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APPLYING BIOECONOMIC MODELS IN REBUILDING FISH STOCKS:
TRADEOFFS, RISKS, & CAUTIONARY TALES

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Caveats

- Models need bounds
- … which may mean ignoring known characteristics of the fishery
  - Ecosystems
  - Multispecies/multifisheries
  - Risk and uncertainty
  - Equity
  - Efficiency
  - Consumer behavior
  - Industrial organization
  - Finance (portfolio theory)
  - Marketing
  - Trade
  - Etc.

Background

- From a biological perspective, rebuilding an overfished stock is straightforward
  - but what about economic and social concerns?
- Within an optimal control framework, bang-bang solutions imply a race to save the stock
  - but are prescribed catch levels “optimal”?

Our Recent Multi-cohort Bioeconomic Findings

- Intrinsic quality and seasonal quotas
- Intrinsic quality – space (region/depth), size, sex – and fleet size
- Rebuilding horizons and δ

Findings Relevant to Dynamic Multicohort Bioeconomic Models

- Older cohorts may be better spawners
- Stock changes, regulations and gear improvements all affect catchability
- LAPP programs could incorporate recreational sector
- Harvesting may have changed stocks over time
- Bioeconometric models improve results, complex life histories critical

Multi-cohort Bioeconomic Models for Rebuilding

1. Heterogeneous spawning cohorts
2. Cohort structure pre- and post-rebuild
3. Stock assessments and fishery closures

$\Rightarrow$ Consideration of cohort structure may be critical

Key Model Equations

Objective
Maximize NPV:

$$\sum_t \left(\frac{1}{1+\delta}\right)^t \left[TAC_t(P_t - VC_t) - FC_t\right]$$

$$\sum_a H_{t,a} W_{t,a}$$

Price:

θ - τ TAC_t

Variable Cost:

ψ-η SB_W

Harvest in Numbers:

$$\left(\frac{F_{t,a}}{Z_{t,a}}\right) N_{t,a}(1 - e^{Z_{t,a}})$$

Individual weight:

$$\gamma \; L_a^{\phi}$$

where L is von Bertalanffy

Stages of Modeling

Stage 1: Pristine stock

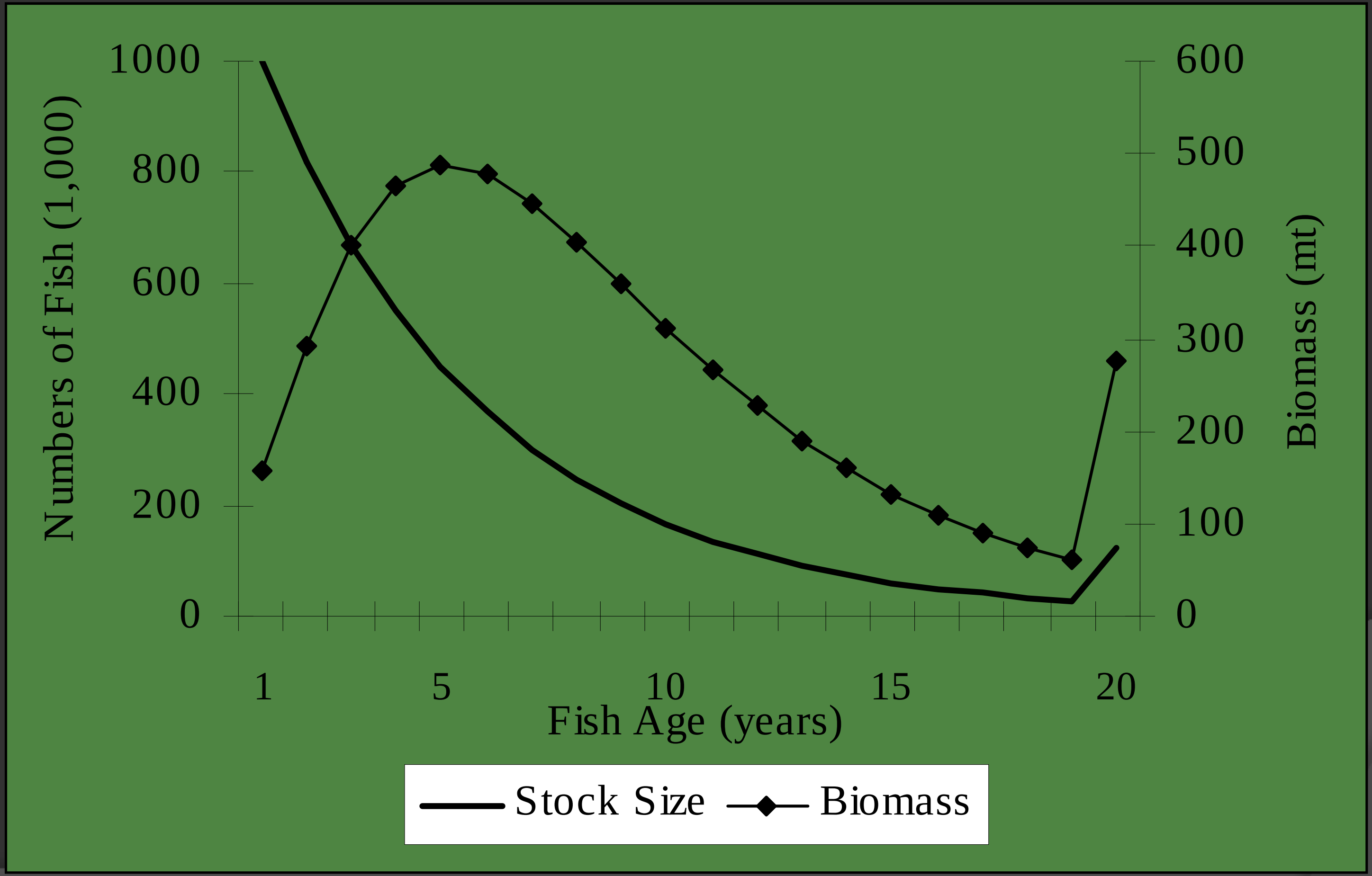
Stage 2: MSY and cohort structure

Stage 3: Overfishing

Stage 4: Rebuild

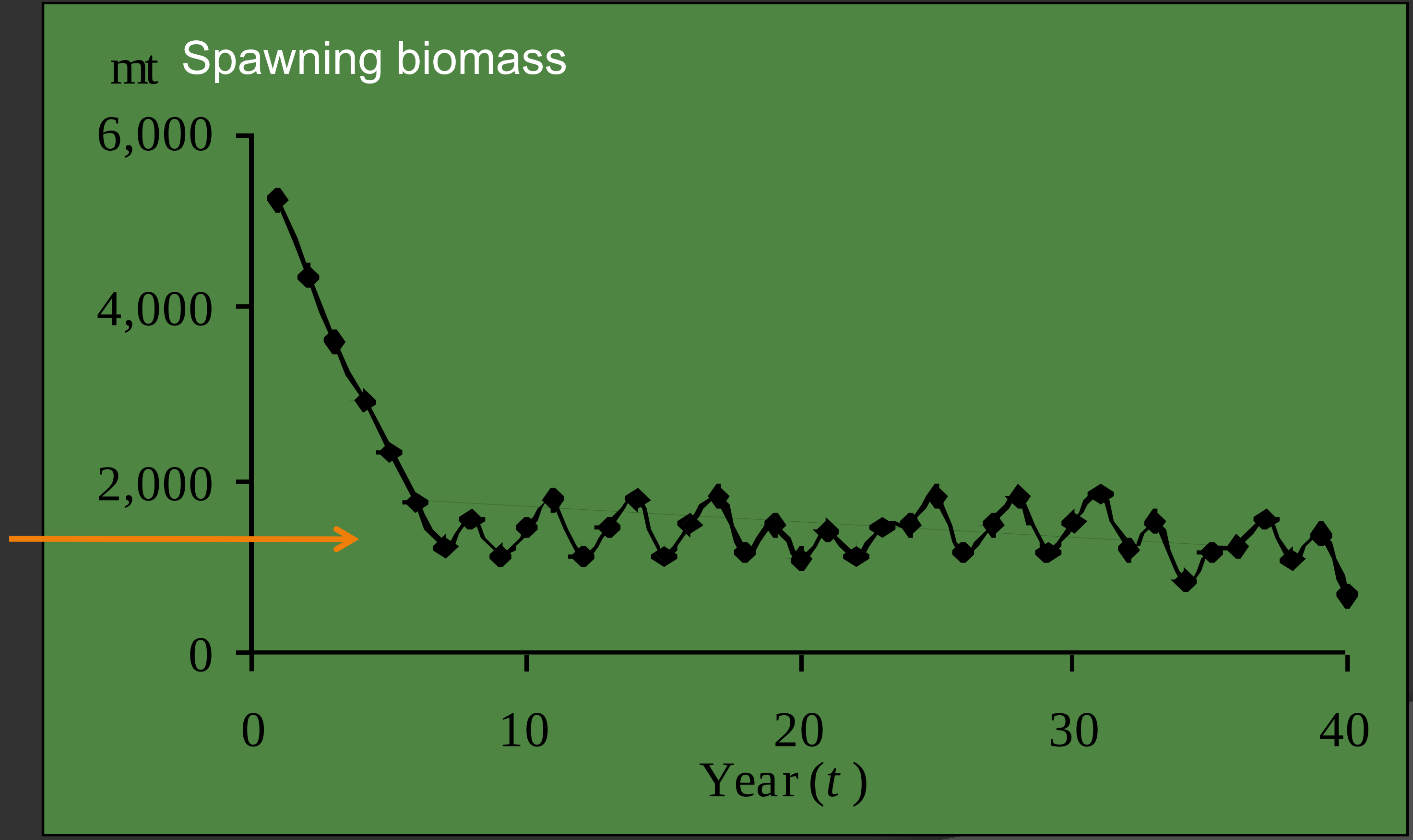
Stages of Modeling

Stage 1: Pristine stock



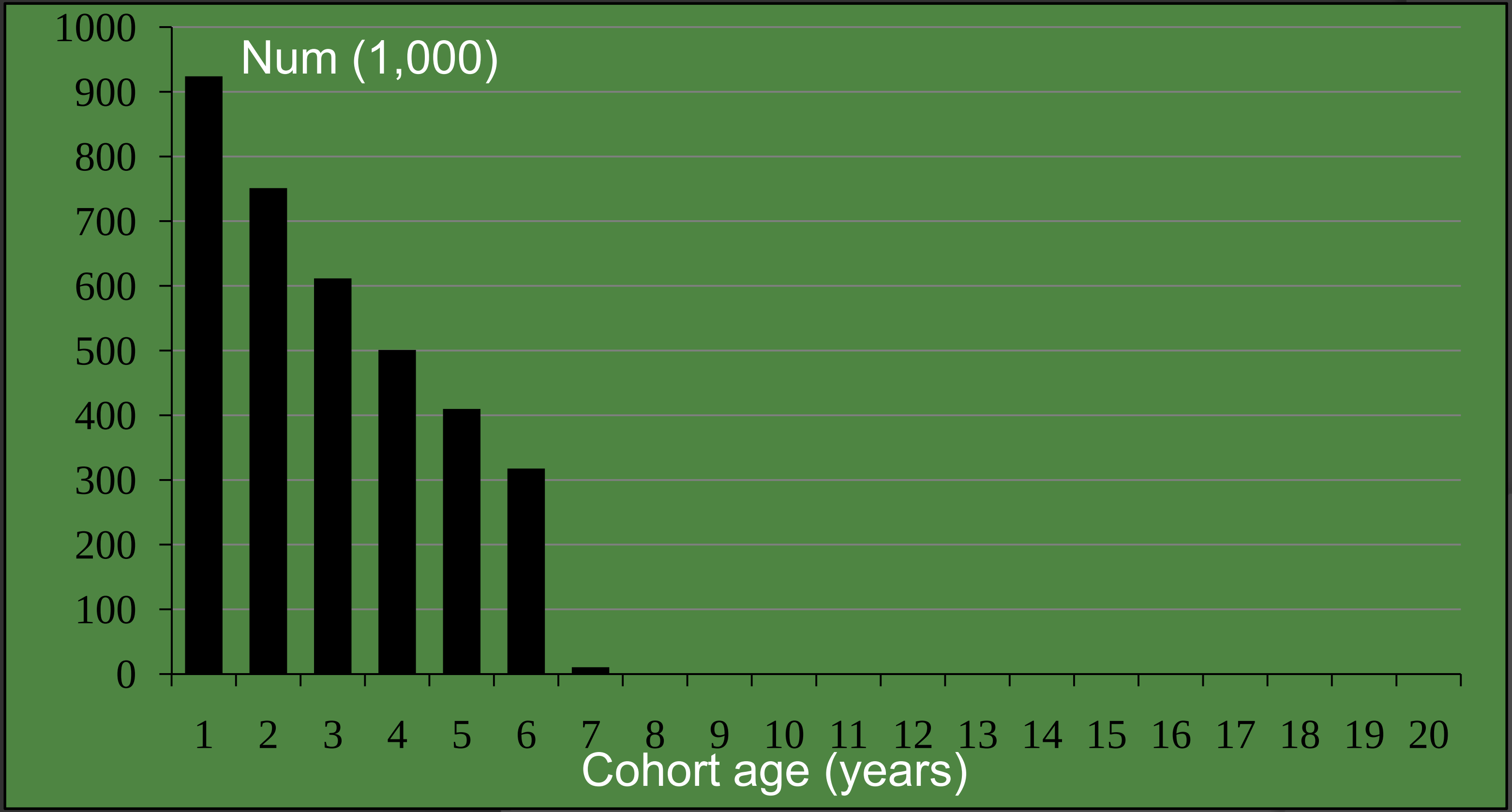
Stages of Modeling

Stage 2: *MSY* & cohort structure



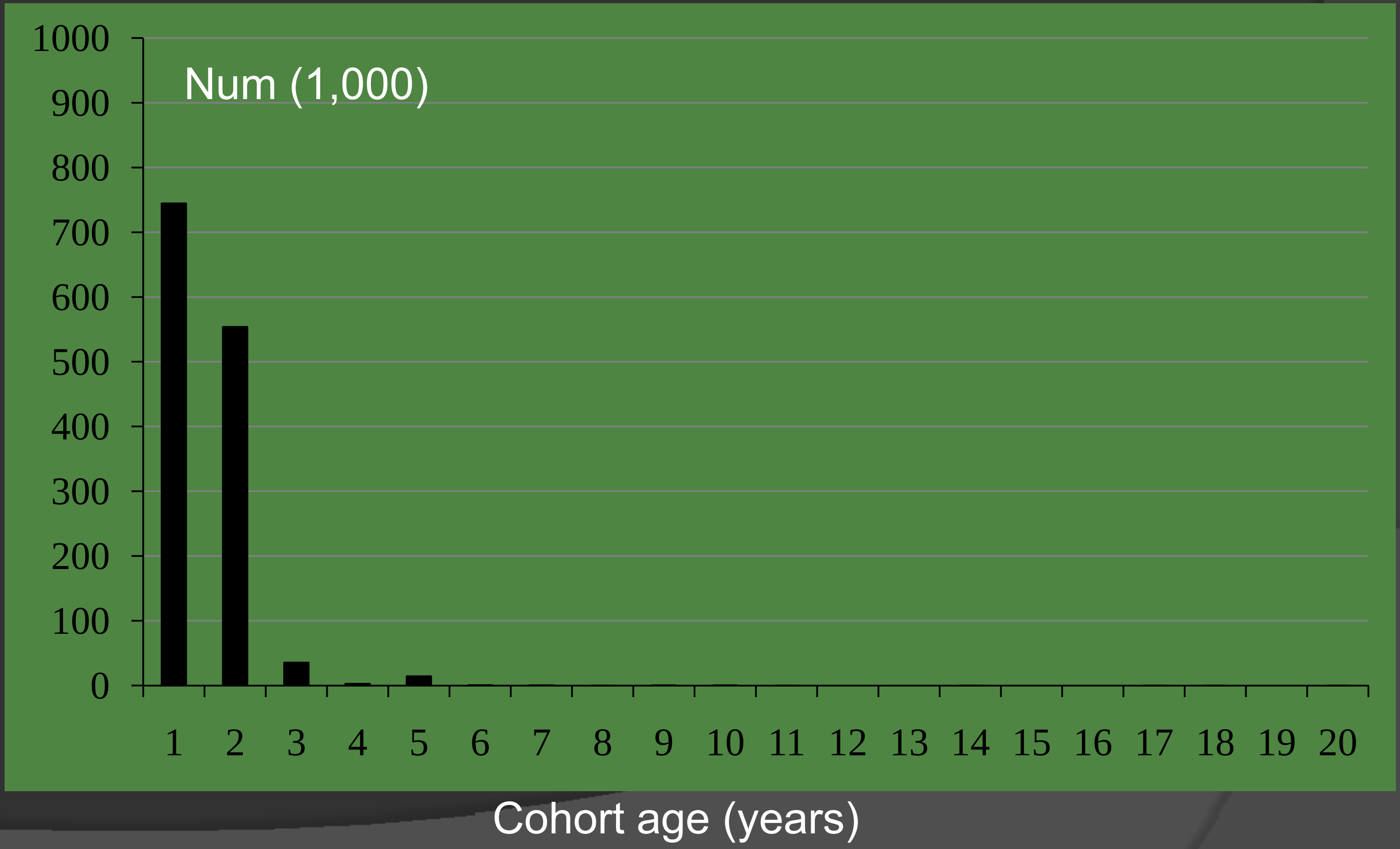
Stages of Modeling

Stage 2: MSY *& cohort structure*



Stages of Modeling

Stage 3: Overfished cohort structure



“Optimal Rebuilding of Fish Stocks in Different Nations: Bioeconomic Lessons for Regulators”

- Begin with ‘moderate’ and ‘long’ lived overfished stocks
- Follow U.S. and New Zealand rebuilding guidelines
- Compare different T_{target} and δ

For "overfished" stocks

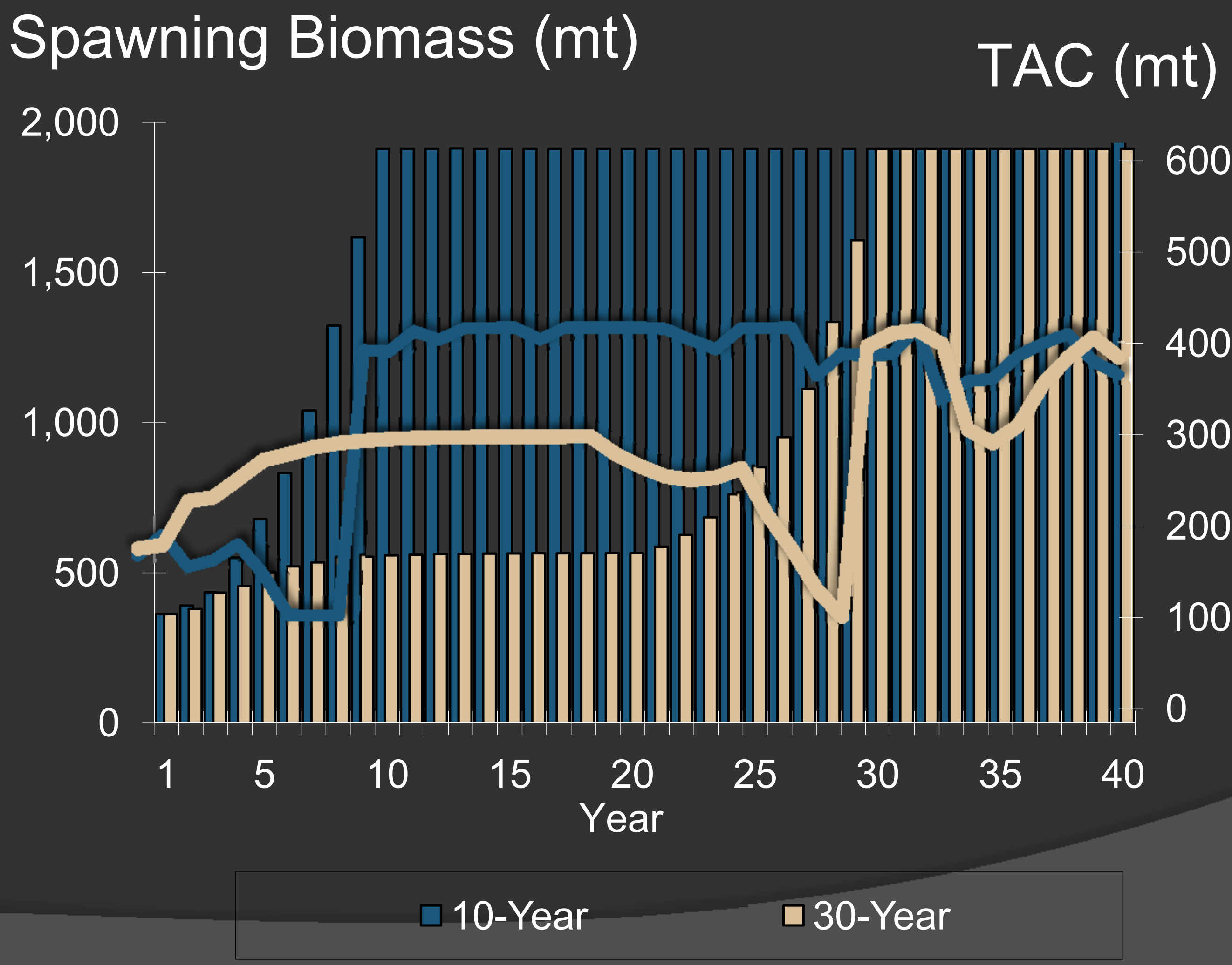
Effective July 12, 2009*, within 2 years of an "overfished" or "approaching overfished" stock status notification, Councils (or Secretary for Atlantic HMS) must "prepare and implement" management measures to:

1. Immediately end overfishing
2. Rebuild affected stocks
   - "as quickly as possible"
   - "not to exceed 10 years", unless biological or environmental circumstances, or management under an international agreement dictates otherwise

MSA Sec. 304(e)

*MSA sec. 303 note, MSRA sec. 104(b)

10 vs. 30 year Rebuild



Benefits of Delay:
↑ NPV: 4%
↑ Avg TAC: 97%

Summary

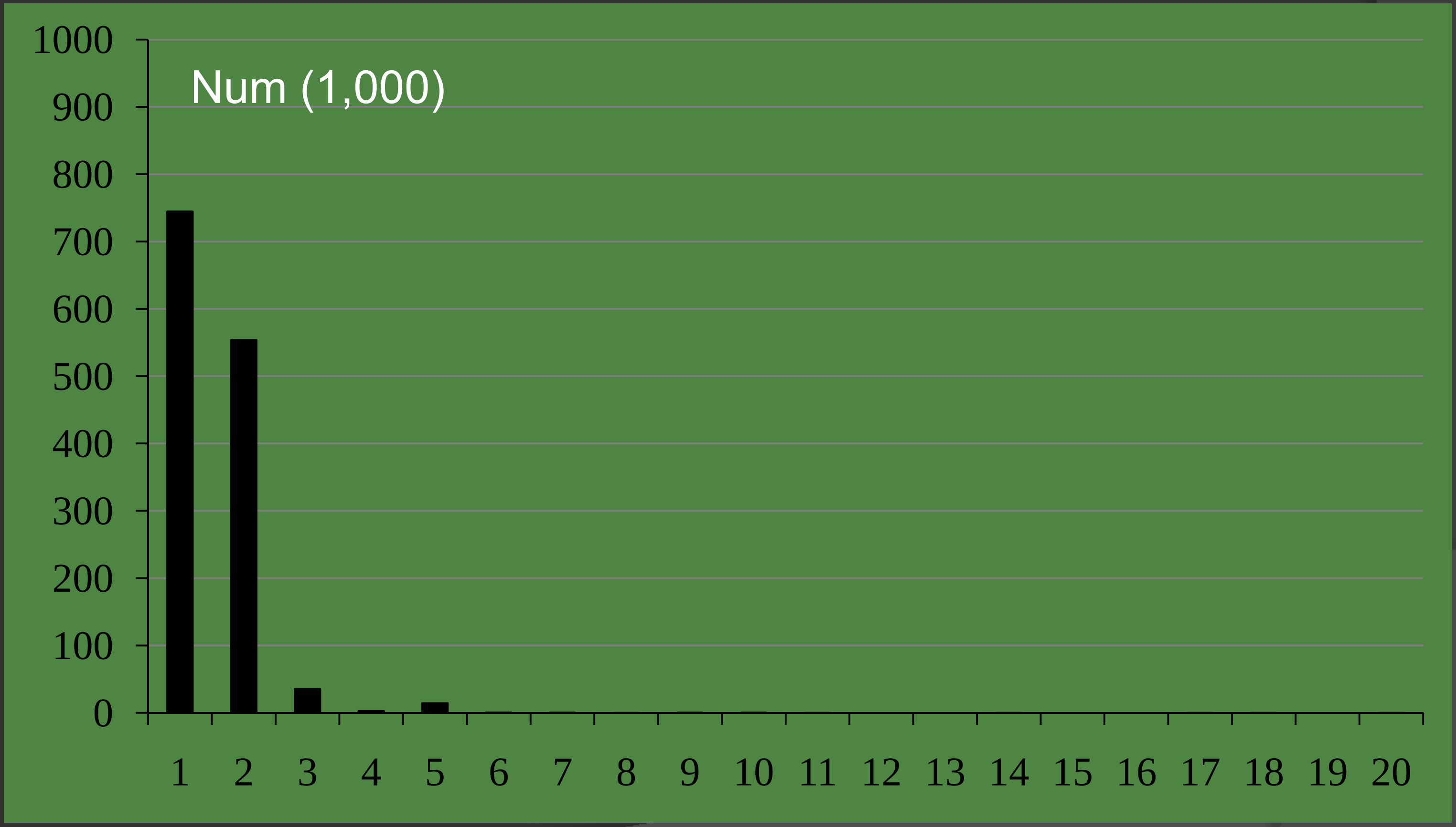
- "as quickly as possible" and "not to exceed 10 years" may produce significant social losses, particularly for slow-growing stocks

- What about the cohort structure?

  Failure to consider full range of biological changes could compromise productivity of rebuilt stock

Stages of Modeling

Stage 3: Overfished cohort structure



Cohort age (years)

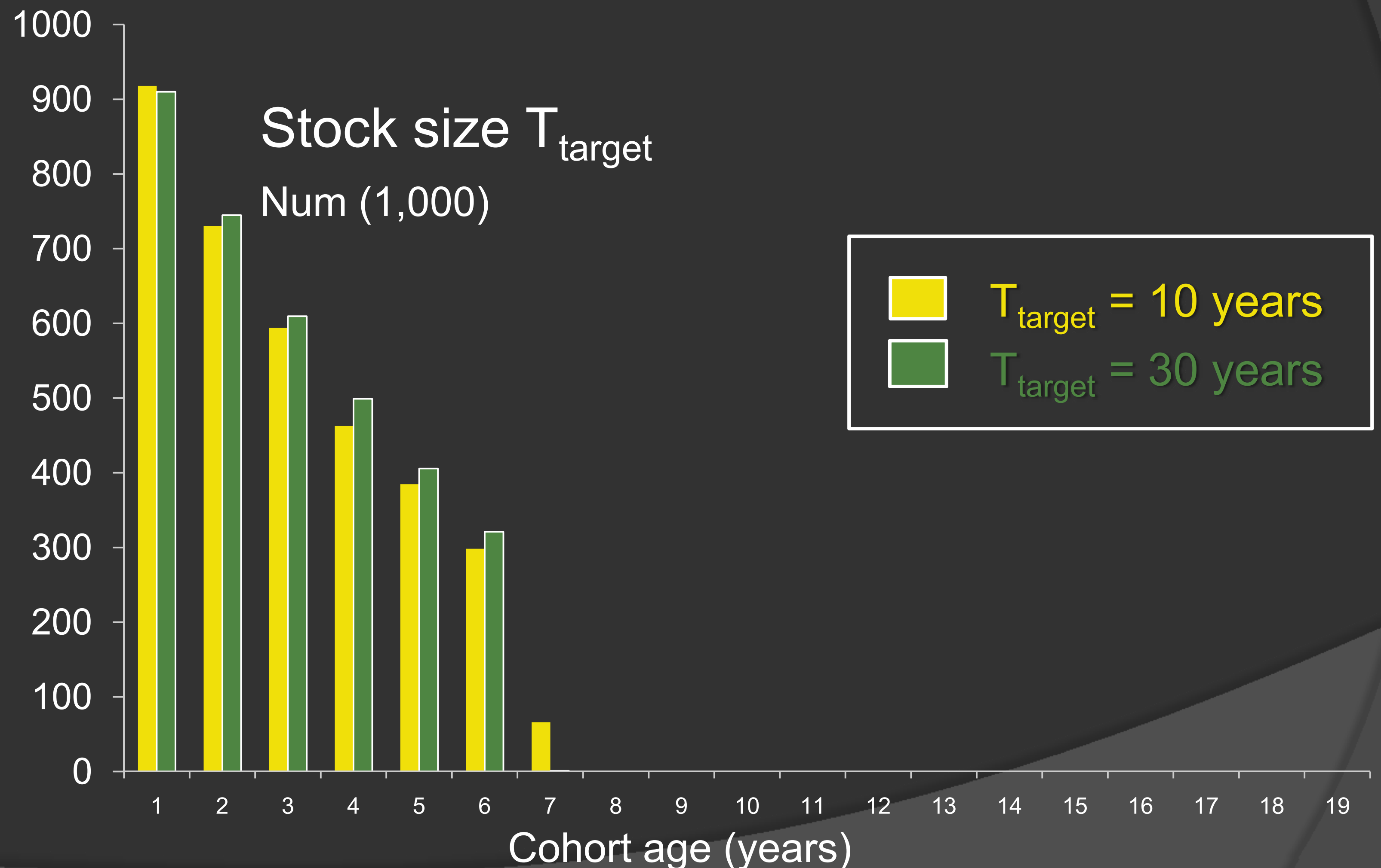
Stages of Modeling

Stage 4: Rebuilding Scenarios

		Cohort Structure	
		Unrestricted	Pristine
Time Horizon:	10 years	***A***	***C***
	30 years	***B***	***D***

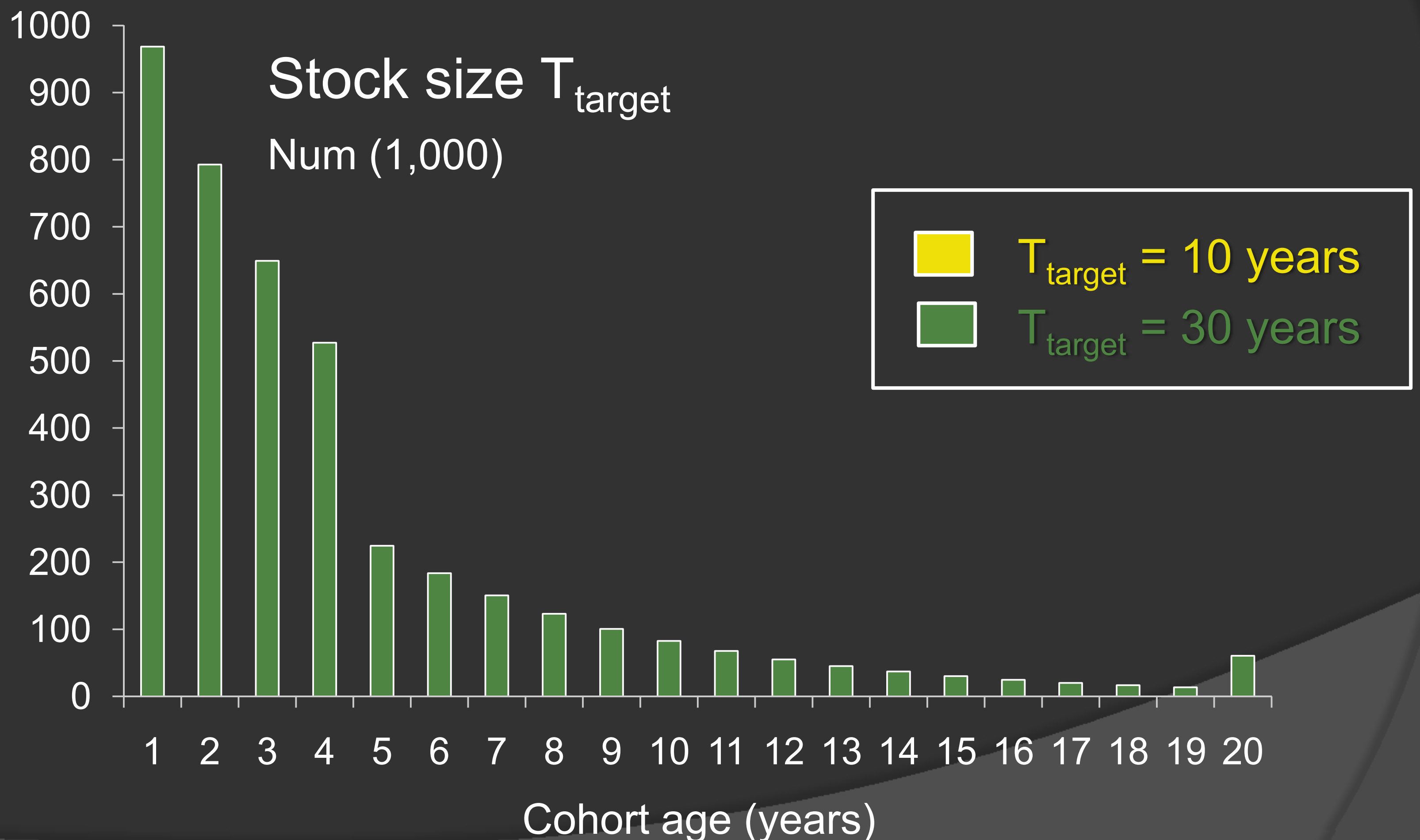
Rebuilding Scenario A & B

Unrestricted cohort structure



Rebuilding Scenario D

Restricted cohort structure (pristine)



Summary Observations

- TRADEOFFS
- RISKS
- CAUTIONARY TALES

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New SSC Requirements

"Each scientific and statistical committee shall provide its Council ongoing scientific advice for fishery management decisions, including recommendations for acceptable biological catch,

- *preventing overfishing,*
- *maximum sustainable yield, and*
- *achieving rebuilding targets, and*
- *reports on stock status and health,*
- *bycatch*
- *habitat status*
- *social & economic impacts of management measures, and*
- *sustainability of fishing practices."*

MSA Section 302(g)(1)(B)