Low trophic level fisheries
Cape Town, November 2011

Background on Marine Stewardship Council

- International standard setting body for sustainable seafood
- Three principles – stocks, ecosystems, governance
- Incentive based approach – participation is voluntary
- Independent 3rd party certification
- Assess each fishery against MSC principles and criteria
- Common assessment framework for all fisheries
  - Common FAM since 2008

MSC approach to LTL fisheries

- Common FAM required special consideration of LTL fisheries
  - more conservative reference points to take account of possible trophic effects
- Lack of clarity about how this should be interpreted
- Set up LTL working group in 2009
  - review best practice
  - wide stakeholder engagement
    - ► industry, science, NGOs, certification bodies
  - commissioned scientific study

LTL science study

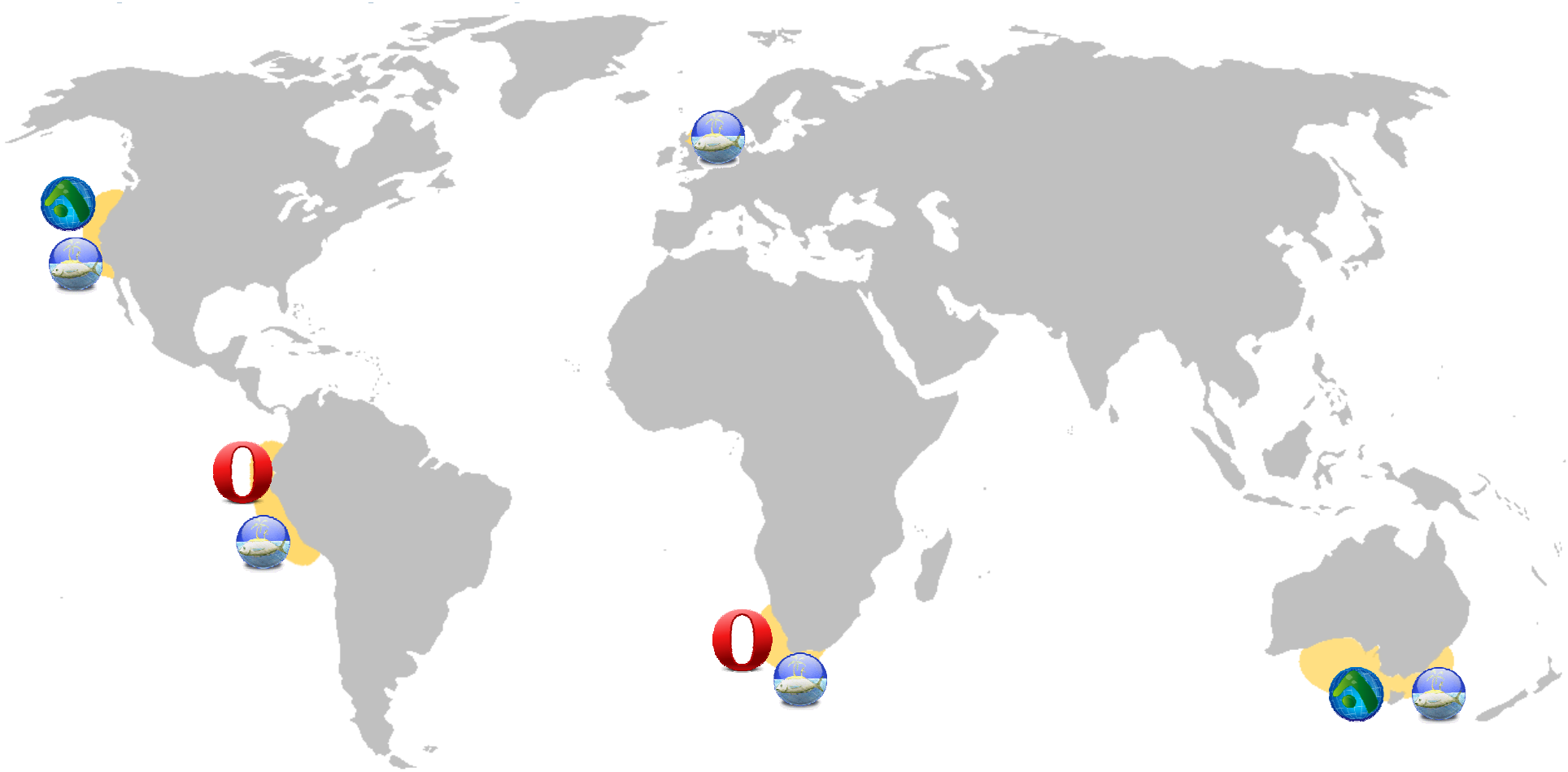
- Use existing ecosystem models to explore the effects of different levels of depletion of LTL species
- Use a range of model types to (partly) deal with aspects of model uncertainty


Atlantis Ecosim OSMOSE


	Atlantis	Ecosim	OSMOSE
Currency	Nitrogen	Biomass	Individuals
Spatial structure	Dedicated (polygons)	None	Grid
Time step	12 hr	Monthly	Weekly
Oceanography	Yes (e.g. links to ROMS model)	V5 No, V6 yes (model coupling)	Yes, forcing/coupling (e.g. ROMS)
Trophic Groups	~60: vert., plankton, benthos, prim. producer	<100: vert., plankton, benthos, vert., prim. producer	~10, typically forage and demersal fish
Age structure	Vertebrates: 10 age classes	"Multistanza" age classes	Cohorts
Nitrogen cycling	Nitrogen cycling	None	None
Functional response	Holling Type I,II,III, others	"Foraging Arena": implicit refuges	Size-based predation and max ingestion rate
Reproduction	Ricker, Beverton, fixed #/adult, others	Biomass growth rate w/ compensation in juveniles	Based on fecundity and SSB=f(predation efficiency)
Movement	Foraging and seasonal	Seasonal	Foraging and seasonal
Fishing	Spatial: Fleets' catch, effort, or F	Fleets' catch, effort, or F	Non-spatial fishing mortality rates
In summary	Flexible	Fast, stakeholder game playing	IBM, focused on forage+demersal fish

Models (and the Team)

- Expert users/developers + Multiple models per system



Atlantis **EwE** **Osmose**

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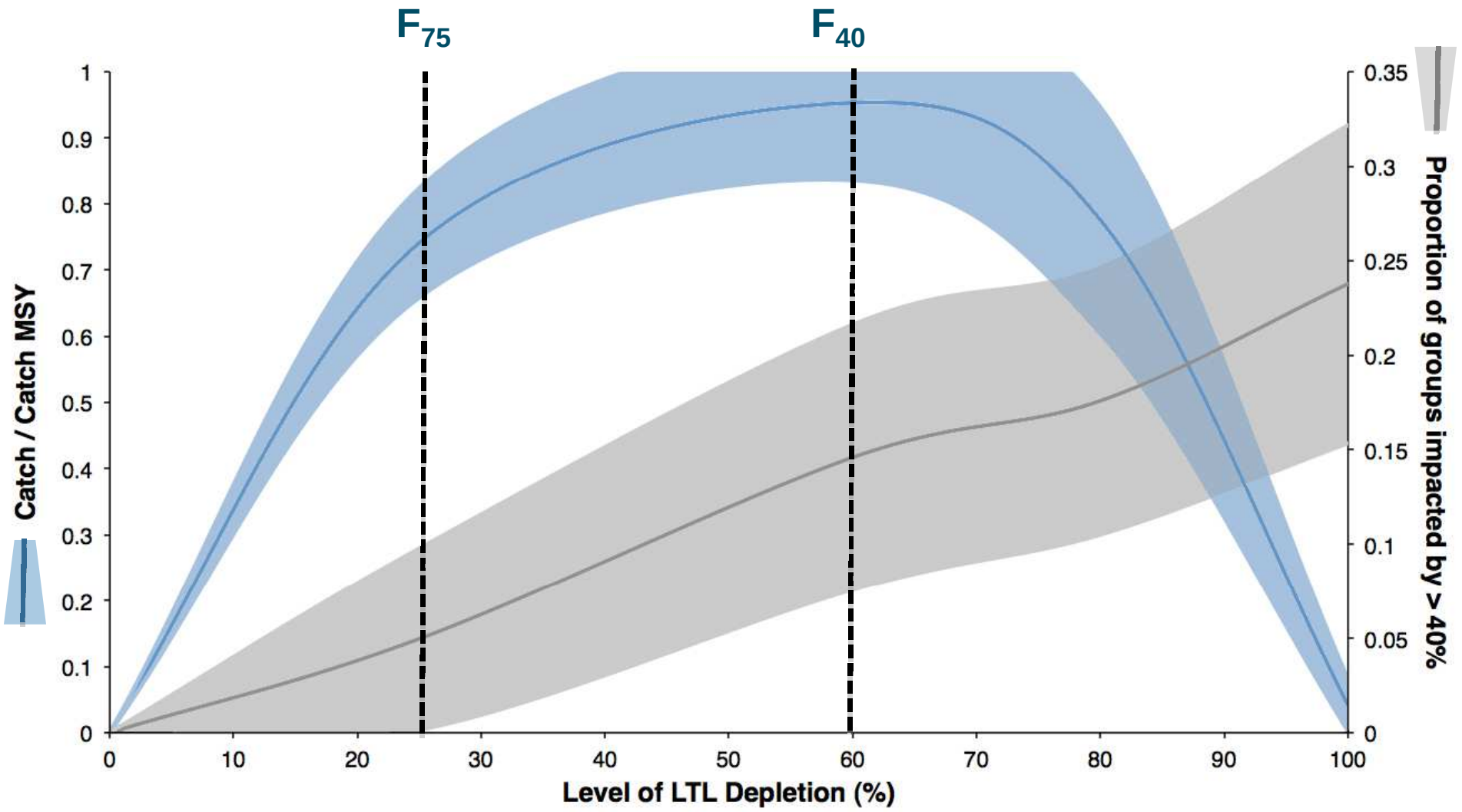
Methods used – depletion analysis

- Hold fishing pressure for the rest of the system constant
- Iteratively apply increasing F to LTL
  - from F = 0 to F causes extirpation
  - look at effects on all other groups in model
  - % of groups that change biomass > 40% (up or down)

Results – overall



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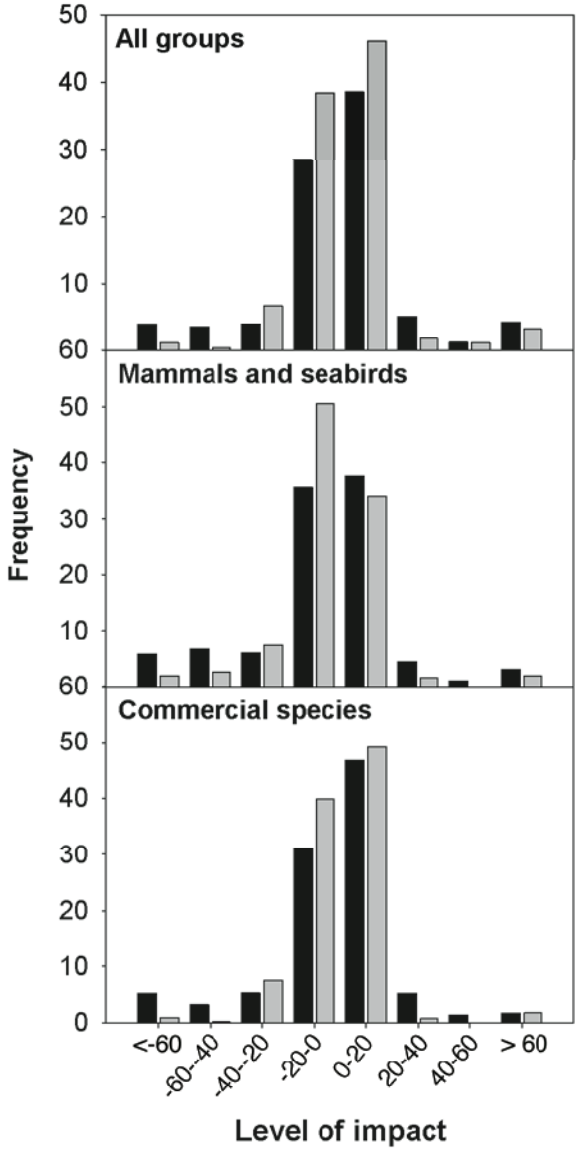
Results – overall

Drop ⟷ Rise



LTL depleted by 25%

LTL depleted by 60%

- Most groups little effect
- Some groups large effect
- Increase and decrease

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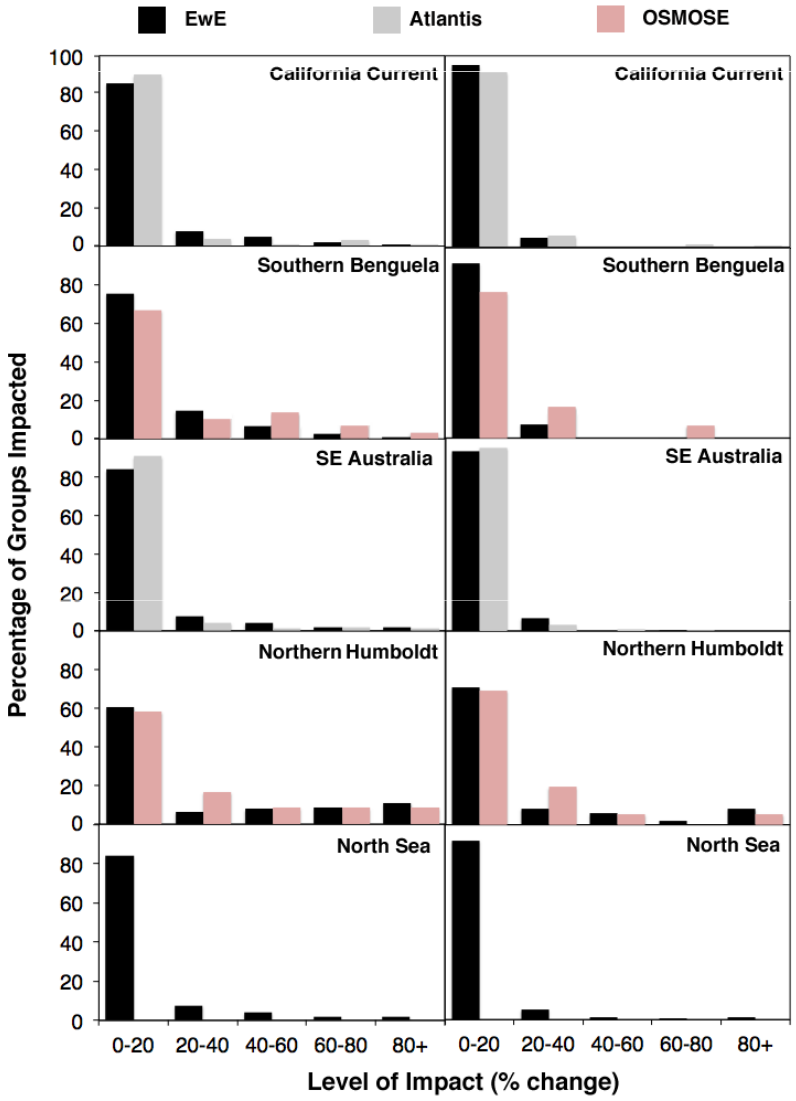
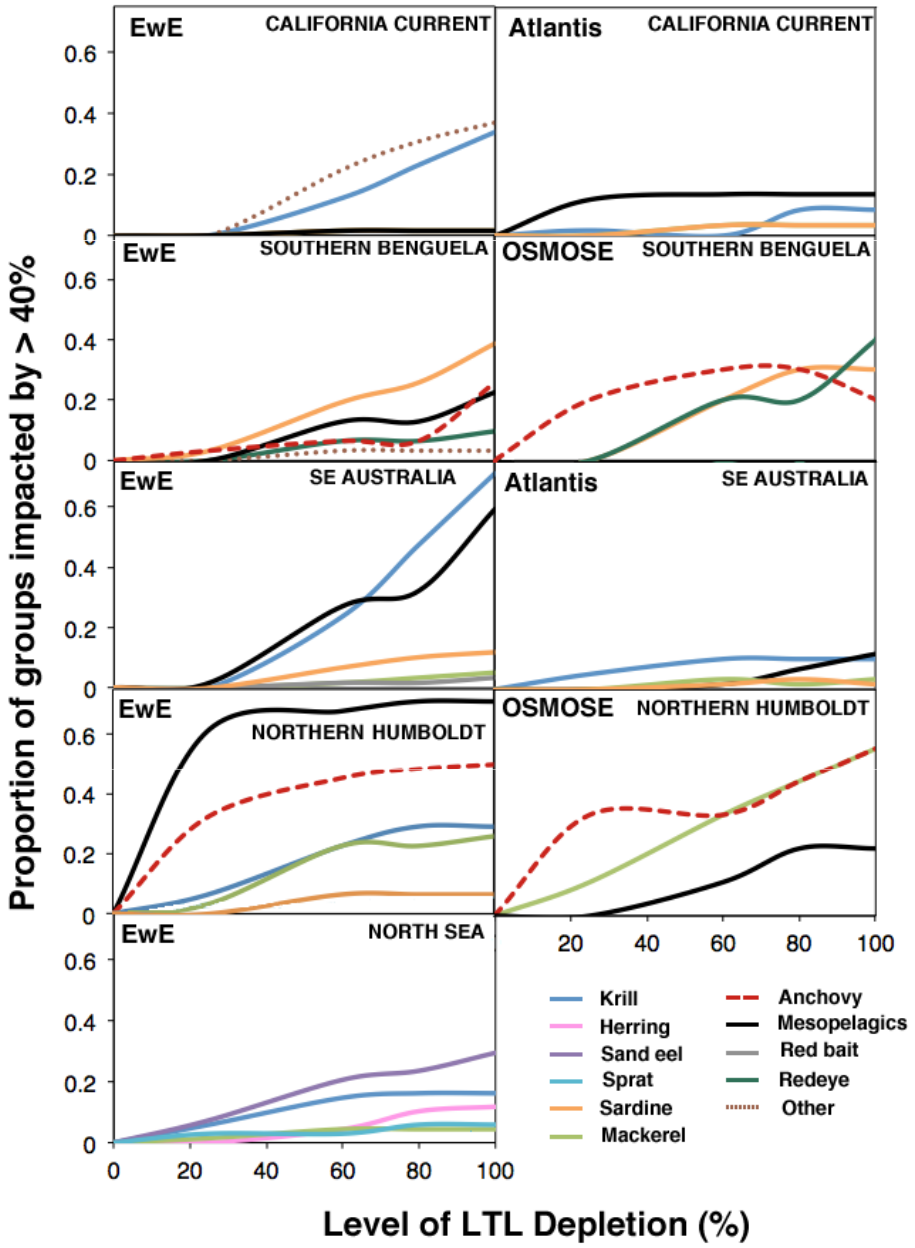
Results – overall

- Similar patterns in general terms across models



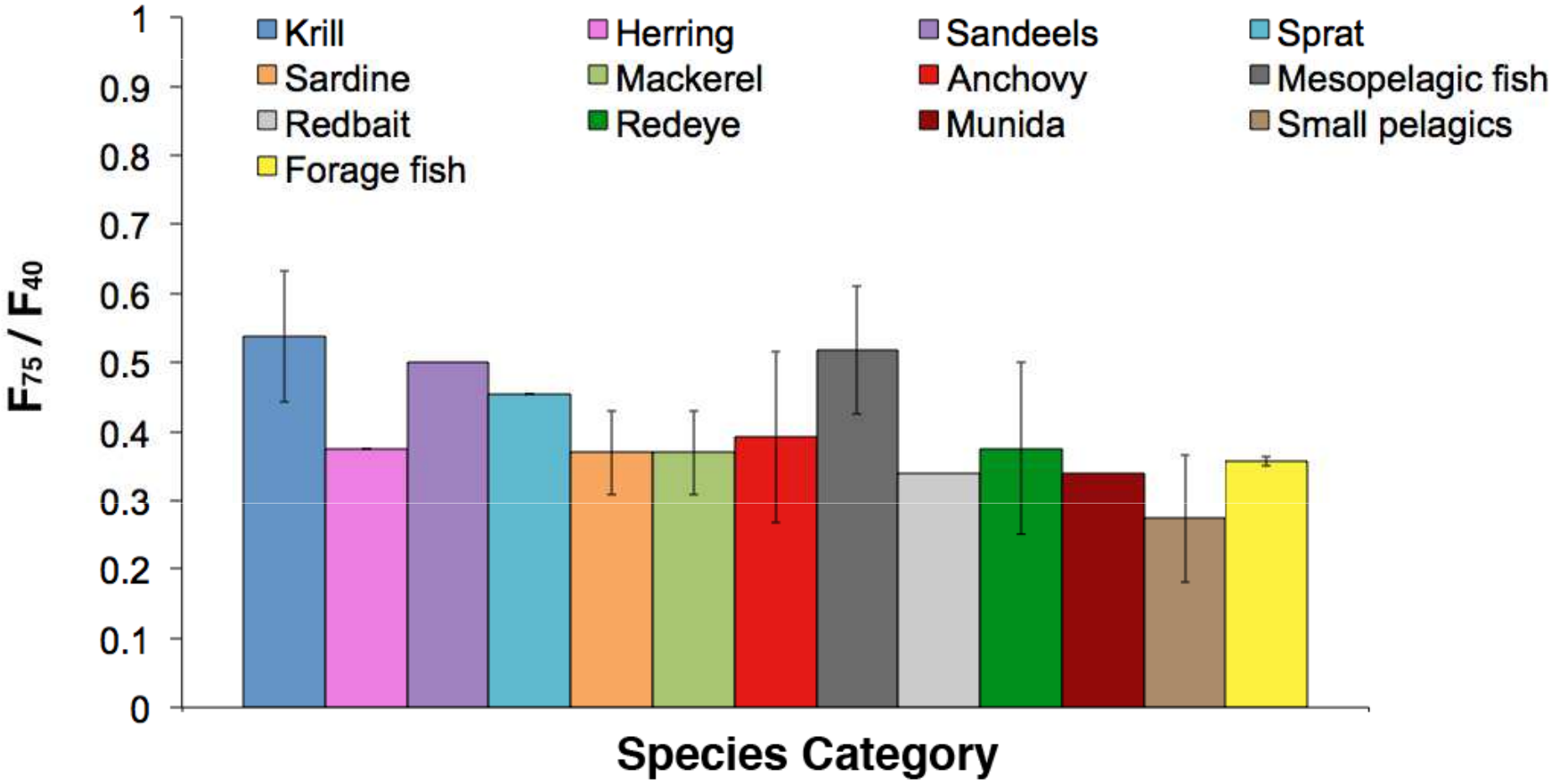
  - Most groups little effect
  - Some groups large effect

Results – devil in the details



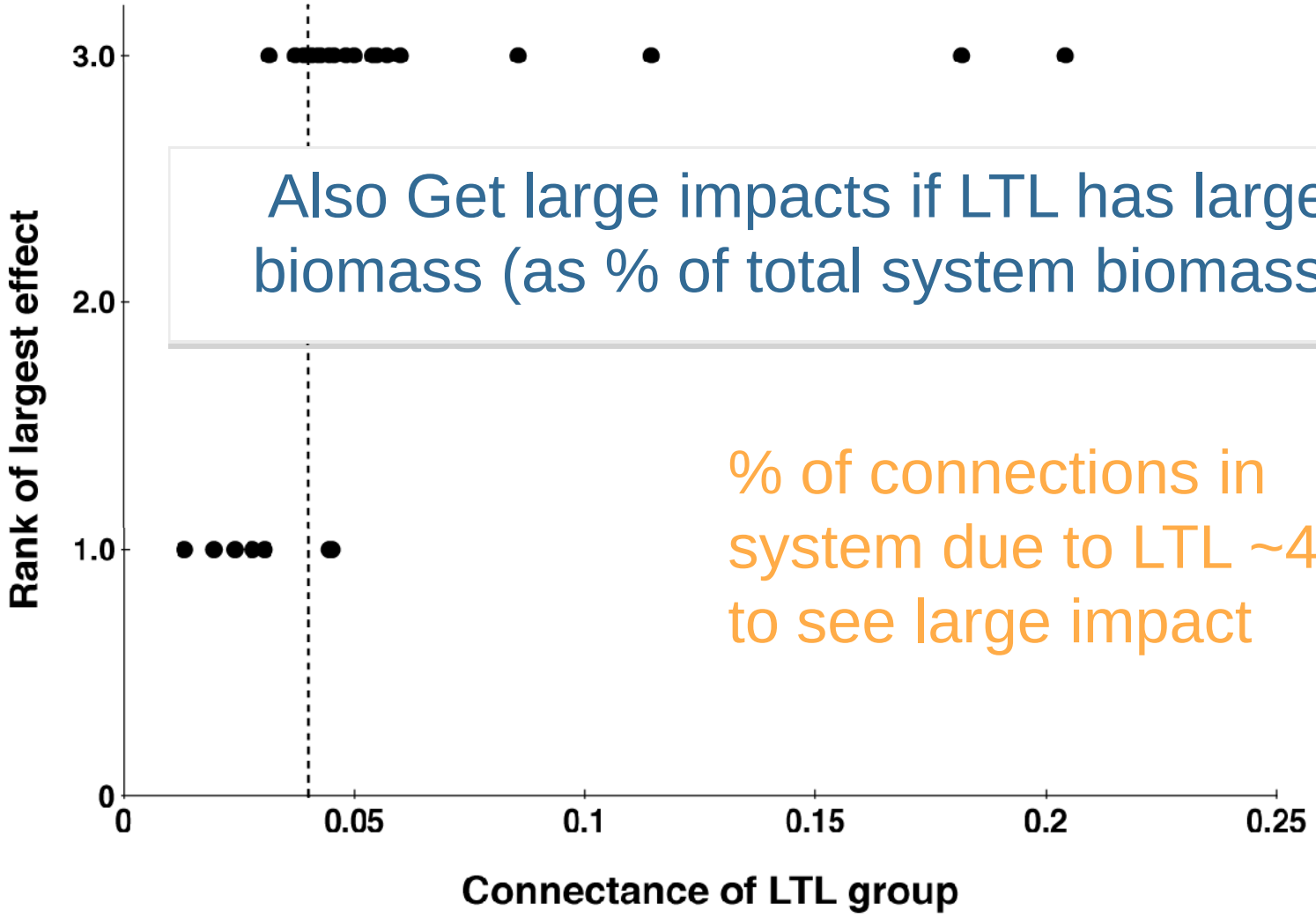
Results – F_{75} vs F_{40}

- "Not much" lost yield for less F



Can we predict large effects?

- Significant connective trophic link – connectivity



Also Get large impacts if LTL has large biomass (as % of total system biomass)

% of connections in system due to LTL ~4+% to see large impact

Back to the MSC process

- LTLWG considered outcomes from stakeholder engagement process and scientific study
- Recommendations on changes in FAM to the TAB
- Public consultation process
- Reconsideration of changes to the FAM and promulgation of TAB directive (August 2011)

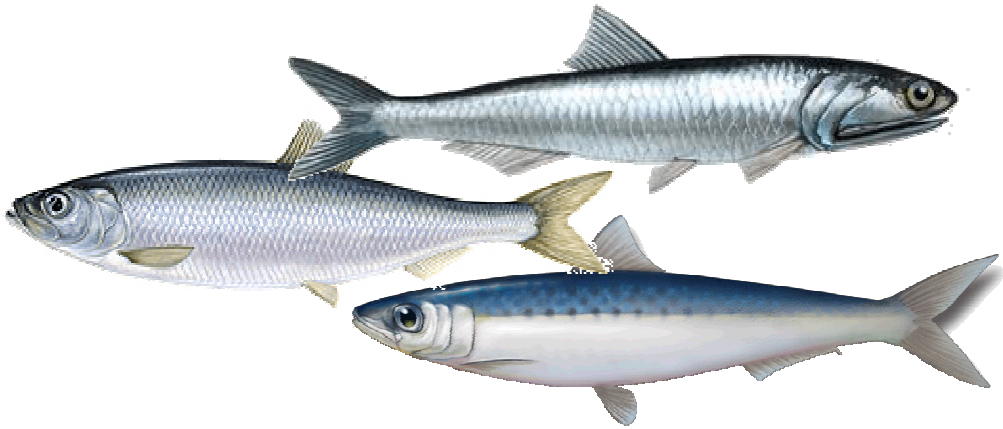
Criteria for key LTL species

- Feed predominantly on plankton (TL ~3 potentially 2-4)
- Form dense schools
- Small body size (e.g. <30cm adults)
- Early maturity (<= 2 years on average)
- High fecundity (> 10000 eggs per spawning)
- Short life span (<10 years)

- Significant connective trophic link between plankton resources and higher trophic levels

Key LTL species (default)

- Anchovy
- Capelin
- Krill
- Menhaden
- Myctophids
- Sandeel
- Sardine (including pilchards)
- Sprat



Determining “key” status

1. Species is of a type listed in Appendix 1 and meets one or more of the ‘ecosystem role’ sub-criteria in Appendix 2
2. Species is not of a type listed in Appendix 1 but still meets all of the ‘life history characteristics’ criteria in Appendix 3 and one or more of the ‘ecosystem role’ sub-criteria

- Burden of proof to show species is *not* key LTL

Reference points (pass)

- Default TRP shall be 75%B_0
- Higher or lower TRP where it can be demonstrated that the level does not:
  - Impact the abundance of more than 15% of other species/groups by >40% (compared to no fishing) or
  - Reduce the abundance of any other single species/group by >70%
- Default LRP shall be half the TRP, and in any case shall not be less than 20%B_0

PWG (DLB) concerns

Norms for acceptability

- What quality of fits to data is needed before ecosystem models can be considered to provide sufficiently reliable advice for management purposes – this by comparison to the single species models in regular use for this purpose?
- Whereas the advice from single species models follows predominantly from trends based on relative measures, ecosystem models need measures of food consumption and hence estimates in absolute terms. Have results used from ecosystem models in formulating the MSC's requirements been tested sufficiently for robustness to the uncertainties in these estimates?
- Are the MSC's criteria requiring a tactical use of ecosystem models which, in their current state of development, are at best defensibly applied only at a broad strategic level?

Cont'd

Reflecting recruitment variability of forage fish – a fundamental requirement?

- Does the highly varying recruitment of species such as sardine and anchovy render the dynamics of their ecosystems qualitatively different from what would be indicated by models which are able to reflect that variability to only a limited extent in their fits to abundance index data?
- Does reliable prediction from ecosystem models require explicit modelling of recruitment fluctuations, rather than the "forcing function" and similar surrogate approaches presently used in these models which have arguably unrealistic side effects associated with them?

Cont'd

Criteria for acceptable levels of impact on predator populations

- How justifiable is the choice of 40% as an impact threshold on predators (it is this choice which leads in turn to the 75% of pristine abundance target for forage fish indicated by the MSC)?
- How strong is direct empirical confirmation of the extent of the impact on predators, in response to fishing on a forage species, which ecosystem models predict?

Cont'd

Operational considerations

- In practice, how well estimable are quantities such as (average) pristine abundance of a forage species which are required to implement the new MSC regulations?
- How are biomass-related estimates from single stock models to be calibrated to those from the ecosystem models used to develop the MSC criteria (the different forms of the models will lead to relative biases in their estimates)?

Process issues

- Given that ecosystem models seem as yet not to have been used for tactical fisheries management advice, or subjected in application to the same level of scrutiny and requirements as the single species models used for such purposes, is it reasonable to expect fishing industry to accept what (unlike standard single species approaches) is not as yet well established practice internationally?
- For the reason just given, the vagaries of reviewers in assessing whether the new MSC criteria have been met will be much greater than when judgments are made in relation to single species based management concepts. Given that adjustments of levels of exploitation in a fishery can have substantial socio-economic implications, is it reasonable to render such industries and those dependent upon them vulnerable to such vagaries?

Cont'd

- Does best practice not require field testing of new procedures – checking for a number of fisheries that the new criteria can be reasonably operationalized and yield sensible results – before putting them into place when based on mainly if not entirely more theoretical evaluations?
- Data collection needs to improve feeding information, coupled to heavy personpower requirements to conduct complex analyses, would require allocation of a large proportion of the resources available for fisheries research locally if ecosystem modelling results are to approach the level of reliability of single species models. Would that be the best use of such funds in a local context?