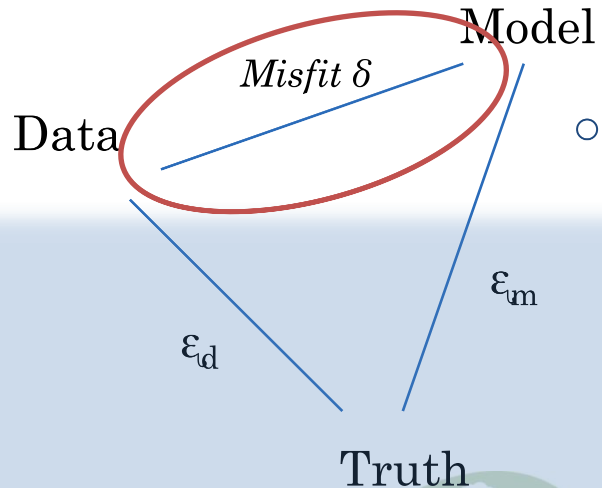
Analyse de sensibilité et optimisation pour la gestion des pêches

Sigrid Lehuta

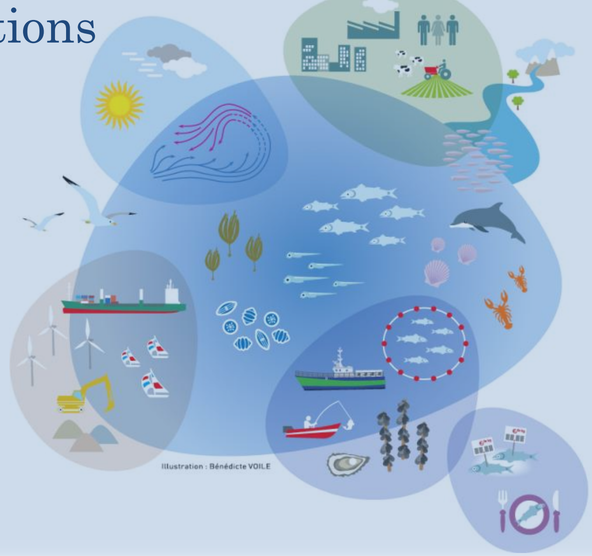
Ecole chercheur Mexico: Optimisation
La Rochelle, 26-30 Mars 2018

The uncertain context of fisheries



- Experimental platforms

- ~~Observations~~ Estimations
- Few expensive data
- Limited understanding
- No control on drivers



Lynch, 2009

INCREASED COMPLEXITY I... MANAGEM...

Complexity

Quota setting

Spatial management

Ecosystem based management

Human behavior

Integrated Ecosystem assessment

Climate change

1!

ELSEVIER
Current Opinion in Environmental Sustainability
Volume 2, Issues 5–6, December 2010, Pages 326-333

Modelling the potential impacts of climate change and human activities on the sustainability of marine resources

Manuel Barange [1] , William W.L. Cheung [2], Gorka Merino [1], R Ian Perry [3]

FISH and FISHERIES

FISH and FISHERIES, 2011, 12, 2–17

Human behaviour: the key source of uncertainty in fisheries management

Elizabeth A Fulton, Anthony D M Smith, David C Smith & Ingrid E van P

FISH and FISHERIES, 2005, 6, 307–349

Spatially explicit fisheries simulation models for policy evaluation

Dominique Pelletier & Stéphanie Mahévas

...sheries management

feature

Toward Ecosystem-Based Fisheries Management: Strategies for Multispecies Modeling and Associated Data Requirements

ABSTRACT

Considerable effort has been directed in the last decade towards the development of multispecies, ecosystem-based approaches to fisheries management. One aspect of this is the development of models that take into account direct and indirect ecological interactions among species and their environment. We review four multispecies modeling approaches that we feel have great potential for use in fisheries management: multispecies production models, multispecies virtual population analysis, Ecopath with Ecosim, and multispecies bioenergetics models. All four can predict biomass trajectories over time and under various fishing pressures, but with different spatial, temporal, and biological resolution, quantitative/qualitative nature of the results, and insight into system function. We present the data requirements of each model and give examples of field programs that have provided data for model construction and validation. We conclude with a set of issues to consider when designing a coupled field-modeling research program, including the scale of the problem, appropriate sampling platform, and data collection.

...bert J. Latour
...ark J. Brush
Christopher F. Bonzek

Introduction

Historically, fisheries management has been based on the results of single-species stock assessment models that focus on the interplay between ...

... of the importance and role of ecological processes on yield performances of fish stocks, but were generally viewed as underdeveloped. In recent years, however, this belief has changed significantly, largely due to the sophistication and increased number of multispecies stock assessment models (Hollowed et al. 2000a; Whipple et al. 2000).

Complexity and uncertainty

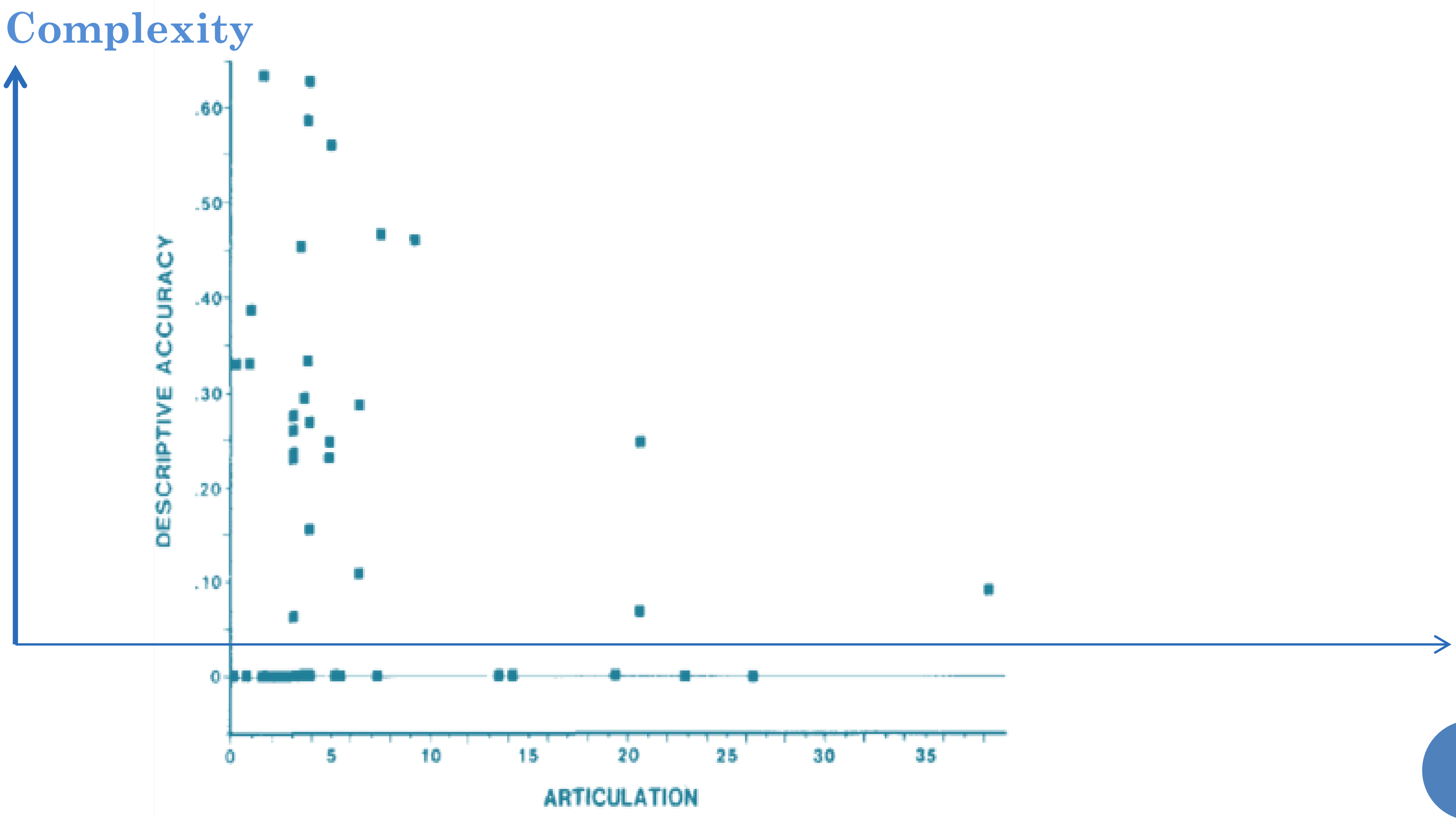


Fig. 1. Plot of articulation index vs. descriptive accuracy index for the models reviewed in this study, showing the current accuracy frontier.

Complexity and uncertainty

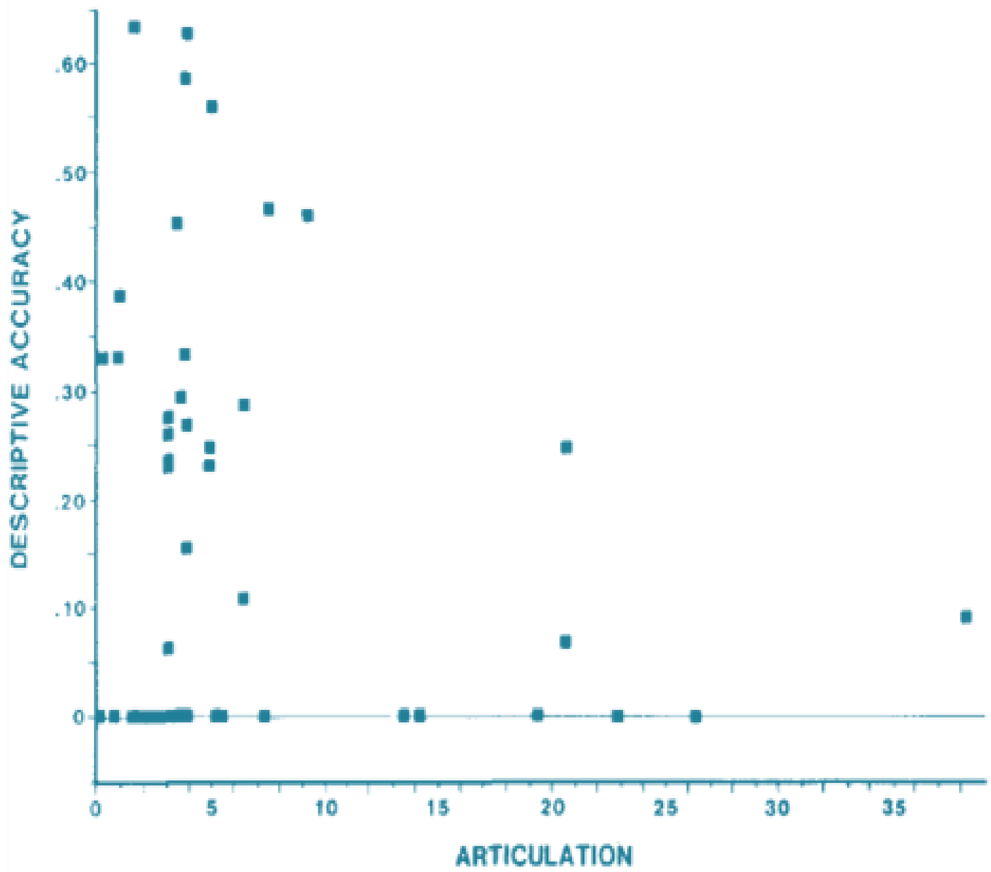


Fig. 1. Plot of articulation index vs. descriptive accuracy index for the models reviewed in this study, showing the current accuracy frontier.

Model precision evolves with complexity
(Costanza and Sklar, 1985)

Complex models as decision support tools ?

Levins 1966
Guisan and Zimmermann 2000
Sharpe 1990
From Dickey-Collas et al 2014

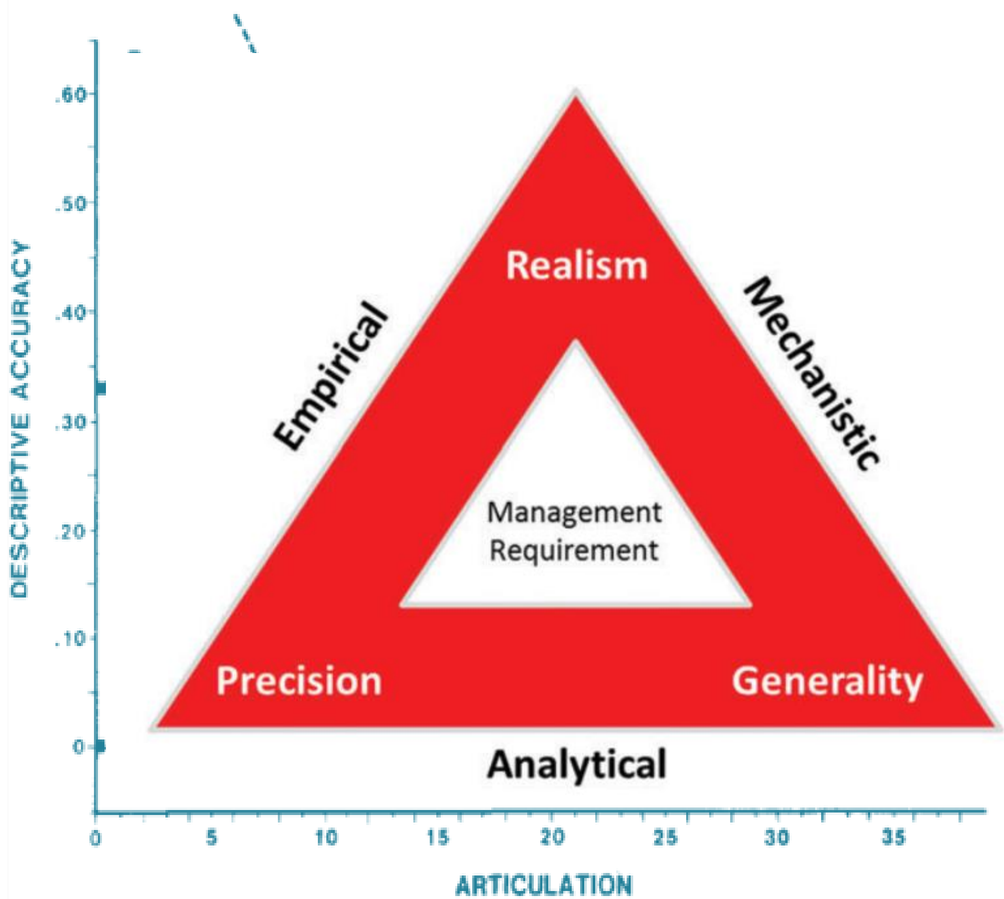


Fig. 1. Plot of articulation index vs. descriptive accuracy index for the models reviewed in this study, showing the current accuracy frontier.

COMPLEX ECOSYSTEM MOD
DECISION SUPPORT TOOLS

Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science

Management, and Ecosystem Science
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/umcf20

End-To-End Models for the Analysis of Marine Ecosystems: Challenges, Issues, and Next Steps

Kenneth A. Rose [a], J. Icarus Allen [b], Yuri Artioli [b], Manuel Barange [b], Jerry Blackford [b], Francois Carlotti [c], Roger Cropp

Contents lists available at SciVerse ScienceDirect
Progress in Oceanography
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Dealing with uncertainty in ecosystem models: The paradox of use for living marine resource management

J.S. Link [a,*], T.F. Ihde [b], C.J. Harvey [c], S.K. Gaichas [d], J.C. Field [e], J.K.T. Brodziak [f], H.M. Townsend [b], R.M. Peterman [g]

ICES Journal of Marine Science
ICES CIEM International Council for the Exploration of the Sea
ICES Journal of Marine Science; doi:10.1093/icesjms/fst215

Food for Thought

Hazard warning: model misuse ahead

End-to-end models for marine ecosystems: Are we on the precipice of a significant advance or just putting lipstick on a pig?

NETH A. ROSE

Simulation-based management strategy evaluation: ignorance disguised as mathematics?

Marie-Joëlle Rochet and Jake C. Rice

ss in Oceanography
: www.elsevier.com/locate/pocean

dels of intermediate complexity
hn [b]

Complex dynamics may limit predicti

Sarah M Glaser[1,2], Michael J Fogarty[3], Hui Liu[4], Irit Altman[5], Chi
Alec D MacCall[7], Andrew A Rosenberg[8], Hao Ye[9] & George Sugihar

Aquat. Living Resour. 29, 208 (2016)
© EDP Sciences 2016
DOI: 10.1051/alr/2016022
www.alr-journal.org
Aquatic Living Resources

Reconciling complex system models and fisheries advice: Practical examples and leads

Sigrid LEHUTA[1,a], Raphaël GIRARDIN[2], Stéphanie MAHÉVAS[1], Morgane TRAVERS-TROLET[2] and Youen VERMARD[1]

[1] IFREMER Ecologie et modèles pour l'halieutique, Rue de l'île d'Yeu, BP 2011, 44311 Nantes Cedex 03, France
[2] IFREMER Halieutique Manche Mer du Nord, 150 Quai Gambetta, 62200 Boulogne-sur-Mer, France

Food for Thought

Projecting the future state of marine ecosys illusion"?

rine Policy 61 (2015) 291–302
ists available at ScienceDirect
Marine Policy
journal homepage: www.elsevier.com/locate/marpol
ELSEVIER

Making modelling count - increasing the contribution of shelf-seas community and ecosystem models to policy development and management

FISH and FISHERIES

On scientists' discomfort in fisheries advisory science: the example of simulation-based fisheries management-strategy evaluations

Sarah B M Kraak[1,2], Ciaran J Kelly[2], Edward A Codling[3] & Emer Rogan[1]

[1]Department of Zoology, Ecology and Plant Science, University College Cork, Ireland; [2]Marine Institute, Rinville, Oranmore, Co. Galway, Ireland; [3]Departments of Mathematical Sciences and Biological Sciences, University of Essex, Wivenhoe Park, Colchester, CO4 3SQ, UK

Marine and Coastal Fisheries
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Article

Recommendations on the Use of Ecosystem Modeling for Informing Ecosystem-Based Fisheries Management and Restoration Outcomes in the Gulf of Mexico

Arnaud Grüss, Kenneth A. Rose, James Simons, Cameron H. Ainsworth, Elizabeth A. Babcock, David D. Chagaris, Kim De Mutsert, John Froeschke, Peter Himchak, Isaac C. Kaplan, Halie O'Farrell, Manuel J. Zetina Rejon

View issue TOC
Volume 9, Issue 1
January 2017
Pages 281–295

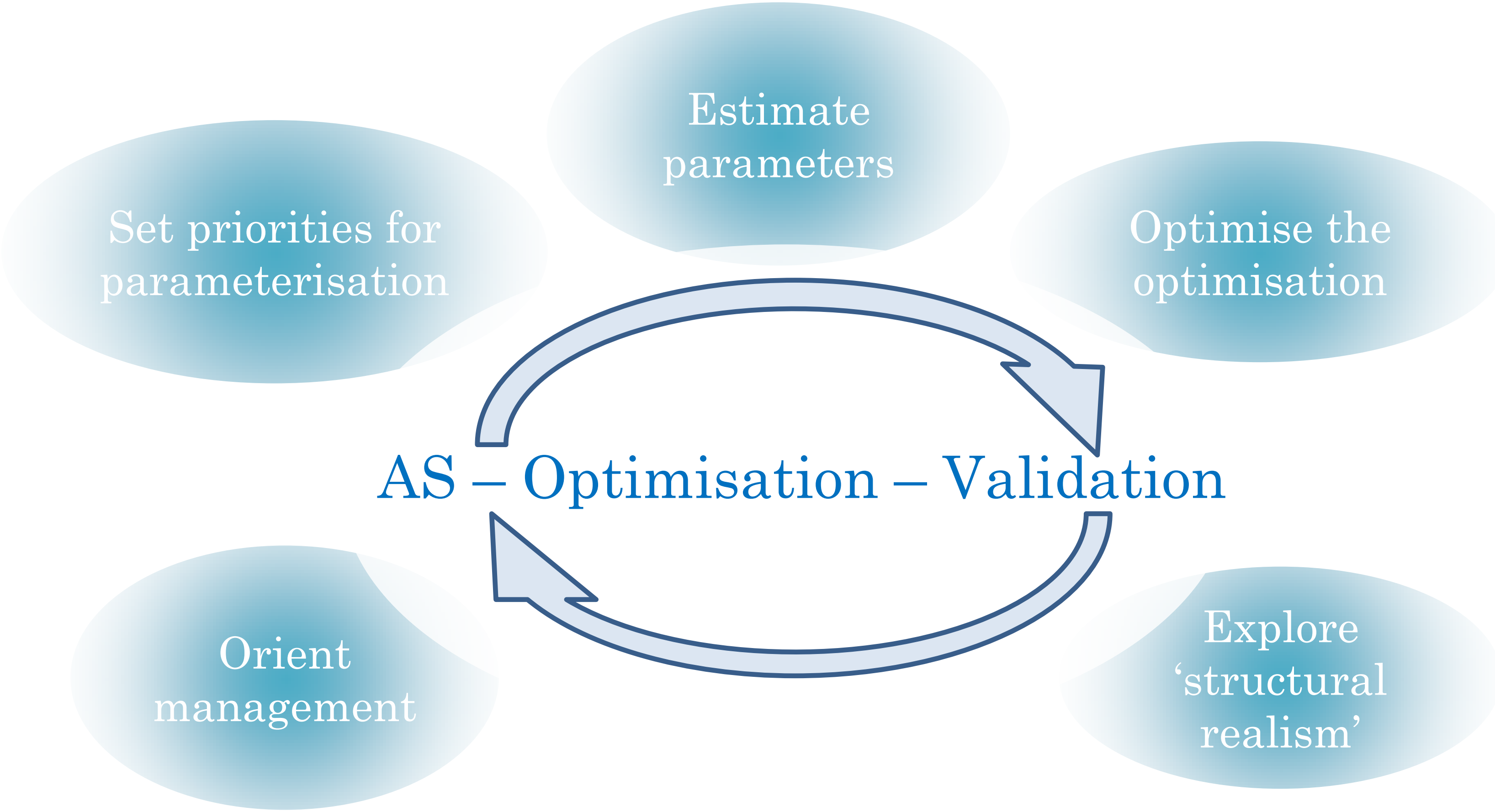
Models are not perfect but they are needed

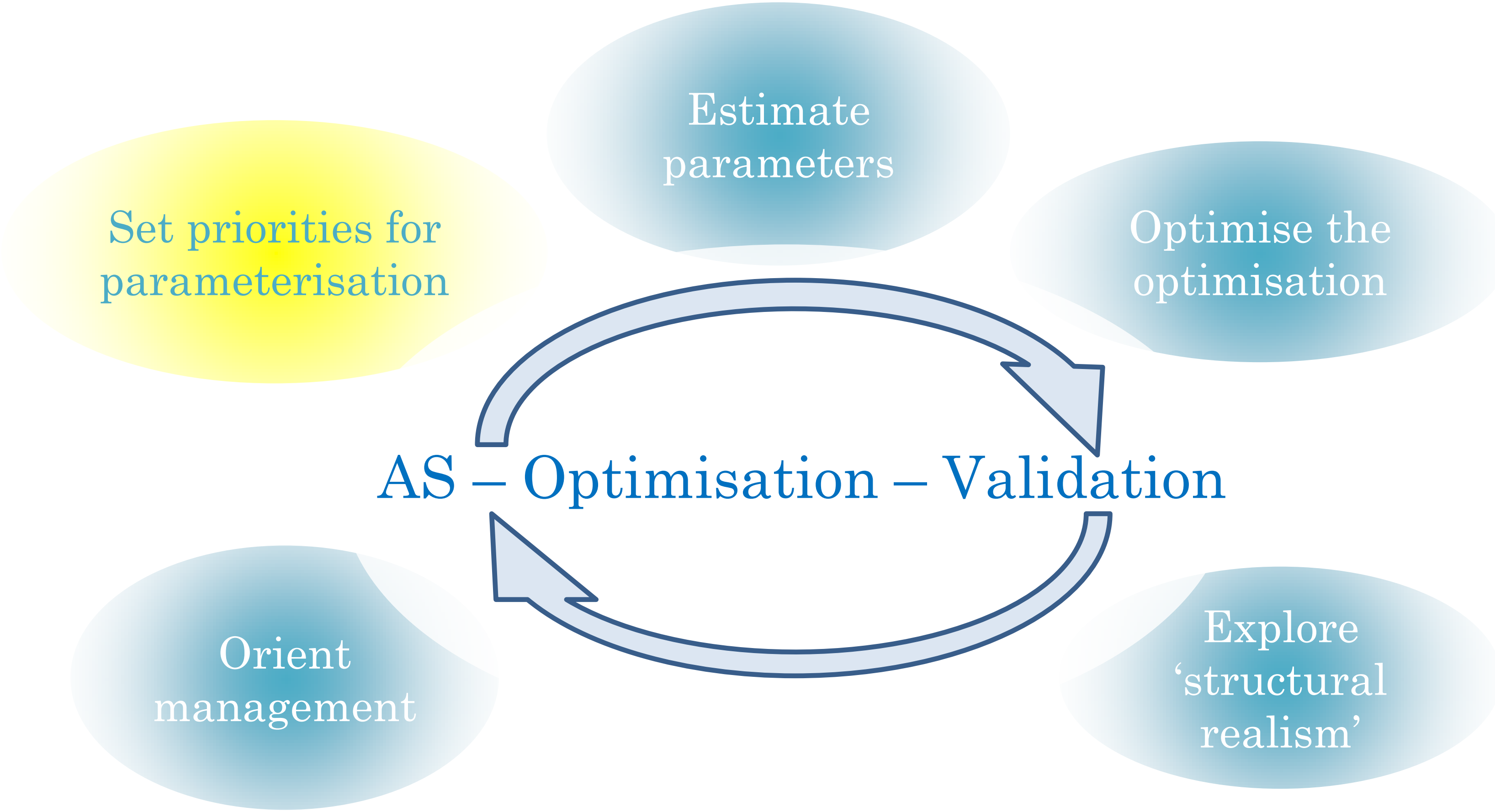
BUILD CONFIDENCE

Through generic, rigorous, transparent development frameworks

Build confidence

Through generic, rigorous, transparent development frameworks


Estimate parameters
Set priorities for parameterisation
Optimise the optimisation
AS – Optimisation – Validation
Orient management
Explore ‘structural realism’


Estimate parameters
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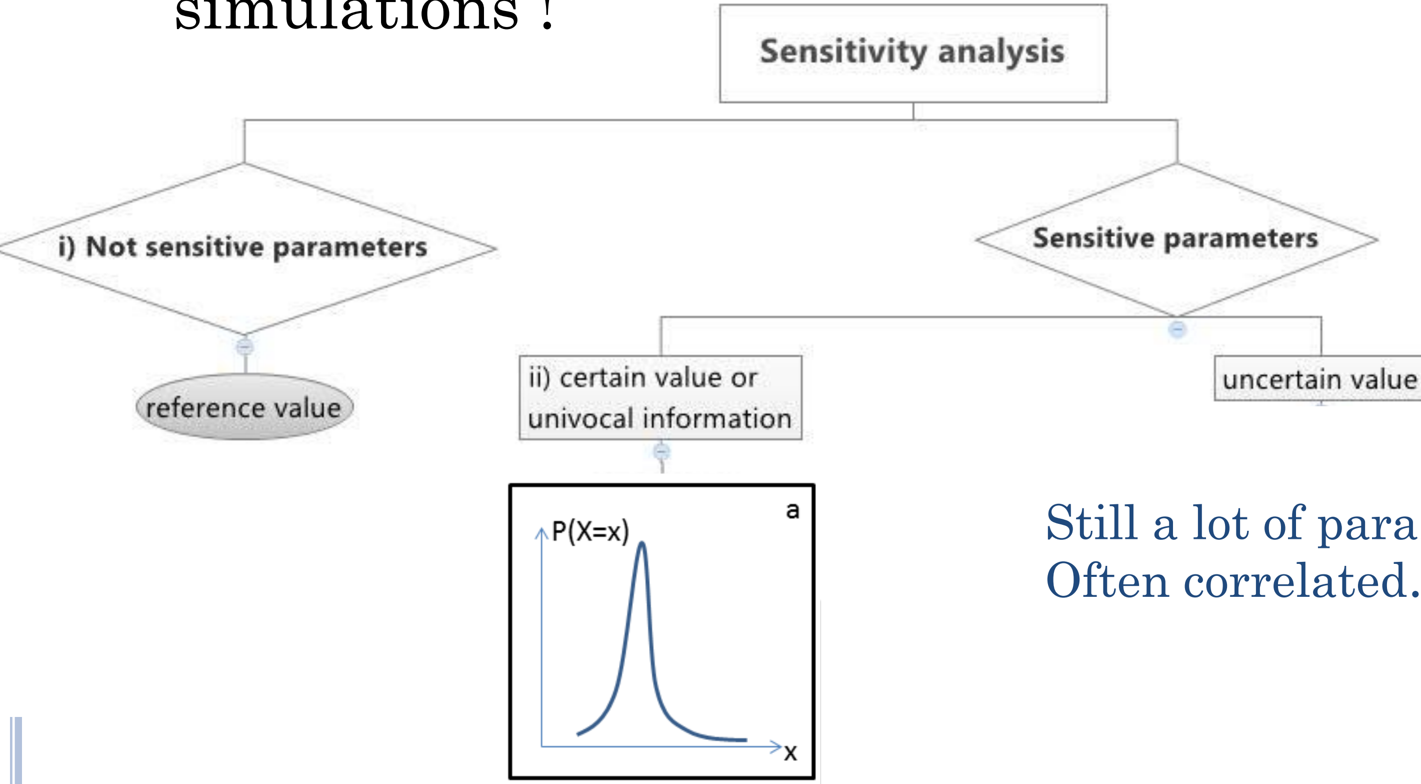
Explore 'structural realism'

Set priorities for parameterization

- Too many parameters, too few data and/or simulations !

Set priorities for parameterization

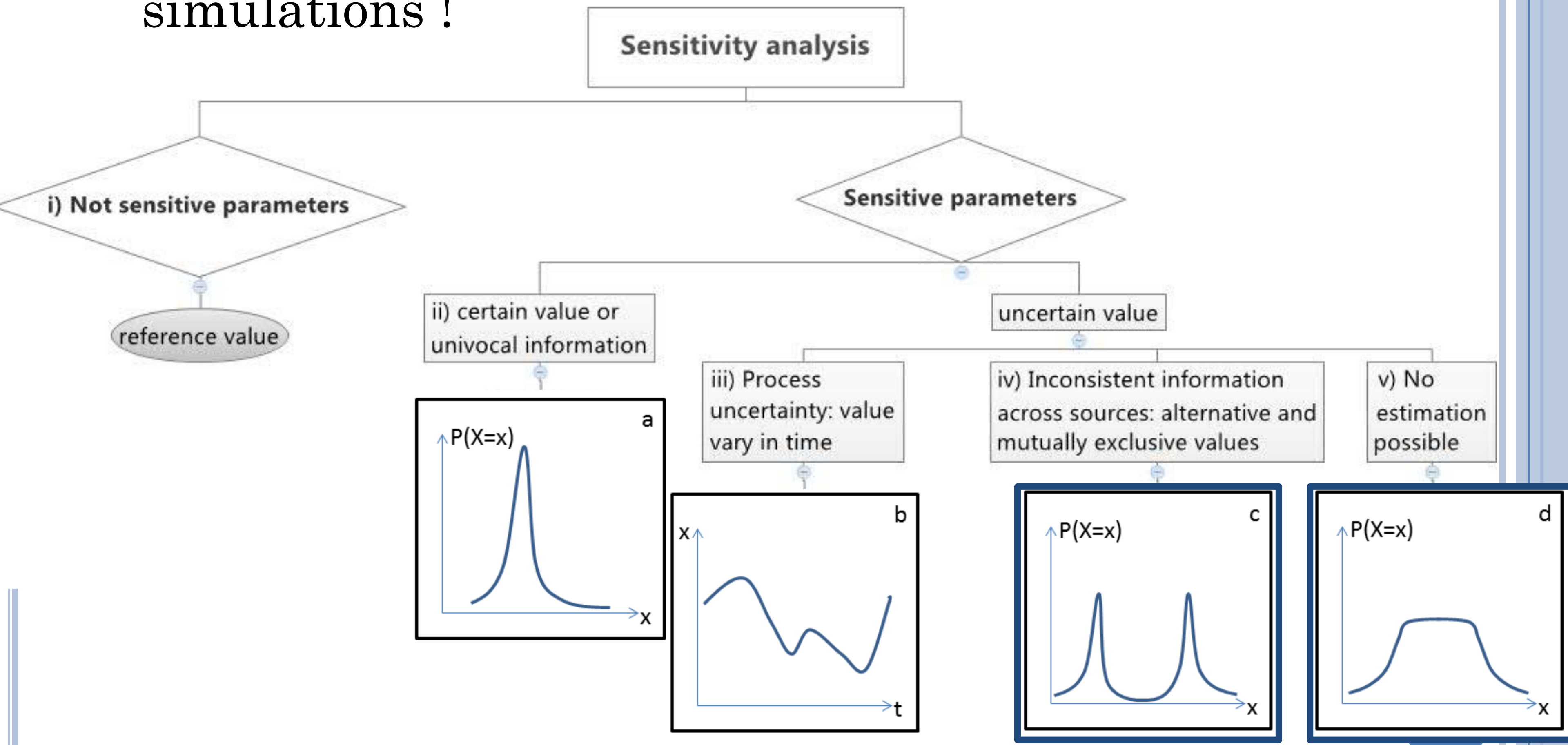
- Too many parameters, too few data and/or simulations !



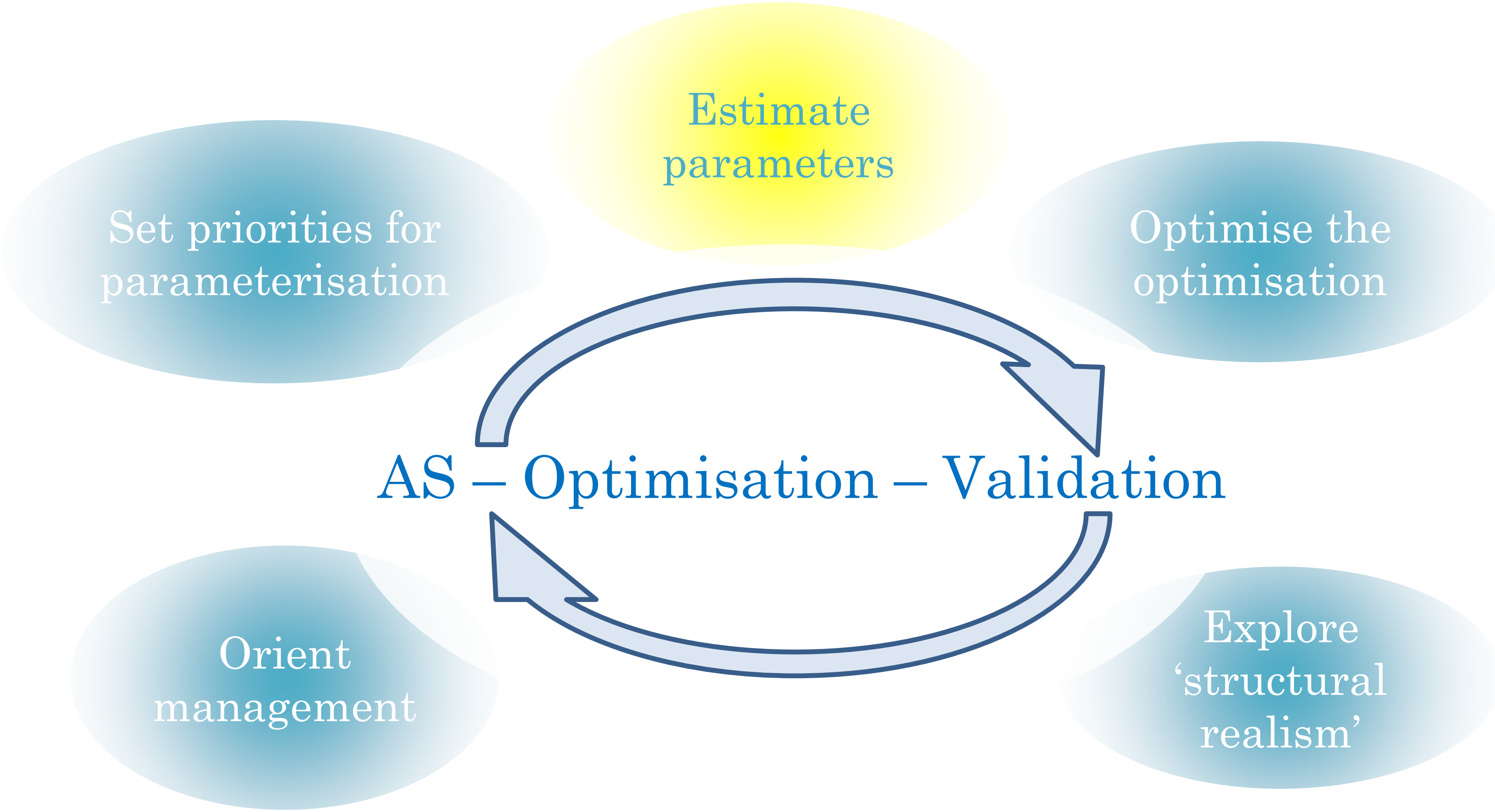
Still a lot of parameters !
Often correlated…

Set priorities for parameterization

- Too many parameters, too few data and/or simulations !



Lehuta et al. 2013


Estimate parameters
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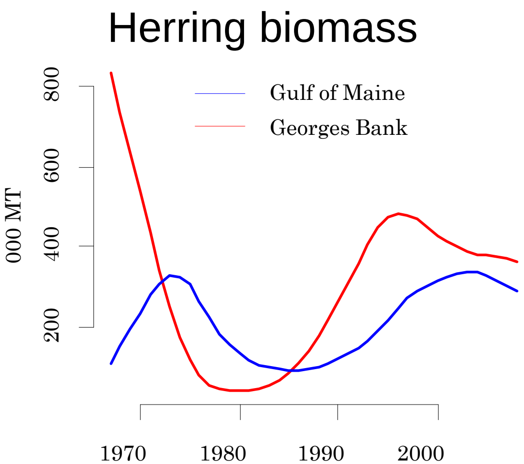
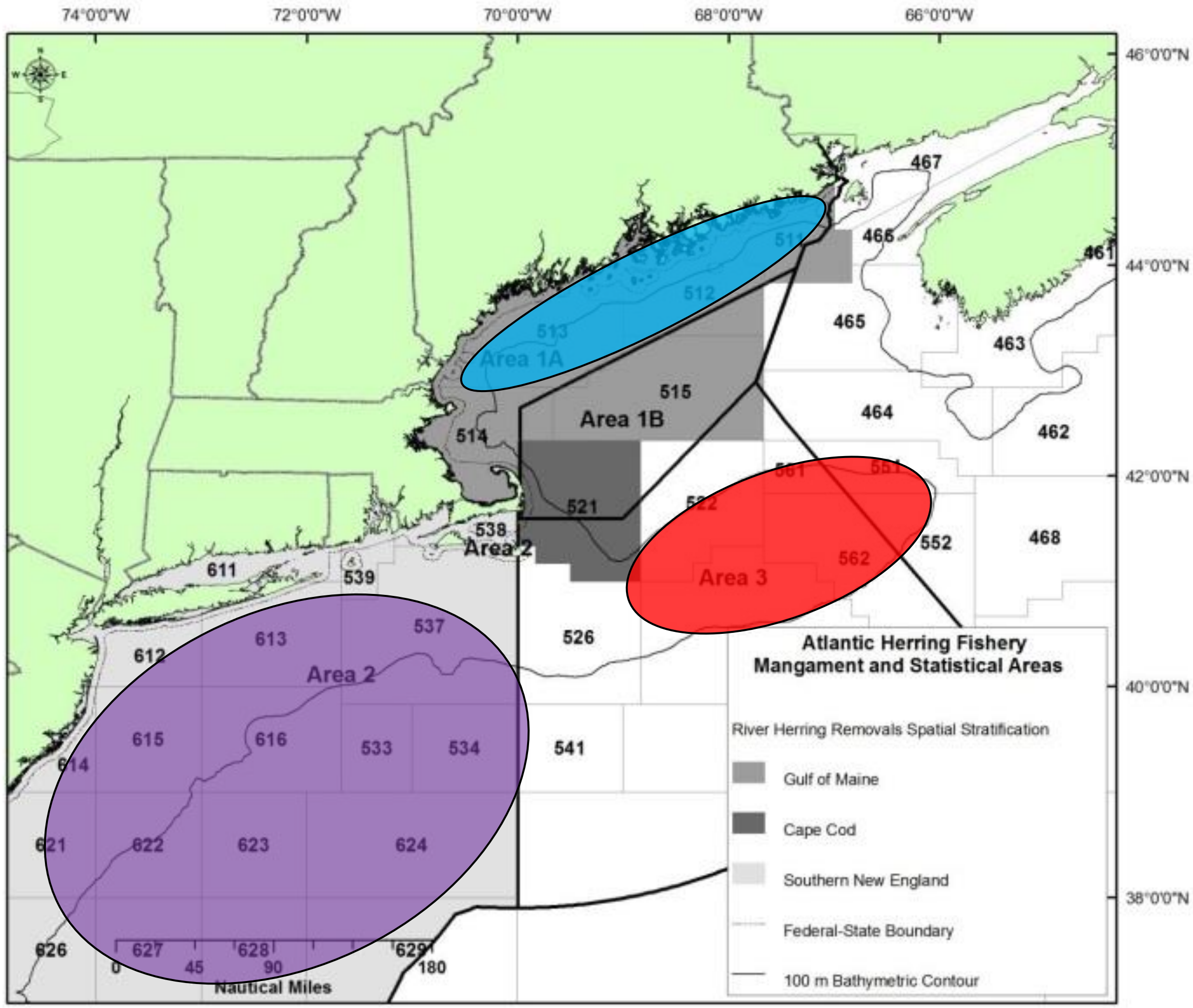
Explore 'structural realism'

Estimate Parameters: Herring meta-population Gulf of Maine

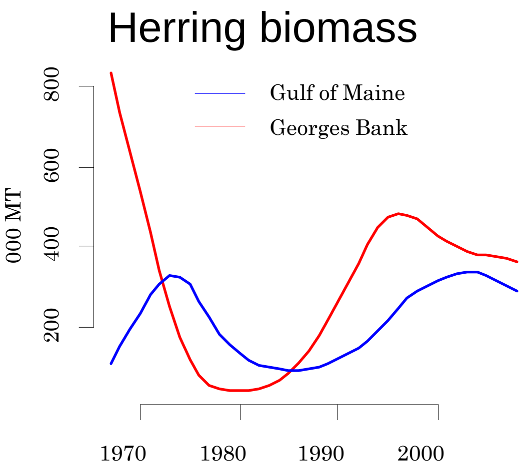
1 unique quota

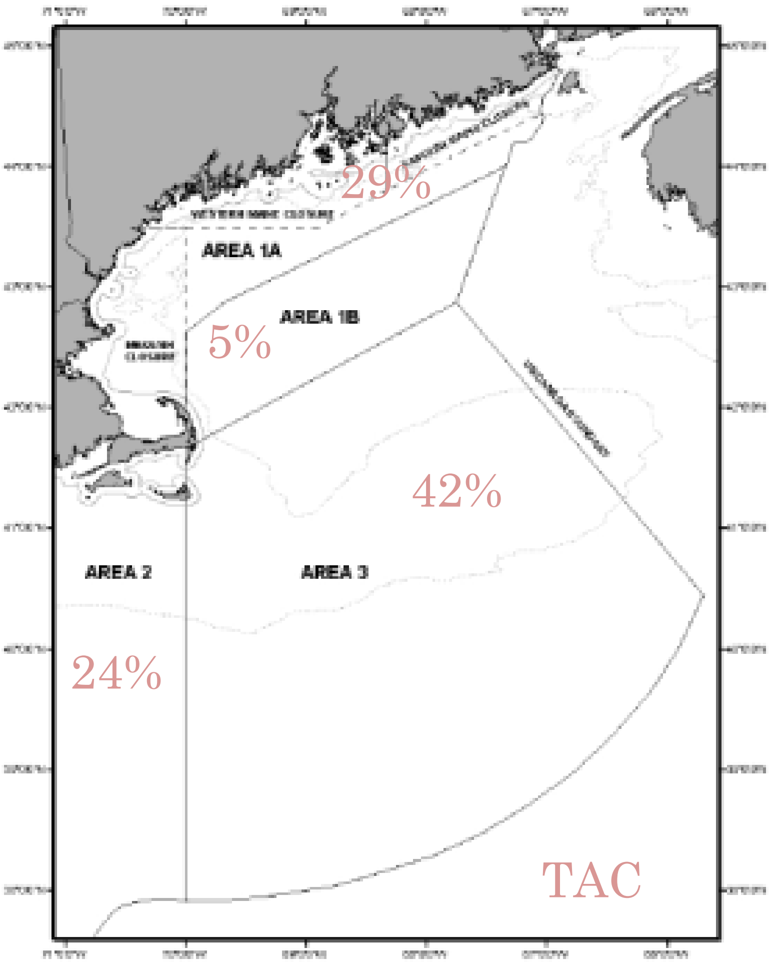




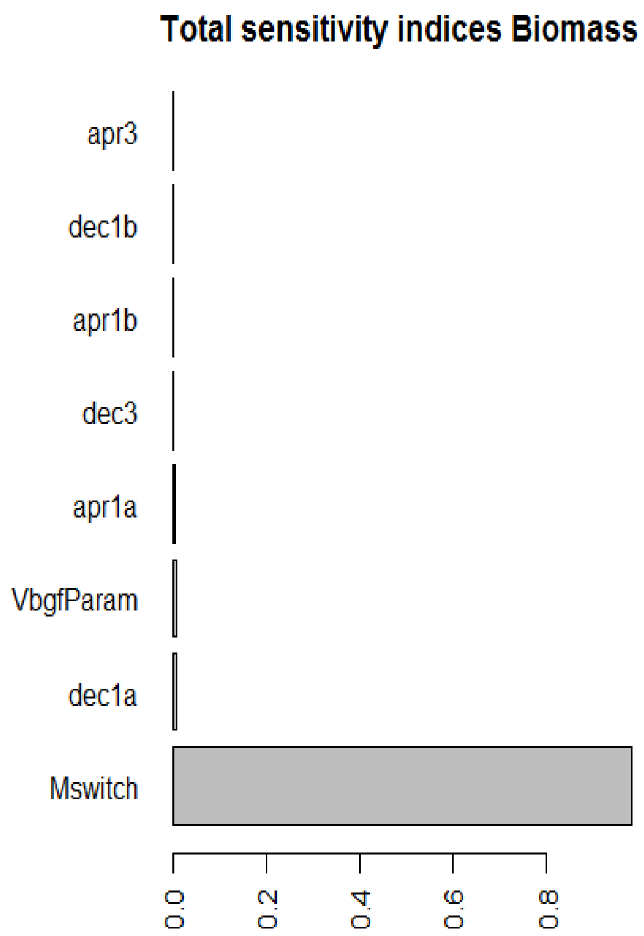
ESTIMATE PARAMETERS: HERRING META-POPULATION GULF OF MAINE

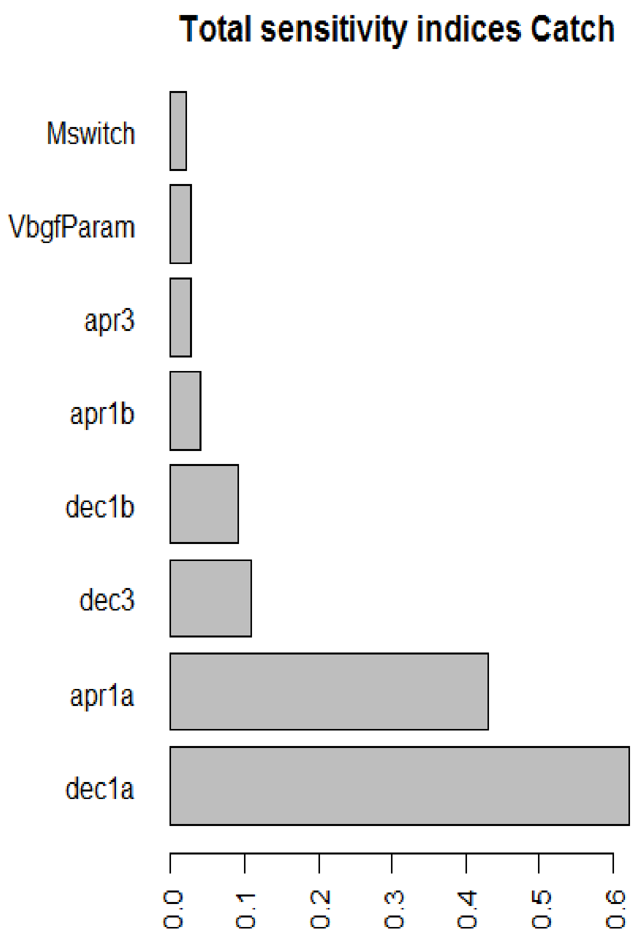
1 unique quota





Estimate Parameters : Sensitivity analysis Herring meta-population Gulf of Maine





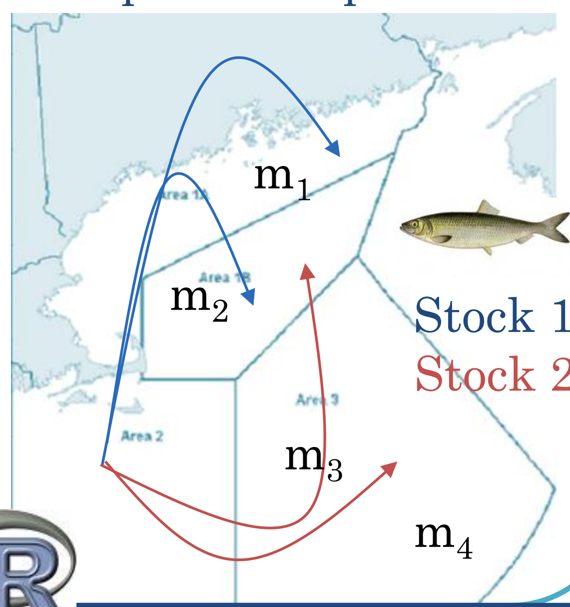
Estimate Parameters: Calibration Herring meta-population Gulf of Maine

Données campagnes scientifiques

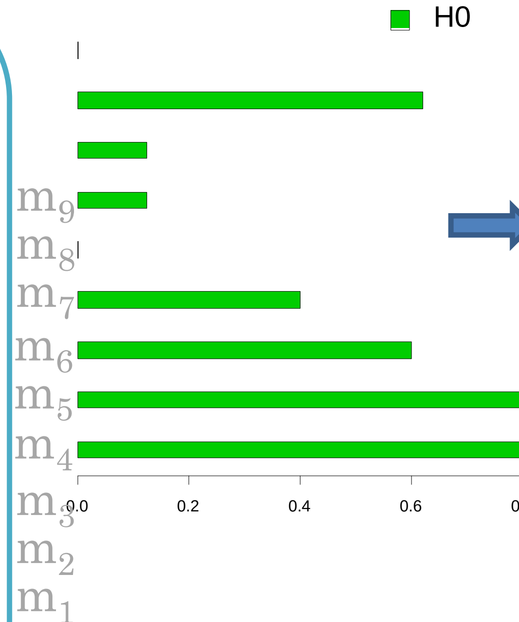
Logbook

+

Modèle de dynamique de pêcherie spatialisé



Coefficients de la matrice de migration



Distribution du TAC par zone et saison

Estimation de M ?

Algorithme génétique

Ensemble run (20)
20 output variables

$$FO = \sum_{obs\ variables}^{20} (obs - sim)^2$$

Record, N. et al. 2010.

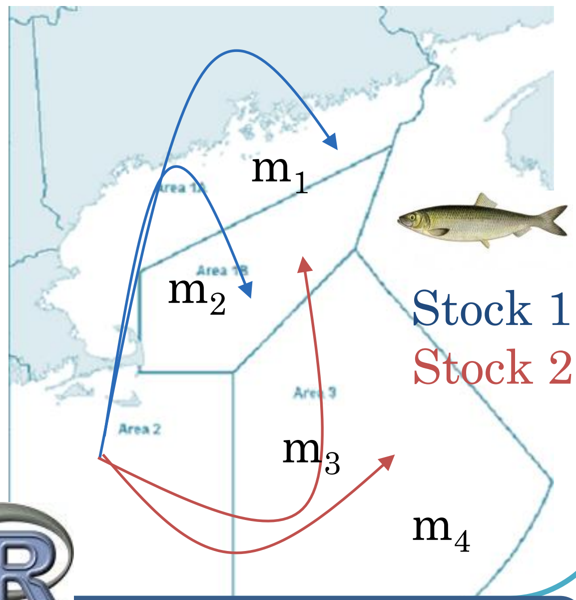
Estimate Parameters: Calibration Herring meta-population Gulf of Maine

Données campagnes scientifiques

Logbook

+

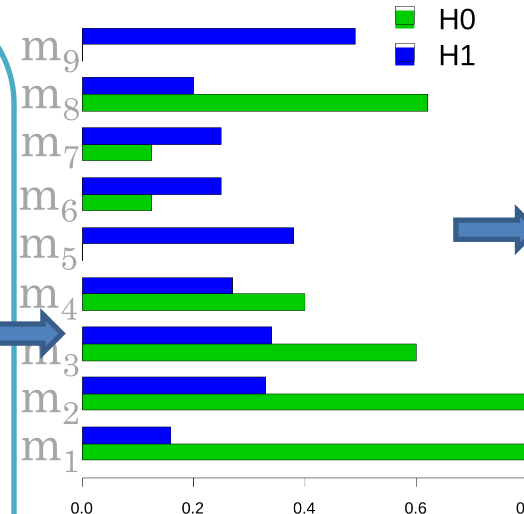
Modèle de dynamique de pêcherie spatialisé



Algorithme génétique

Record, N. et al. 2010.

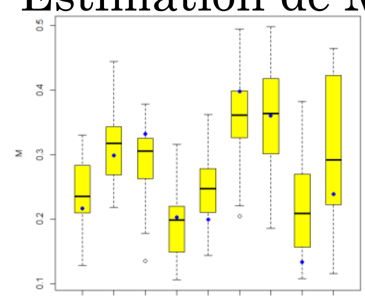
Coefficients de la matrice de migration



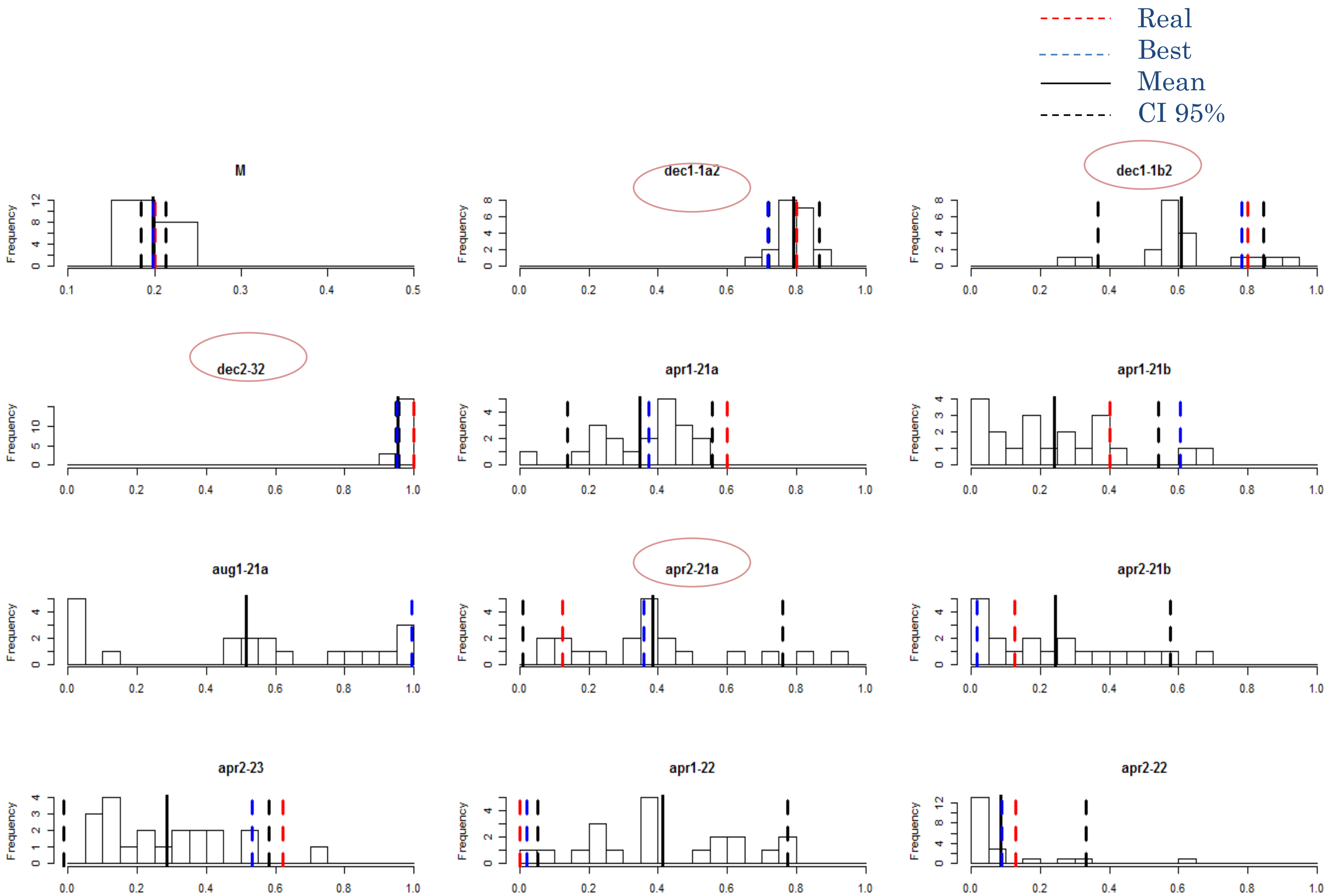
Distribution du TAC par zone et saison

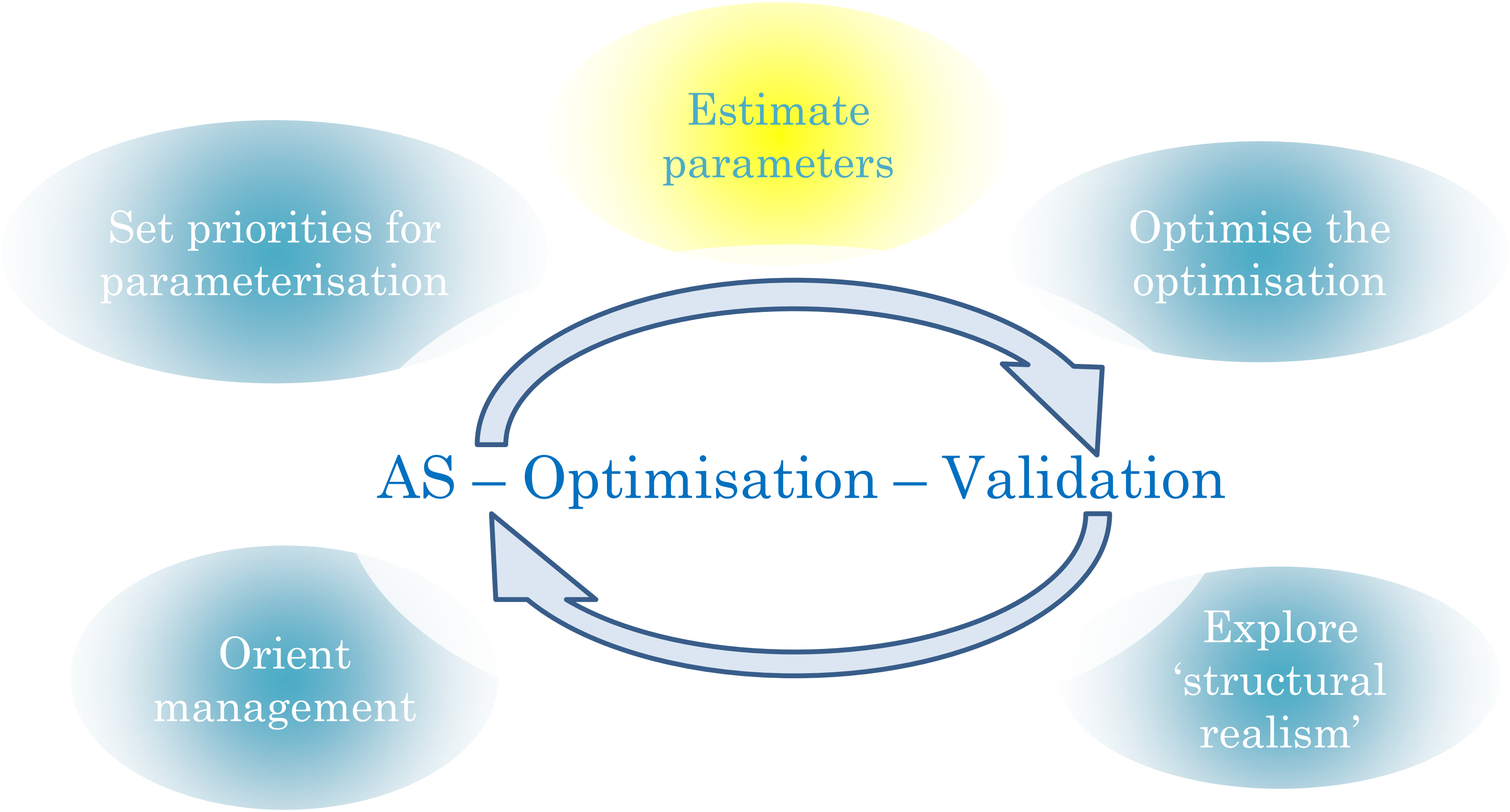
Vision très différente des migrations

Estimation de M



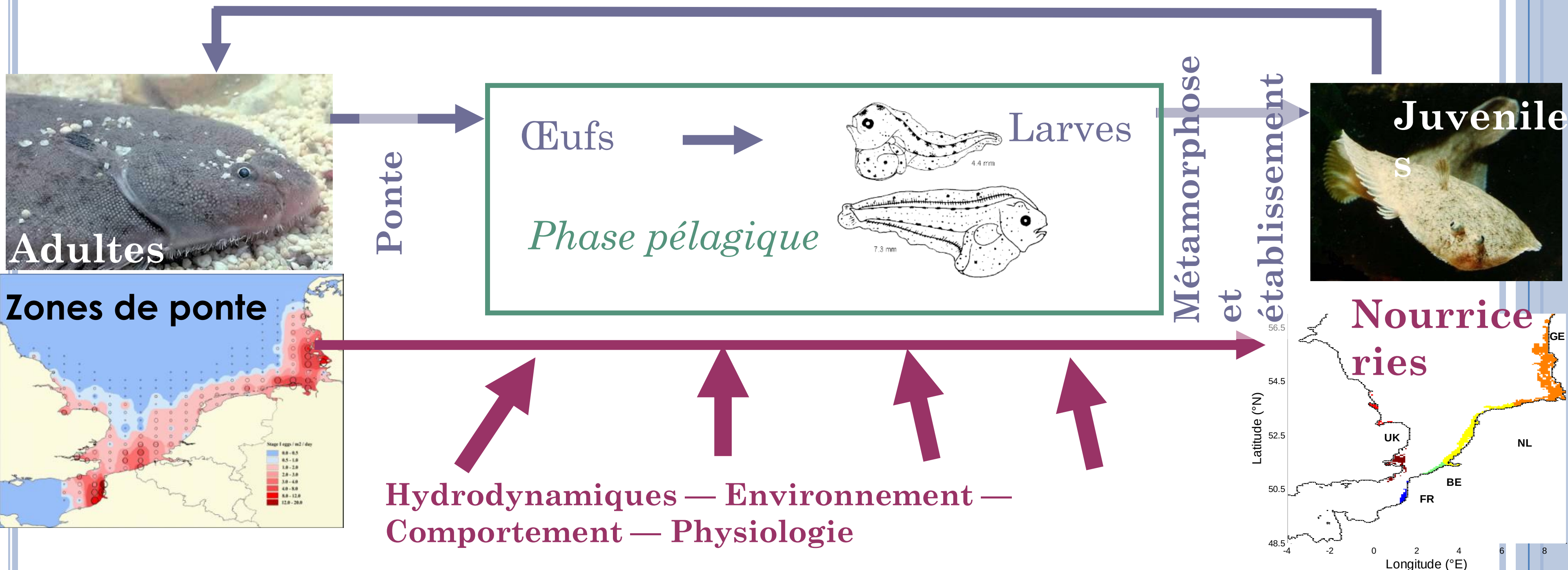
Estimate Parameters:
Twin experiment & ensemble run (20)
Herring meta-population Gulf of Maine





Estimate parameters
Set priorities for parameterisation
Optimise the optimisation
AS – Optimisation – Validation
Orient management
Explore 'structural realism'

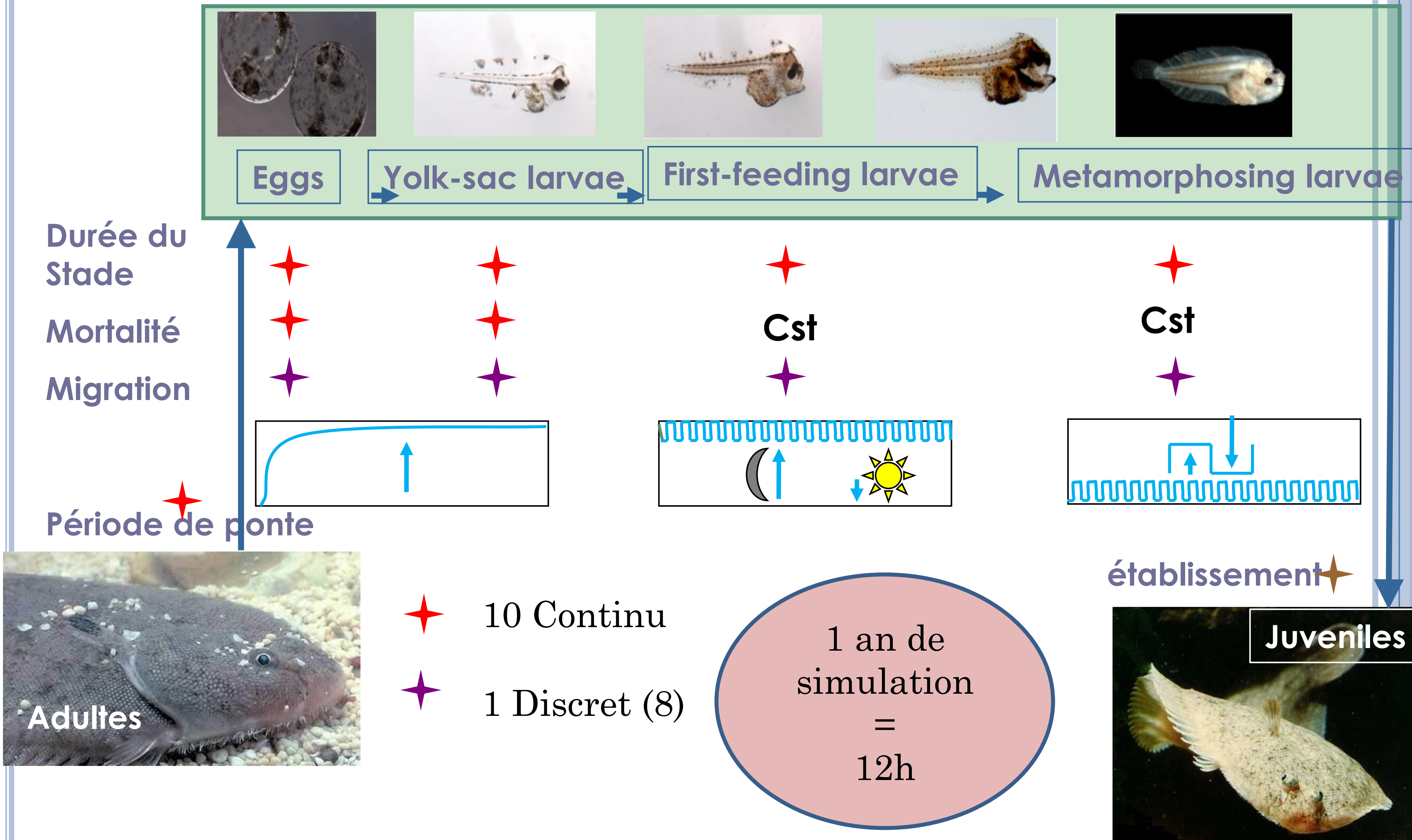
Estimate Parameters: Derive larvaire de la sole de Mer du Nord (Barbut et al., in prep.)



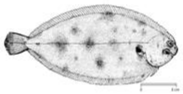
- ❖ **Choisir les paramètres permettant de reproduire le recrutement dans les nourriceries de manière la plus réaliste**

- ❖ **Comprendre les processus biologiques et environnementaux qui influent sur le recrutement de la sole**

ESTIMATE PARAMETERS: 11 PARAMETRES INCONNUS



Estimate Parameters: Multiples Objectifs



Estimation du recrutement (âge 1) pour l'ensemble du système entre 1995-2006 (Stock assessment in IV Area ICES)

- ***Global***, représente la taux d'écart entre recrutement prédit et simulé

$g_y = \frac{Ny - \widehat{N}y}{Ny}$ Ny & $\widehat{Ny}$: recrutement standardisé total observé et prédit par le modèle pour l'année y

Variations de g(y | Θ)

Indicateur d'abondance locale (âge 0) entre 1995-2006 (Demersal Young Fish Survey, ICES)

- ***Local*** montre la différence en terme d'anomalie de recrutement dans chacune des nourriceries (NL, UK, GE, BE).

Données et résultats sont standardisés ($N_i|\theta$), et on calcule un taux d'écart pour chacune des nourriceries:

$l_{iy} = \frac{Ind\ iy - \widehat{Ind}\ iy}{Ind\ iy}$ $Ind\ iy$ & $\widehat{Ind}\ iy$: recrutement standardisé observé et simulé dans la nourricerie i, l'année y

$variations\ de\ l_i|\theta$

Calibration

Estimate Parameters:
In summary

- Discrete and continuous parameters
- Multiple objectives
- Long simulation runs

=> Difficult optimisation problem

Estimate Parameters: Strategy

Etapes	Questions	méthodes
Etape 1: Analyse de sensibilité	• Quels paramètres ont une forte influence sur les prédictions du modèle?	Plan factoriel optimisé sur une année moyenne
Etape 2: Calibration	• Quel est le meilleur modèle?	Plan complet sur les paramètres identifiés comme très influents sur toutes les années

Plan complet : 472392 simulations * 12h = 647 ans

Estimate Parameters: Strategy

Etapes	Questions	méthodes
Etape 1: Analyse de sensibilité	• Quels paramètres ont une forte influence sur les prédictions du modèle?	Plan factoriel optimisé sur une année moyenne
Etape 2: Calibration	• Quel est le meilleur modèle?	Plan complet sur les paramètres identifiés comme très influents sur toutes les années

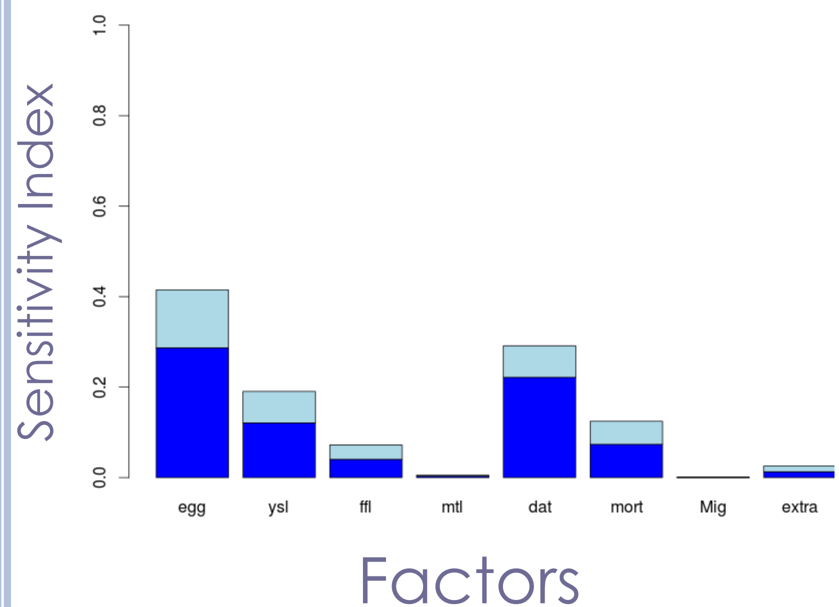
~~Plan complet : 472392 simulations * 12h = 647 ans~~

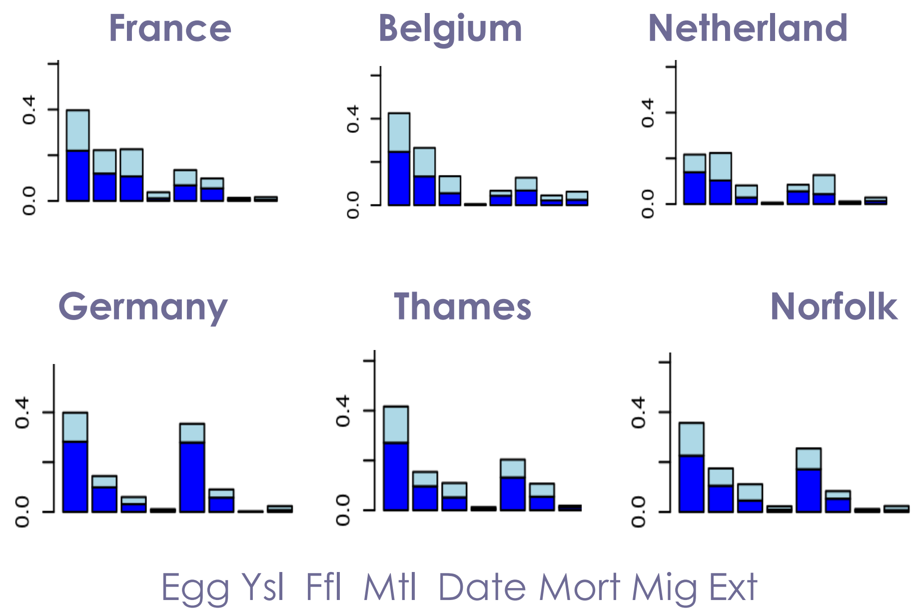
Plan optimisé : 353 simulations * 12h = 176 jours

Estimate Parameters: Sensitivity analysis

Principal effect

Interaction effect





Results / global

Résultats / nourricerie

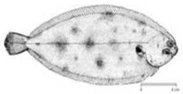
Estimate Parameters: Strategy

Etapes	Questions	méthodes
Etape 1: Analyse de sensibilité	• Quels paramètres ont une forte influence sur les prédictions du modèle?	Plan factoriel optimisé sur une année moyenne **Durée larvaire** **Période de ponte** **Mortalité**
Etape 2: Calibration	• Quel est le meilleur modèle?	Plan complet sur les paramètres identifiés comme très influents sur toutes les années

Plan complet sur la période 1995-2006 pour les paramètres:

- Durée larvaire (continue avec 3 modalités)
- Migration verticale (discret 3 modalités)
- Période de ponte (continue avec 3 modalités)
- Mortalité (continue avec 3 modalités)

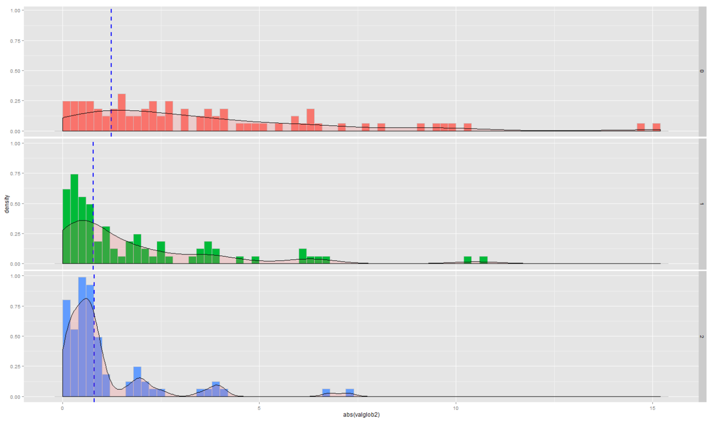
Estimate Parameters: Résultats



❖ **Période de ponte: distribution de la valeur absolu du taux d'erreur entre observé et simulé**

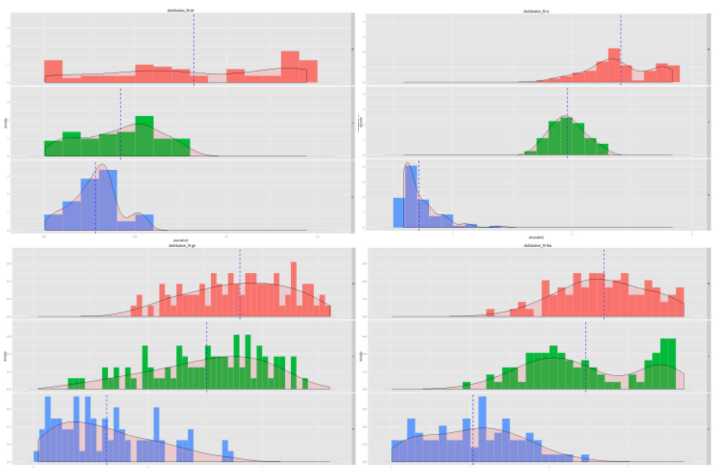
1995

Globa



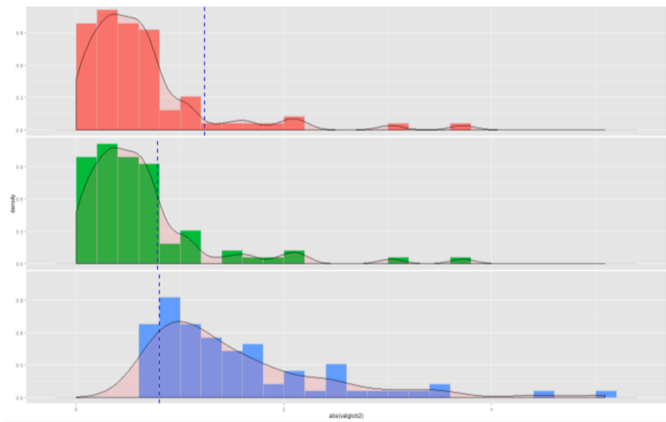
Belgium Netherland

Local



Germany Thames

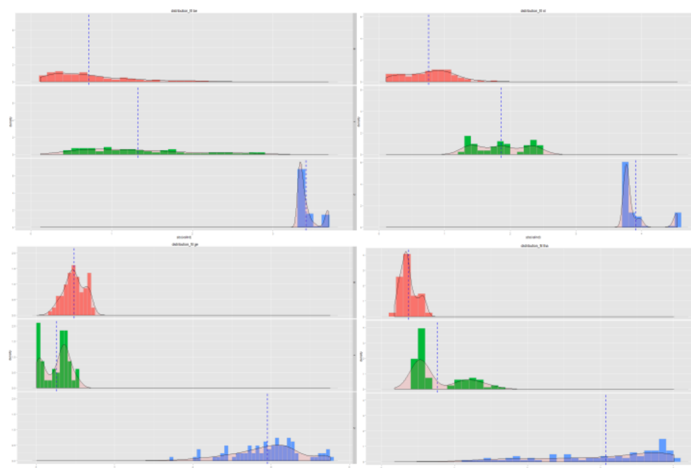
2001



Période de ponte

- Précoce
- Moyenne
- Tardive

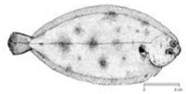
Belgium Netherland



Germany Thames

Calibration

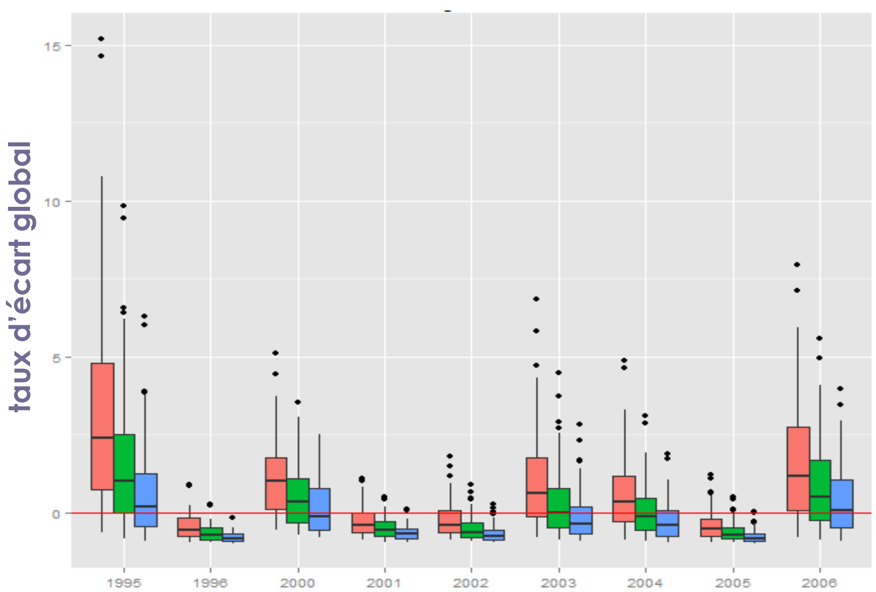
Estimate Parameters: Résultats

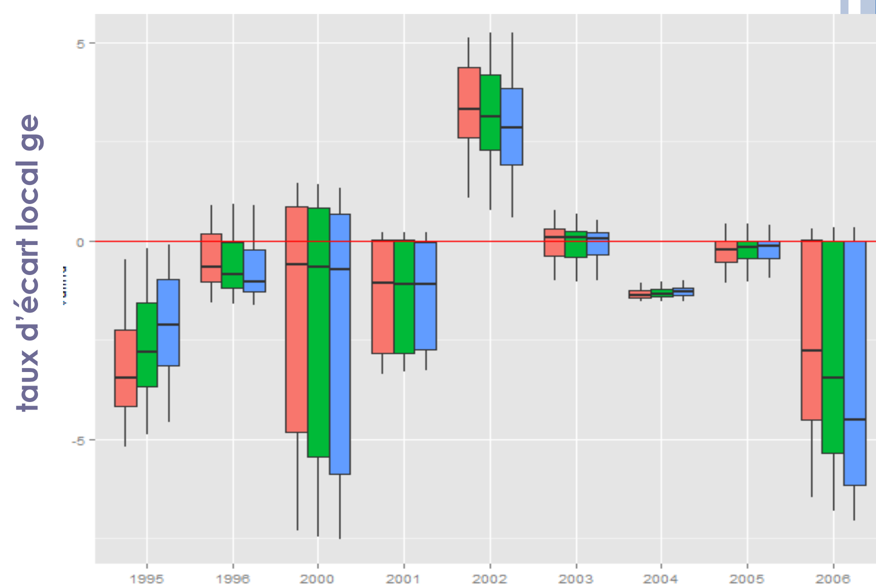


❖Mortalité

Mortalité

- Faible
- Moyenne
- Haute



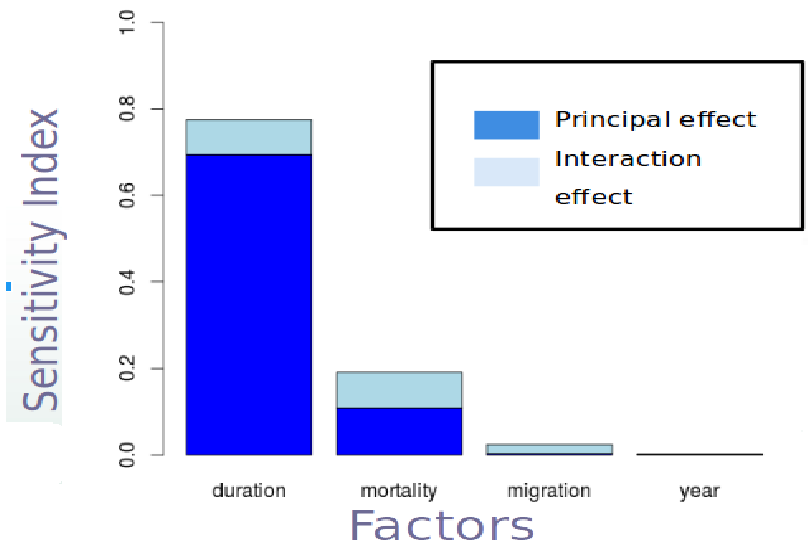


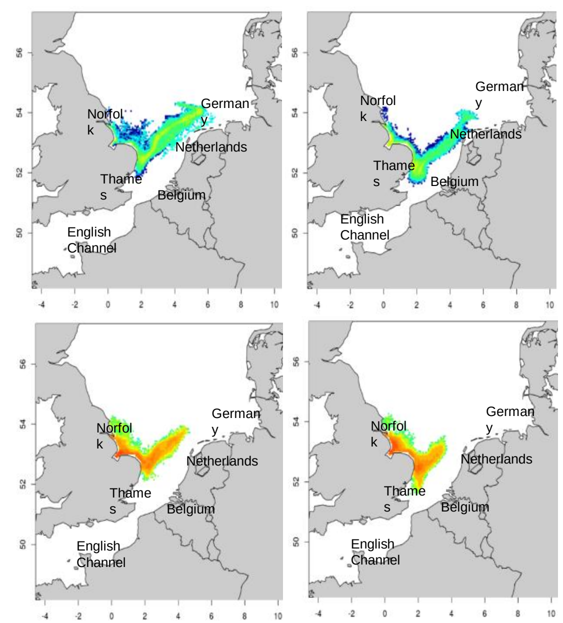
Estimate Parameters: Strategy

Etapes	Questions	méthodes
Etape 1: Analyse de sensibilité	• Quels paramètres ont une forte influence sur les prédictions du modèle?	Plan factoriel optimisé sur une année moyenne **Durée larvaire** **Période de ponte** **Mortalité**
Etape 2: Calibration	• Quel est le meilleur modèle?	Plan complet sur les paramètres identifiés comme très influents sur toutes les années **Disapointing!**

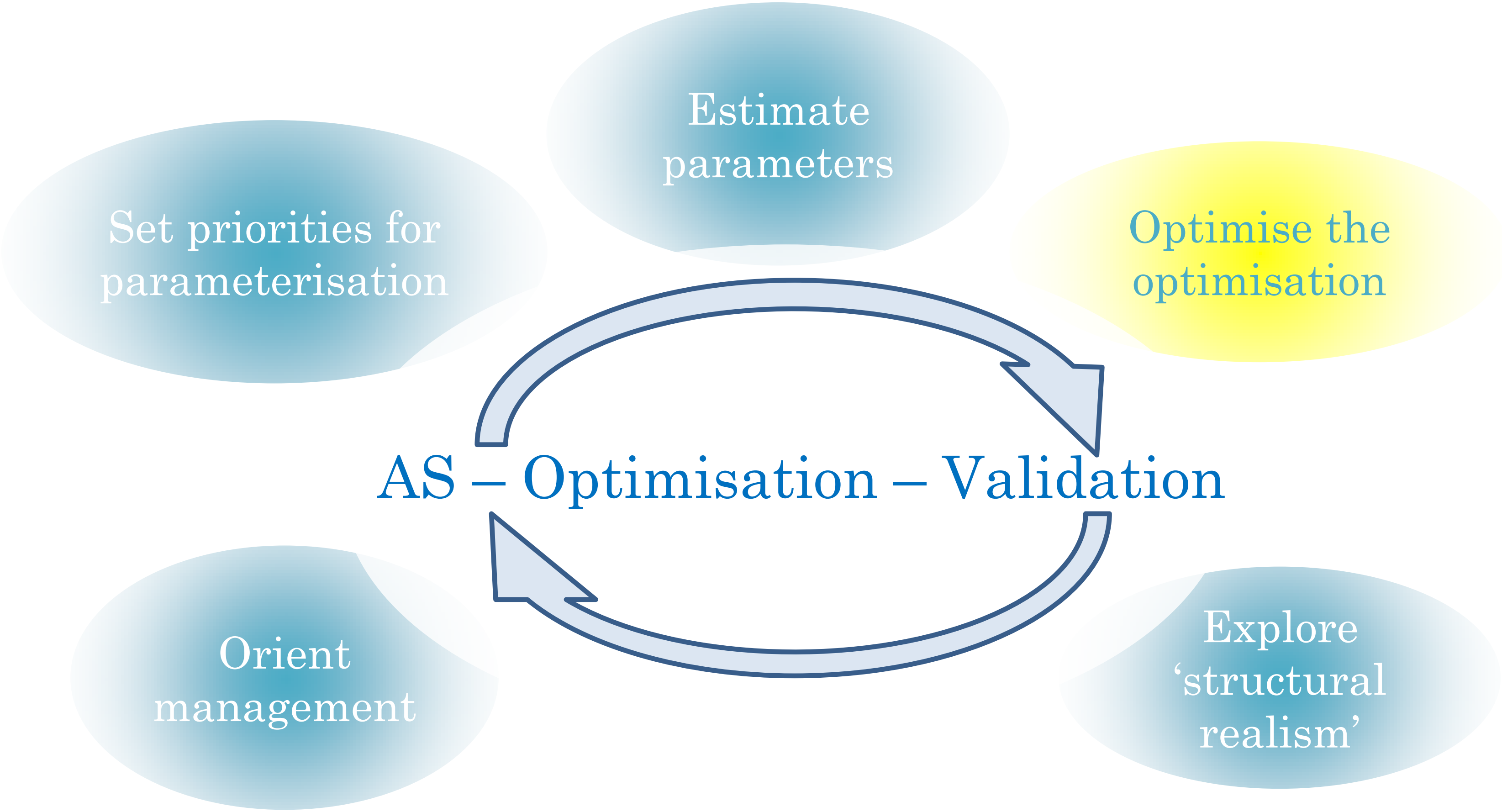
ESTIMATE PARAMETERS: DISAPPOINTING!

- We should have planned ahead
- Years were neglected in the first AS





- AS on the indices and not the FO !

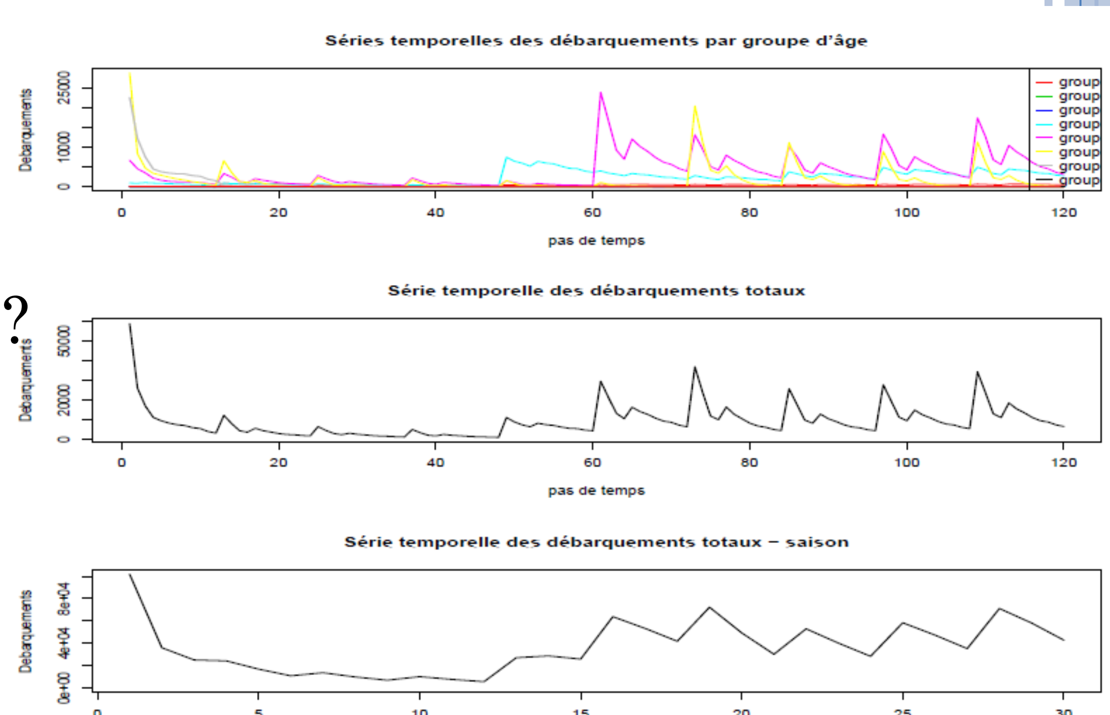


Estimate parameters
Set priorities for parameterisation
Optimise the optimisation
AS – Optimisation – Validation
Orient management
Explore 'structural realism'

Optimise the optimisation

- Which objective function to use ?
- Objective :
  - reproduce catch at age, each month over ten years
  - Estimate catchability parameters
- parameters:

10 catchability at age



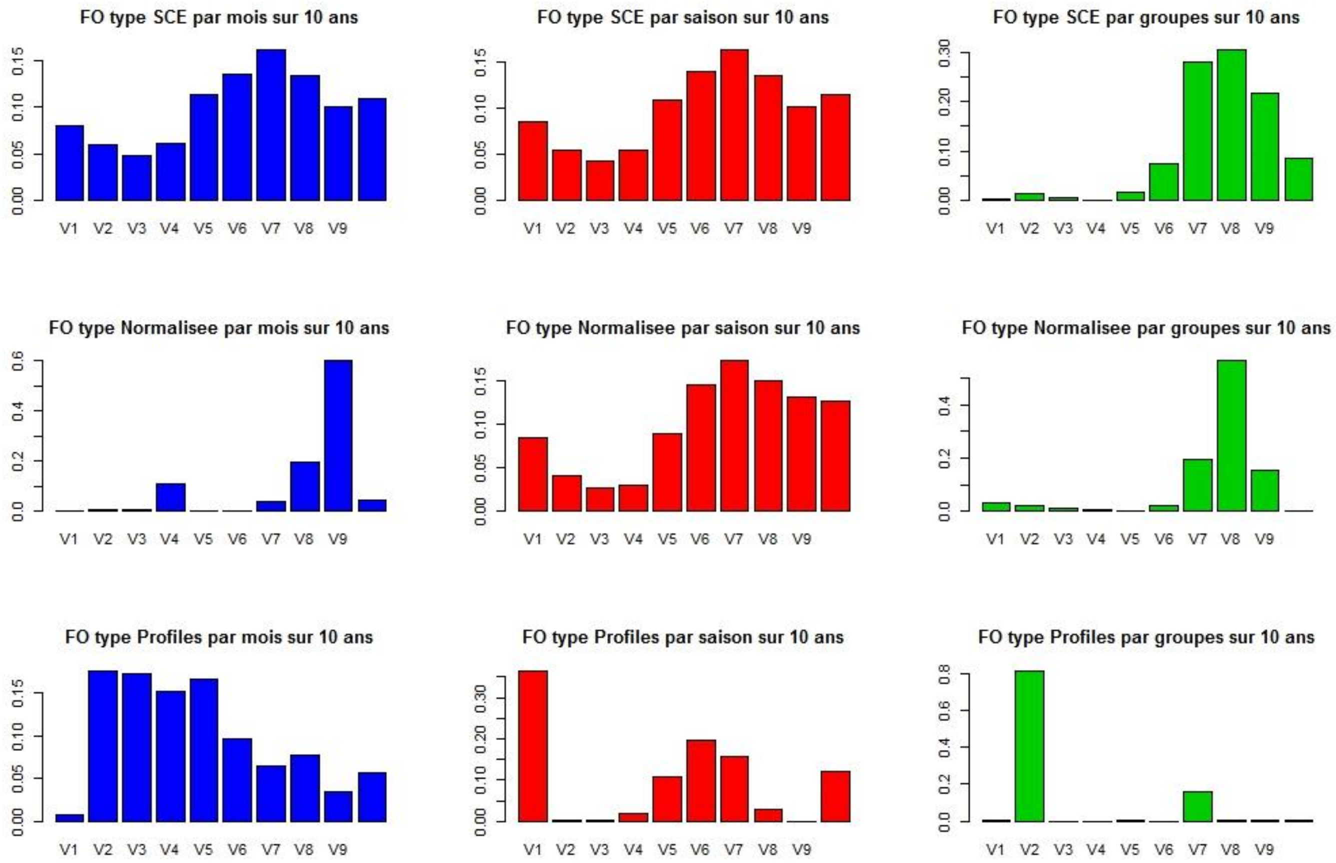
- How to build the OF ?
  - What time scale ?
  - Disagregate per age ?

Optimise the optimisation
9 alternative objective functions

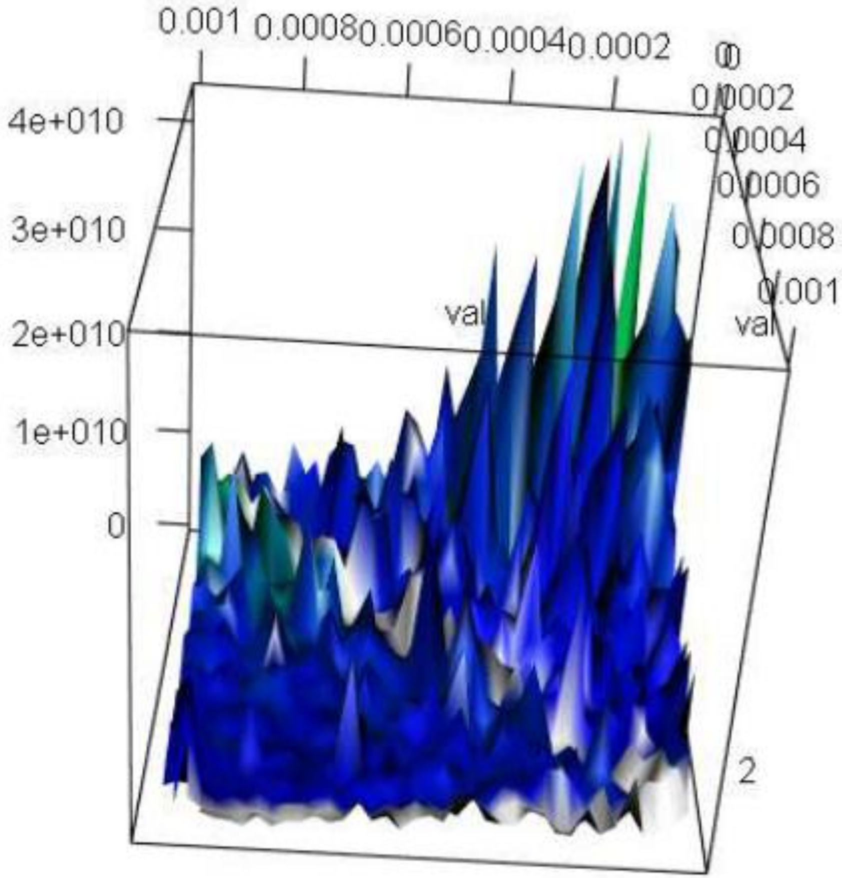
Échelle	Fonction d'objectif = SCE
Sur Y années par t mois	$\sum_{y=1}^{Y}\sum_{t=1}^{12}(D^{obs}_{y,t,.} - D^{sim}_{y,t,.})^2$
Sur Y années par les saisons de S	$\sum_{y=1}^{Y}\sum_{s\in S}(\sum_{t\in s}(D^{obs}_{y,t,.}) - \sum_{t\in s}(D^{sim}_{y,t,.}))^2$
Sur Y années par G groupes d'âge	$\sum_{y=1}^{Y}\sum_{t=1}^{12}\sum_{g=1}^{G}(D^{obs}_{y,t,g} - D^{sim}_{y,t,g})^2$
Échelle	**Fonction d'objectif = SCE standardisée**
Sur Y années par t mois	$\sum_{y=1}^{Y}\sum_{t=1}^{12}\frac{(D^{obs}_{y,t,.} - D^{sim}_{y,t,.})^2}{(\sum_{i=1}^{12} D^{obs}_{y,i,.})^2}$
Sur Y années par les saisons de S	$\sum_{y=1}^{Y}\sum_{s\in S}\frac{((\sum_{t\in s} D^{obs}_{y,t,.})-(\sum_{t\in s} D^{sim}_{y,t,.}))^2}{(\sum_{y=1}^{Y}\sum_{t\in s} D^{obs}_{y,t,.})^2}$
Sur Y années par G groupes d'âge	$\sum_{y=1}^{Y}\sum_{t=1}^{12}\sum_{g=1}^{G}\frac{(D^{obs}_{y,t,g} - D^{sim}_{y,t,g})^2}{\sum_{i=1}^{12}(D^{obs}_{y,i,g})^2}$
Échelle	**Fonction d'objectif = Profil**
Sur Y années par t mois	$\sum_{y=1}^{Y}\sum_{t=1}^{12}(\frac{D^{obs}_{y,t,.}}{\sum_{i=1}^{12} D^{obs}_{y,i,.}} - \frac{D^{sim}_{y,t,.}}{\sum_{i=1}^{12} D^{sim}_{y,i,.}})^2$
Sur Y années par les saisons de S	$\sum_{y=1}^{Y}\sum_{s\in S}(\frac{\sum_{t\in s} D^{obs}_{y,t,.}}{\sum_{y=1}^{Y}\sum_{t\in s} D^{obs}_{y,t,.}} - \frac{\sum_{t\in s} D^{sim}_{y,t,.}}{\sum_{y=1}^{Y}\sum_{t\in s} D^{sim}_{y,t,.}})^2$
Sur Y années par G groupes d'âge	$\sum_{y=1}^{Y}\sum_{t=1}^{12}\sum_{g=1}^{G}(\frac{D^{obs}_{y,t,g}}{\sum_{i=1}^{12} D^{obs}_{y,i,g}} - \frac{D^{sim}_{y,t,g}}{\sum_{i=1}^{12} D^{sim}_{y,i,g}})^2$

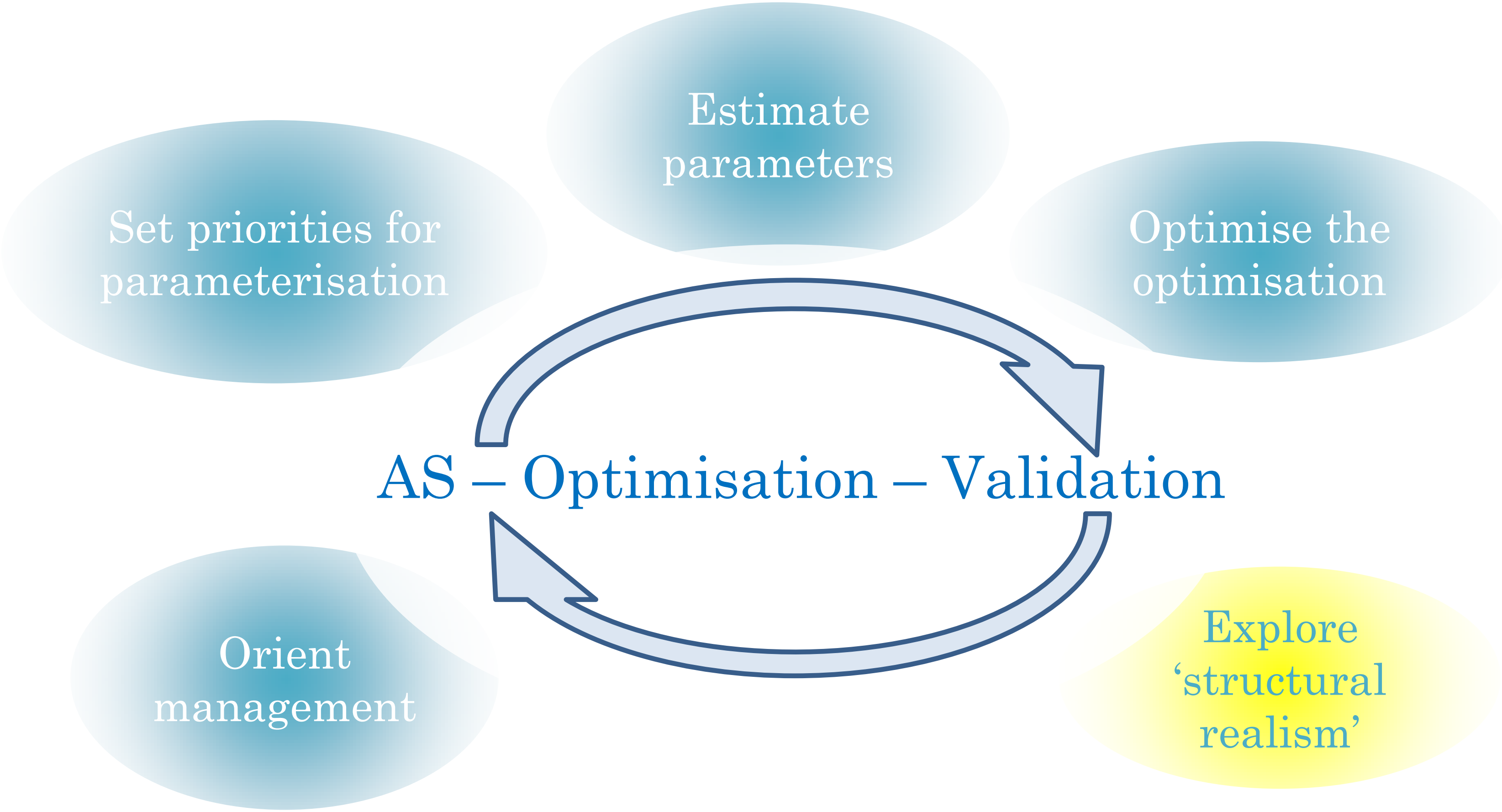
Optimise the optimisation Find the most sensitive FO to all parameters

- LHS 2000 + anova (sans interaction)



Optimise the optimisation
Gain a first exploration of the parameter space




Estimate parameters
Set priorities for parameterisation
Optimise the optimisation
AS – Optimisation – Validation
Orient management
Explore 'structural realism'

Explore structural realism

Is the model ~~« Valid »~~?

«Useful », «Inspiring confidence», «Convincing»,
»Illuminating», « suitable for a particular purpose »

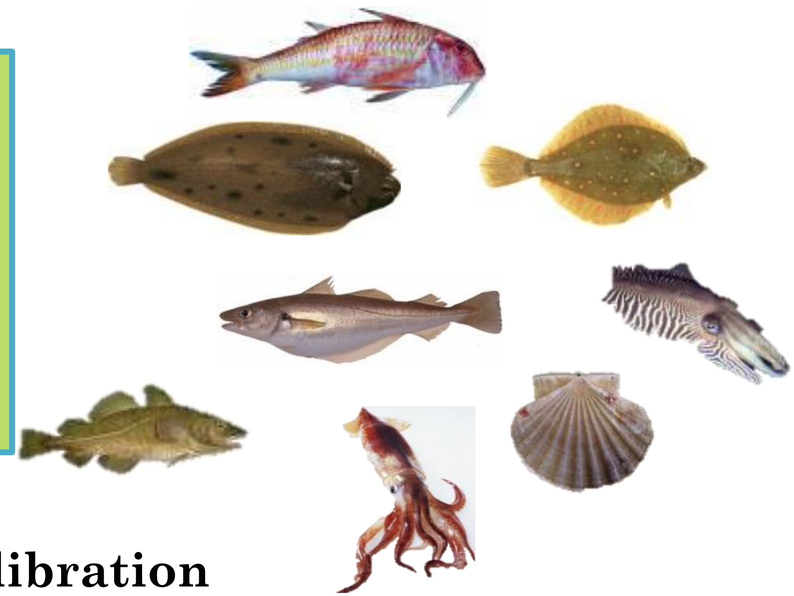
1. **INTRODUCTION**

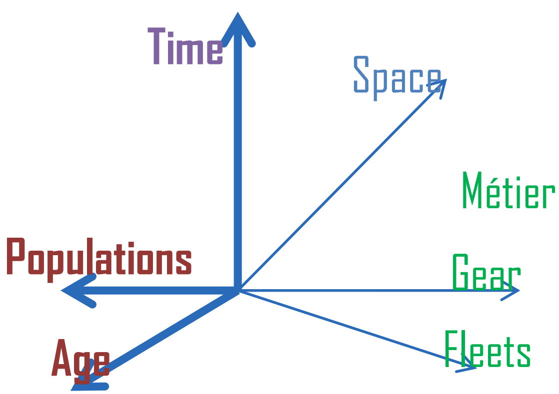
System Dynamics modelers are often faulted for their reluctance to employ formal measures of goodness-of-fit when assessing the historical behaviour of models. As a result, the validity of system dynamics models is often questioned even when their correspondence to historical behaviour is quite good. This paper argues that the failure to present formal analysis of historical behaviour creates an impression of sloppiness and unprofessionalism. After reviewing the theory of validity in system dynamics, the paper proposes a simple set of summary statistics appropriate for system dynamics models. The statistics allow the error due to individual behaviour modes to be analysed, do not require the use of formal parameter estimation procedures, and can be conveniently computed.

Sterman, 1984

Explore structural realism
Calibration/validation

- ISIS-Fish model of the Eastern English Channel





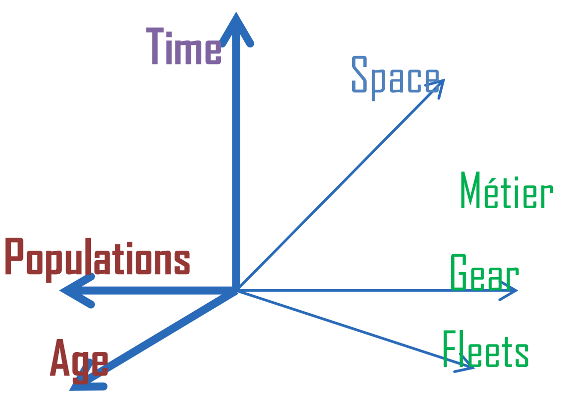
Calibration
Catch@age2008-2011

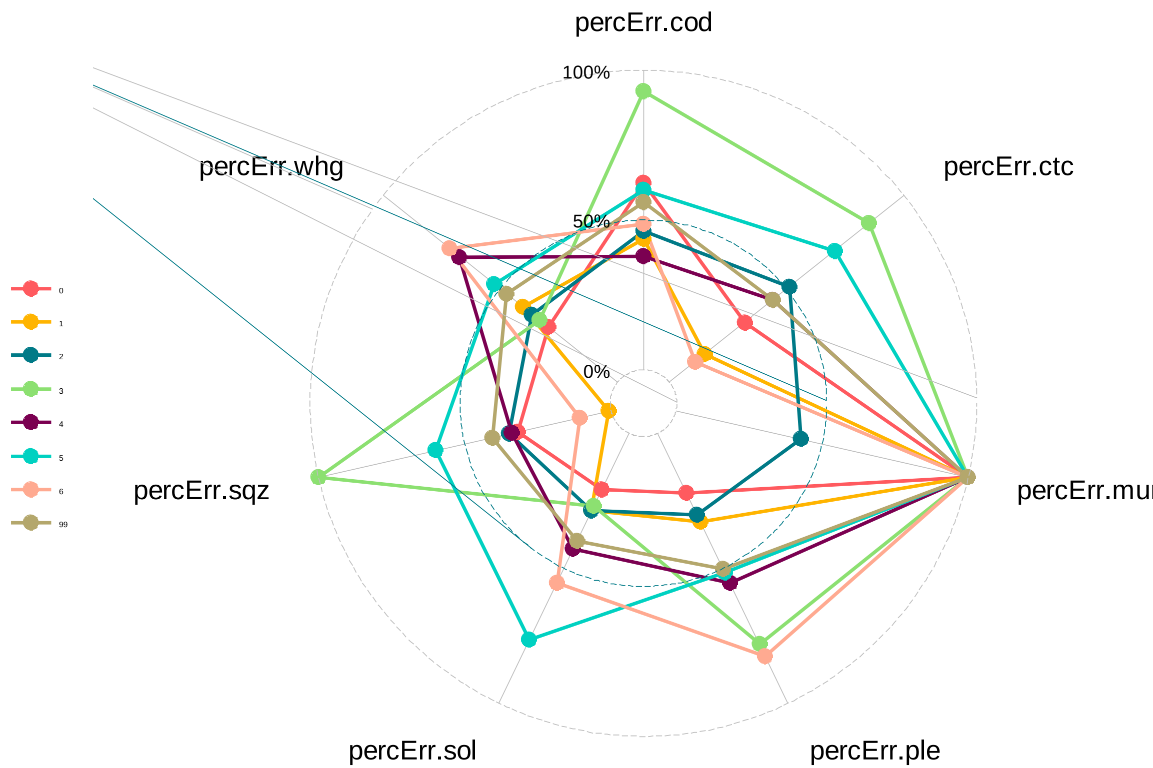
Validation
Autres échelles
Multi-variée
2008-2014

Explore structural realism Calibration results / species

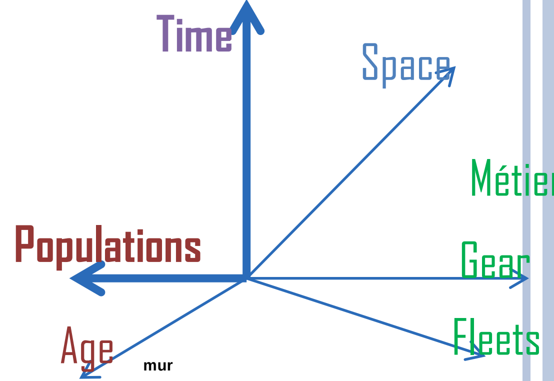
- Radar plot %err moyen /sp (par an)

Id problematic
- species : RedMullet
- Years : 2011, 2013

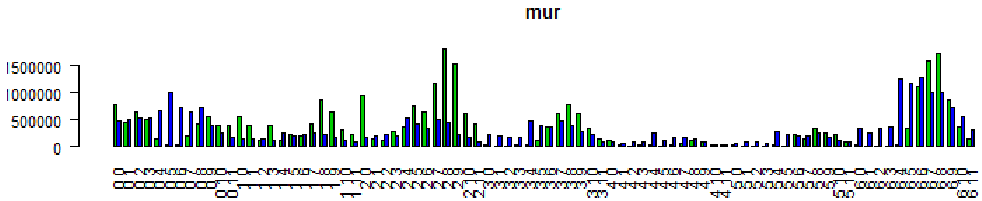




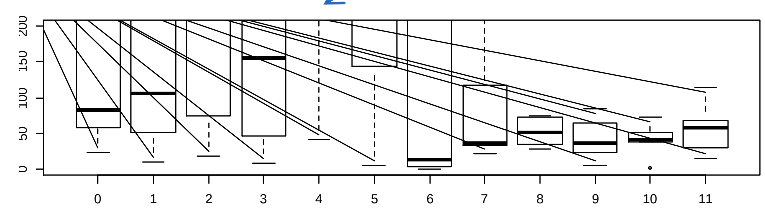
Explore structural realism
Validation



Seasonnal patterns

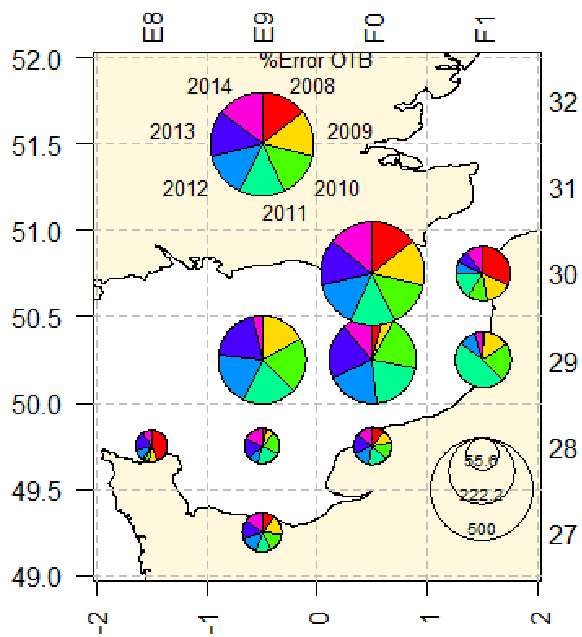


%error

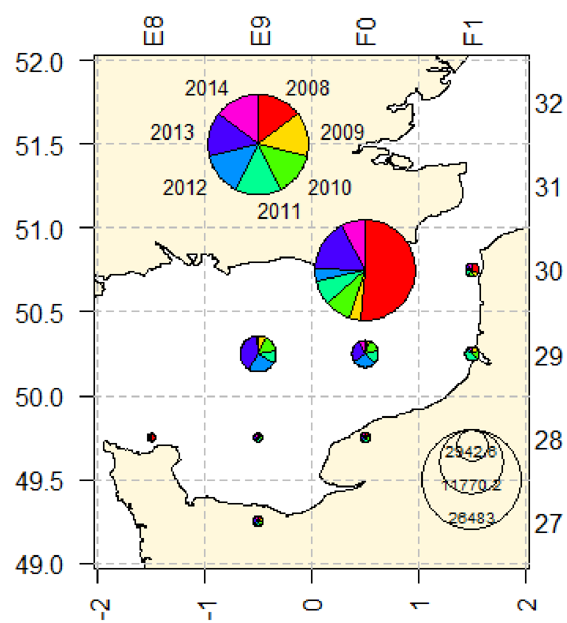


Spatial patterns / Gear & Year

%error



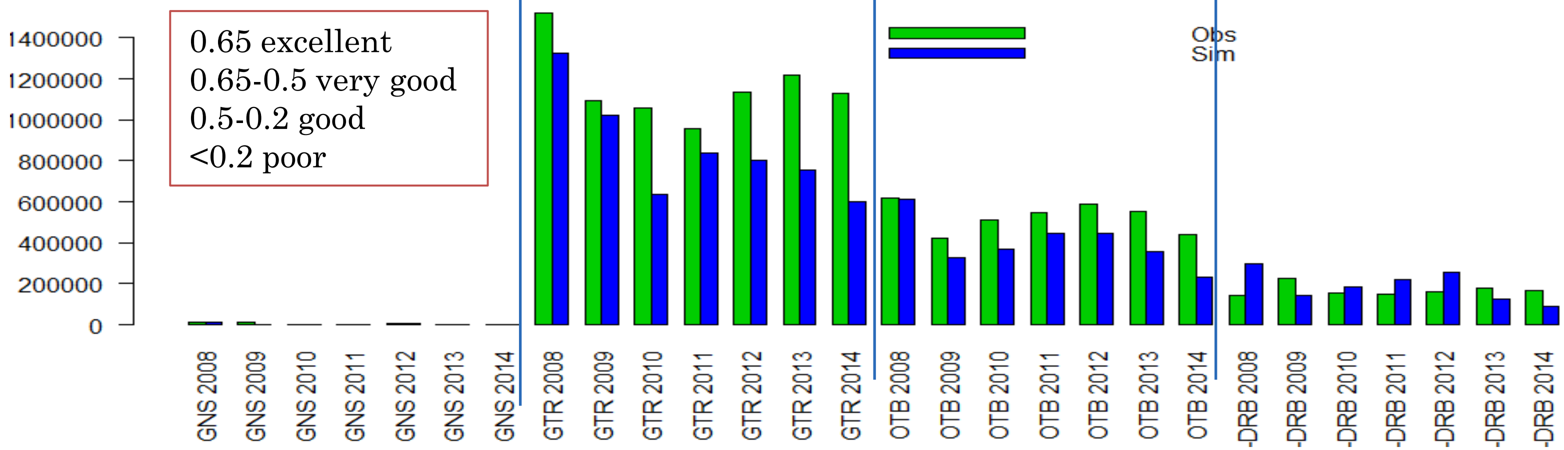
Absolute difference

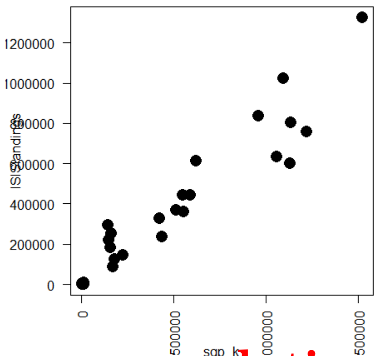


Explore structural realism
Validation: metrics

	Nets	gillnets	trawls	Dredges - beam trawl
MEF	0.41	-3.4	-3.3	-10

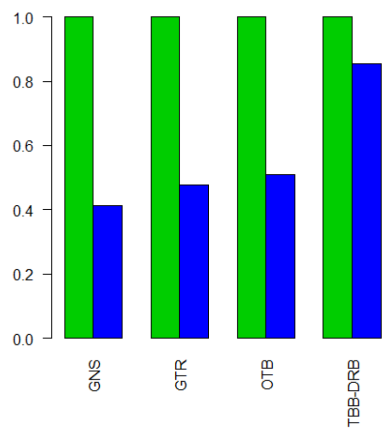
0.65 excellent
0.65-0.5 very good
0.5-0.2 good
<0.2 poor

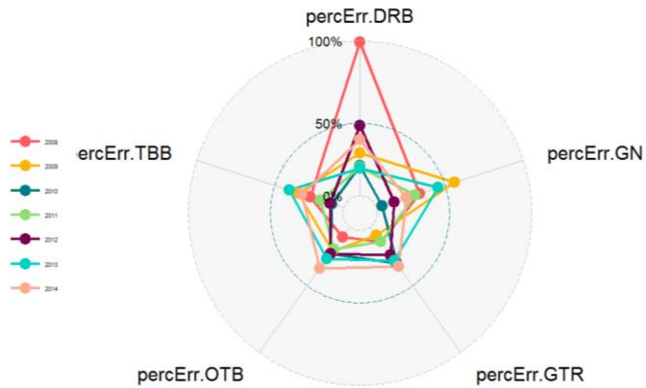


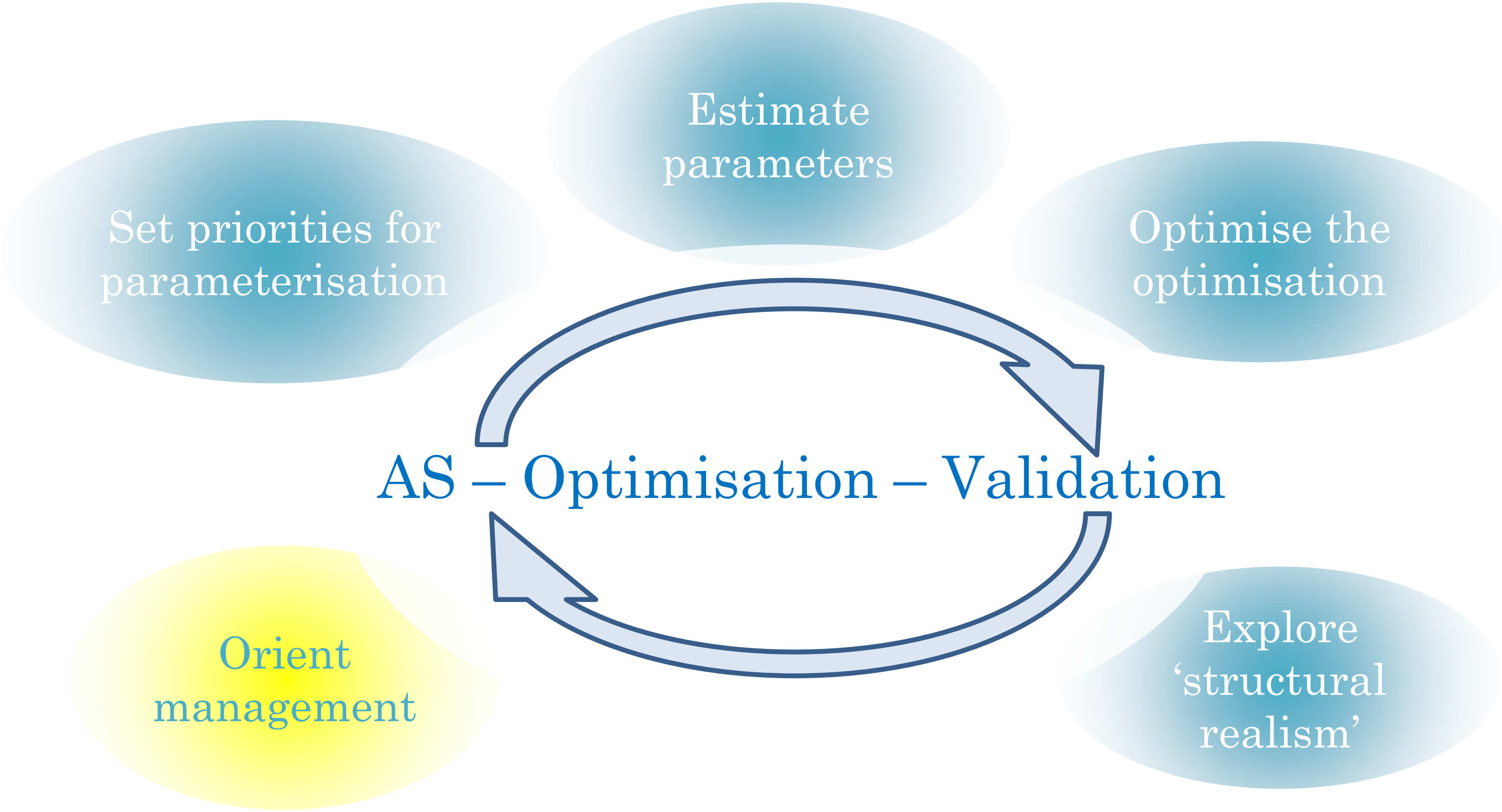


Linear correlation : 0.9536
Rank correlation : 0.93

Cumulated catches over year
% error per gear

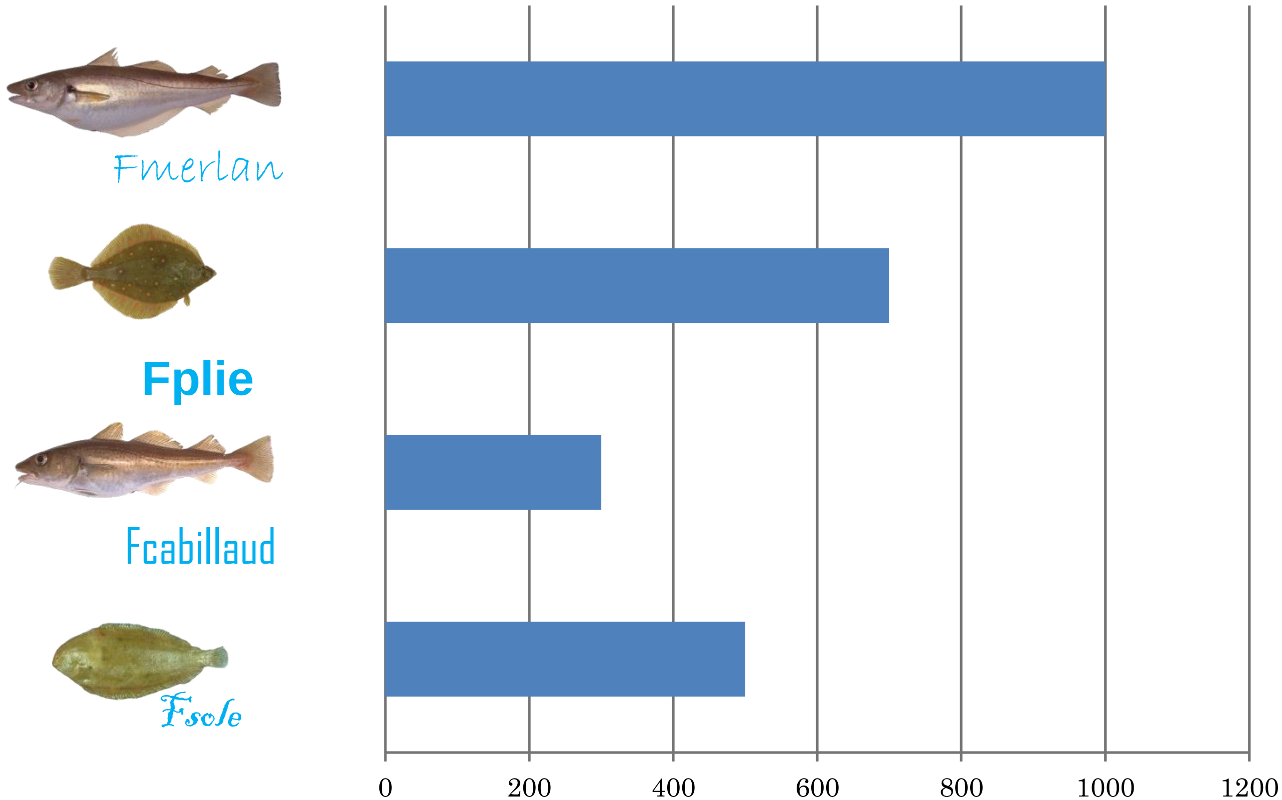





Estimate parameters
Set priorities for parameterisation
Optimise the optimisation
AS – Optimisation – Validation
Orient management
Explore 'structural realism'

Management strategy optimisation
Mixed Fisheries

Management strategy optimisation
Mixed Fisheries

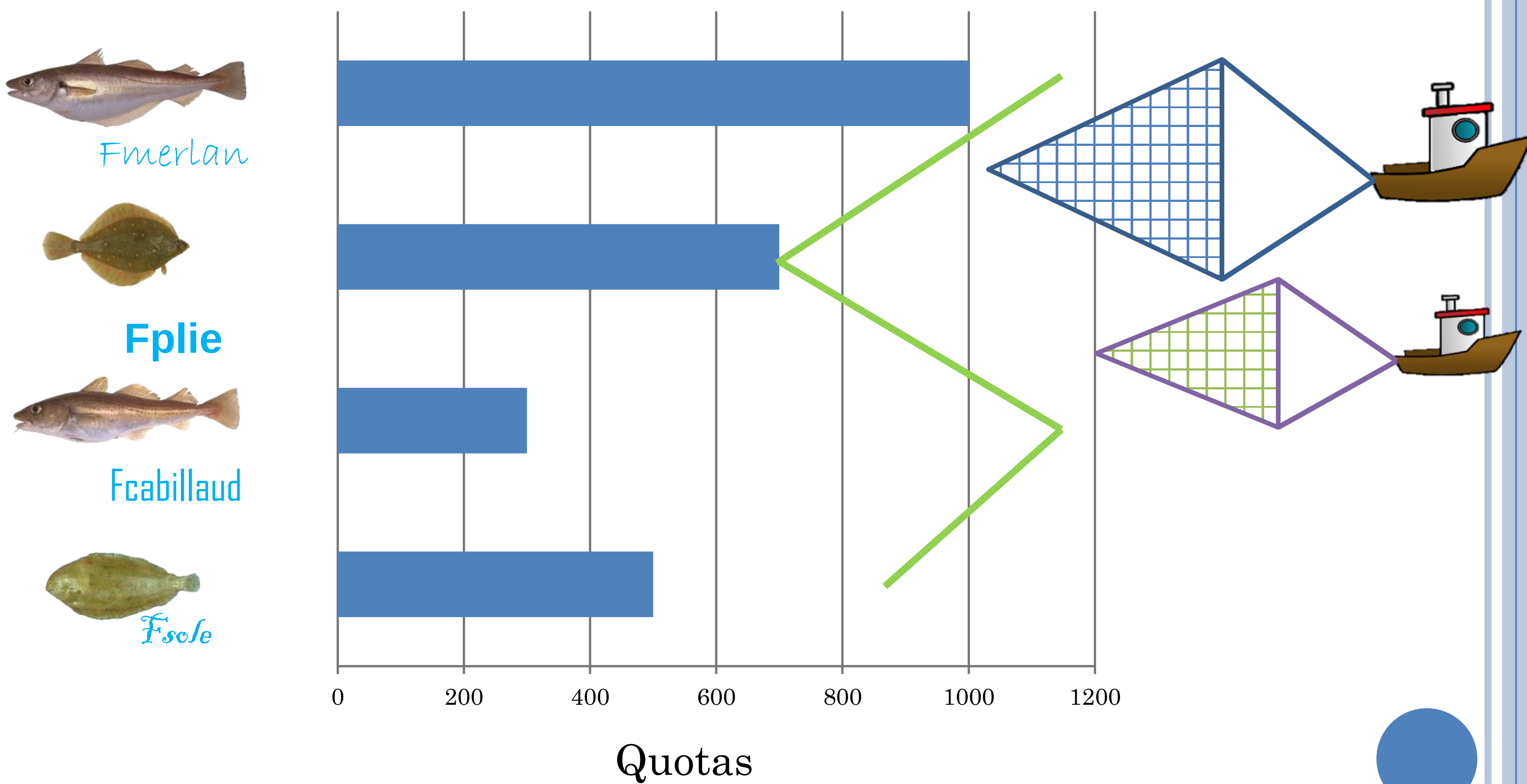


Quotas ~Etat biologique du stock

Maximum sustainable yield

Management strategy optimisation
Mixed Fisheries

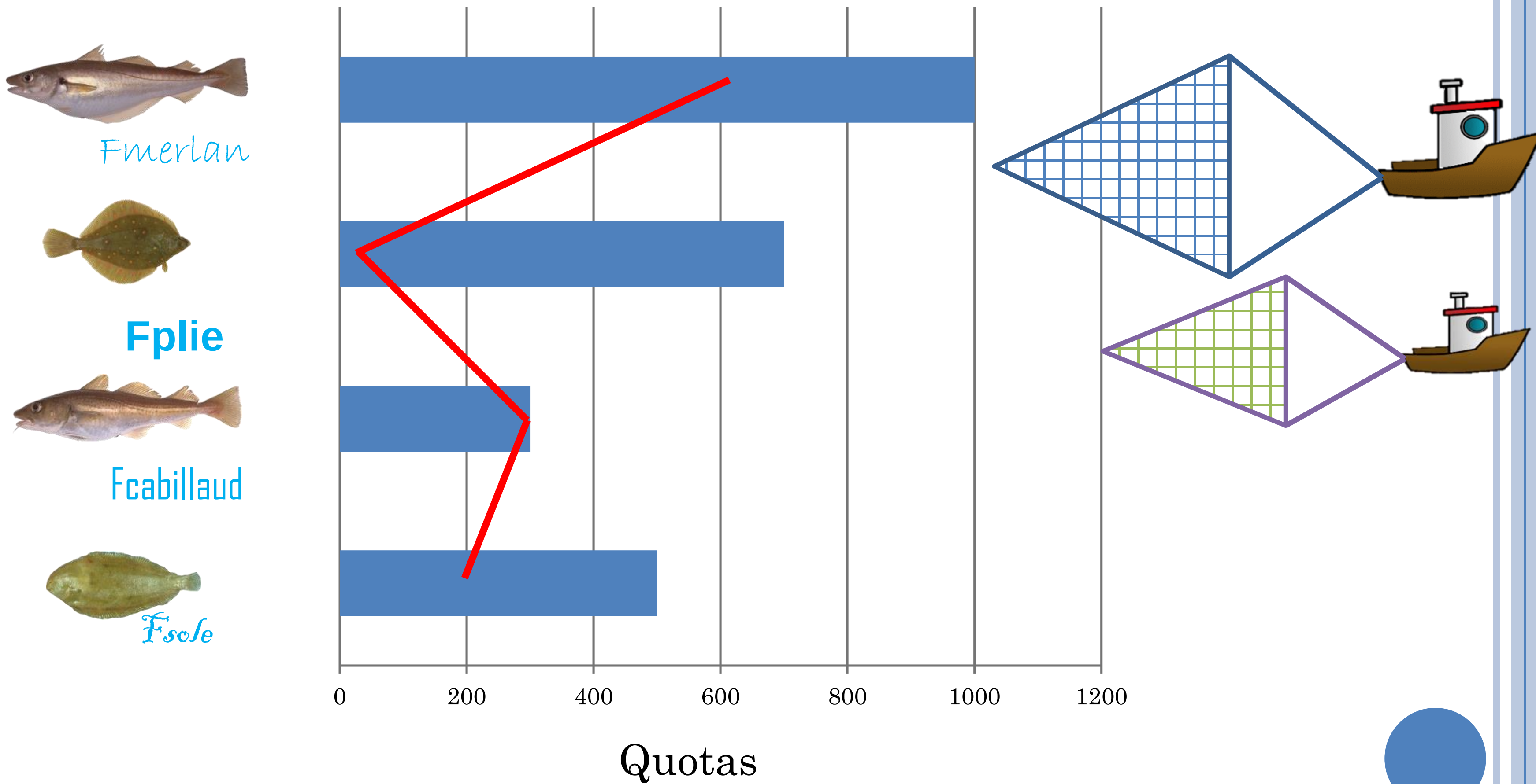
Sc. Max : Effort E1 = Effort 1 +Effort 1



Maximum sustainable yield

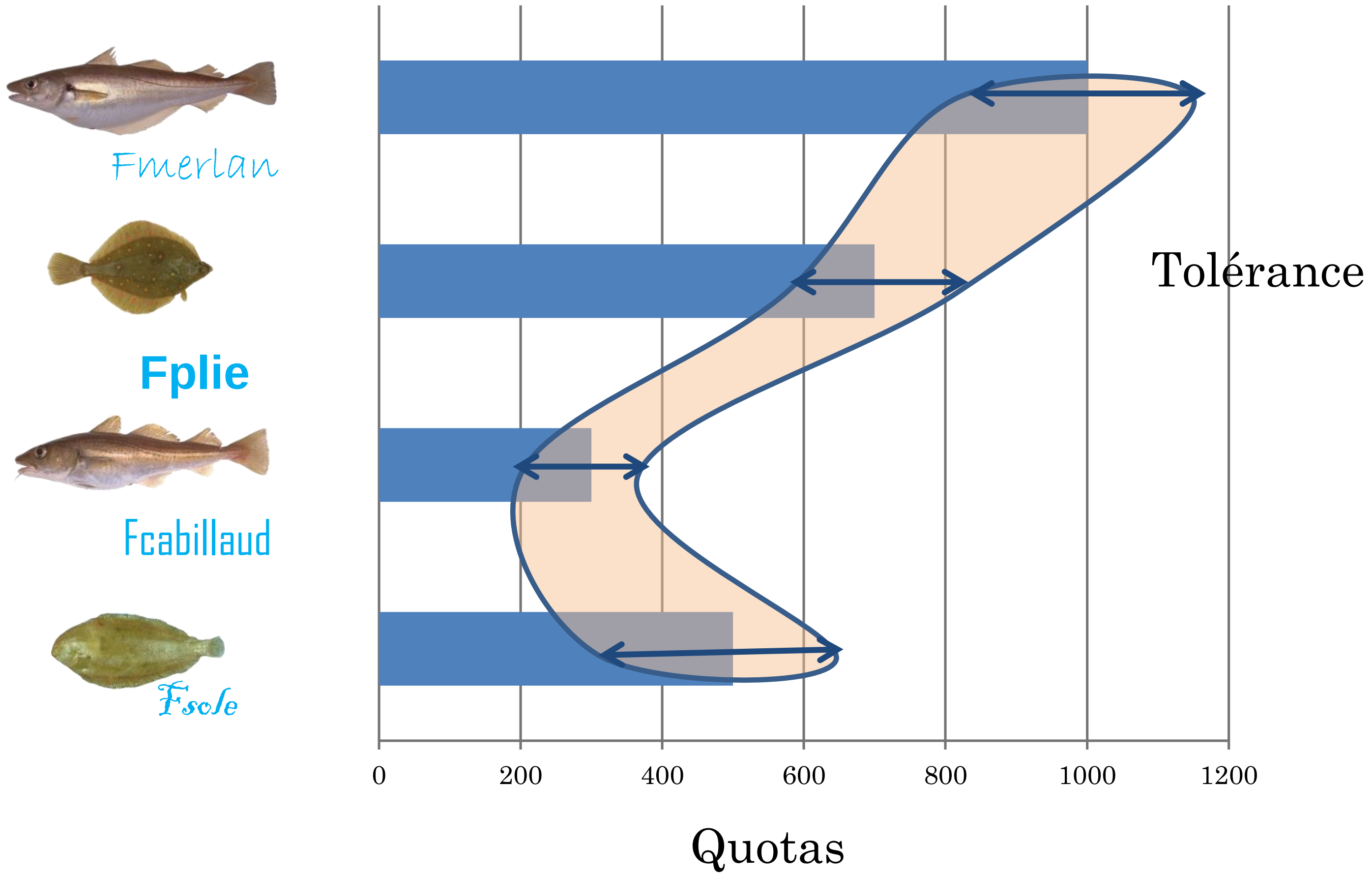
Management strategy optimisation Mixed Fisheries

Sc. Min : Effort E2 = Effort 2 +Effort 2



Maximum sustainable yield

Management strategy optimisation
Mixed Fisheries

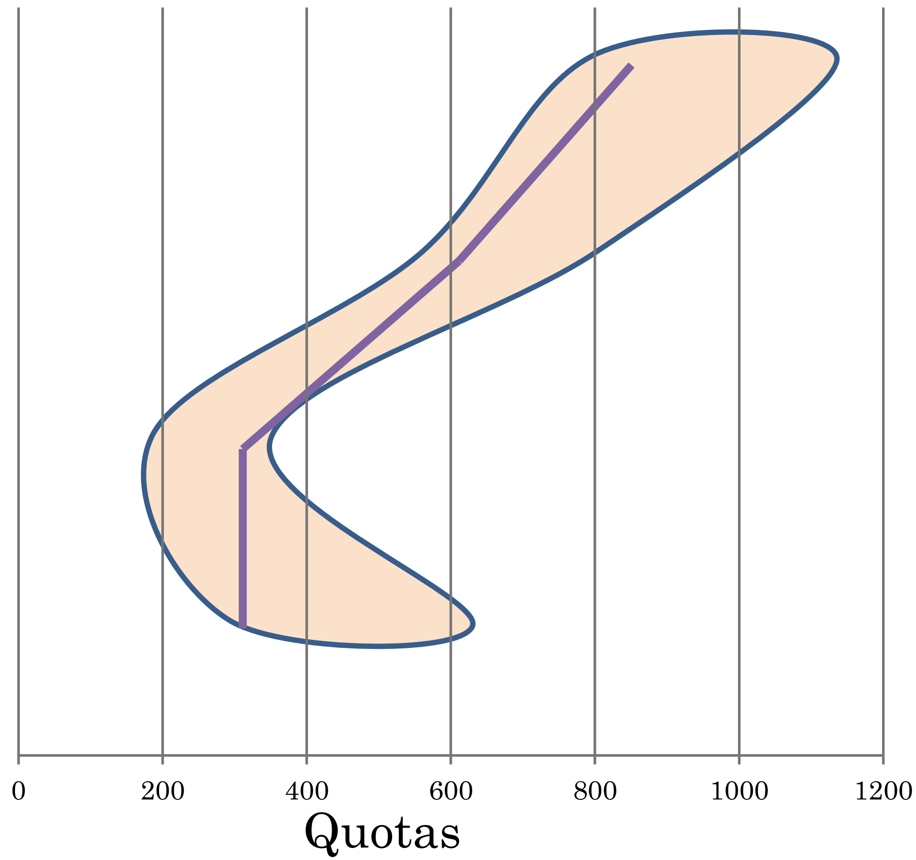


Pretty good yield

(Rindorp et al. 2016)

Management strategy optimisation Mixed Fisheries

Search for {quotas} optimal within constrainsts
That minimizes (Catch Sc. Max – Catch Sc. Min)



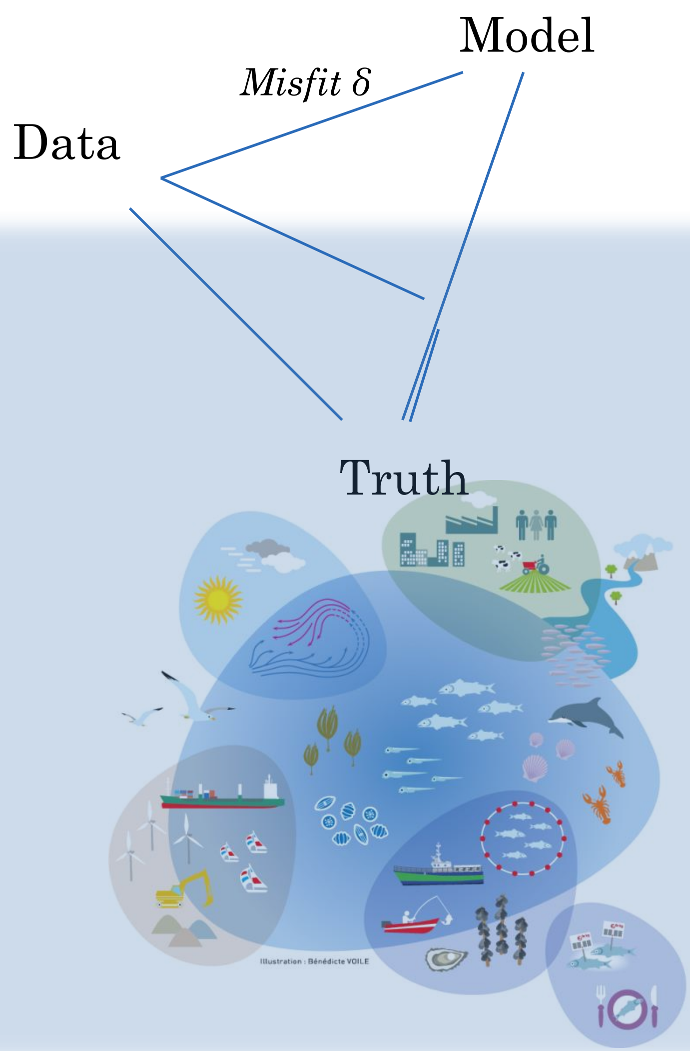
Genetic algorithm

Pretty good yield

Ulrich et al. 2016

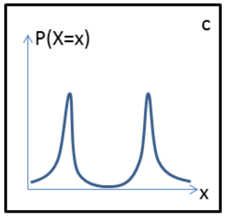
« The cautious modeler : Craftsmanship without wizardry »

Andréa Saltelli

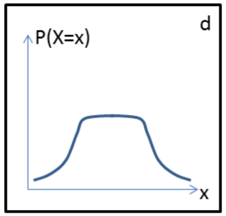


MERCI!

SA-CALIBRATION-VALIDATION FOR PARAMETERIZATION



Param 1 : mortalité des oeufs
Param 2 : durée de la ponte
Param 3 : date de migration
⇒ 8 alternative parameterizations



Param 4 : accessibilité
Param 5 : mortalité adultes
⇒ Calibration

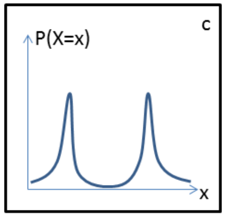
ISIS-Fish

Pêcherie pélagique

1 run = 20 min

Lehuta et al. Fish.Res. 2013.

SA-CALIBRATION-VALIDATION FOR PARAMETERIZATION



Param 1 : mortalité des oeufs
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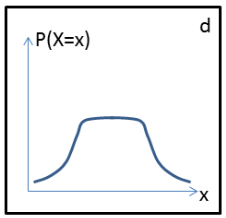
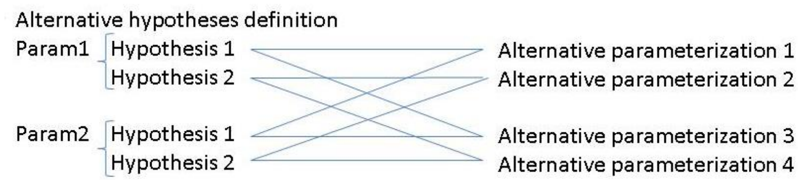
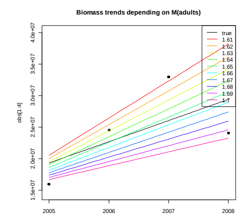
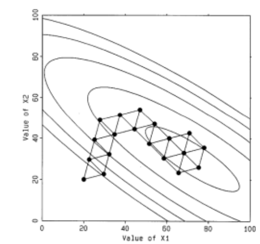


Param 4 : accessibilité
Param 5 : mortalité adultes
⇒ Calibration

- Systematic building alternative parameterizations
- Calibration of continuous parameters







ISIS-Fish

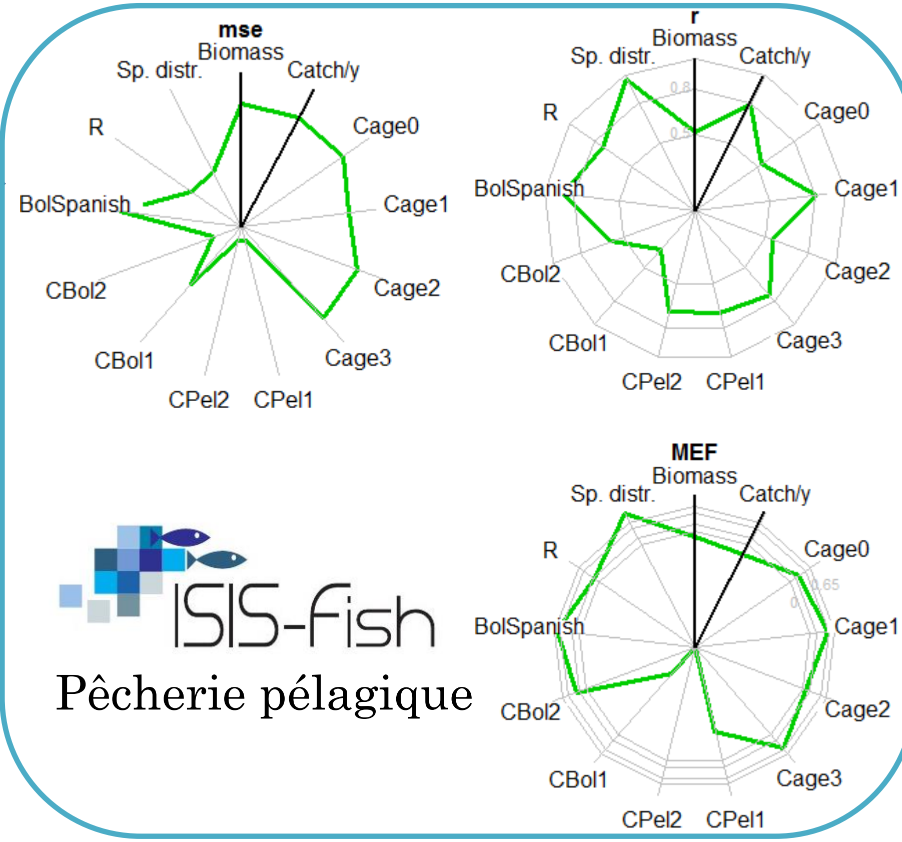
Pêcherie pélagique

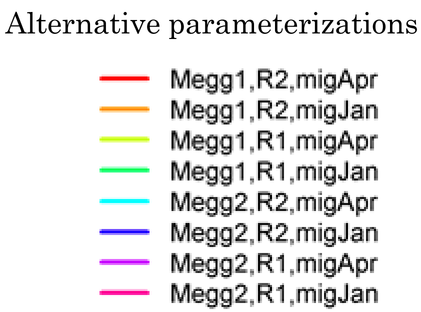
Lehuta et al. Fish.Res. 2013.

SA-CALIBRATION-VALIDATION FOR PARAMETERIZATION

- Systematic building alternative parameterizations
- Calibration of continuous parameters
- Evaluation of alternative parameterizations against observations

« Model skill assessment »
Multi-variables and multi-criteria validation and model selection





Lehuta et al. Fish.Res. 2013.

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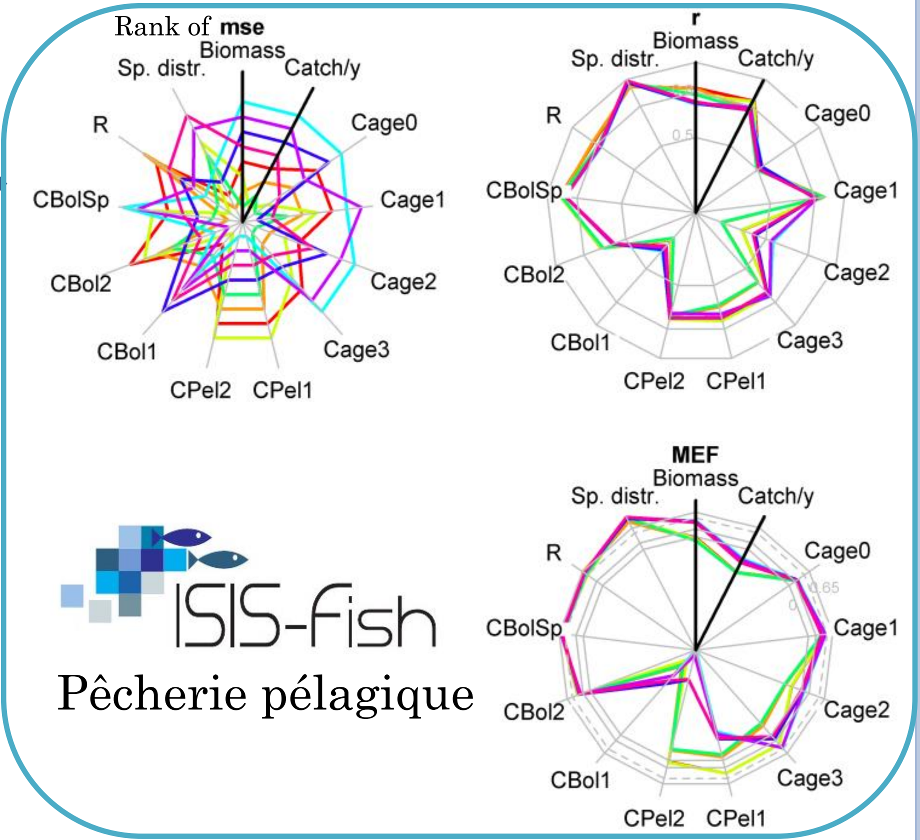
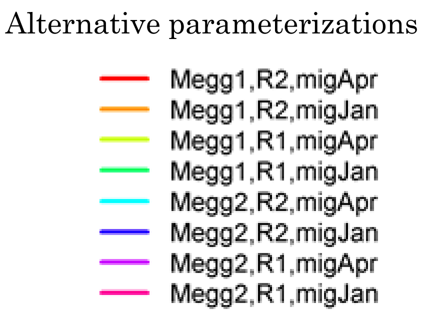




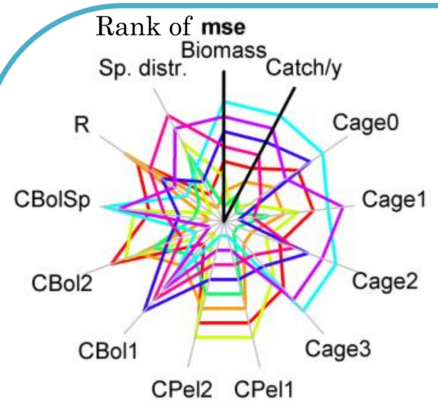
Lehuta et al. Fish.Res. 2013.

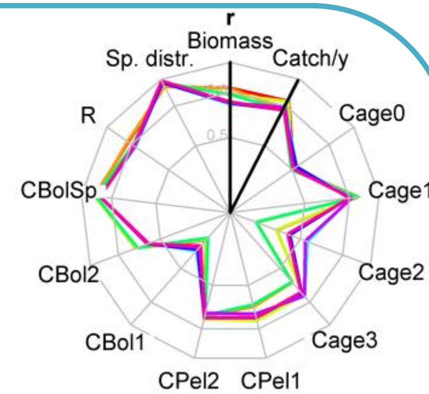
SA-calibration-validation for parameterization

- Systematic building alternative parameterizations
- Calibration of continuous parameters
- Evaluation of alternative parameterizations against observations

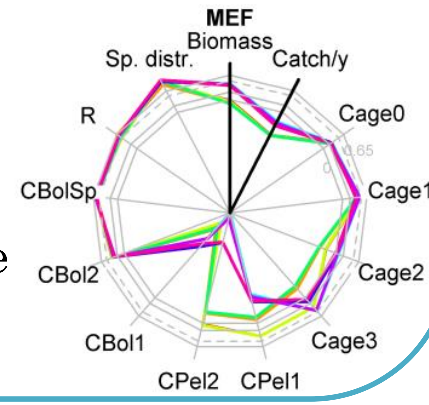
Limits :
Caricature of parameter space to limit alternatives

« Model skill assessment »
Multi-variables and multi-criteria validation and model selection





ISIS-Fish
Pêcherie pélagique



Lehuta et al. Fish.Res. 2013.

- Uncertitude et AS
- AS sur FO
- Créer de la connaissance / gérer : Herring/SMAC metapop : calibration -> orientation
- Fcube
- Sur-parametrage
- Validation POM/ multi variée + sterman
- Precaution !

- Choisir les parametres à calibrer, differentes natures -> ad hoc solutions
- AS sur la FO (what is the question?): selon l objectif exclude useless param or build the most sensitive FO.
- Tester la qualité de l optim: twin experiments, several runs, try different methods (simplex vs. AG)
- Calibrated is not validated (prez IPEM 2017)
- Calibration and management in fisheries : Fcube, Sole metapop
- Leo modele de derive

LÉO

Complexity and uncertainty in marine models

Model efficiency evolves with complexity (Costanza and Sklar, 1985)

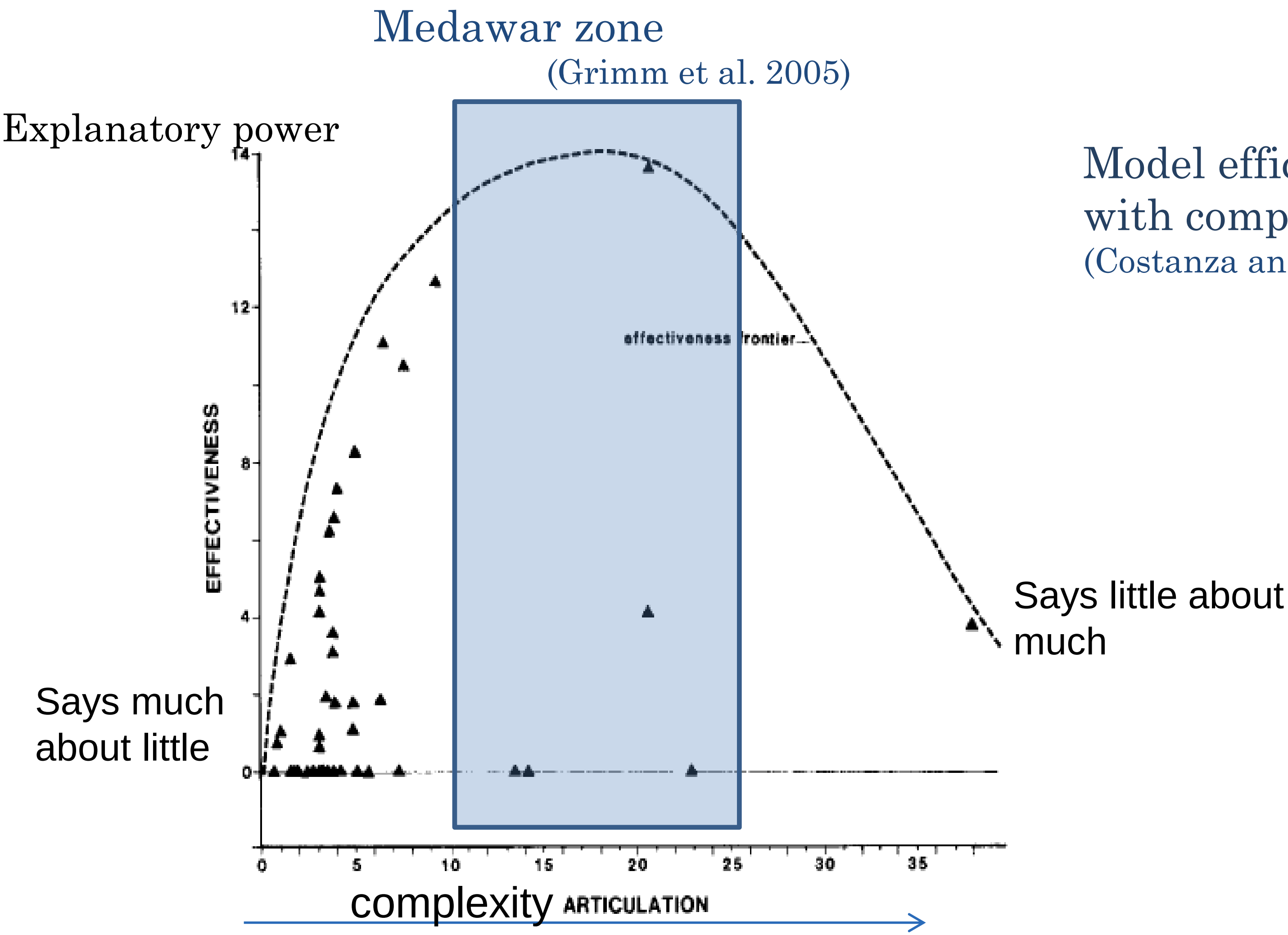


Fig. 2. Plot of articulation index vs. effectiveness index showing the current effectiveness frontier.

ICES Journal of Marine Science

ICES Journal of Marine Science (2012), 69(1), 3–7. doi:10.1093/icesjms/fsr179

Food for Thought

Advice under uncertainty in the marine system

Dorothy J. Dankel[1*], Robert Aps[2], Gurpreet Padda[3], Christine Röckmann[4], Jeroen P. van der Sluijs[5], Douglas C. Wilson[6], and Poul Degnbol[7]

2009

Developing management procedures that are robust to uncertainty: lessons from the International Whaling Commission

André E. Punt and Greg P. Donovan

Punt, A. E. and Donovan, G. P. 2007. Developing management procedures that are robust to uncertainty: lessons from the International Whaling Commission. – ICES Journal of Marine Science, 64: 603–612

NATURE|Vol 449|25 October 2007

ESSAY

Fishing for certainty

Science advisers should have confidence in their data, or risk being undermined by more dogmatic and vociferous stakeholders during the policy-making process.

"Emphasizing what we don't know often drowns out what we do know."

Andrew A. Rosenberg

resources. Exploitation of species such as

depletion are good things; many argue

Coping with uncertainty in ecological advice: lessons from fisheries

John Harwood[1] and Kevin Stokes[2]

2003

ELSEVIER Journal of Environmental Economics and Management 50 (2005) 300–318
www.elsevier.com/locate/jeem

Fishery management under multiple uncertainty

Gautam Sethi[a,*,1], Christopher Costello[b,1], Anthony Fisher[c], Michael Hanemann[c], Larry Karp[c]

[a]Bard Center for Environmental Policy, Bard College, Annandale-on-Hudson, NY 12504, USA
[b]Donald Bren School of Environmental Science & Management, University of California, Santa Barbara, USA
[c]Department of Agricultural and Resource Economics, University of California at Berkeley, USA

Received 21 December 2001
Available online 5 March 2005

"Risk" in fisheries management: a review

R.I.C.C. Francis and R. Shotton

1997

FISH and FISHERIES

Complex dynamics may limit prediction in marine fisheries

Sarah M Glaser[1,2], Michael J Fogarty[3], Hui Liu[4], Irit Altman[5], Chih-Hao Hsieh[6], Les Kaufman[5], Alec D MacCall[7], Andrew A Rosenberg[8], Hao Ye[9] & George Sugihara[9]

Vol. 533: 47–65, 2015
doi: 10.3354/meps11387
MARINE ECOLOGY PROGRESS SERIES
Mar Ecol Prog Ser
Published August 6

Modelling the Mediterranean marine ecosystem as a whole: addressing the challenge of complexity

Chiara Piroddi[1,2,*], Marta Coll[2,3,4], Jeroen Steenbeek[4], Diego Macias Moy[1], Villy Christensen[4,5]

FISH and FISHERIES

FISH and FISHERIES, 2016, 17, 101–125

Ecosystem models for fisheries management: finding the sweet spot

Jeremy S Collie[1], Louis W Botsford[2], Alan Hastings[3], Isaac C Kaplan[4], John L Largier[5], Patricia A Livingston[6], Éva Plagányi[7], Kenneth A Rose[8], Brian K Wells[9] & Francisco E Werner[10]

Vol. 253: 1–16, 2003
MARINE ECOLOGY PROGRESS SERIES
Mar Ecol Prog Ser
Published May 15

Effect of complexity on marine ecosystem models

Elizabeth A. Fulton[1,*], Anthony D. M. Smith[1], Craig R. Johnson[2]

[1]CSIRO Division of Marine Research, GPO Box 1538, Hobart, Tasmania 7001, Australia
[2]School of Zoology and Tasmanian Aquaculture and Fisheries Institute (TAFI), University of Tasmania, GPO Box 252-05, Hobart, Tasmania 7001, Australia

FISH and FISHERIES

FISH and FISHERIES, 2014, 15, 1–22

Multispecies fisheries management and conservation: tactical applications using models of intermediate complexity

Éva E Plagányi[1], André E Punt[2,3], Richard Hillary[2], Elisabetta B Morello[1], Olivier Thébaud[1], Trevor Hutton[1], Richard D Pillans[1], James T Thorson[1,3], Elizabeth A Fulton[2], Anthony D M Smith[2], Franz Smith[4], Peter Bayliss[1], Michael Haywood[1], Vincent Lyne[2] & Peter C Rothlisberg[1]

ELSEVIER
Progress in Oceanography
Volume 84, Issues 1–2, January–February 2010, Pages 121-128

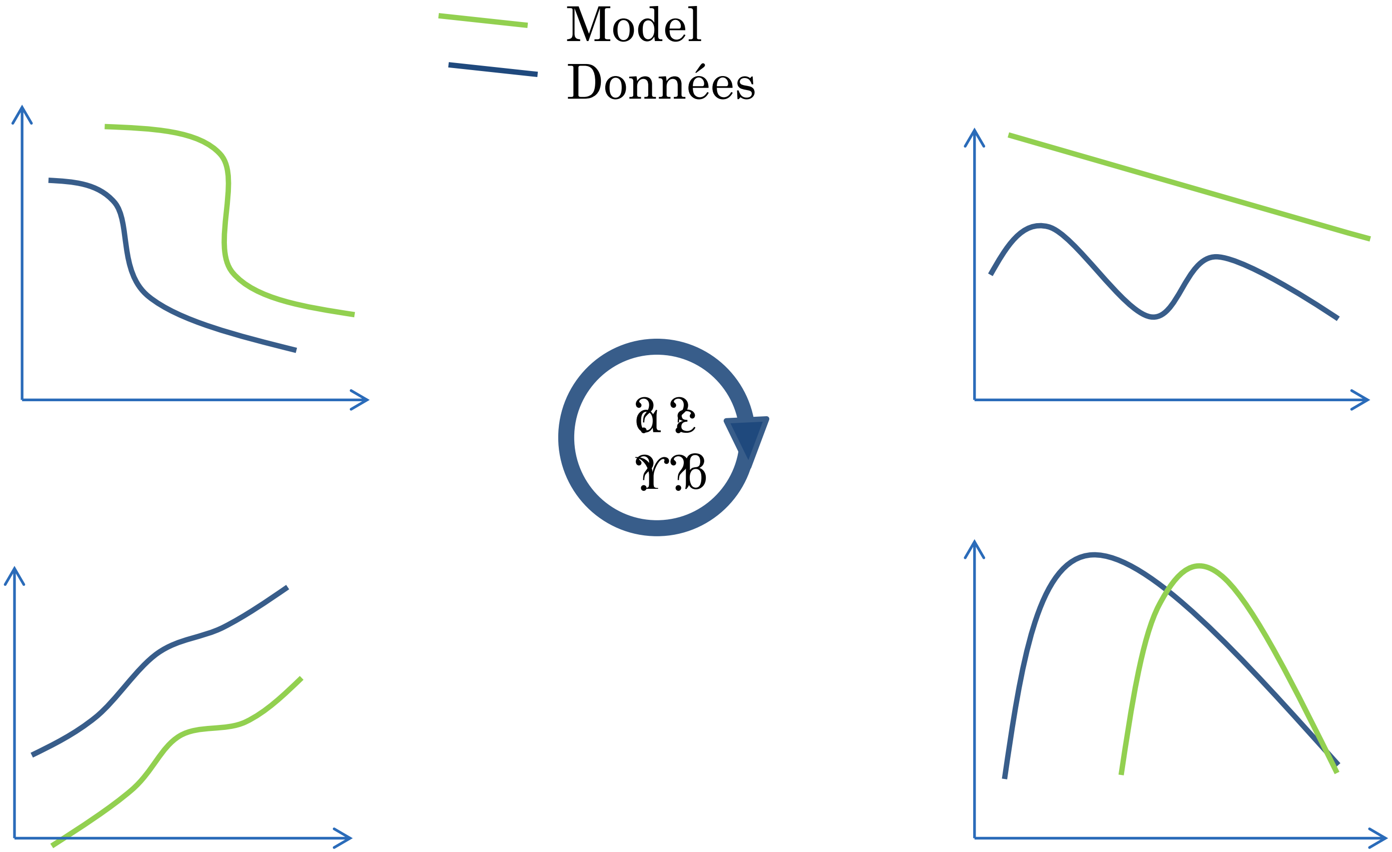
The case for marine ecosystem models of intermediate complexity

Charles Hannah [a], Alain Vezina [a], Mike St. John [b]

- Trop de paramètres, trop peu de données !
- Un peu bien, tout mal !

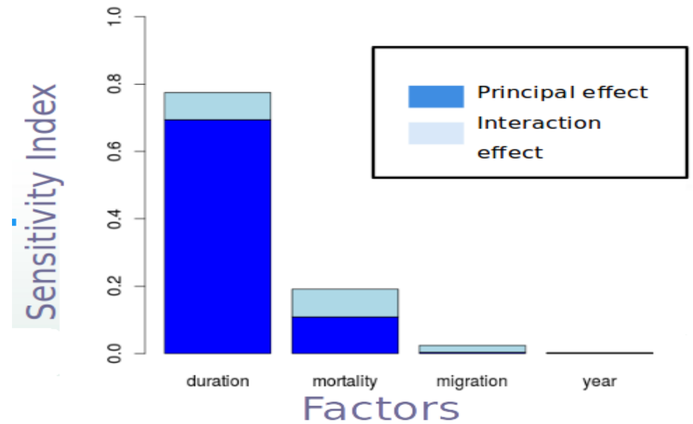
- Confidence: reproducing the past, reproducing patterns

ESTIMATE PARAMETERS: CALIBRATION



Etape 1:
Exploratoire

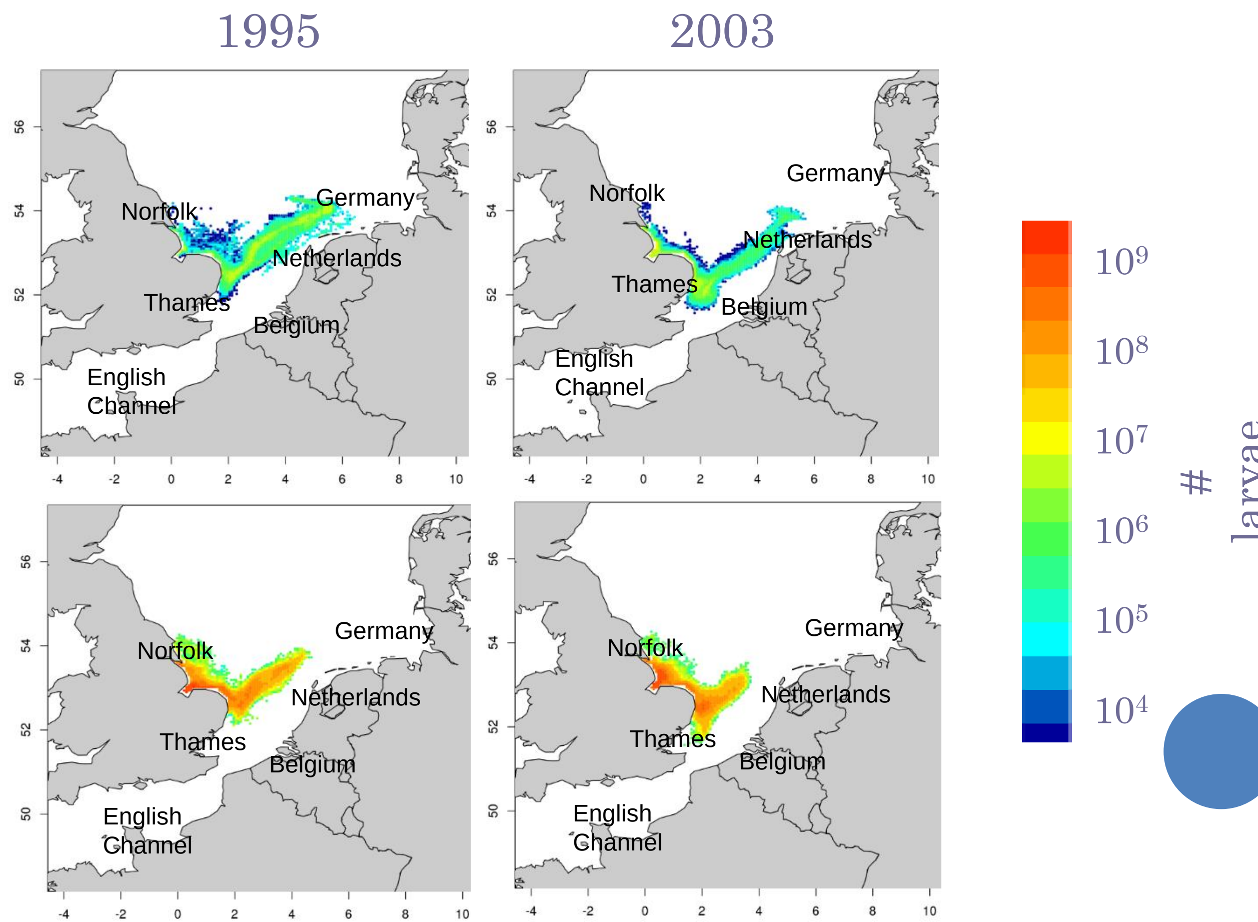
Y = recrutement prédit par le modèle



Paramétrisation:

- Longue durée larvaire
- Migration nycthémérale + tidal
- Forte mortalité

- Courte durée larvaire
- Migration passive
- Faible mortalité



Etapes	Questions	méthodes
Etape 1: Exploratoire	• **La variabilité interannuelle a-t-elle plus d'impact que les autres paramètres?** • **Quels sont les paramètres les plus influents?**	**Non** **La durée larvaire**
Etape 2: Analyse de sensibilité	• Quels paramètres ont une forte influence sur les prédictions du modèle?	Plan factoriel optimisé sur une année moyenne
Etape 3: Calibration	• Quel est le meilleur modèle?	Plan complet sur les paramètres identifiés comme très influents sur toutes les années

Etape 2: Analyse de sensibilité

Paramétrisation testée:

- Migration verticale (discret, 8 modalités)
- Durée larvaire (continue)
    - avec 3 modalités * 4 stades
- Mortalité (continue)
    - 3 modalités
- Période de ponte (continue)
    - 3 modalités : estimation +- 15 jours
- Délai supplémentaire (continu)
    - 3 modalités

- Pour l'année 2003

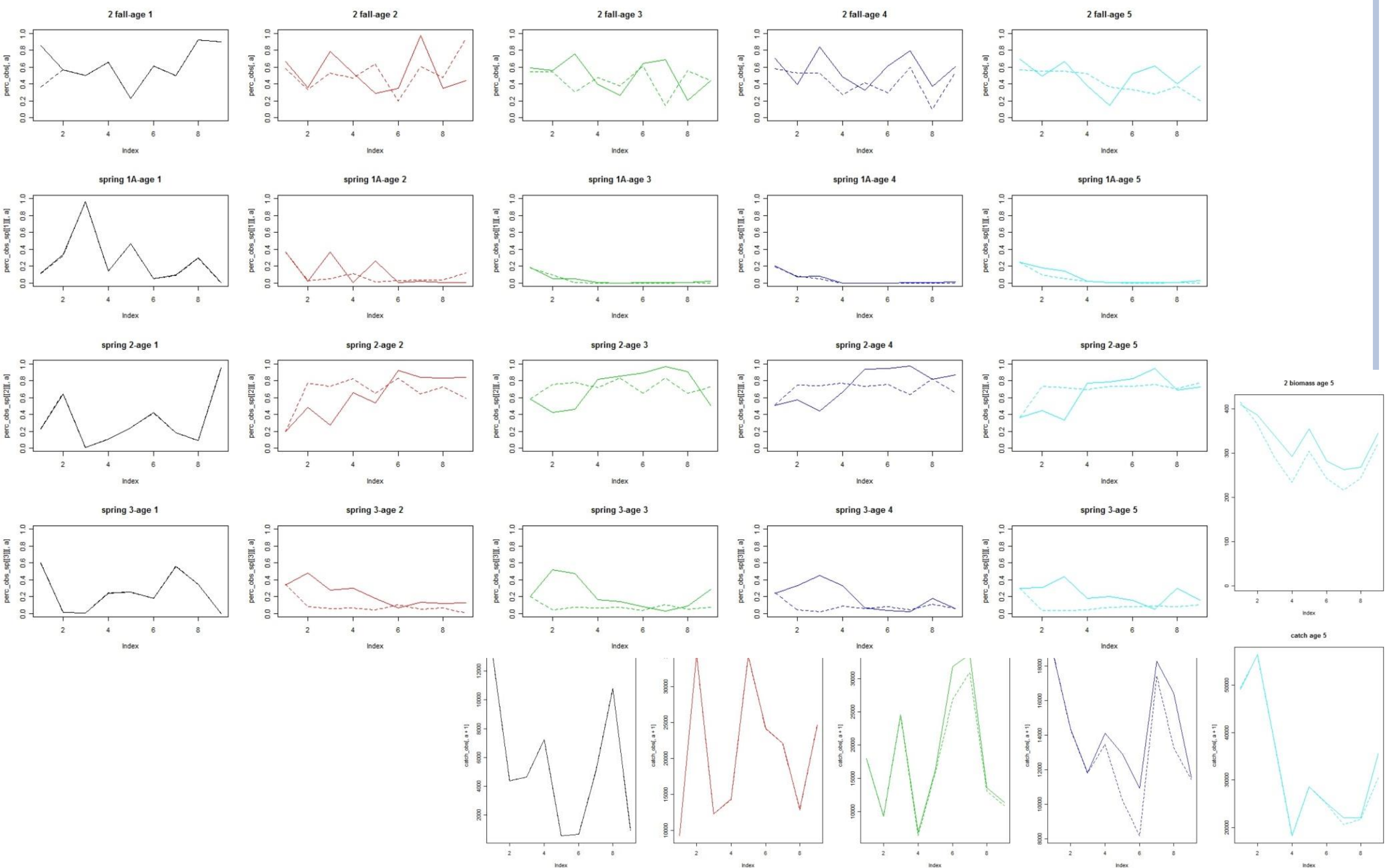
❖ **Plan factoriel optimisé d'ordre 2**

(353 simulations, obtenu avec la fonction optFederov (library r AlgDesign))

Plan complet : 472392 simulations * 12h = 647 ans

Plan optimisé : 353 simulations * 12h = 176 jours

Estimate Parameters: Twin experiment & ensemble run (20) Herring meta-population Gulf of Maine



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Sarah M Glaser[1,2], Michael J Fogarty[3], Hui Liu[4], Irit Altman[5], Chih-Hao Hsieh[6], Les Kaufman[5],

Vol. 533: 47–65, 2015
doi: 10.3354/meps11387 | MARINE ECOLOGY PROGRESS SERIES
Mar Ecol Prog Ser | Published August 6

Modelling the Mediterranean marine ecosystem as a whole: addressing the challenge of complexity

Chiara Piroddi[1,2,*], Marta Coll[2,3,4], Jeroen Steenbeek[4], Diego Macias Moy[1], Villy Christensen[4,5]

FISH and FISHERIES

FISH and FISHERIES, 2016, 17, 101–125

Vol. 253: 1–16, 2003 | MARINE ECOLOGY PROGRESS SERIES
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Effect of complexity on marine ecosystem models

Elizabeth A. Fulton[1,*], Anthony D. M. Smith[1], Craig R. Johnson[2]

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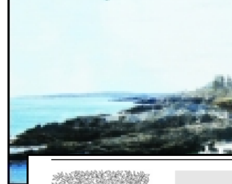
Progress in Oceanography
Volume 84, Issues 1–2, January–February 2010, Pages 121-128

The case for marine ecosystem models of intermediate complexity

Charles Hannah [a], Alain Vezina [a], Mike St. John [b]



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J.S. Link [a,*], T.F. Ihde [b], C.J. Harvey [c], S.K. Gaichas [d], J.C. Field [e], J.K.T. Brodziak [f], H.M. Townsend [b], R.M. Peterman [g]

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KENNETH A. ROSE

Reconciling complex system models and fisheries advice: Practical examples and leads

Sigrid LEHUTA[1,a], Raphaël GIRARDIN[2], Stéphanie MAHÉVAS[1], Morgane TRAVERS-TROLET[2]

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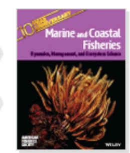

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Volume 9, Issue 1
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Pages 281–295

Making modelling count - increasing the contribution of shelf-seas community and ecosystem models to policy development and management

Kieran Hyder [a,*], Axel G. Rossberg [a], J. Icarus Allen [b], Melanie C. Austen [b], Rosa M. Barciela [c], Hayley J. Bannister [d], Paul G. Blackwell [e], Julia L. Blanchard [d,f], Michael T. Burrows [g], Emma Defriez [h], Tarquin Dorrington [i], Karen P. Edwards [j], Bernardo Garcia-Carreras [a,h]