

Do numerical simulation and  
optimization results improve  
management? Experimental evidence.

by

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# Do models improve management?

- Focus on
  - Decision quality
  - Simulation versus optimization
  - Numerical guidance
- Not focus on
  - Model quality (forecast/strategy)
  - Competition with other advises
  - Improved understanding
- Previous studies find positive effects
  - Expert/information systems
  - No studies of social planning

# Experiment

- “Virtual reality” to be managed:
  - Two-species fishery model, age-classes, non-linearities, economics, unemployment, randomness and measurement error
- Simulation tool
  - “Correct” single-species models with uncertain initial stocks and no economics. Advice: 4-year stock predictions for two simple fishing strategies,  $h(\text{own stock})$ , for each species.
- Optimization tool
  - Stochastic Lotka-Volterra model estimated on data from “virtual reality” with correct economics, max: expected NPV. Advice: Fixed fishing strategies,  $h(\text{both stocks})$ .

# Computer screen

Management of Cod and Capelin - Barents Sea			RESULT	
<b>Decisions</b>	Cod	Capelin	PV Cod	
Quota			PV Cap.	
<b>INFORMATION</b>	Cod	Capelin	-Unemp.	
Stock estimate	864	3840	Criterion	
Catch	238	2325	Payoff	
Income	1425	1163		
Cost	889	187		
Net Income	536	976		
Unemp., %	0	0		

**Year 0**

**NEXT YEAR**

Advice from economist		
	Cod	Capelin
Target esc.	1222	7000

**Help from biological model: Cod**

	15 %	30 %
Catch next year	130	259

**Help from biological model: Cap.**

	40 %	80 %
Catch next year	1536	3072

# Experimental design

- 64 students with higher economic education, no practical experience
- 3 by 3 factorial design: The two tools and the initial conditions (high and low stocks)
- 16 realizations of random variable
- Financial incentives to perform well
- Pre questionnaire (check and data)
- Post questionnaire (strategy and value of tool)
- Benchmark score: Score using the exact optimization strategy

## Results:

- ANOVA results: Score- Benchmark score

- Average benchmark score: 17200

Variable	Estimate	t-ratio
Intercept	1973*	4.87
Optimization	1014*	2.51
Simulation	1053*	2.61
Hight stock	-1171*	-2.90
Opt.*Sim.	-222	-0.55
Opt.*High	850*	2.11
Sim.*High	-342	-0.85
All	-256	-0.64

\* Significant at 5 percent level

- Estimated subject strategies

- Only sensitive to “own resource”

- Less sensitive to stock than opt. strategy

- 3/4 year time delay

# Conclusions

- Both tools have positive effects, 10% each
  - Complements rather than substitutes
  - High return on tool development, if not
  - smaller effects in real management?
- Optimization particularly important when initial stocks different from equilibrium
  - Only simulation tool: anchoring of goal on initial disequilibrium
- Subject strategies relative to opt. strategy:
  - correction in direction of more elaborate optimization (non-linearities and measurement error)
  - correction in direction of actual management
- Subjects overestimate the value of both tools (200-300 %)
  - Overselling to naive students?