Ifremer

Indicateurs et analyse qualitative de modèles de communautés exploitées par la pêche

Jeff Dambacher, Dan Gaughan,
Marie-Joëlle Rochet, Phil Rossignol,
& Verena Trenkel

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CSIRO

OSU Oregon State University

Indicateurs

- Utilisation qualitative d'indicateurs (tendances)
- Principes de l'analyse qualitative
- Modèles de communautés exploitées
- Résultats
- Perspectives d'utilisation

	Standard stock advice	Indicator-based advice
Indicators	*B*, *F*	*Z*, ln-*N*, *B*, L_{bar}, $L_{25\%}$, $L_{75\%}$, L_{mat}…
	absolute estimates	**relative variations**
Factors	Fishing mortality	Multiple
Modelling	One mathematical model	Several conceptual models
Outlook	Projection	**Recent trend**
Diagnostic	Reference points	**Reference state / Desirable directions**
Advice	TAC	Type of **change** required

Potential causes of changes in indicators

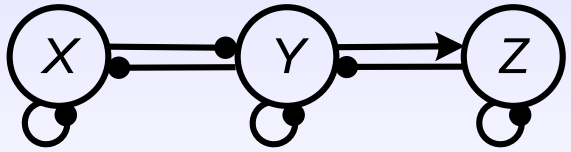
Cause	Z	ln-N	L_{bar}	$L_{25\%}$	$L_{75\%}$
↗ fishing mortality	↗	↘	↘	—	↘
↘ recruitment	—	↘	↗	↗	—
Faster growth	—	—	↗	—	↗
Smaller fish caught	↗	↘	↘	↘	—
?	↘	↘	↗	↗	↘

Modèles dynamiques: matrices de communauté

Graphe signé

Influence positive ⟶

Influence négative —●



Matrice de communauté

$$A = \frac{\partial\left(\frac{dX}{Xdt}\right)}{\partial X} = \begin{bmatrix} -a_{XX} & -a_{XY} & 0 \\ -a_{YX} & -a_{YY} & -a_{YZ} \\ 0 & a_{ZY} & -a_{ZZ} \end{bmatrix}$$

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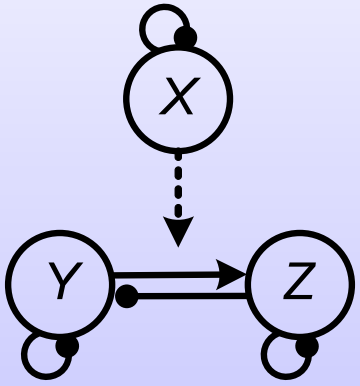

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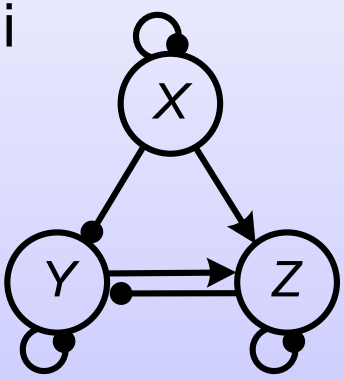


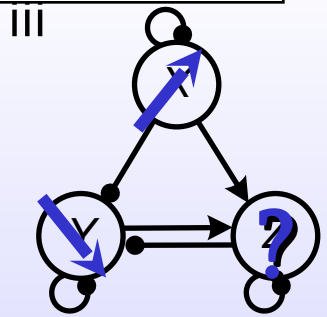
$$\begin{bmatrix} -a_{XX} & 0 & 0 \\ -a_{YX} & -a_{YY} & -a_{YZ} \\ a_{ZX} & a_{ZY} & -a_{ZZ} \end{bmatrix}$$

Analyses

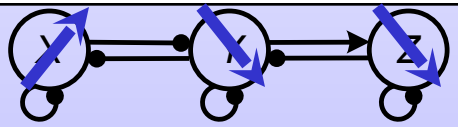
- Equilibre et stabilité
  - Déterminants de Hurwitz de la matrice de communauté
- Analyse de perturbation

$$\frac{\mathrm{d}\mathbf{N}^*}{\mathrm{d}p_h} = -\mathbf{A}^{-1}\frac{\partial \mathbf{g}}{\partial p_h}.$$

$$\mathrm{d}\mathbf{N}^* = \underbrace{\frac{1}{\det(-\mathbf{A})}}_{\text{overall feedback}} \times \underbrace{\mathrm{adj}(-\mathbf{A})}_{\text{complementary feedback}} \times \underbrace{\frac{\partial \mathbf{g}}{\partial p_h}\mathrm{d}p_h}_{\text{strength of input or press perturbation}}$$



$$-\mathbf{A}^{-1} = \frac{1}{\det(-\mathbf{A})}\mathrm{adj}(-\mathbf{A})$$

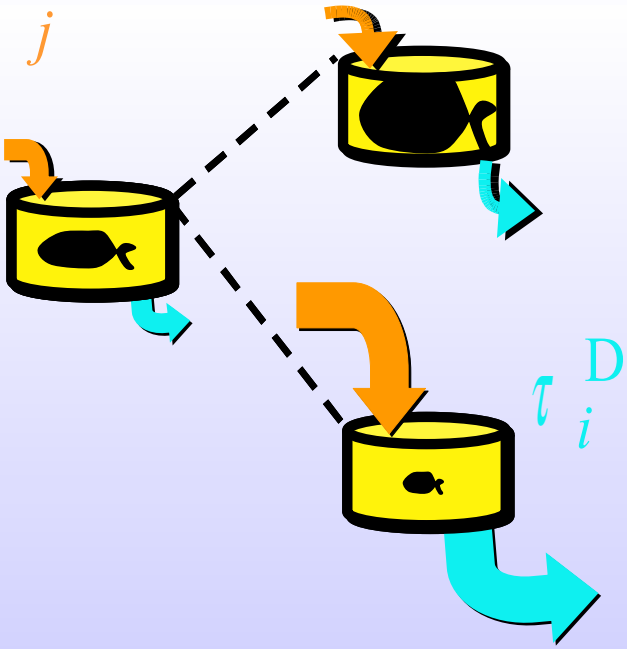


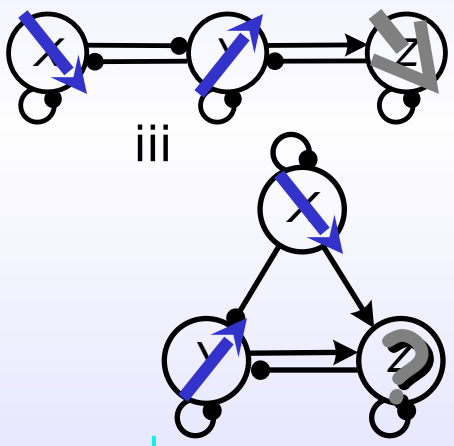
Analyse de l'espérance de vie

$$\left.\frac{dN_i}{N_i dt}\right|_{N^*} = \tau_i^B - \tau_i^D = 0$$

$$\operatorname{sgn}\Delta E^{B,D} = \operatorname{sgn}\left[-\mathbf{A}^{|D|,B}\operatorname{adj}(-\mathbf{A})\right]$$

$$\tau_i^B = \sum_j a_{ij}^{(\operatorname{sgn}+)} N_j^* + \beta_i + \iota_i$$

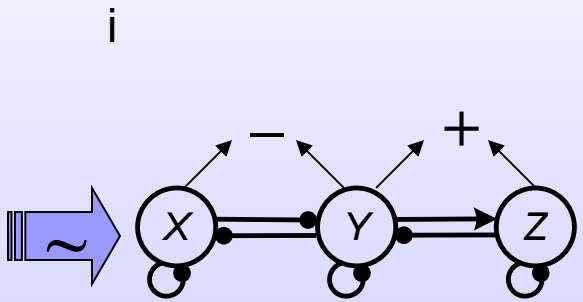


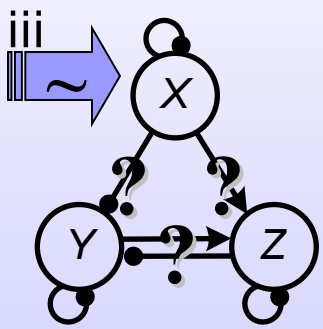


$$\tau_i^D = \sum_j \left|a_{ij}^{(\operatorname{sgn}-)} N_j^*\right| + \left|\delta_i\right| + \left|\varepsilon_i\right|$$

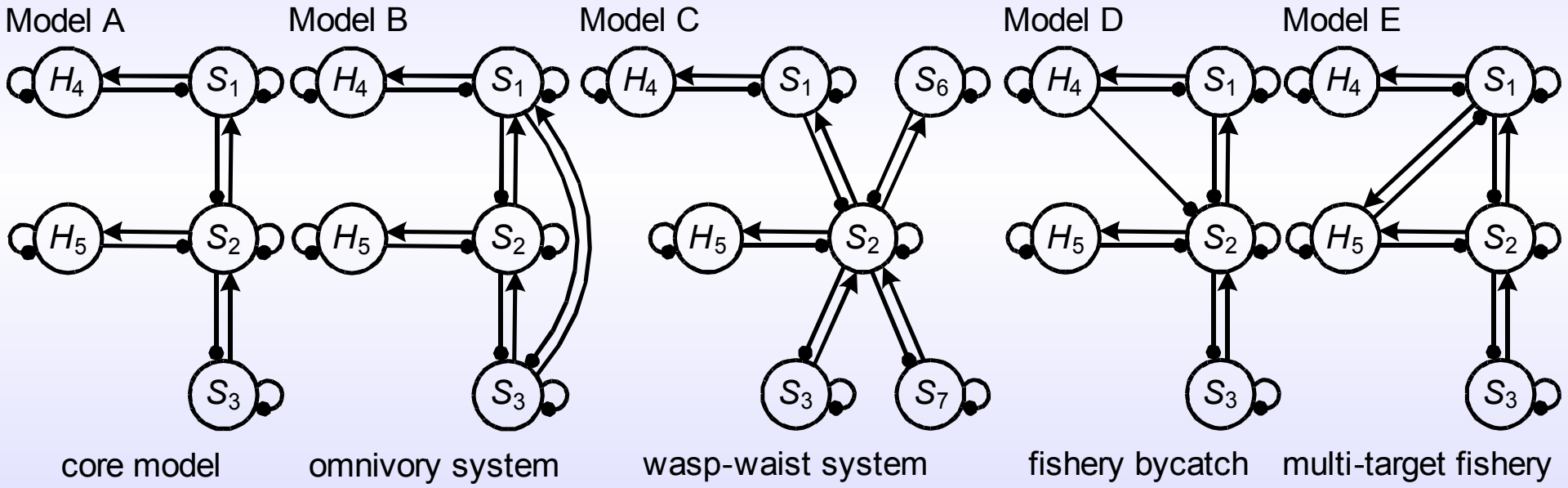
Analyse de covariance

- Changements aléatoires bornés
- Trop rapides pour atteindre l'équilibre
- Technique de la moyenne temporelle: prédiction des covariances



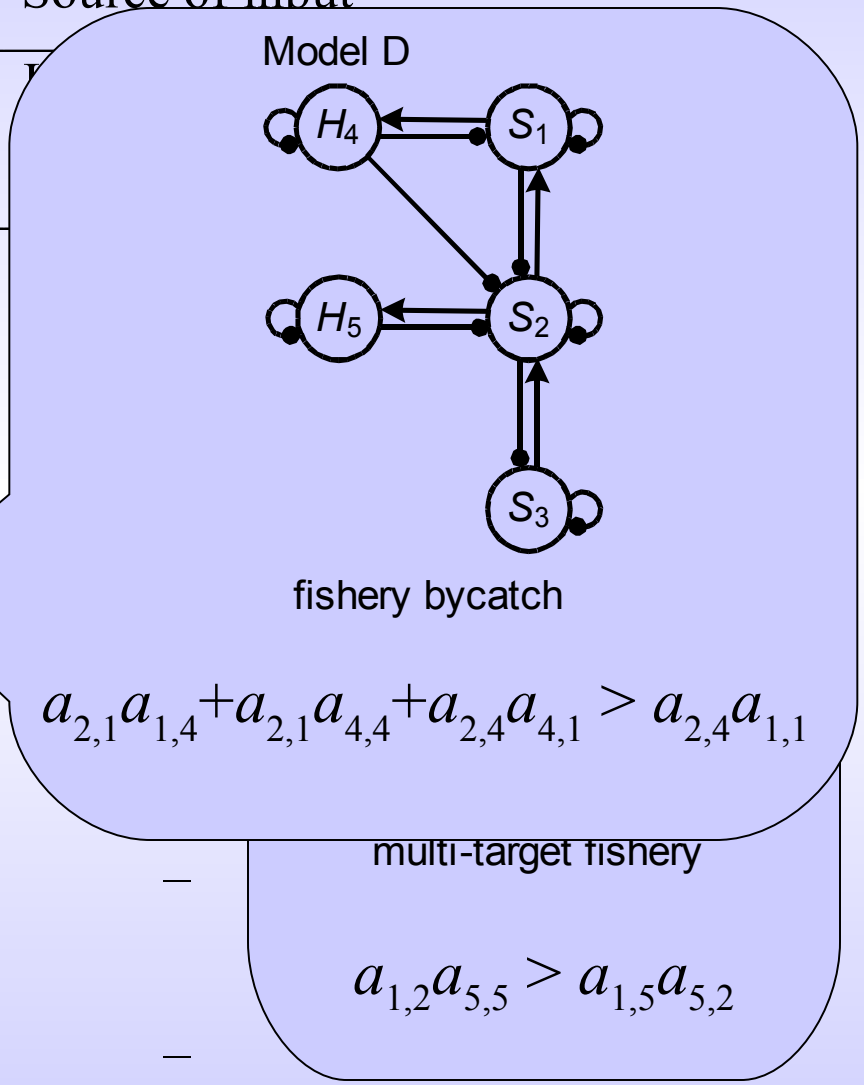


Communautés exploitées



Résultat (1): Combinaisons uniques de variations des indicateurs selon la source de perturbation

Response/ variable	Source of input: Increased q of S_1 by H_4	[illegible]	[illegible]
Abundance			
S_1	–		
S_2	+		
	D^{c*}		
Life expectancy			
S_1	–	–	
	B^{f*}, D^{c*}		
S_2	+	–	
	B^{g}, D^{c*}	E^{h*}	E^{e}



Résultat (2): Signe des covariances entre variables

ovariance	Source of stochastic input		
	S_1's survival	S_3's productivity	H_5's effort
S_1 & S_2	– A, C	+ A, C	+ A, C
S_1 & H_4	+ A–E	+ A–E	+ A–C, E
S_2 & H_5	+ A–D	+ A–D	– A–D

Applications
1 – Validation empirique

	Top species (1)		
	$L \nearrow$	$L \leftrightarrow$	$L \searrow$
$N \nearrow$	$F_1 \searrow$ / $F_2 \nearrow$	?	$P \nearrow$
$N \leftrightarrow$	$g \nearrow$	No change	$g \searrow$
$N \searrow$	$P \searrow$	?	$F_1 \nearrow$ / $F_2 \searrow$

?

14 écosystèmes / campagnes de chalutage de fond
3 métriques d'abondance / 5 métriques de longueur
Niveaux population / groupe fonctionnel

Applications
2 – Interprétation des indicateurs

	Top species (1)		
	$L \nearrow$	$L \leftrightarrow$	$L \searrow$
$N \nearrow$	$F_1 \searrow$	?	$F_2 \searrow$ / $P \nearrow$
$N \leftrightarrow$	$g \nearrow$	No change	$g \searrow$
$N \searrow$	$F_2 \nearrow$ / $P \searrow$	?	$F_1 \nearrow$

	Middle species (2)		
	$L \nearrow$	$L \leftrightarrow$	$L \searrow$
$N \nearrow$	$F_1 \searrow$ / $F_2 \nearrow$	?	$P \nearrow$
$N \leftrightarrow$	$g \nearrow$	No change	$g \searrow$
$N \searrow$	$P \searrow$	?	$F_1 \nearrow$ / $F_2 \searrow$