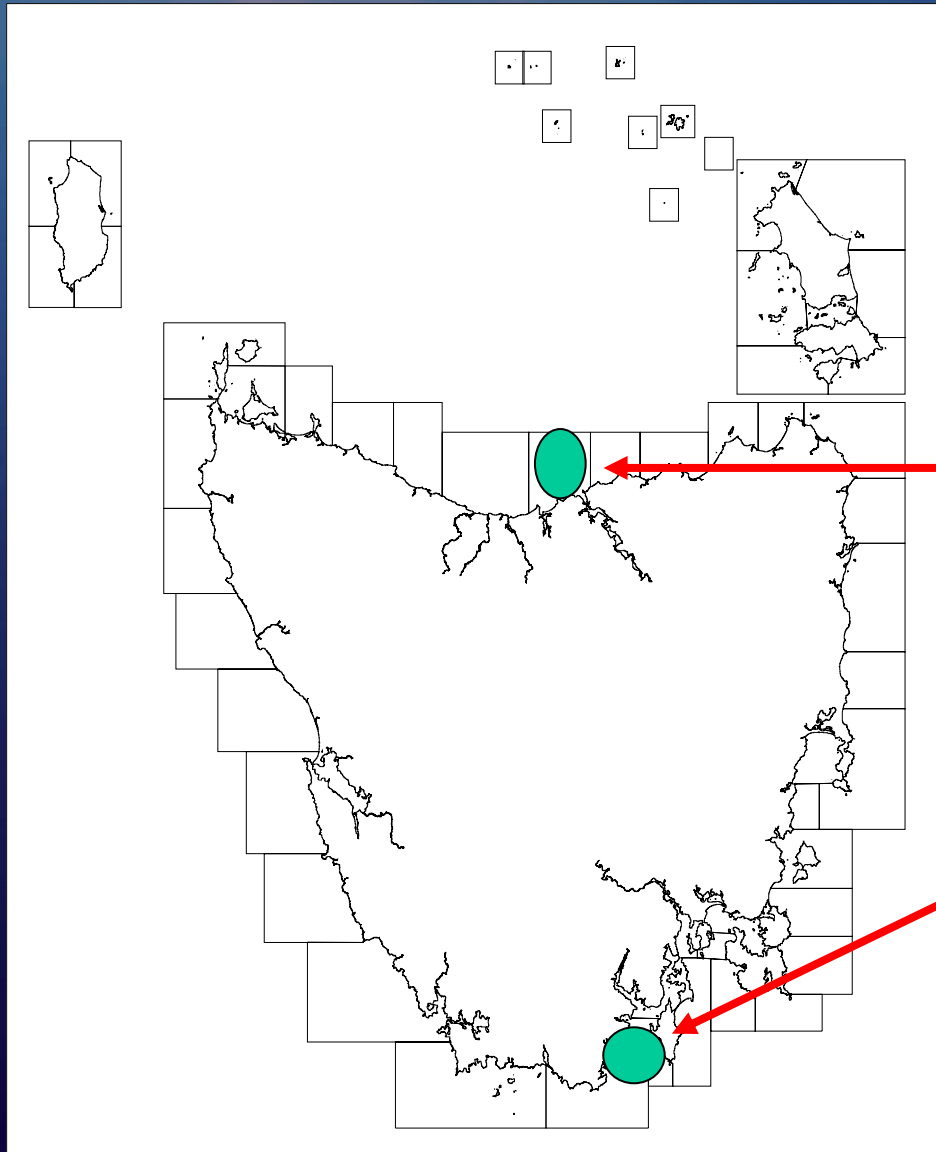
Using a model of the abalone stocks, the implications of the size and location of MPAs can be estimated.

Information mostly available at the scale of reporting blocks.

Model Outputs

- **Impact of catch displacement: variable -**
 - **how the divers respond to exclusion,**
 - **minimum legal size (modelling of recruitment)**
- **Fishery benefits of whole block closures were negligible.**

Where makes a Big Difference!



Very little effect.

Huge effect!

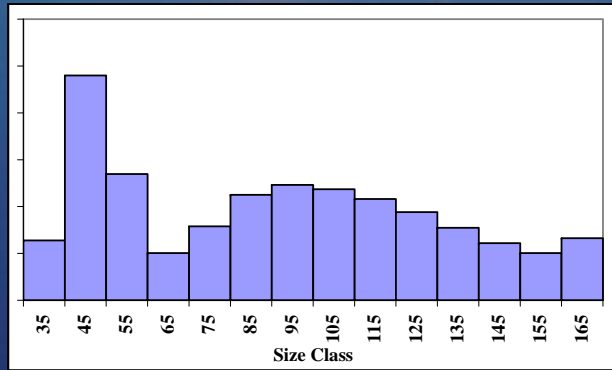
Bits Difficult to Model.

- Fleet dynamics in the presence of large MPAs – unknown.
- **Solution - examine alternatives.**
- Relationship between egg-production and subsequent recruitment levels is unknown.
- **Solution – examine alternatives.**
- **Disadvantage – lots of alternatives means lots to synthesize.**

Model Structure

- **Size-structured x Sex**
- **Annual time step**
- **Spatially explicit**
- **Recruitment is deterministic**
- **Single Species**
- **Movement of adults is only into adjacent areas.**

Size-Structured x Sex



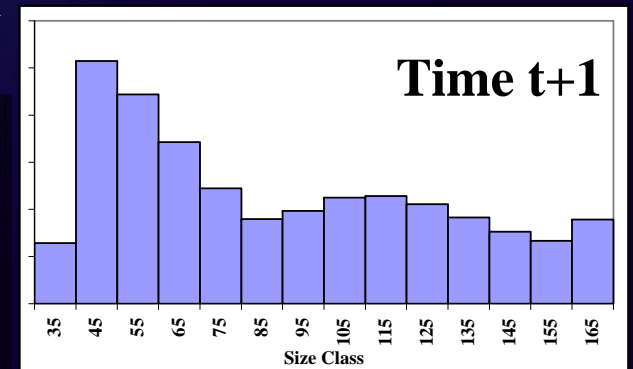
Recruits

**Time step
 $t = 1$ year**

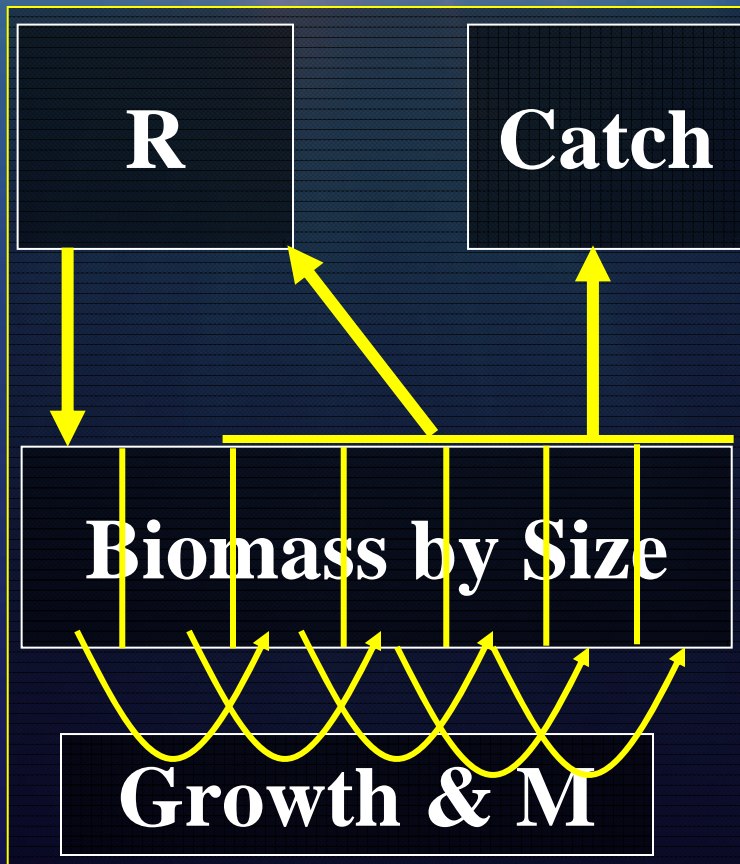
Growth

**Natural
Mortality**

**Fishing
Mortality**

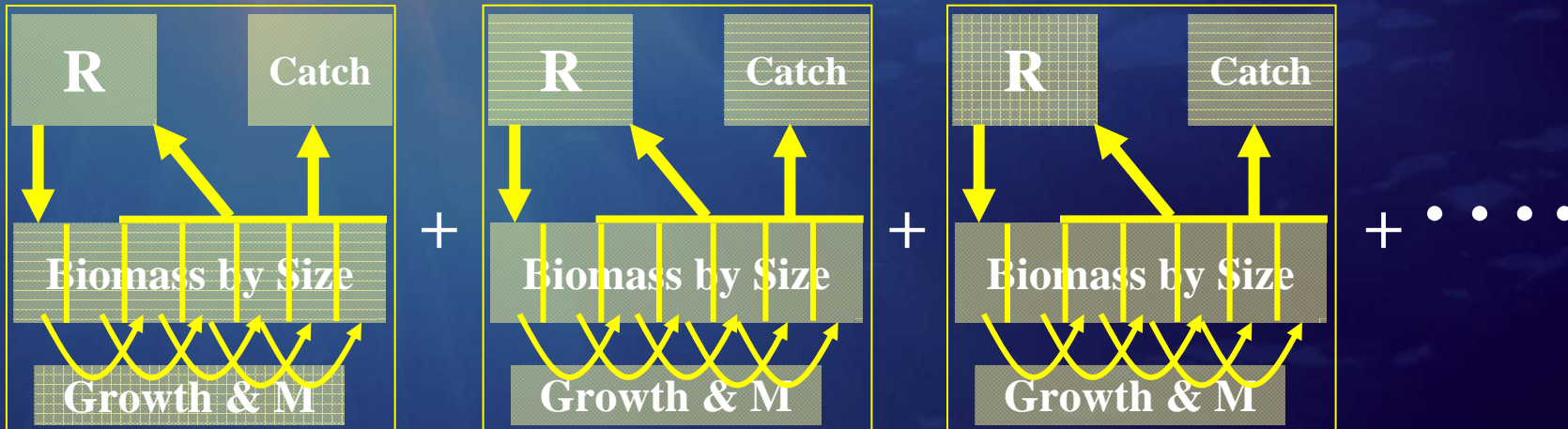


Size-Structured Population



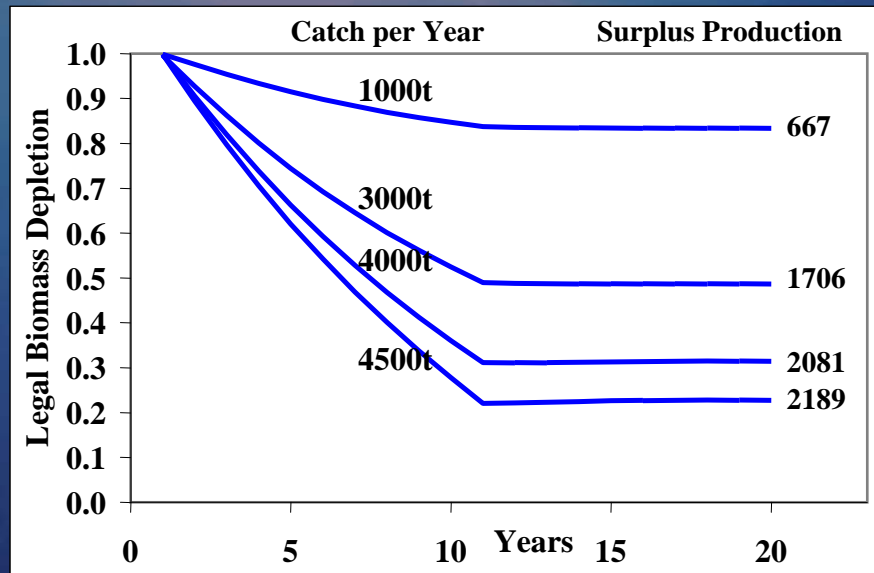
- More realistic population dynamics & growth.
- Selectivity of fishing gear.
- More options for describing recruitment.
- Impacts of fishing on population structure.

Spatially Explicit



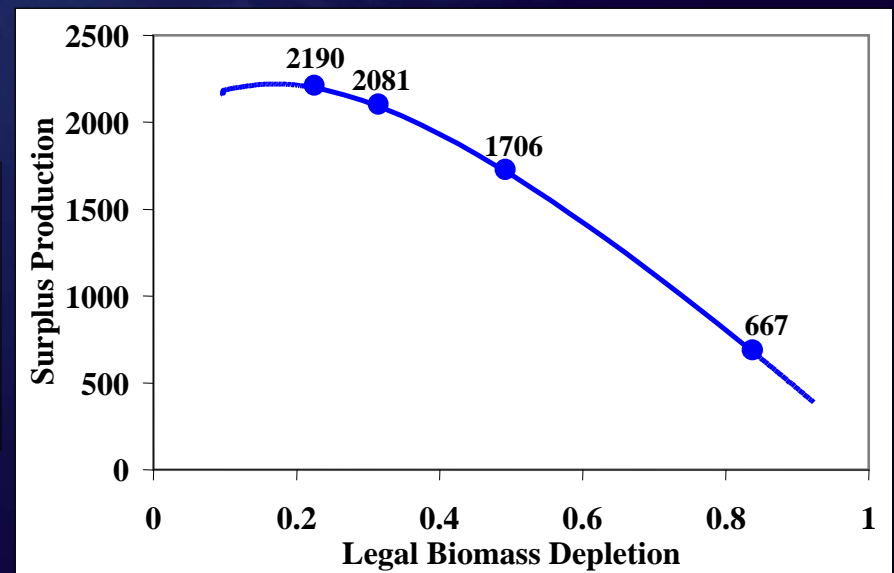
Each population could be a statistical reporting area, an assessment region, or any other scale for which information is available.

Surplus Production

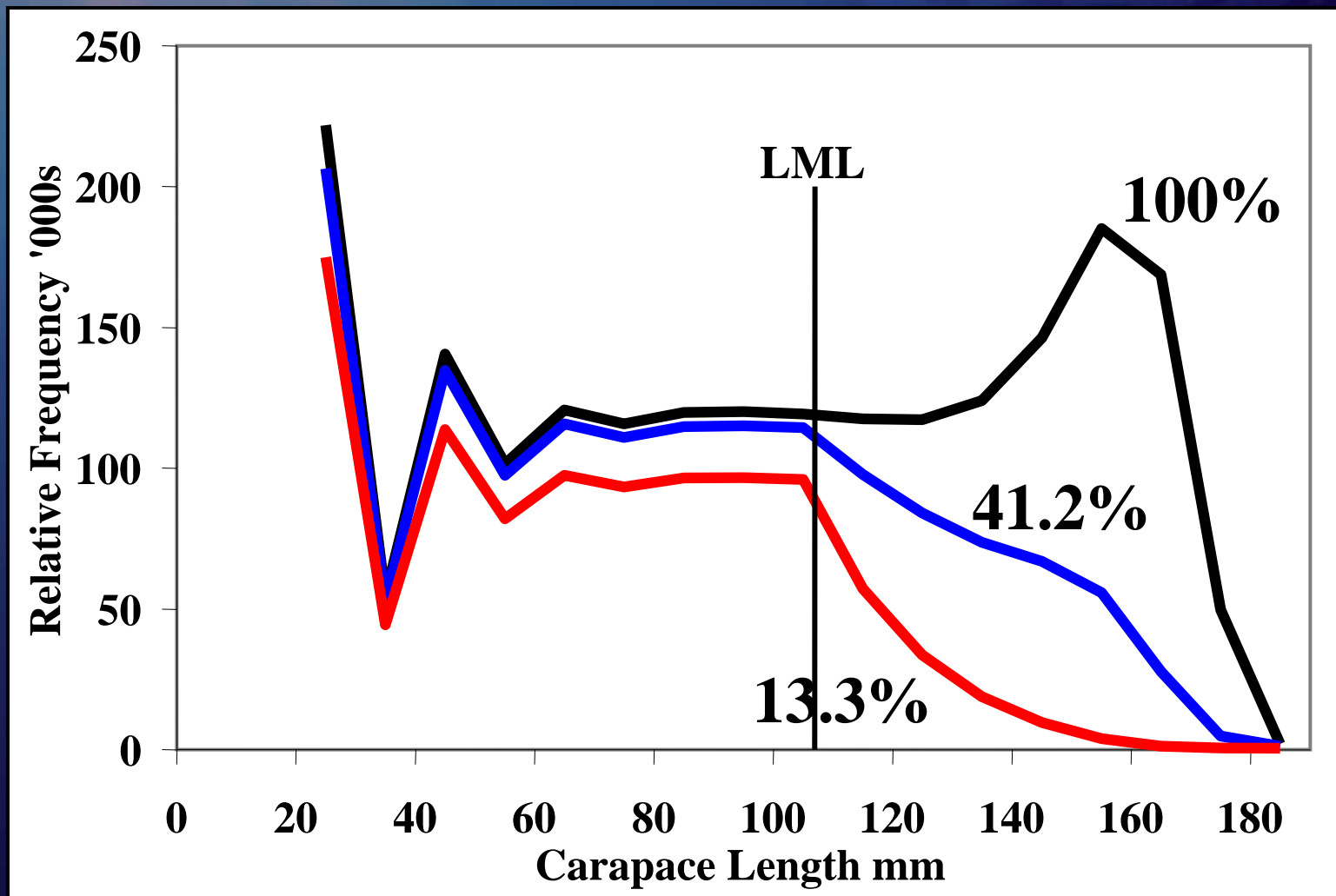


Fish for 10 years at different known levels, then determine sustainable yield

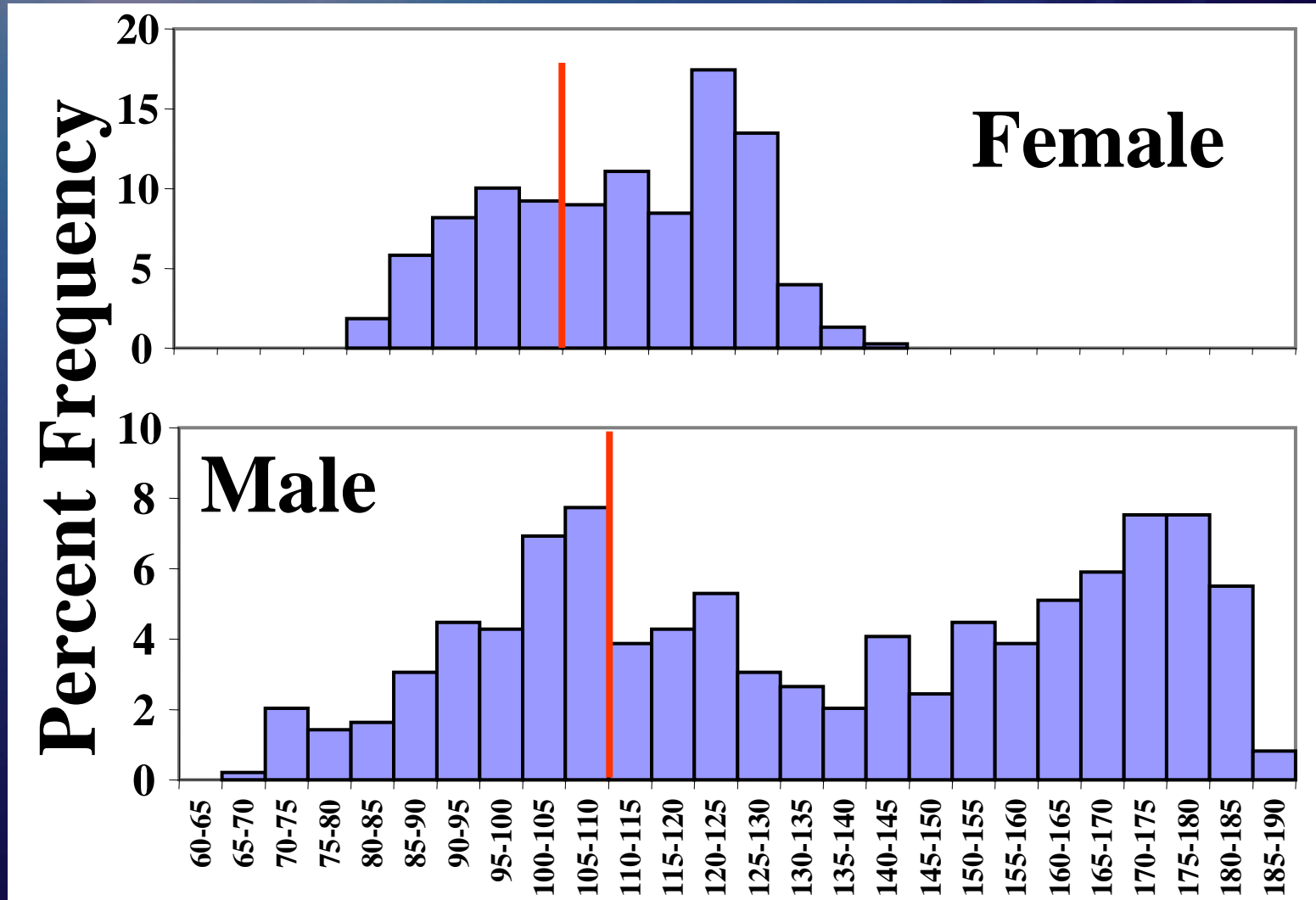
Repeat for many different levels to produce the surplus production curve.



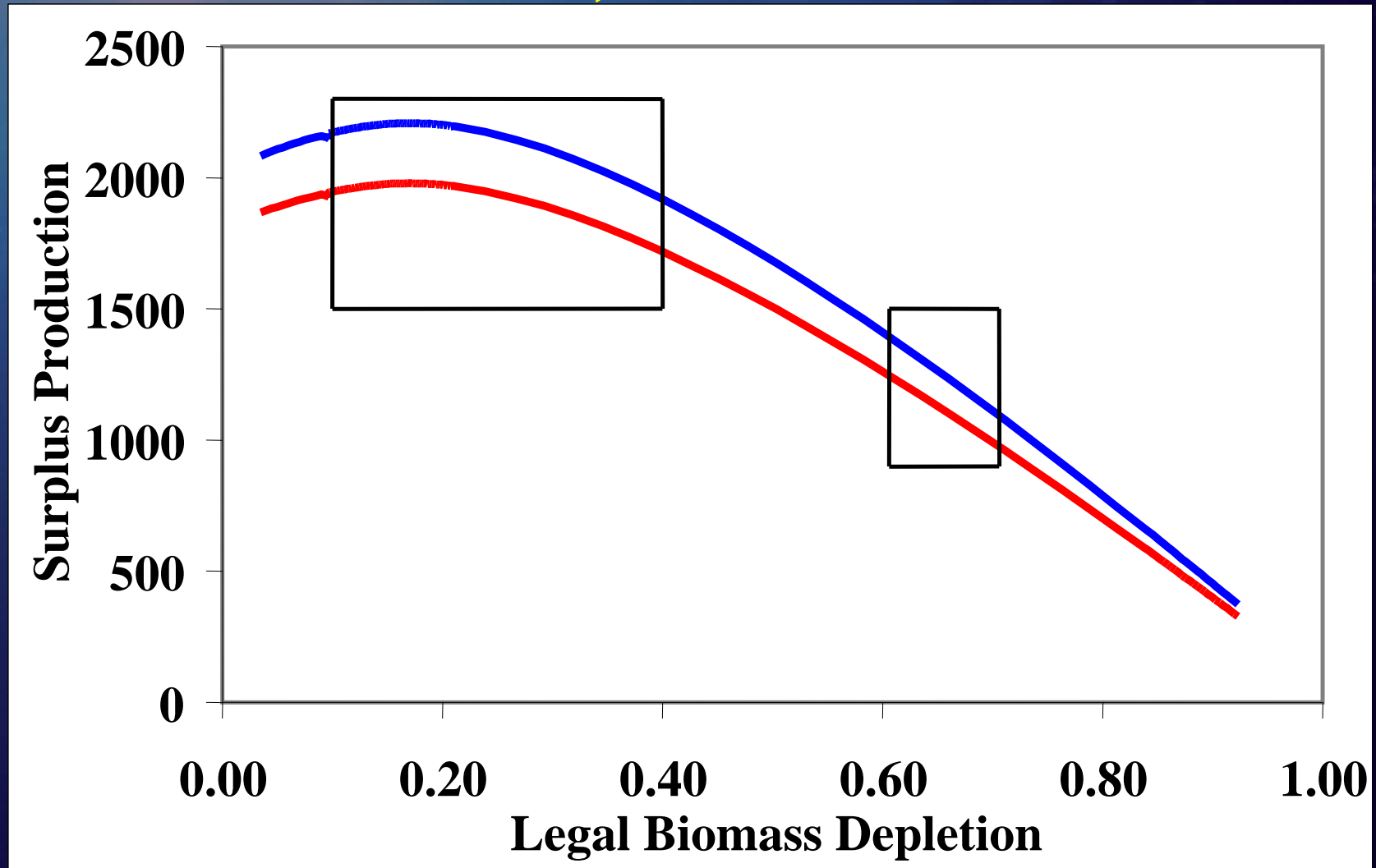
Male Size Distribution vs Depletion



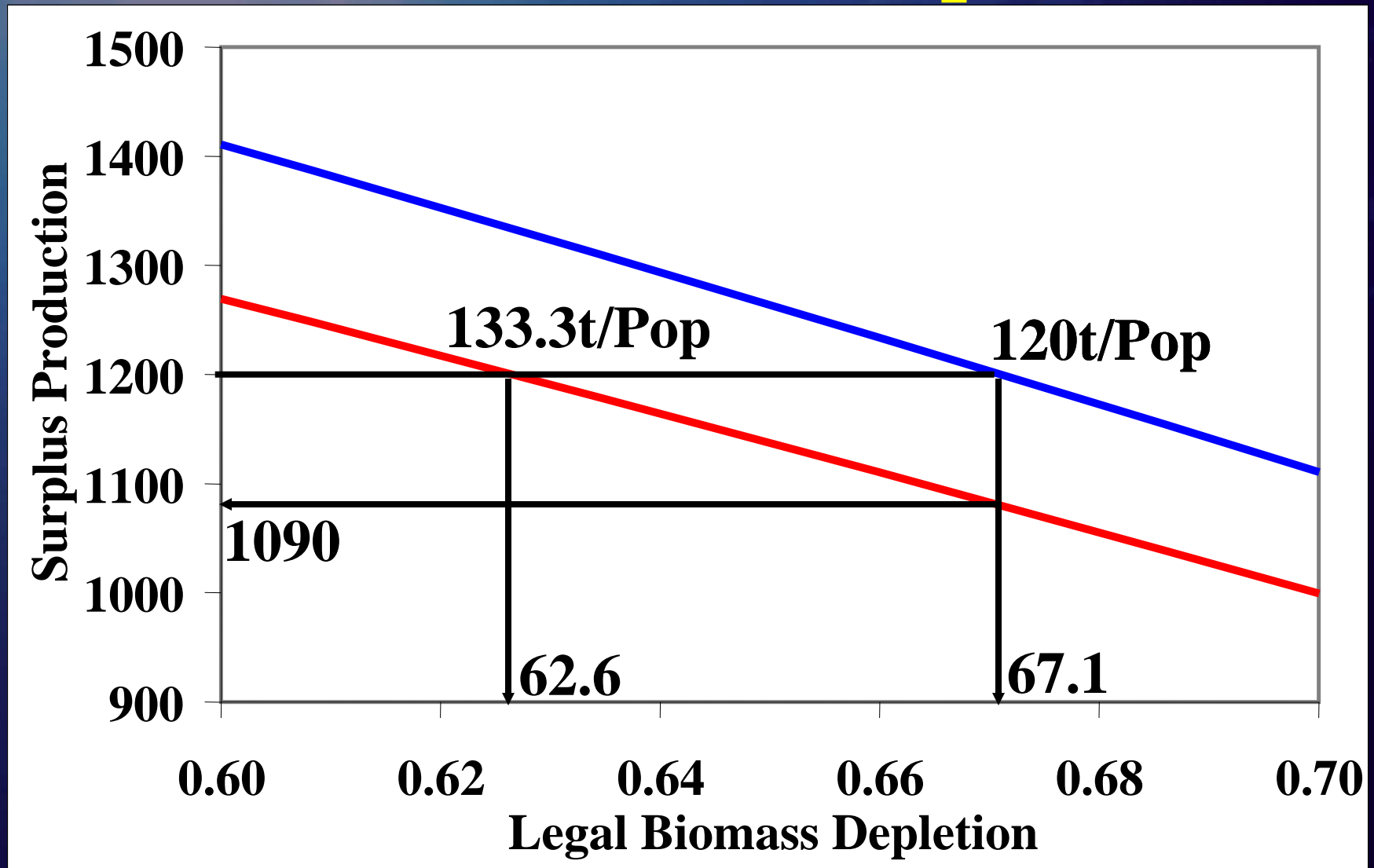
Rock Lobsters at Maria Is.



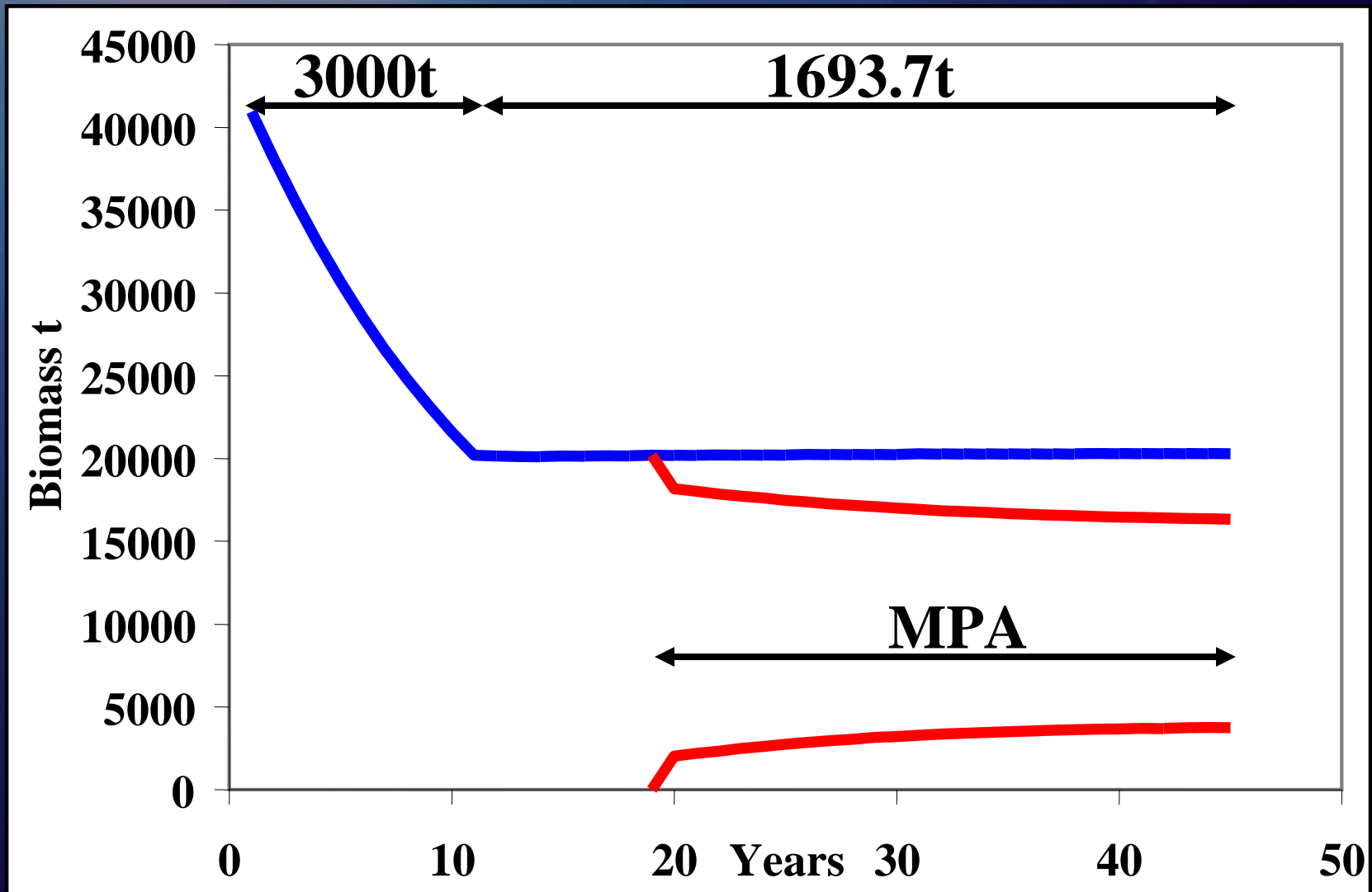
Add MPA, TAC constant



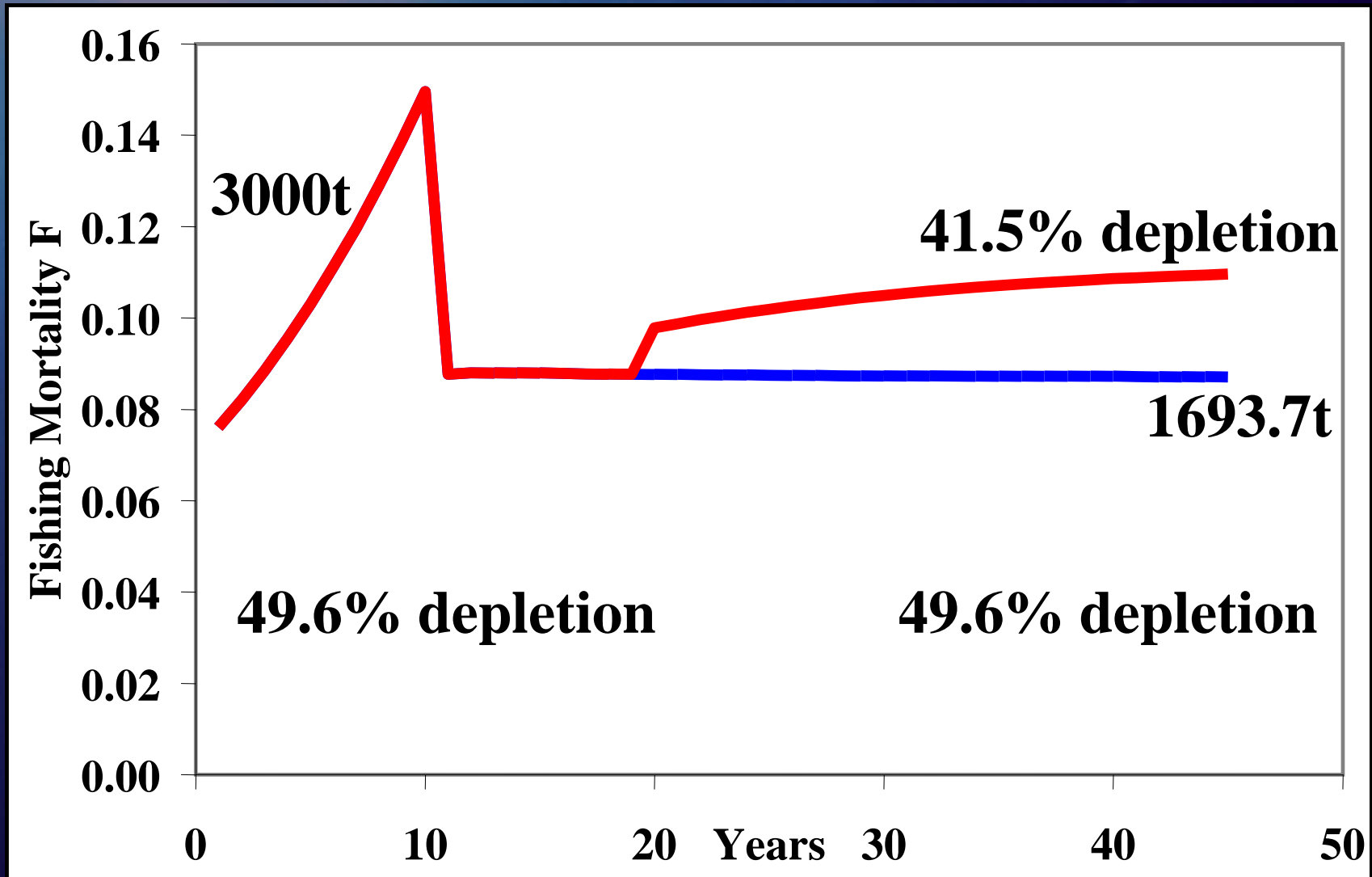
MPA when little Depletion



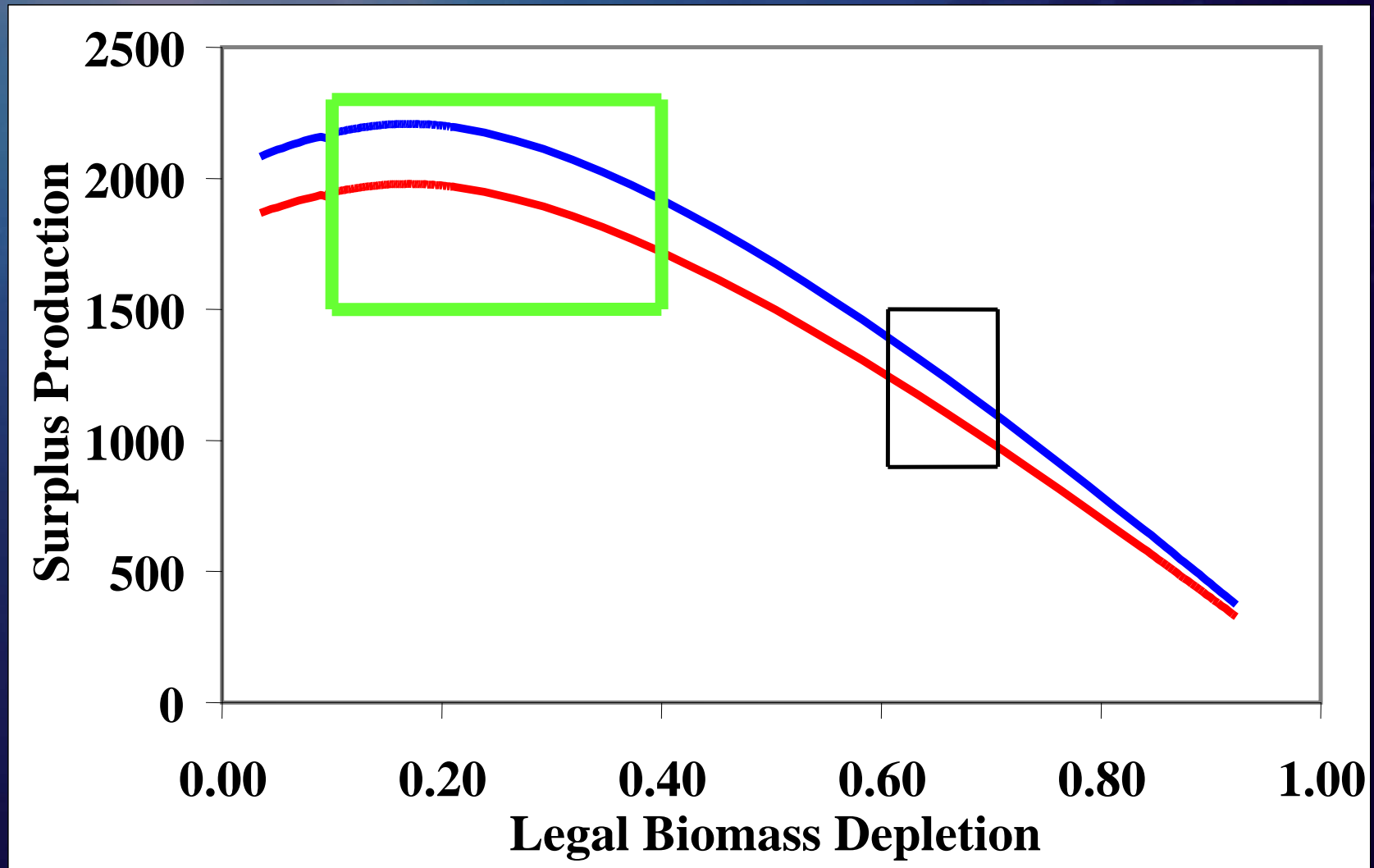
Effect on Biomass (closed + open)



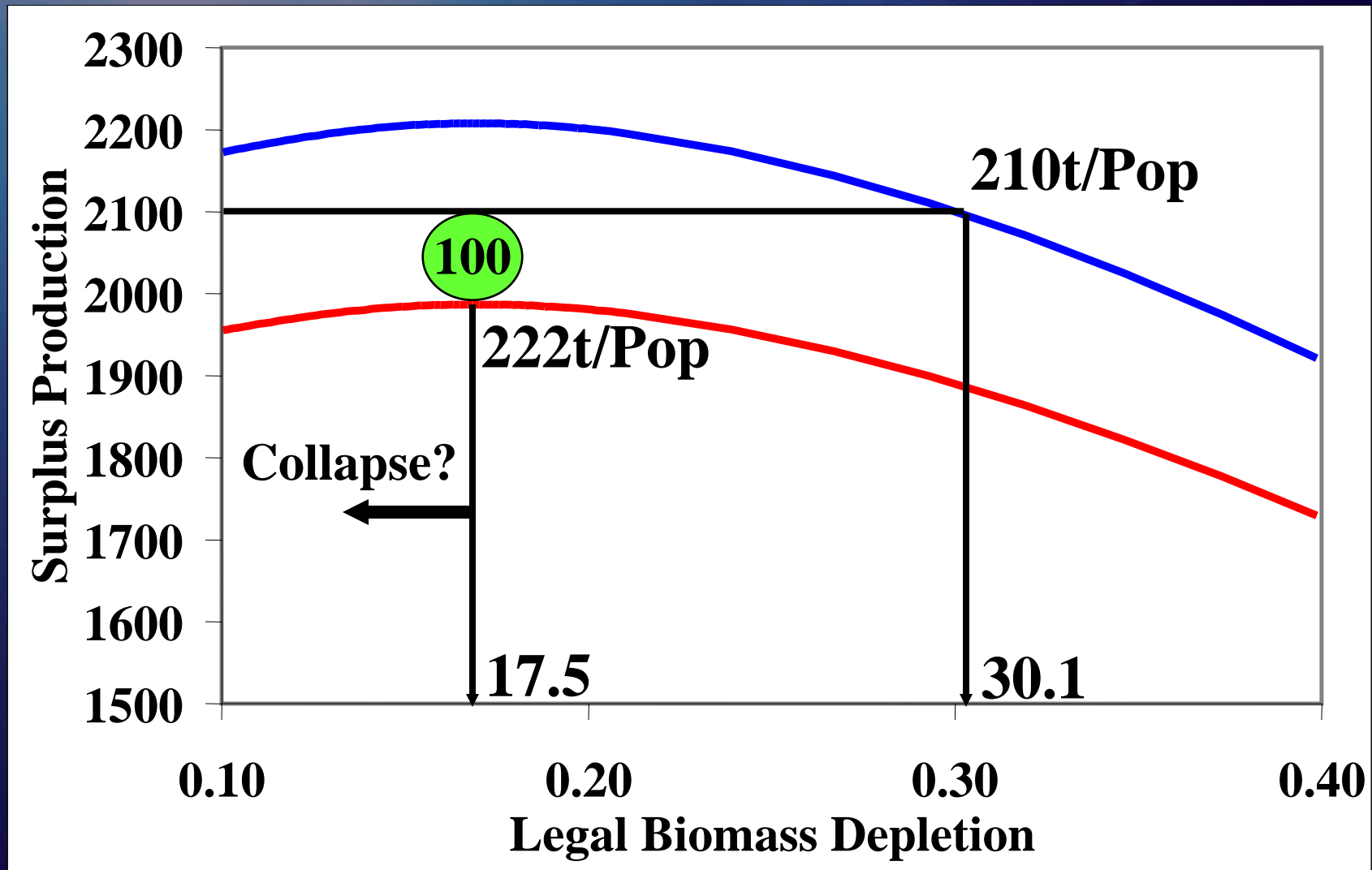
Fishing Mortality Outside an MPA



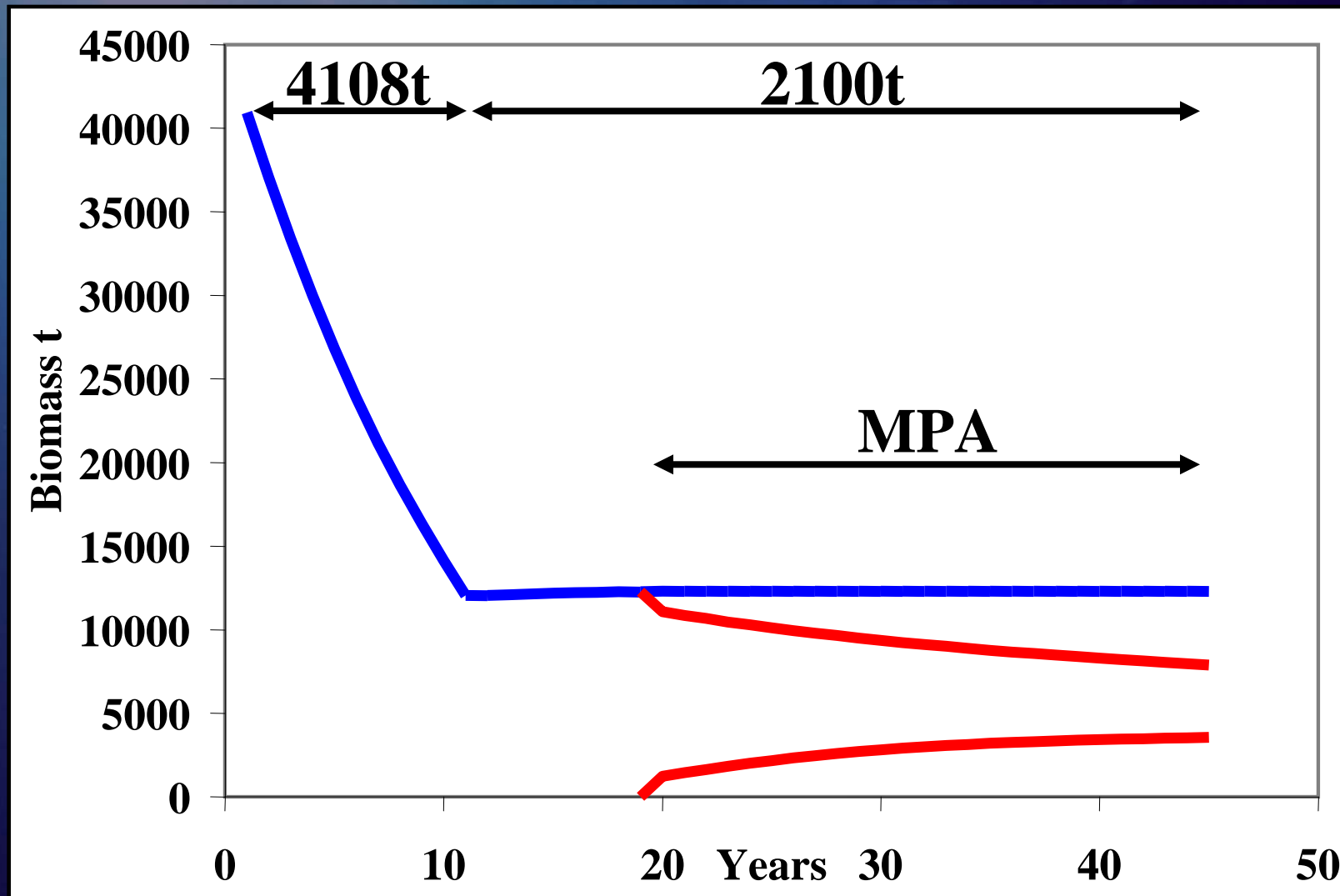
Add MPA, when close to Maximum



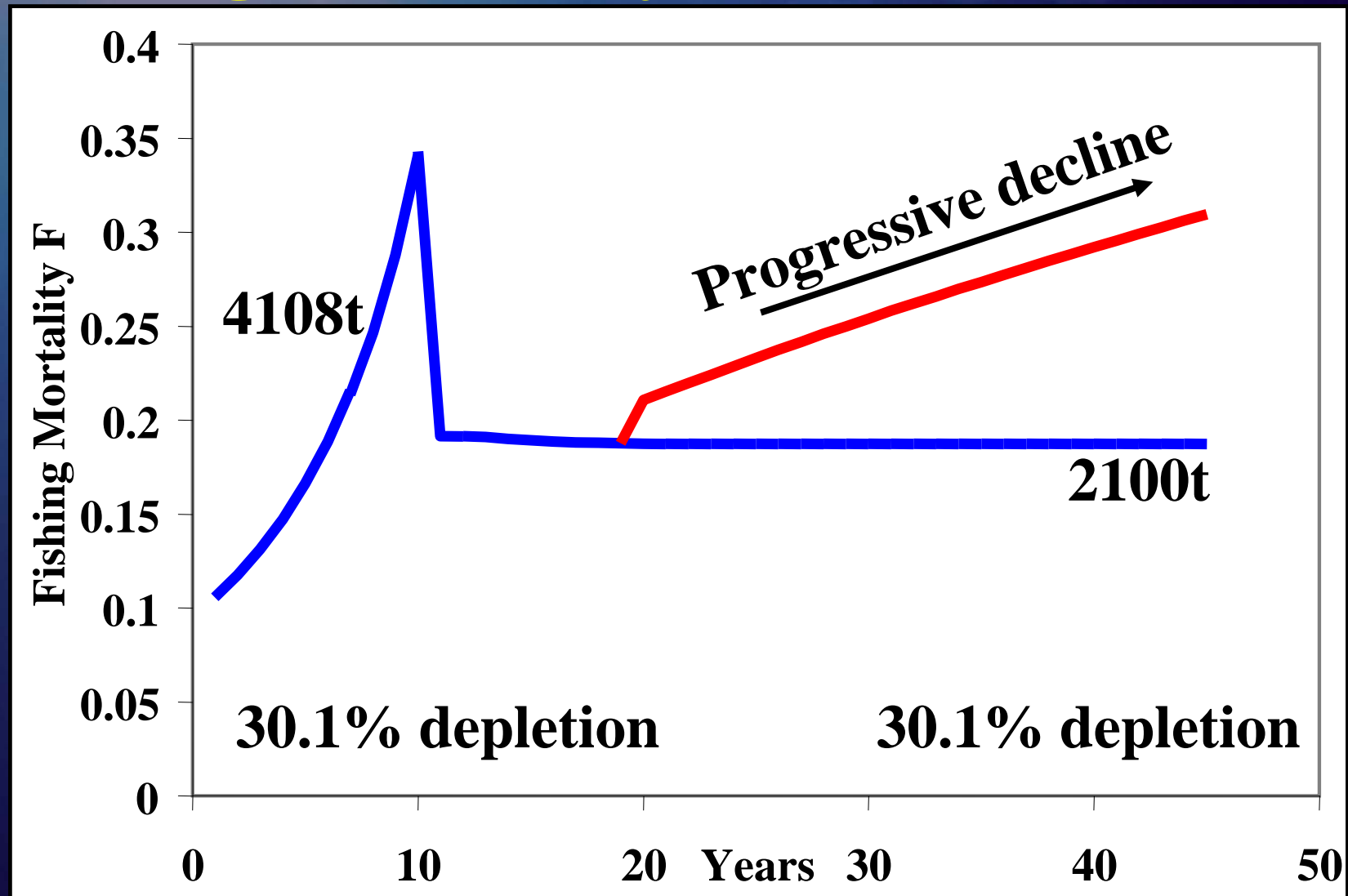
MPA when more Depleted



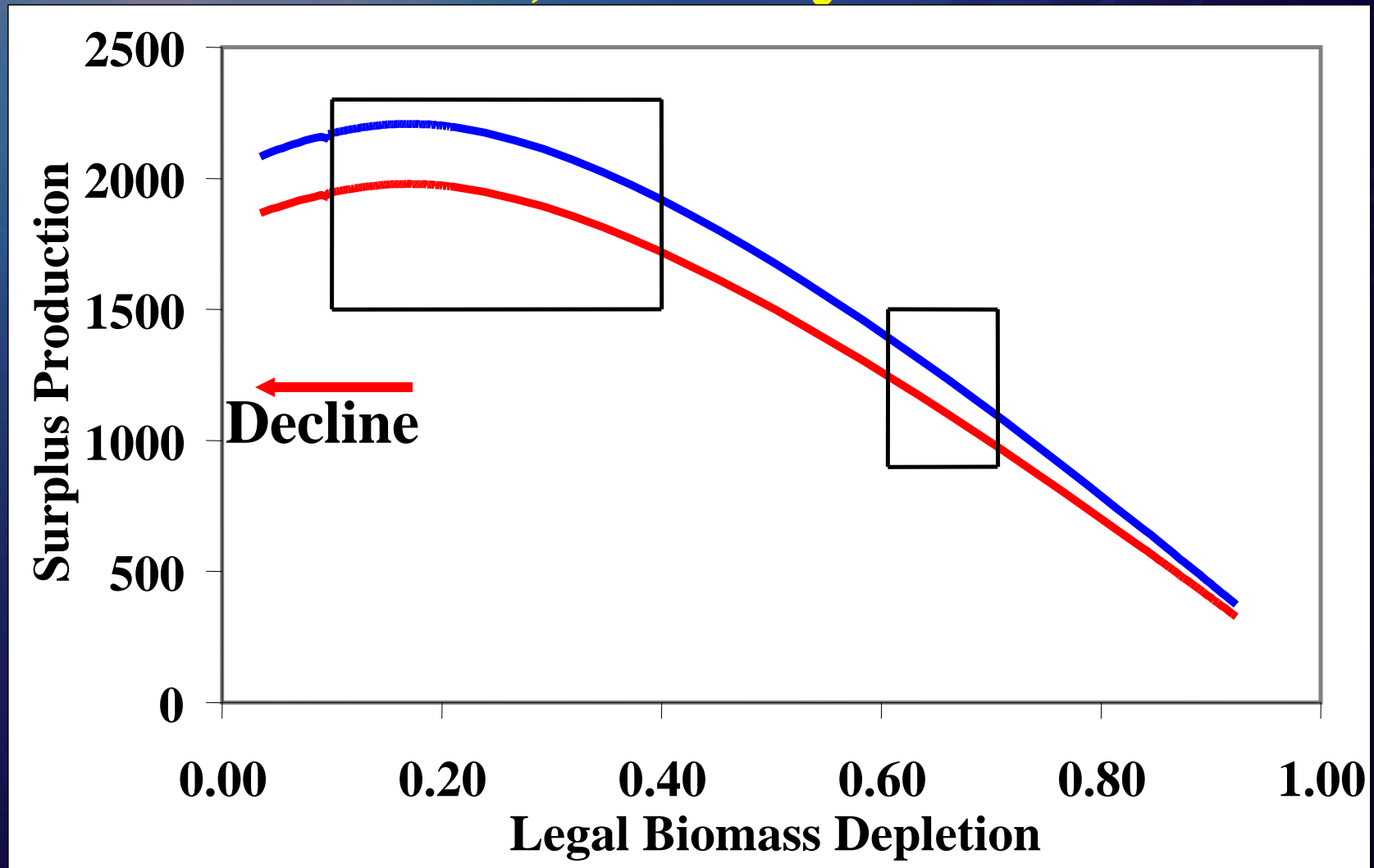
Effect on Biomass (closed + open)



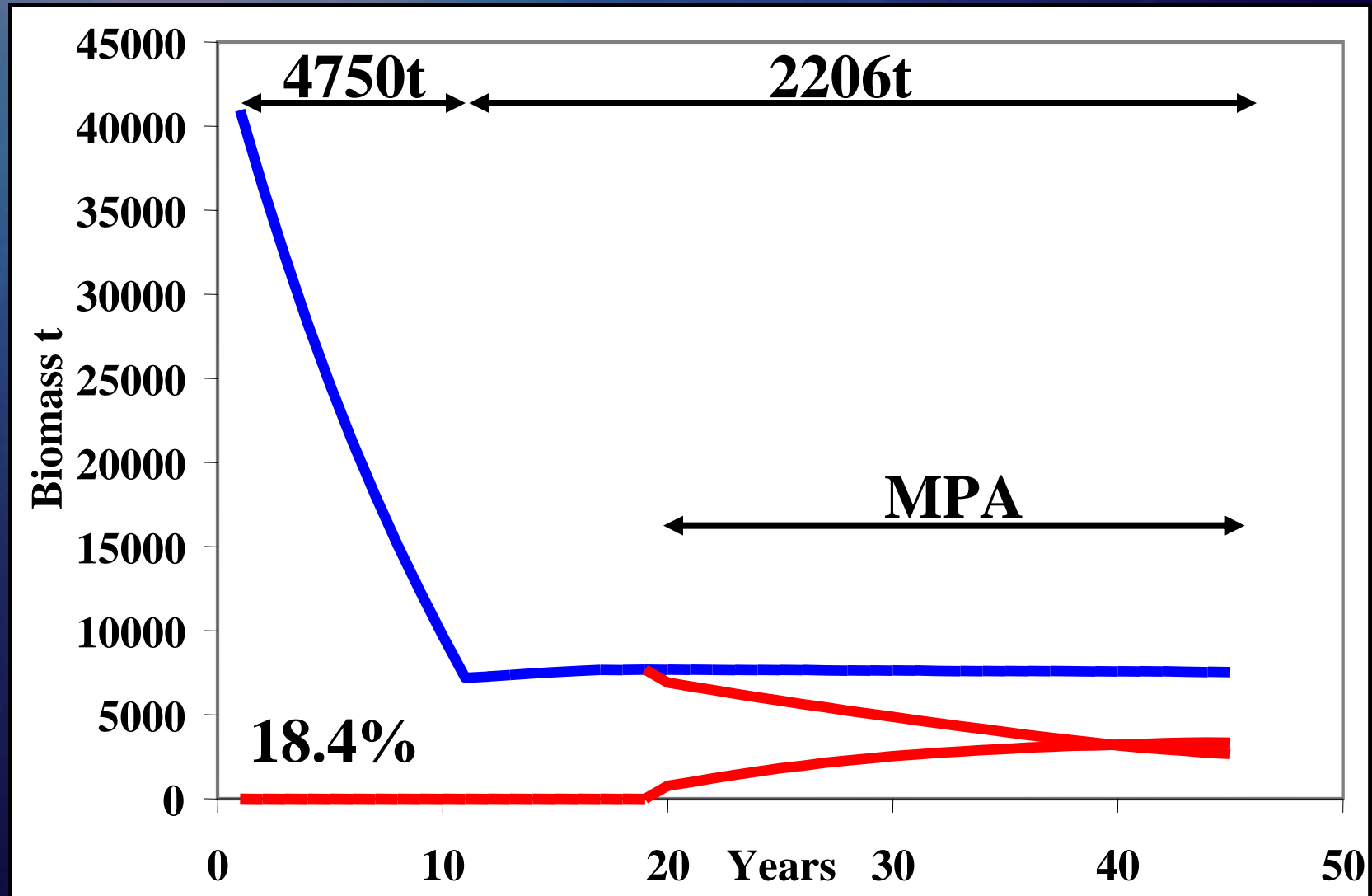
Fishing Mortality Outside an MPA



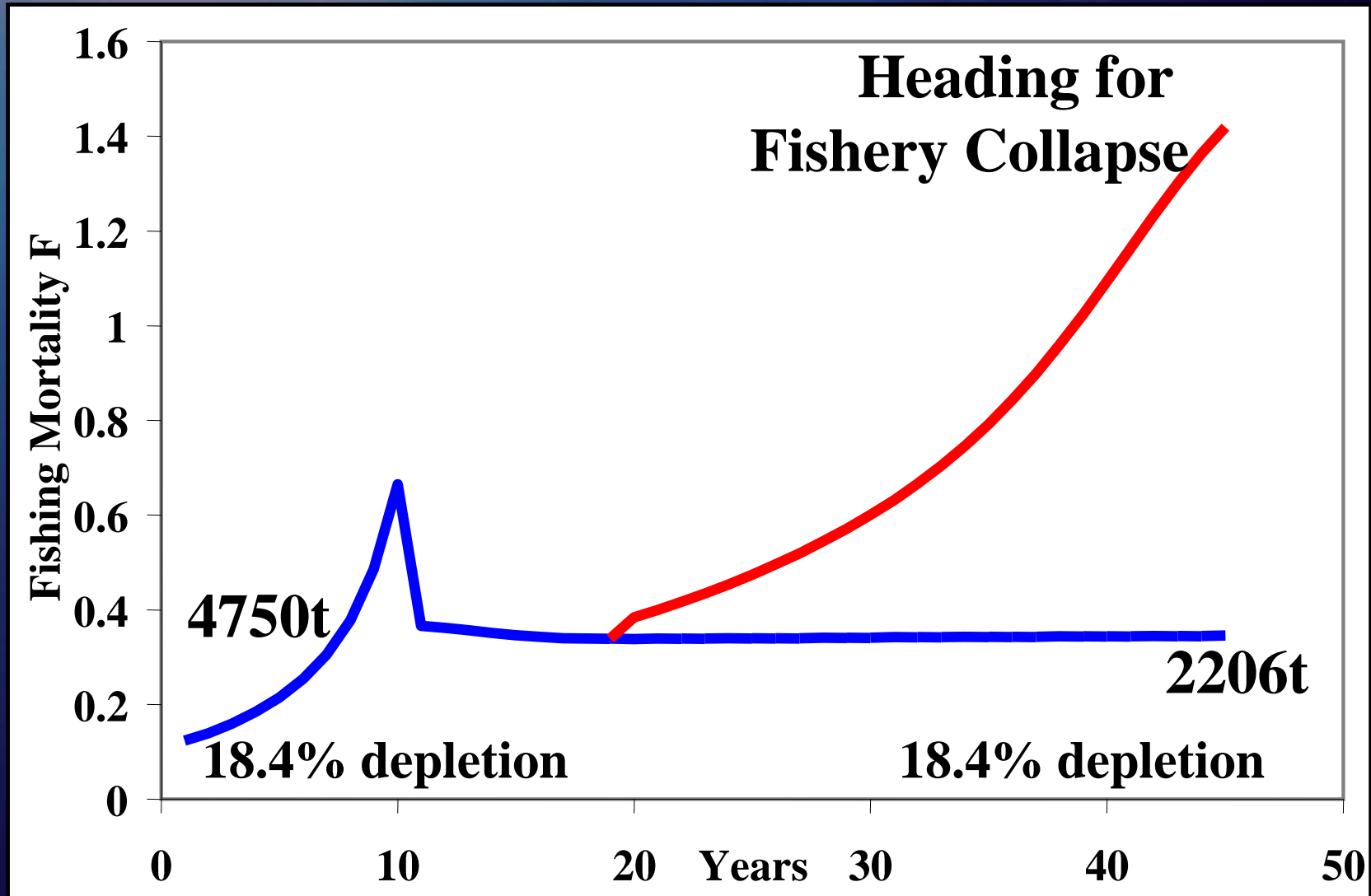
Add MPA, fishery in decline



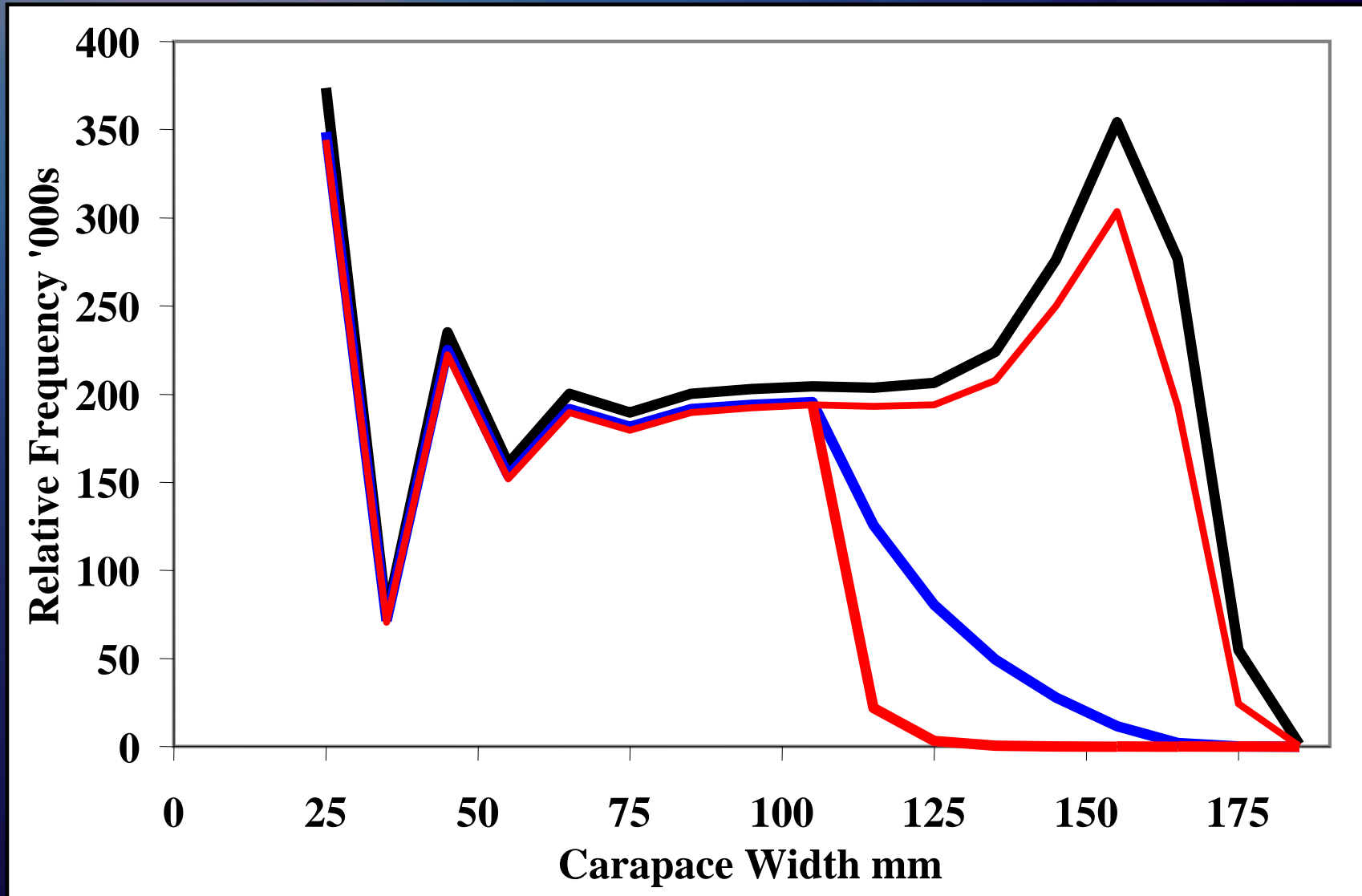
Effect on Biomass (closed + open)



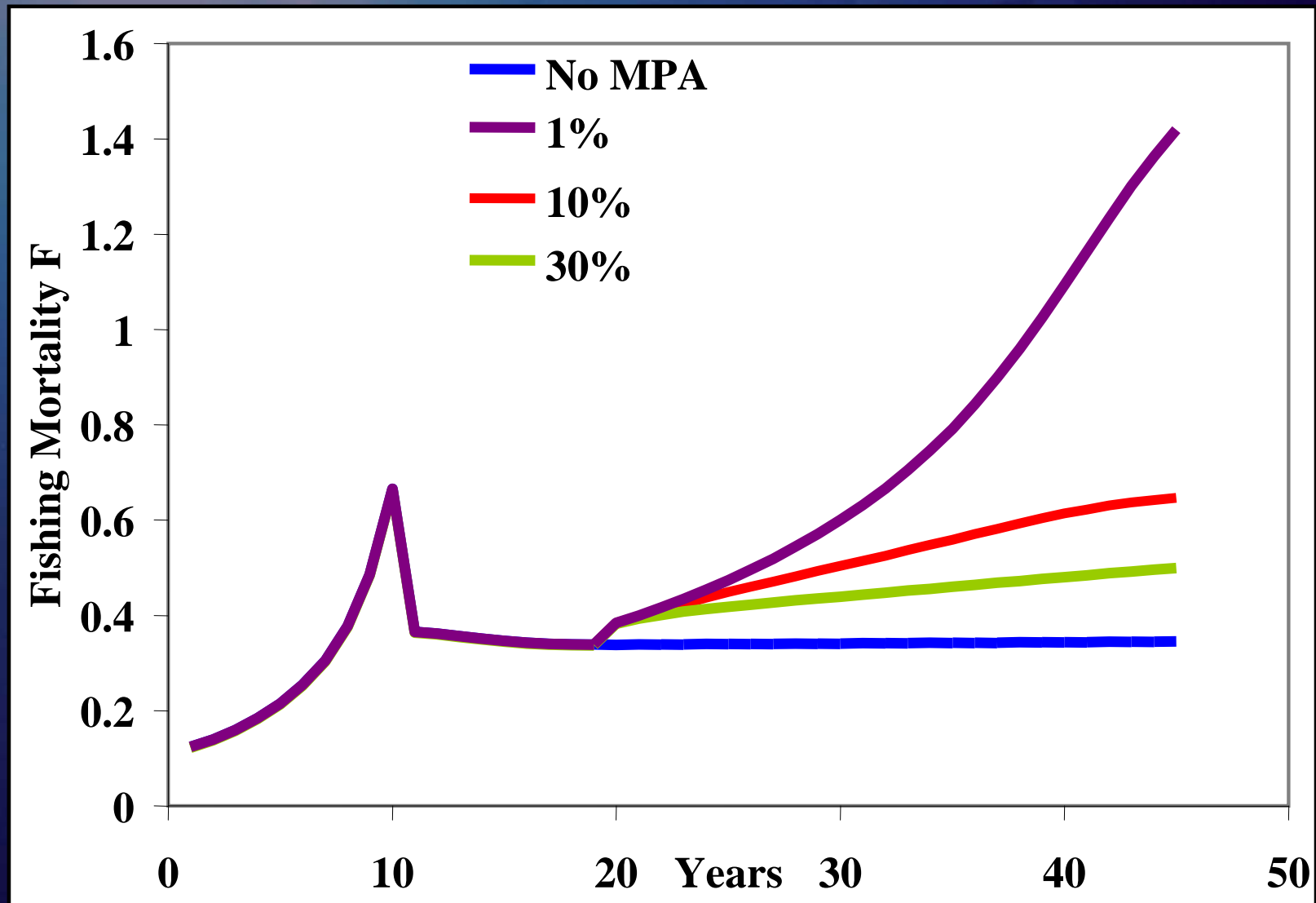
Fishing Mortality Outside an MPA



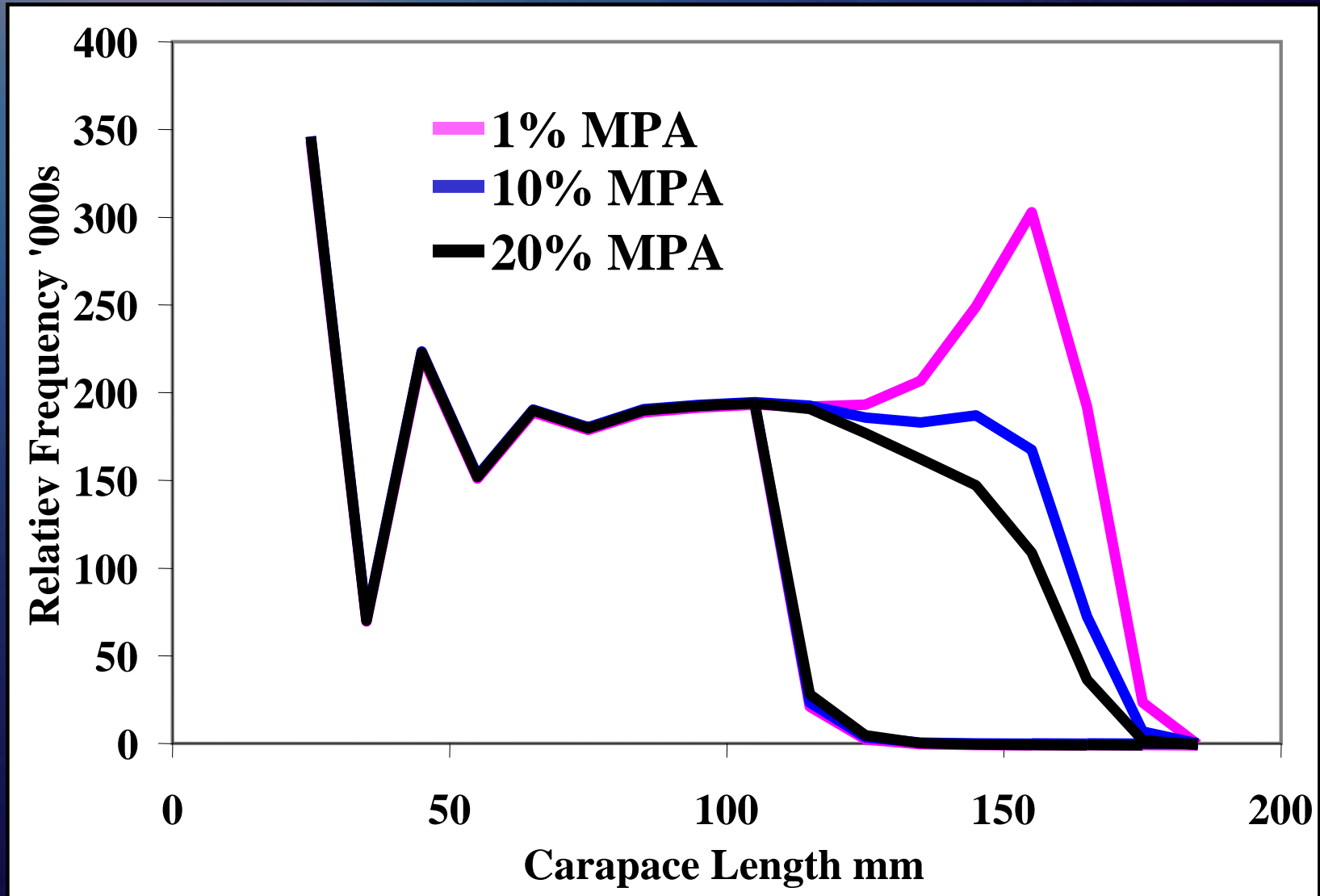
Effect on Size Distribution



Effects of Movement



Size Distribution & Movement



Interim Conclusions

In an exploited population, ignoring inside the MPA, introducing an MPA is equivalent to an increase in the TAC outside a reserve.

Impact depends on:

- which species,**
- the state of stock depletion,**
- whether catch reduced appropriately.**

Tasmanian Conclusions

In Tasmanian rock lobster fishery,

- effort & catch are controlled,**
- stock is rebuilding,**
- there is no evidence of recruit limitation,**
- adult movements are limited.**

MPAs offer few advantages to fisheries.

Better outcomes achievable through existing fisheries management strategies.

General Conclusions

The effects of small MPAs would be hard to detect.

There is a time lag before any positive or negative effects of an MPA become apparent.

Introducing an MPA without reducing catch may have a negative effect upon some fisheries.

If the stock is already in a depleted state, an MPA can hasten fishery collapse.