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Scientific Conference
"Advances in Ecosystem-based Fisheries Management"

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This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no. 613571

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Using Gadget in a multi-criteria analysis of the Icelandic cod fishery

Bjarki Þór Elvarsson[1)], Jónas R. Viðarsson[2)]
Saga Guðmundsdóttir[3)], and Sveinn Agnarsson[3)].

[1)] Marine Research Institute, Iceland, [2)] Matís, Iceland
[3)] University of Iceland,

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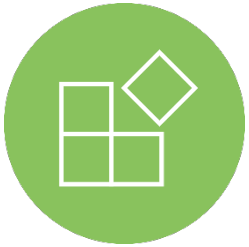
Decision Support Framework (DSF)

- **Links the stakeholders and their objectives with the ecosystem and its descriptors.**

- **DSF helps:**
- **Identify goals and concerns**
- **Analyse what matters**
- **Supports the design of a solution**



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Aim of Icelandic case study

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Use Gadget as statistical framework for two scenarios in the Icelandic cod fisheries

- **Status quo – harvest control rule**
- **MSY fisheries (20% increase of catches)**

Analyse impact on environment, industry, and economy

Use multi-criteria analysis (MCA) to analyse the preferences of stakeholders

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Icelandic cod fisheries

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Fisheries are of paramount importance to the Icelandic economy

- **23% of exported goods and services in 2015**
- **harvesting and processing represent 8% of GDP**

Cod is by far the most important species

- **value of cod amounted to 40% of total value in 2015**

Fisheries – and especially cod fisheries – constitute the backbone of economic activity in coastal communities around Iceland

Several fleet segments;

- **Trawlers**
- **Longliners**
- **Netters**
- **Small boats with handline**

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Icelandic cod fisheries

Managed by ITQ

Harvest control rule in operation since 1995 with the aim to rebuild the cod stock
Changed slightly through the years, but the current version is:

$TAC_{y+1} = (\alpha B^4_y + TAC_y)/2$,
B^4_y = biomass of 4-year old and older cod,
α = harvest rate.
α is set at 0.2 when SSB > 220 thousand tonnes (SSB_{MP})
but set at $\alpha = 0.2\ (SSB_y / SSB_{MP})$ when SSB_y is lower.

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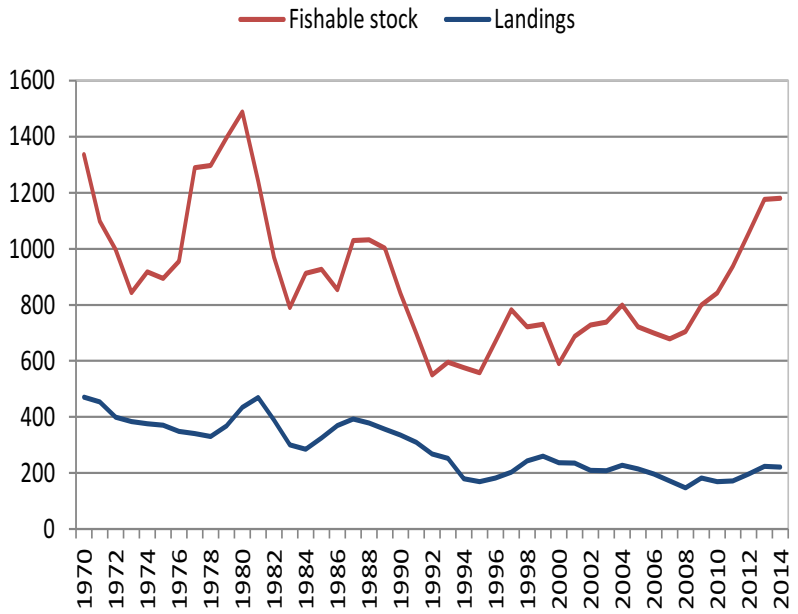
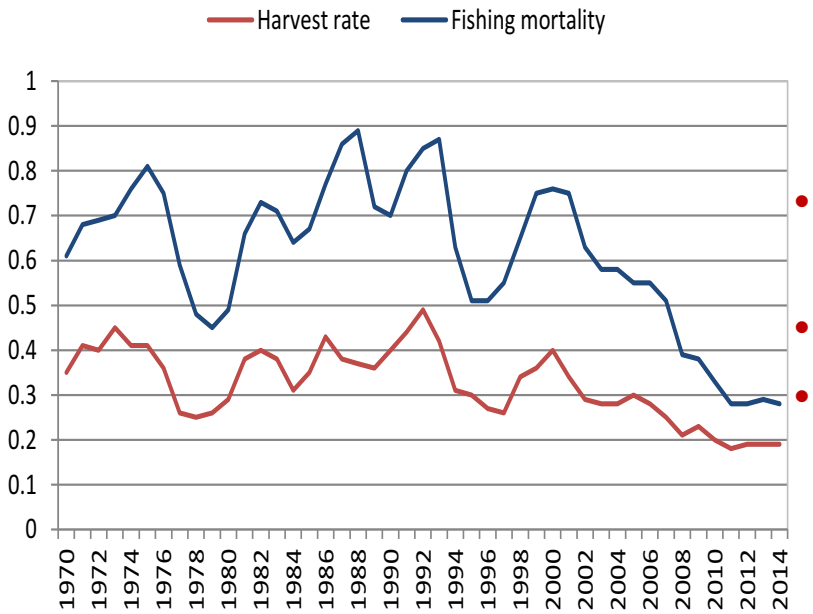
Icelandic cod fisheries

- **TAC decreased to rebuild stocks faster**
- **Catches increased from 147 thousand tonnes in 2007 to 265 thousand tonnes in 2016**
- **Fishable stock larger than at any time since 1981**





- **Mortality decreased from 0.76 in 2000 to 0.28 in 2014**
- **Long-term aim: F = 0.2**
- **Harvest rate reduced from 0.49 in 1992 to 0.19 in 2014**

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Globally applicable Area Disaggregated General Ecosystem Toolbox - Gadget

- Statistical framework for modelling marine ecosystems
- Allows the creation of age-length structured forward-simulation models that can be coupled with an extensive set of data comparison and optimization routines
- Designed as a multi-area, multi-fleet model, capable of including predation and mixed fisheries issues
- Often used to model data challenged species, e.g. when data for traditional age–based assessment models are not available
- Can construct different scenarios that allow for comparisons of different management policies

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Interaction with stakeholders

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First meeting

- Attended by representatives from the industry and government.
- Environmental NGO's were notably missing
- Main interest of stakeholders to maintain a strong and stable cod fishery
- Main concerns were the effects on increased taxation and apparent uncertainty caused by frequent regulatory changes

Second meeting

- Only attended by representatives from the industry
- Objectives for management plan
  - Strong and stable stocks
  - Maintain biodiversity, food-web integrity, and sea-floor integrity
  - Stable employment and settlement throughout Iceland
  - Strong economic performance
  - Agreed on scenarios to be implemented in Gadget

Third meeting

- Wide range of attendees (industry, government, environmental NGOs)
- Engaged stakeholders in the DSF

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Decision support framework

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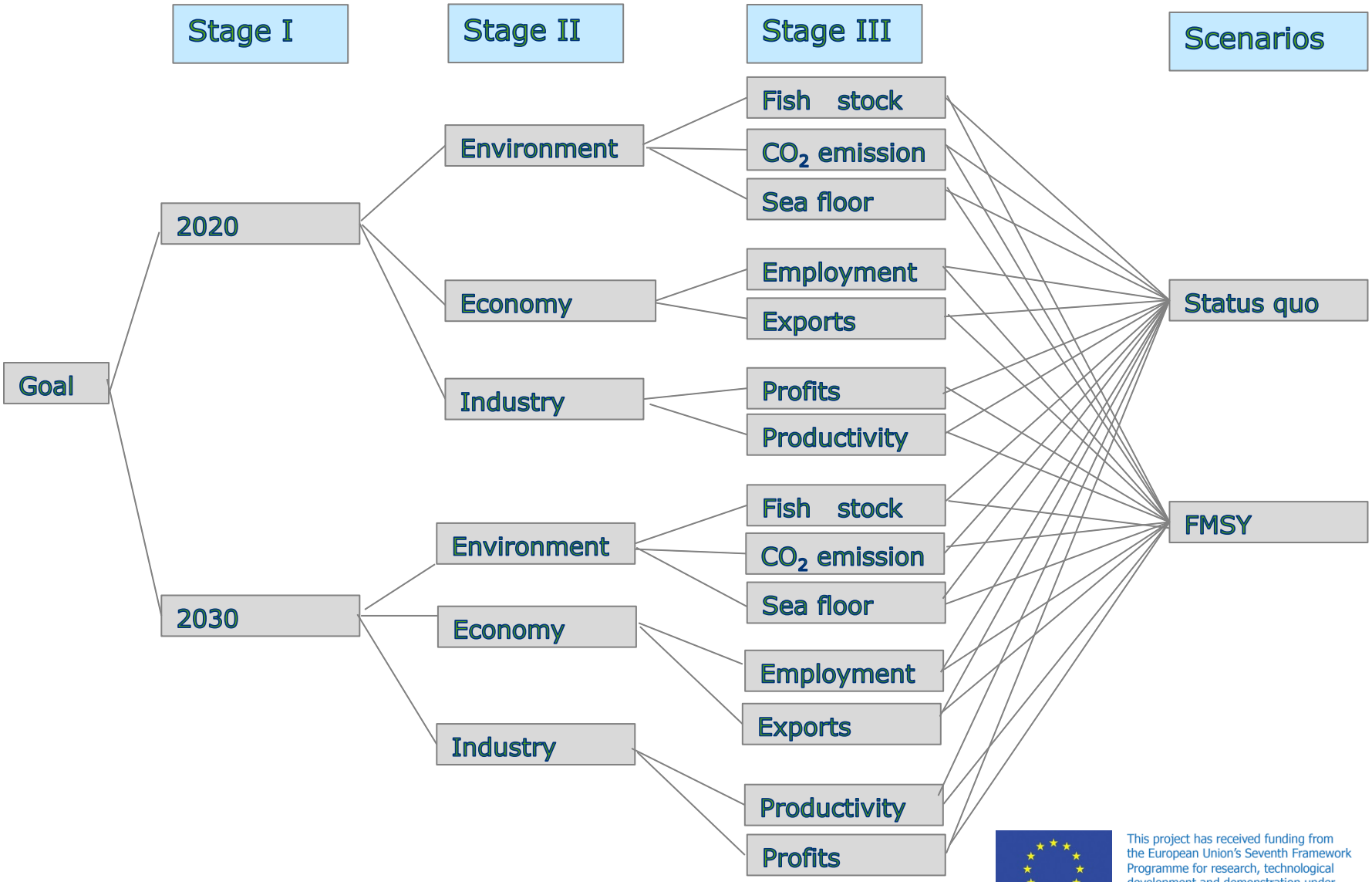

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General framwork of the Icelandic case

1. **Run the two scenarios – Status Quo and FMSY – in Gadget and obtain values for all model variables. Percent changes.**

Medium-run (2020)

	Status Quo	FMSY
Fisk stock	-9.92	-24.94
CO_2 emission	-16.83	-15.56
Sea floor	-14.83	-13.20
Employment	-24.04	-24.29
Exports	-14.93	-13.33
Profits	-0.51	-0.62
Productivity	9.50	11.53

Long-run (2030)

	Status Quo	FMSY
Fisk stock	16.49	-3.99
CO_2 emission	7.28	7.23
Sea floor	10.79	11.30
Employment	-3.11	-5.12
Exports	10.62	11.10
Profits	-0.43	-0.53
Productivity	10.73	13.02

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General framwork of the Icelandic case

2. Use Multi-Criteria Decision Analysis with Gadget
3. Use co-creation to set up the framework in cooperation with stakeholders
4. Model based on the Analytic Hierchy Process (AHP) which is constructed using pair-wise comparison of two or more alternatives in each stage of the model (Stage I – III)
5. Participants asked to compare A to B with a score of 9 indicating that A is very much preferred to A, and a score of -9 indicating that B is preferred to A.
6. This process yields weights for each of the elements in Stage III

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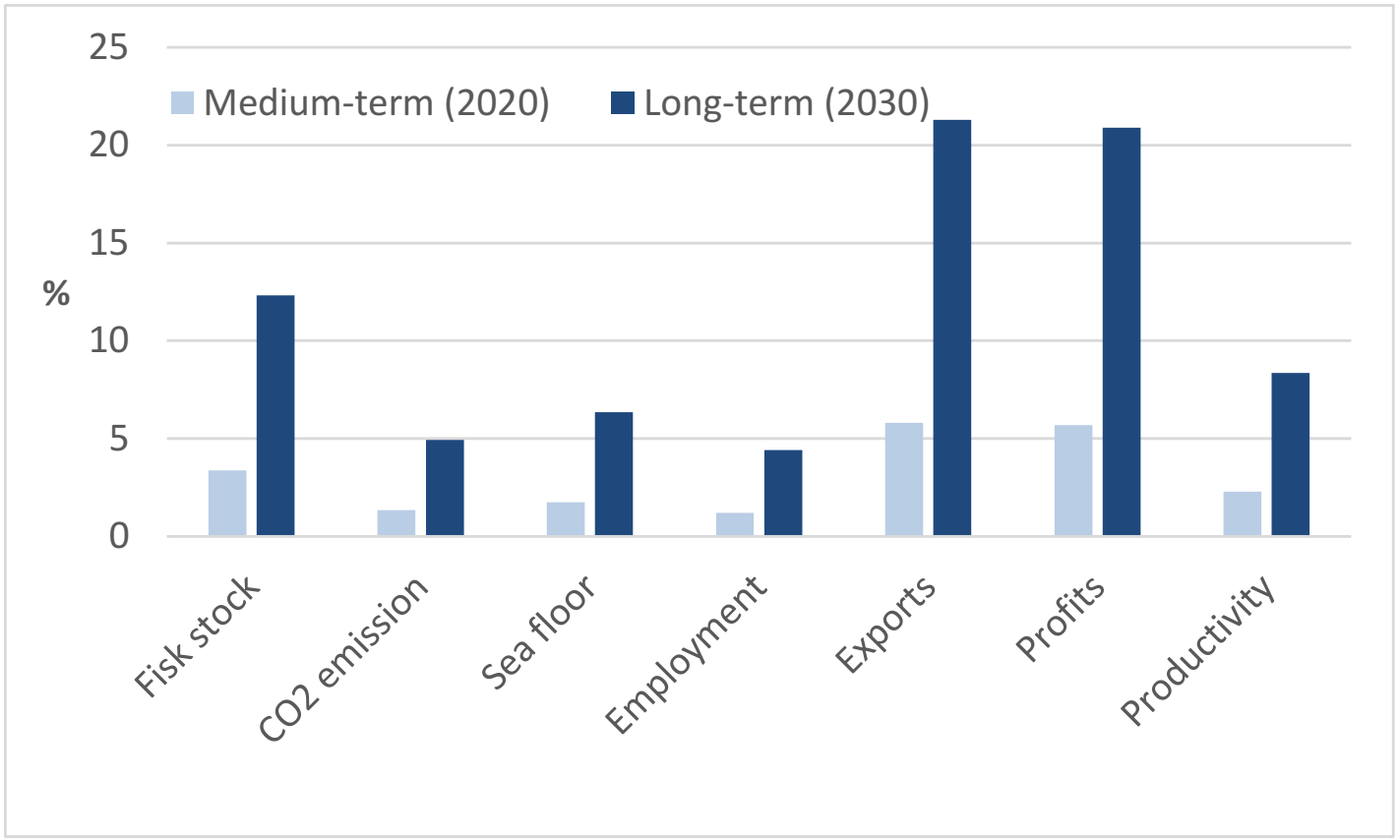
Weights obtained from AHP



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General framwork of the Icelandic case

7. Using the results from Gadget, participants (stakeholders) are asked to pair-wise compare the results from the two scenarios for each of the variables for both time frames (2020 and 2030)
8. The results from this comparison are then corrected using the weights calculated earlier to find out whether stakeholders preferred Status Quo to FMSY (or vice versea), and what mostly influenced that preference
9. Discuss and analyse the results with stakeholders

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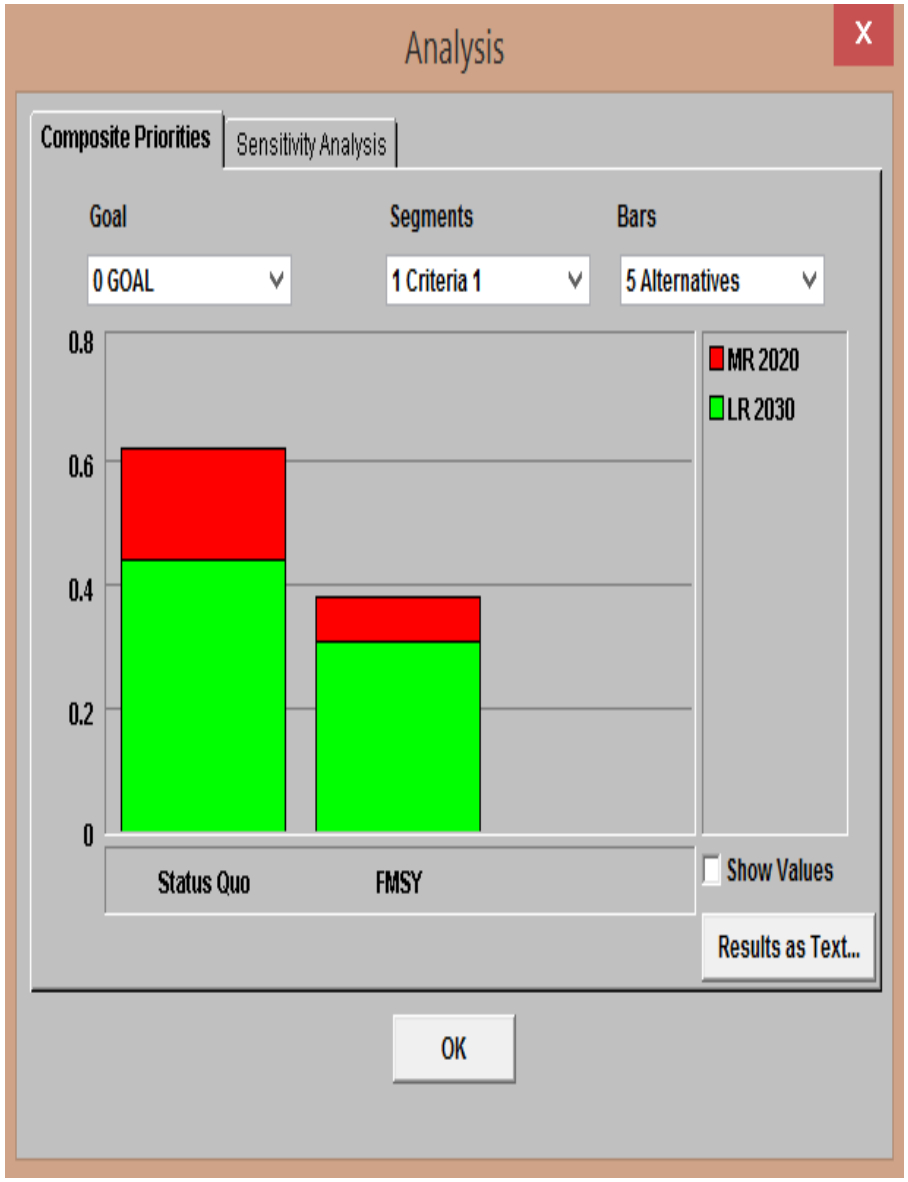
Overall results, Stage I



- **Stakeholders peferred Status Quo to FMSY**
- **Long-term considerations of far greater importance**

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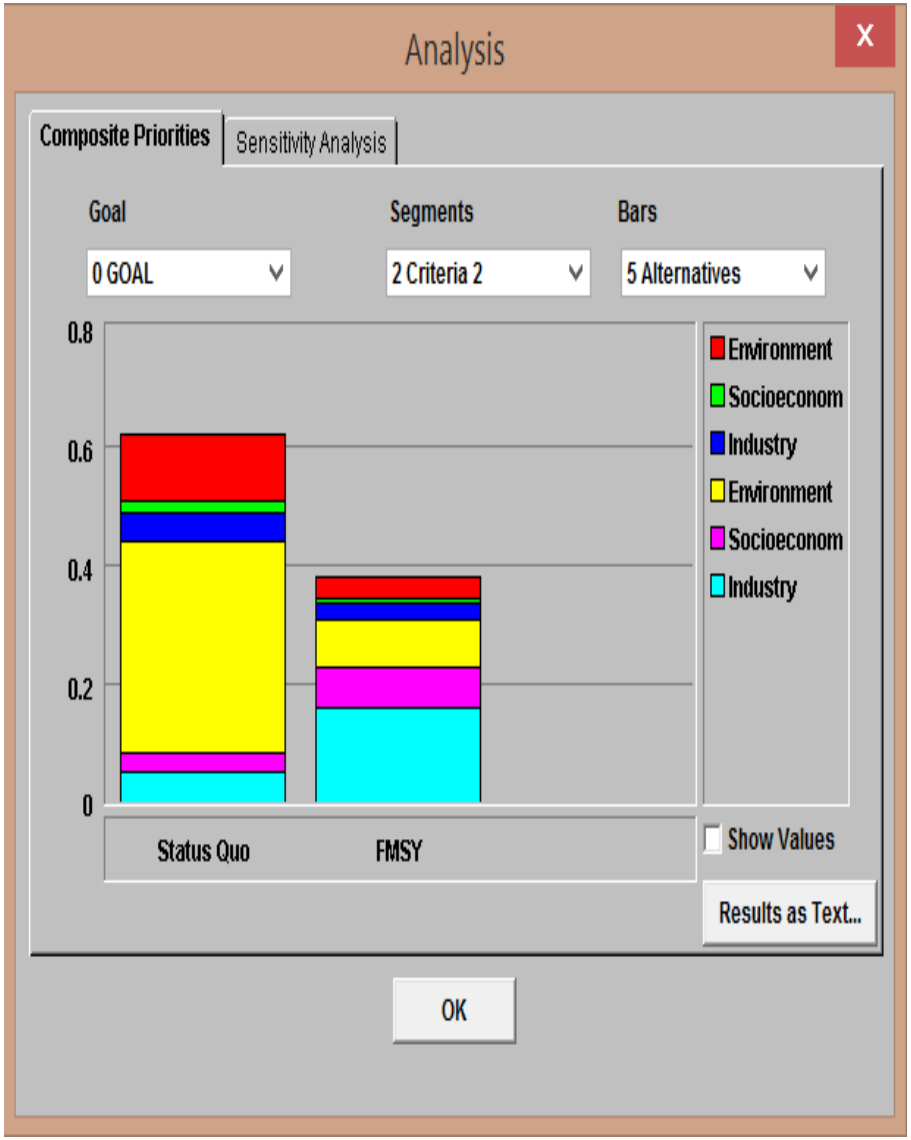
Overall results, Stage II



- **Environmental concerns dominate the views of those preferring Status Quo, both in the medium-term (red) and especially in the long-run (yellow)**
- **For FMSY, long-run industry concerns are of most importance**

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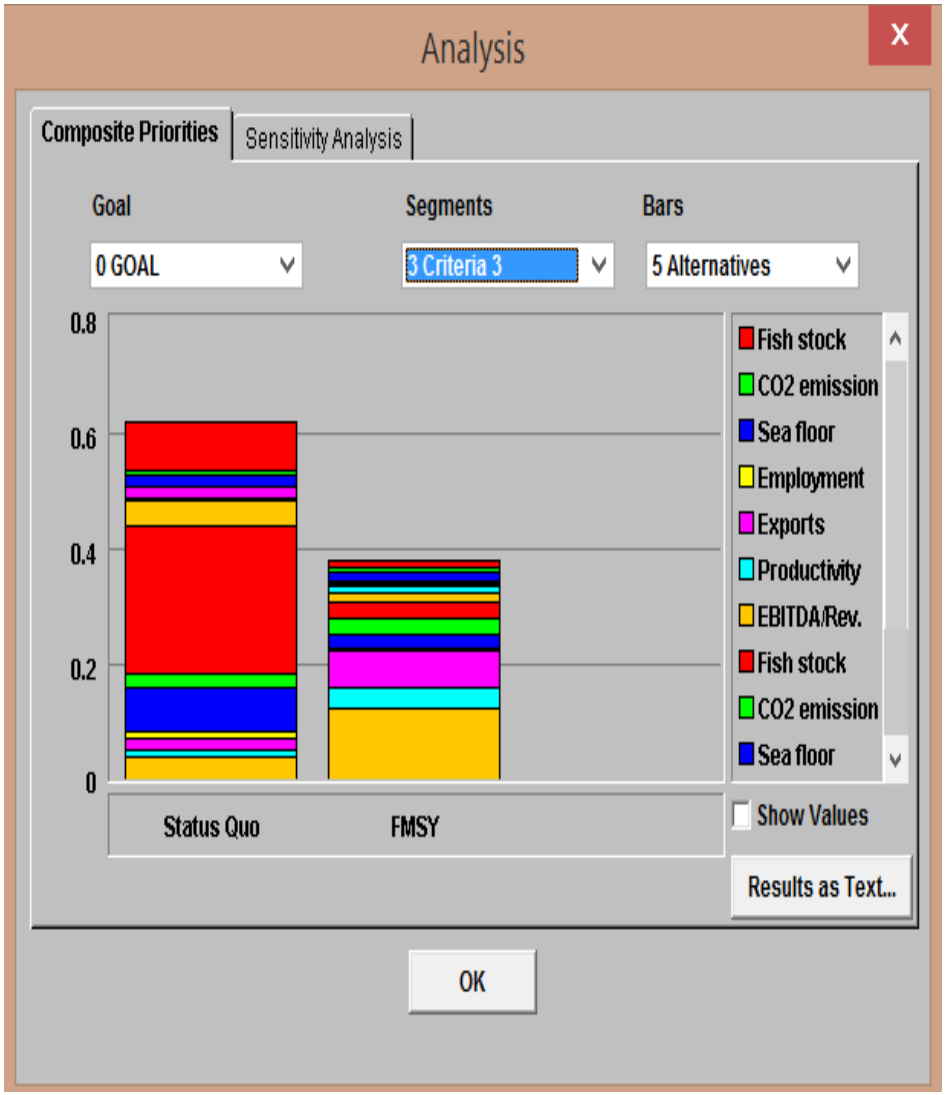
Overall results, stage III



- For Status Quo, the conditions of the cod stock are of primary concerns, both in the medium- and long-run
- Also some serious concerns for the condition of the sea-floor

- For FMSY, long-run profits are the pressing concern
- Long-run exports are also quite important

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Conclusions

- Gadget ideal for simulating the scenarios
- Socio-economic impacts of changes in fisheries management policy can be easily derived
- Stakeholders eager to get to know the models and tools
- Stakeholders understand the choices involved, both the differences between time frames (medium- and long-term) and how changes in policy impact on the environment, society as a whole and industry
- Stakeholders are, in general, mor concerned with the long-term impacts of management policy, and very concerned about the impact on fish stocks and other environmental factors
- A more complex model can be based on this prototype
- Can become part of the toolbox available to government as it is useful to analyse the various aspects of management policies

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Thank you

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