Restauration de la population de corégones du lac du Bourget : analyse historique

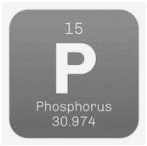
Chloé GOULON, Emilien LASNE, Orlane ANNEVILLE, Rosalie BRUEL, Isabelle DOMAIZON, Sébastien CACHERA, Alexis CHAMPIGNEULLE, Jean GUILLARD

Corégones (*Coregonus* sp)

- Salmonidés essentiellement lacustres
- Sténothermes d'eau froide, oxyphiles
- Très polymorphes

- Espèce européenne : *Coregonus lavaretus*
- Espèce menacée (Annexe 2 de la convention de Berne)

THE IUCN RED LIST
OF THREATENED SPECIES™



Eutrophisation

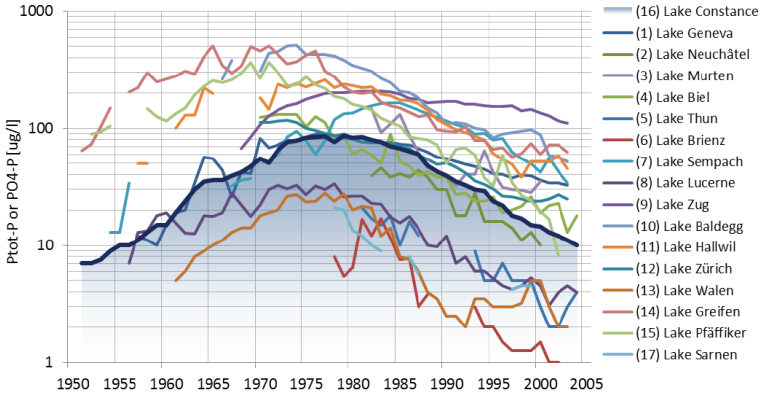
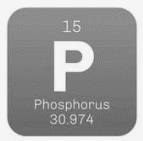


Figure S1 | Change in phosphorus concentrations through time. 50 year trends in phosphorus concentration [µg/l] during lake overturning from 17 lakes included in this study. Lake numbering corresponds to the numbering of Fig. 1 in the main paper.

Volanthen et al., 2012

Dynamique des populations



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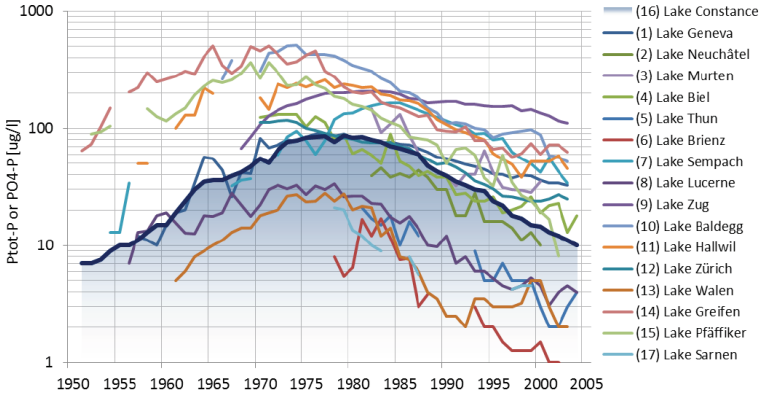

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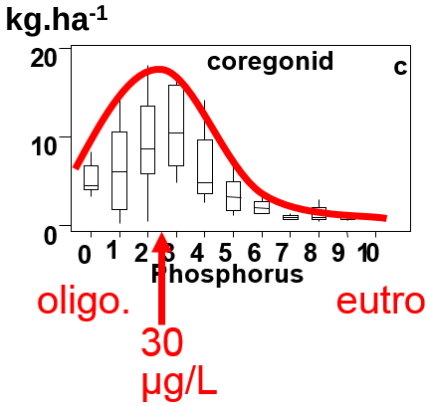
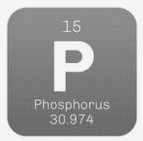


Gerdeaux et al., 2006



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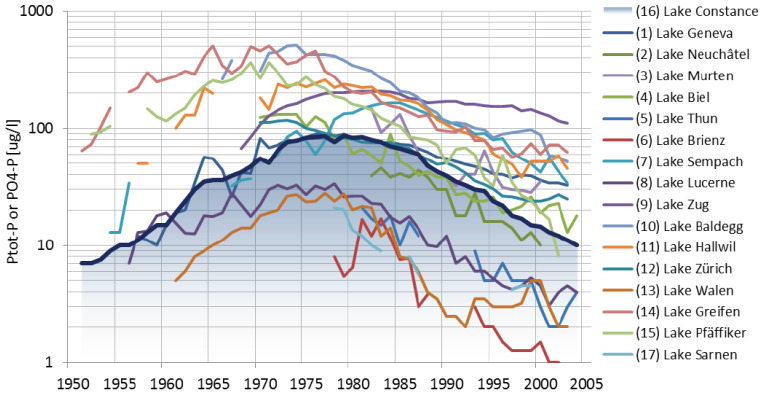

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Dynamique des populations

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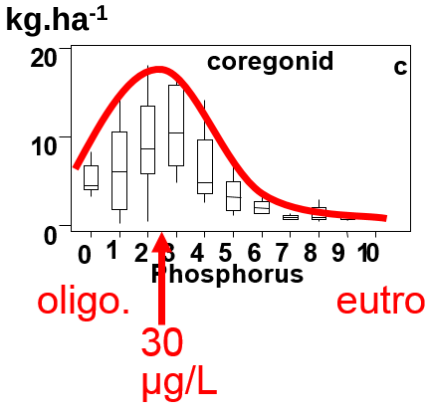

Gerdeaux et al., 2006

15
P
Phosphorus
30.974

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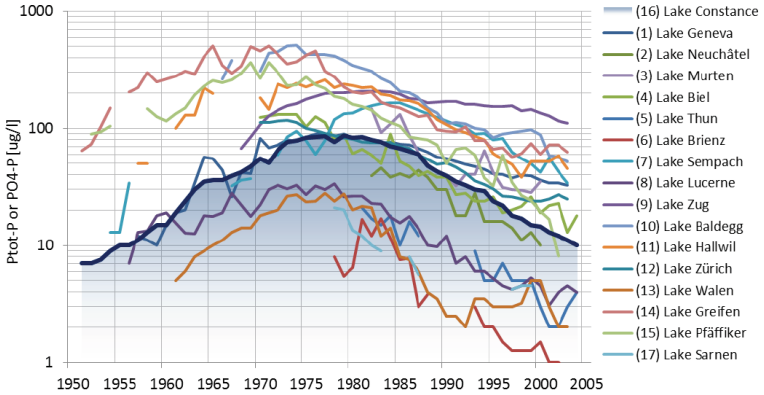

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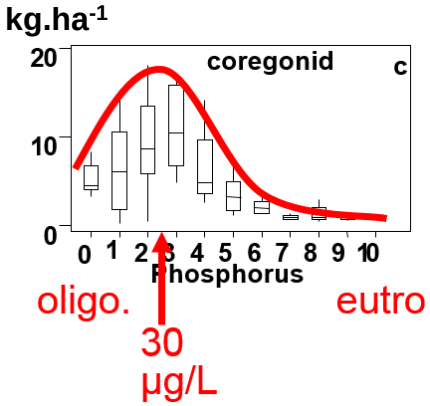

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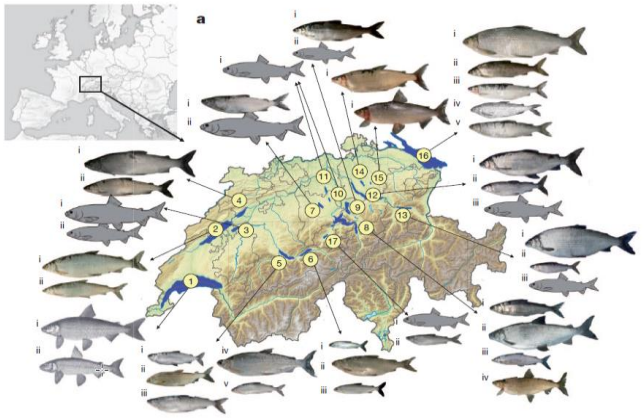
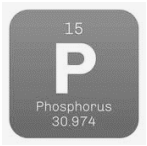


Figure 1 | Distribution of historical whitefish diversity and recent diversity loss. **a,** Whitefish species diversity in Swiss lakes (numbered as in Table 1, fish are named in Supplementary Information; for details of taxonomy see quantification of whitefish diversities in Supplementary Information). **b,** Species richness change in 17 lakes. **c,** Functional diversity change in 16 lakes.

Volanthen et al., 2012



Pratiques de gestion

Dynamique des populations

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Pratiques de gestion

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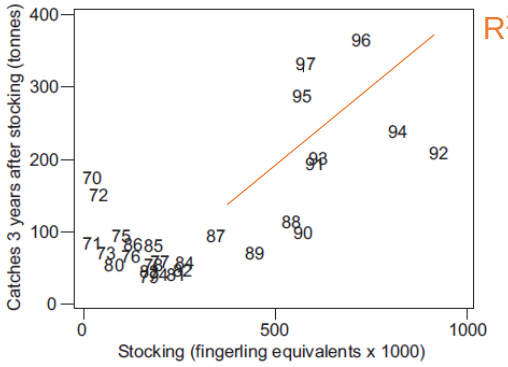

R^2=0.62, p< 0.02

Fig. 6. Relation between stocking and catches 3 years after stocking in Lake Geneva.

Gerdeaux et al., 2004

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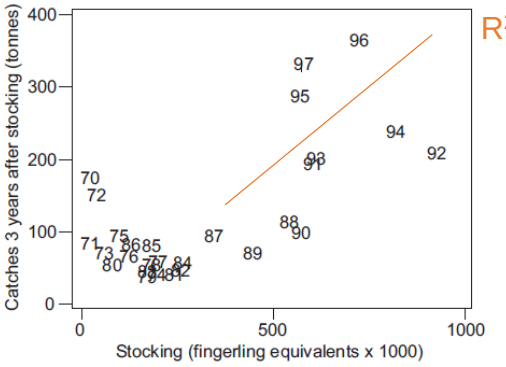

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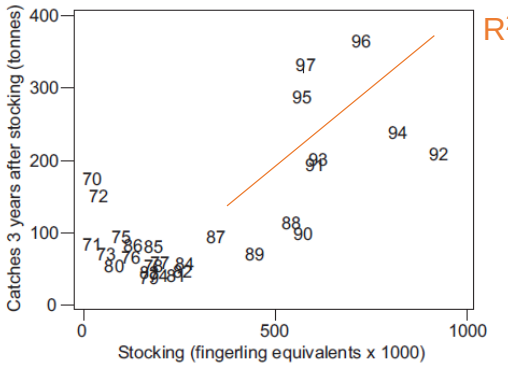

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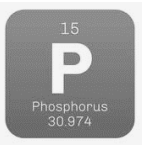
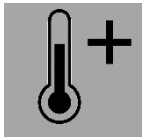
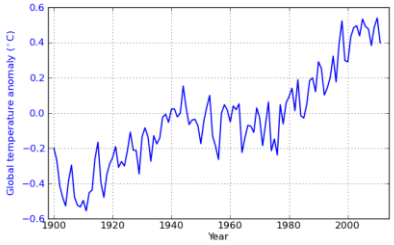
Orlane Anneville[1*], Emilien Lasne[1], Jean Guillard[1], Reiner Eckmann[2], Jason D. Stockwell[3], Christian Gillet[1], Daniel L. Yule[4]





Changement climatique



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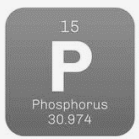

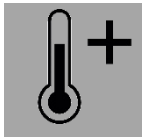

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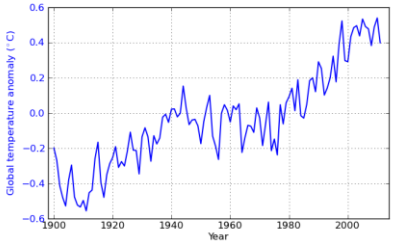

Dynamique des populations

Fisheries Management and Ecology, 2009, **16**, 492–500

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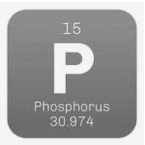

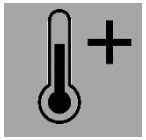

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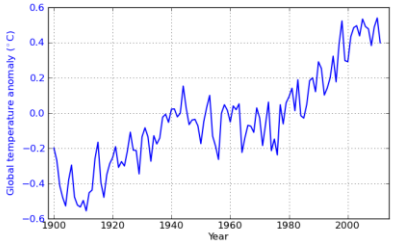

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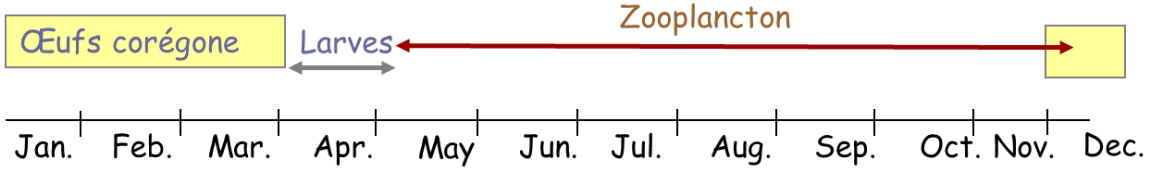

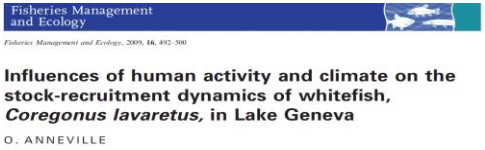

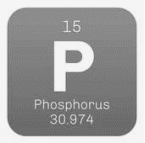

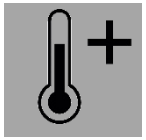

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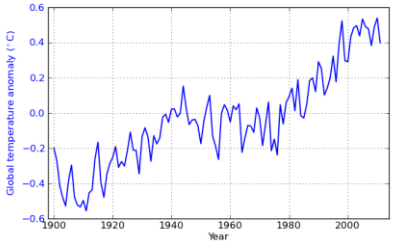

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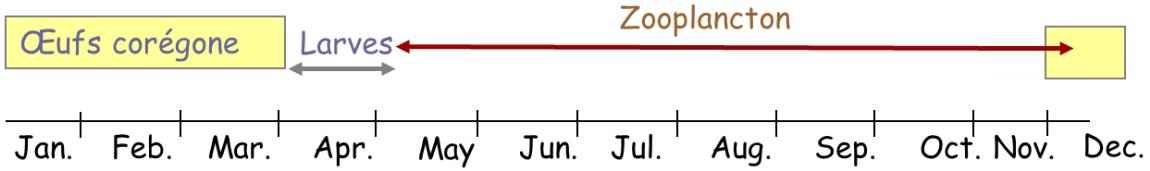

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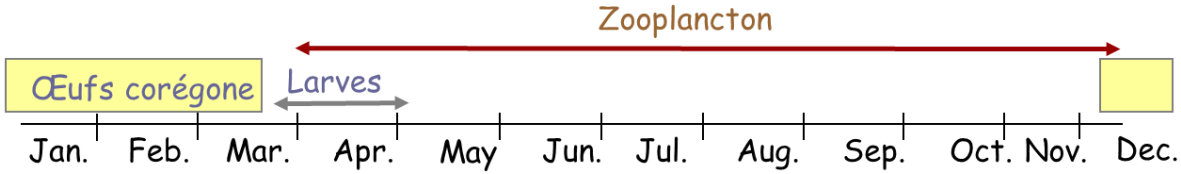

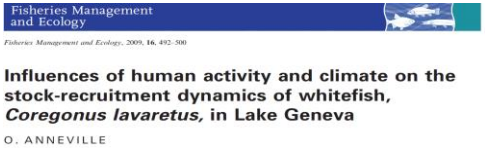
Fisheries Management and Ecology

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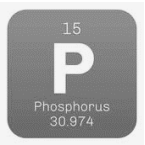

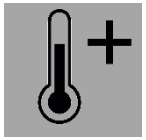

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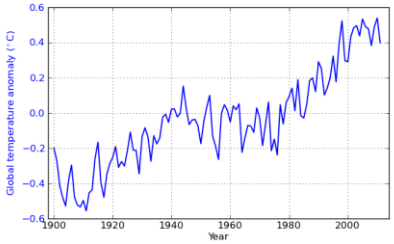

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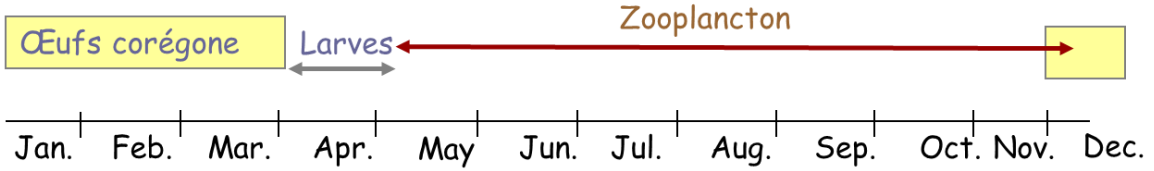

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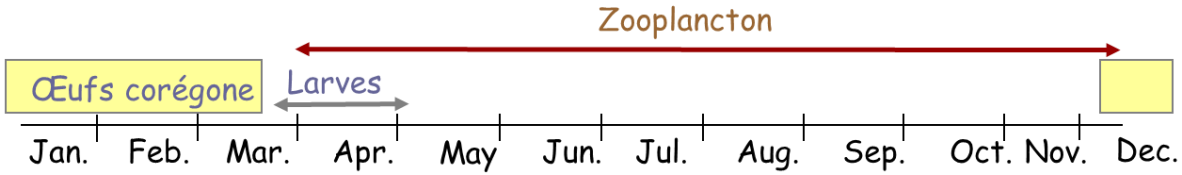
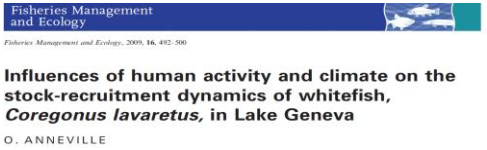
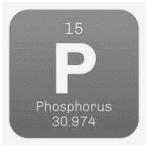
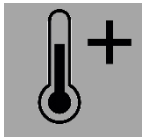




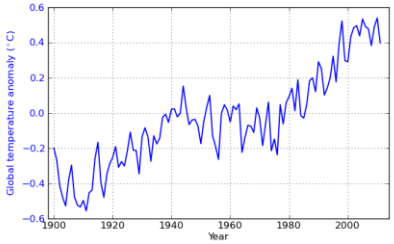
Meilleur synchronisme entre éclosion et développement zooplanctonique

+ Effet direct de la température sur vitesse de croissance





Changement climatique



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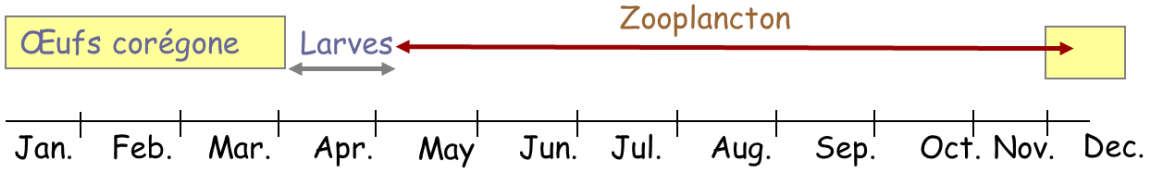

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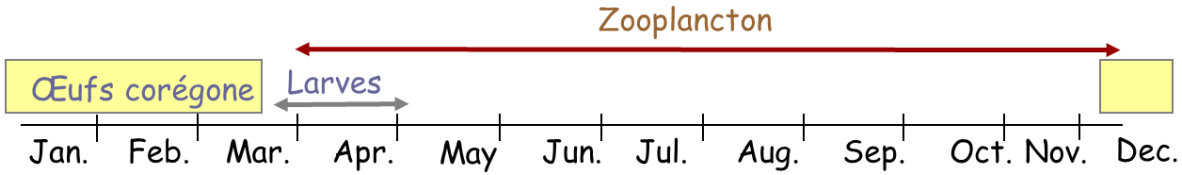

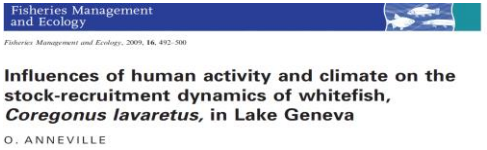

Meilleur synchronisme entre éclosion et développement zooplanctonique

Moins sensibles à la prédation et cannibalisme

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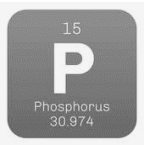

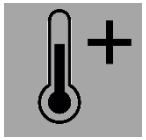

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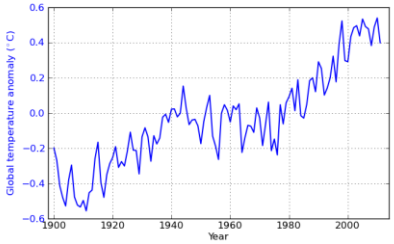

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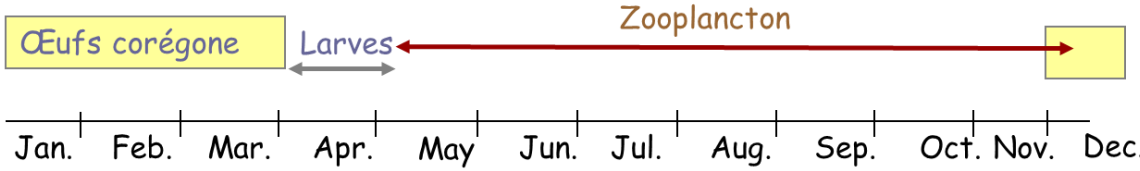

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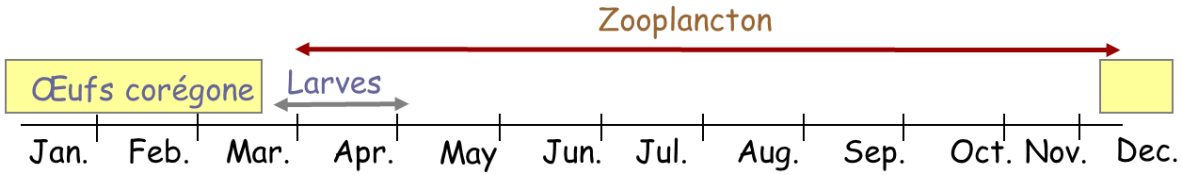
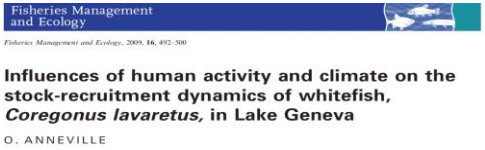
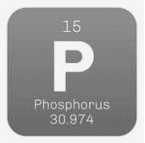
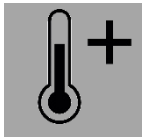




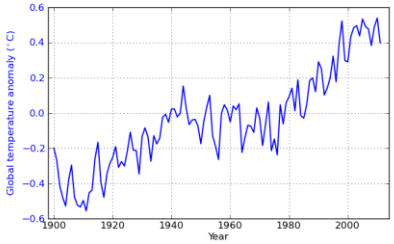
- Meilleur synchronisme entre éclosion et développement zooplanctonique
- Moins sensibles à la prédation et cannibalisme
- Recrutement plus efficace

+ Effet direct de la température sur vitesse de croissance



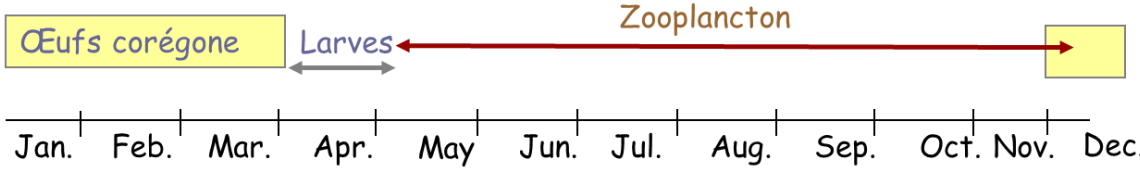


Changement climatique

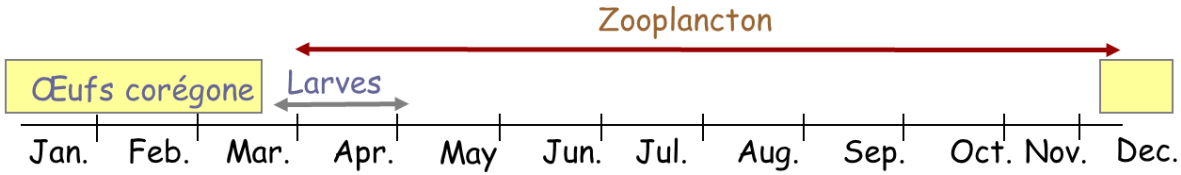


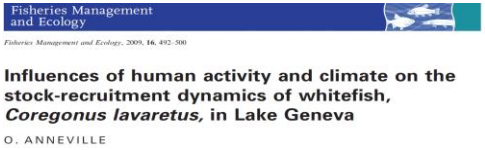
Dynamique des populations

Années froides (1970's-1980's):



Années chaudes (1990's):





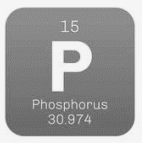
Meilleur synchronisme entre éclosion et développement zooplanctonique

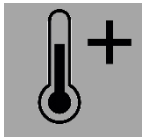
+ Effet direct de la température sur vitesse de croissance

Moins sensibles à la prédation et cannibalisme

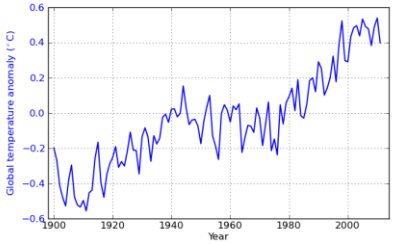
Recrutement plus efficace

Augmentation du stock

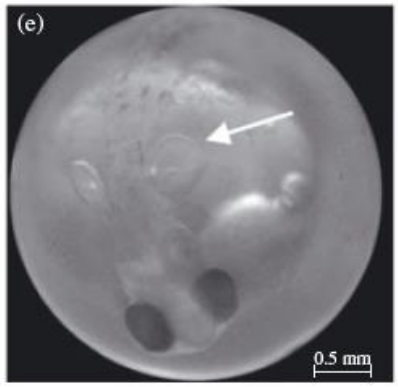


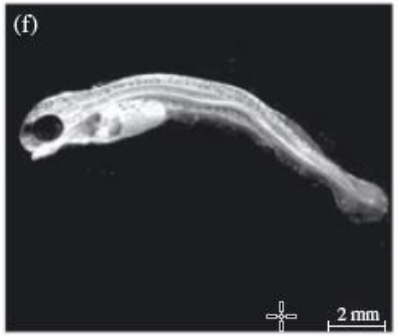


Changement climatique

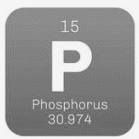


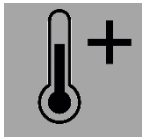
Dynamique des populations



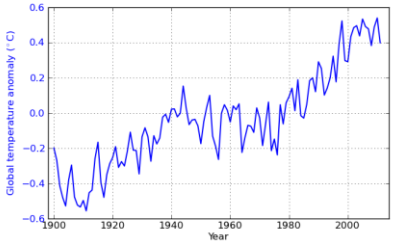


Cingi et al., 2010



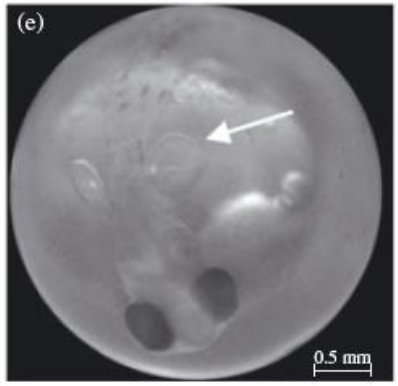


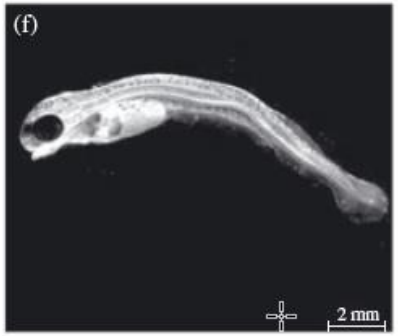
Changement climatique



Dynamique des populations

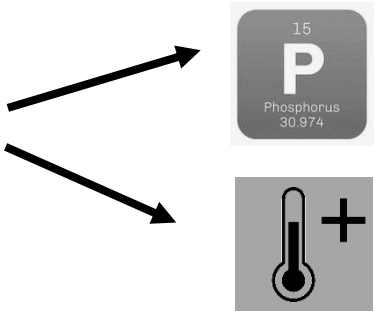
Diversité

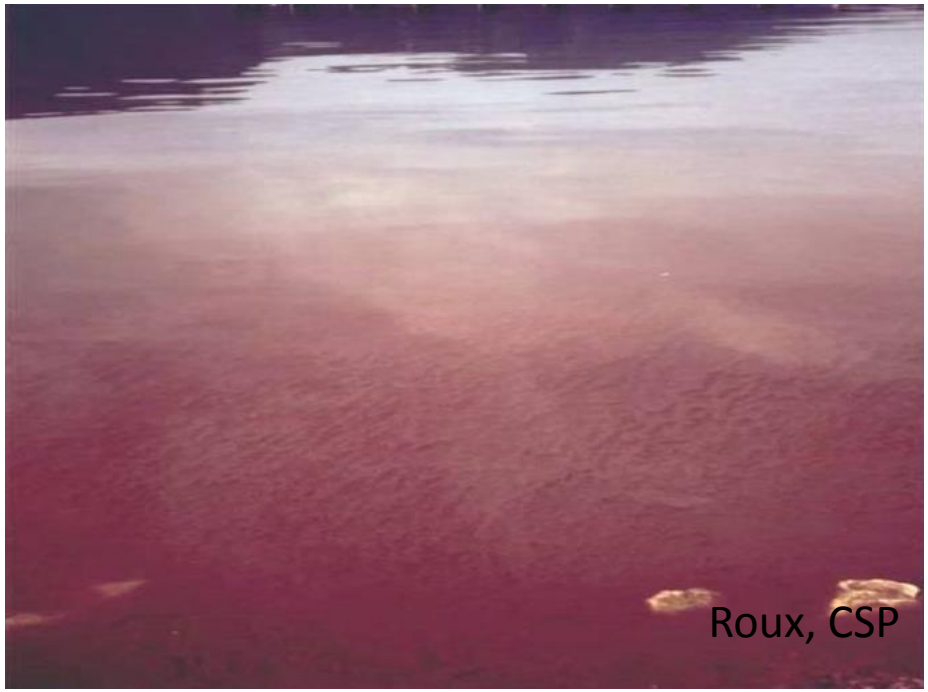




Cingi et al., 2010

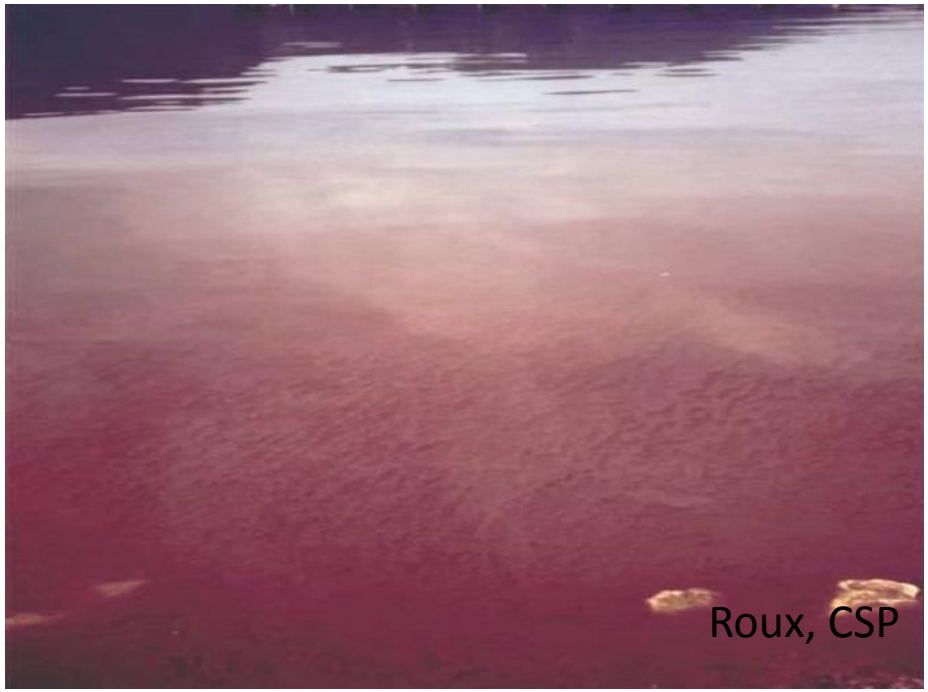
Planktothrix rubescens





Bloom de Planktothrix rubescens, lac du Bourget, 2001

Planktothrix rubescens



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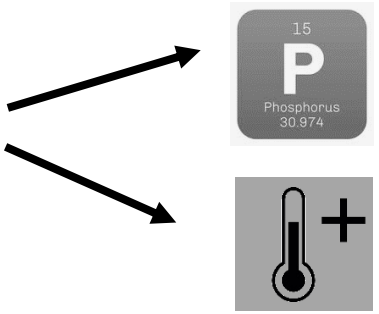
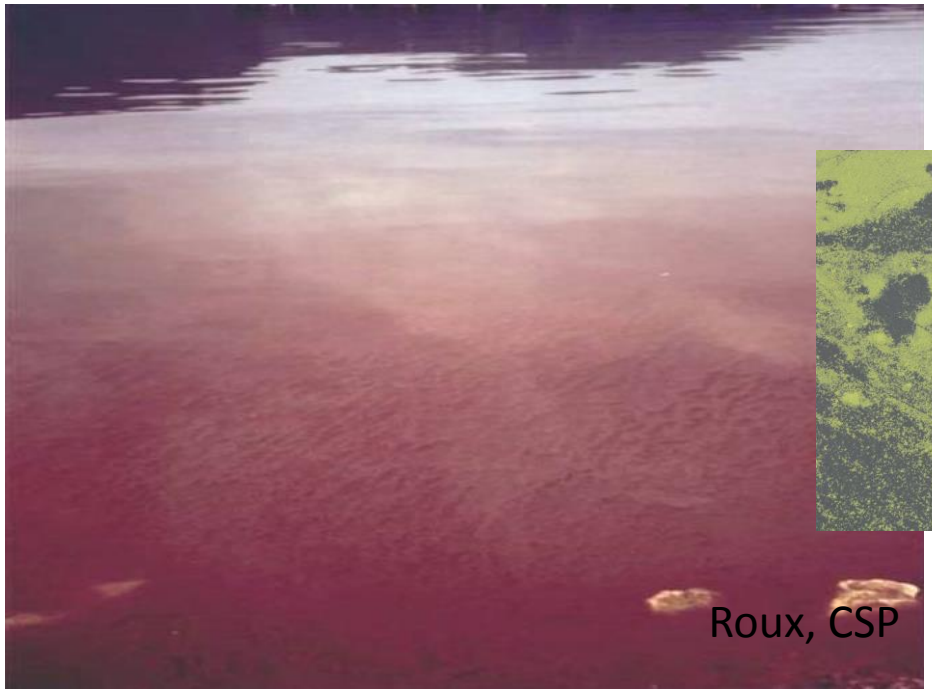
Dynamique des populations

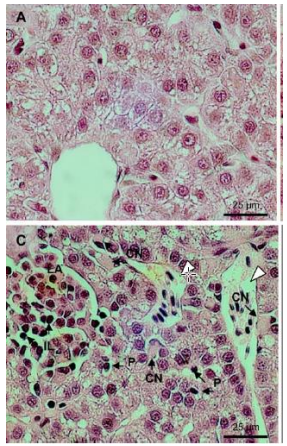
Planktothrix rubescens





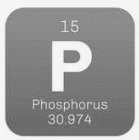
Roux, CSP

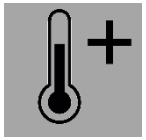
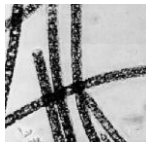
Dynamique des populations



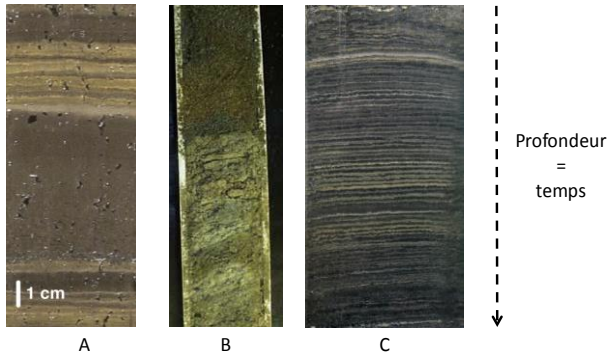
Ernst et al., 2006

Bloom de Planktothrix rubescens, lac du Bourget, 2001



Quel est le rôle joué par les forçages environnementaux dans la dynamique des populations de corégones ?



Le lac du Bourget

Géographie	
Type	Naturel
Superficie	44,5 km^2
Longueur	18 km
Largeur	3,5 km
Altitude	231,5 m
Profondeur	
· Maximale	145 m
· Moyenne	85 m
Volume	3,6 km^3

Le lac du Bourget

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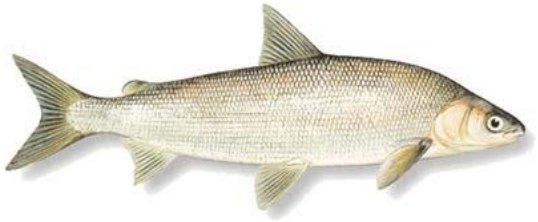
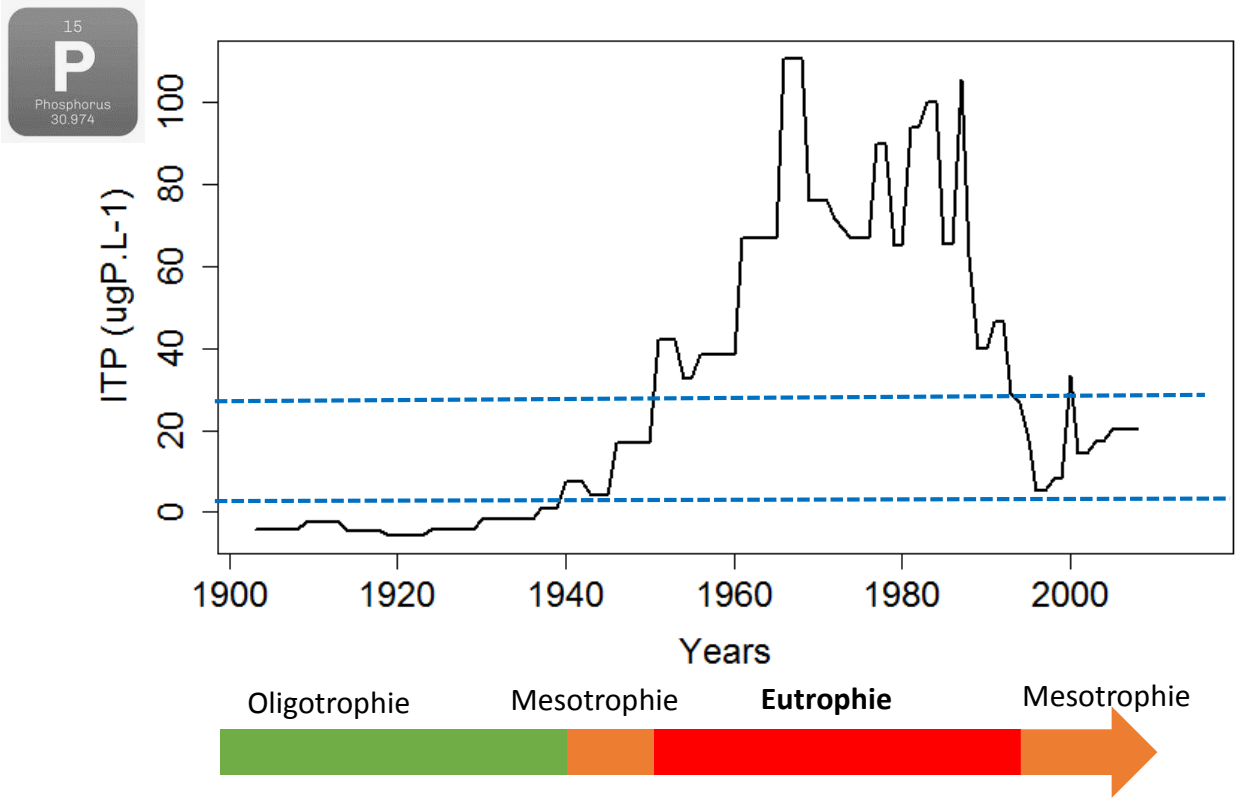
Le lavaret (*Coregonus lavaretus*)

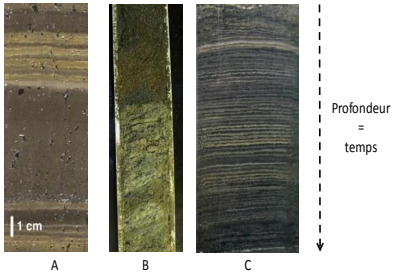


Intérêt scientifique et patrimonial	
Origine	Autochtone du lac du Bourget
Répartition	En limite sud

Exploitation
Principale espèce d'intérêt (pêche professionnelle et amateur)

Historique

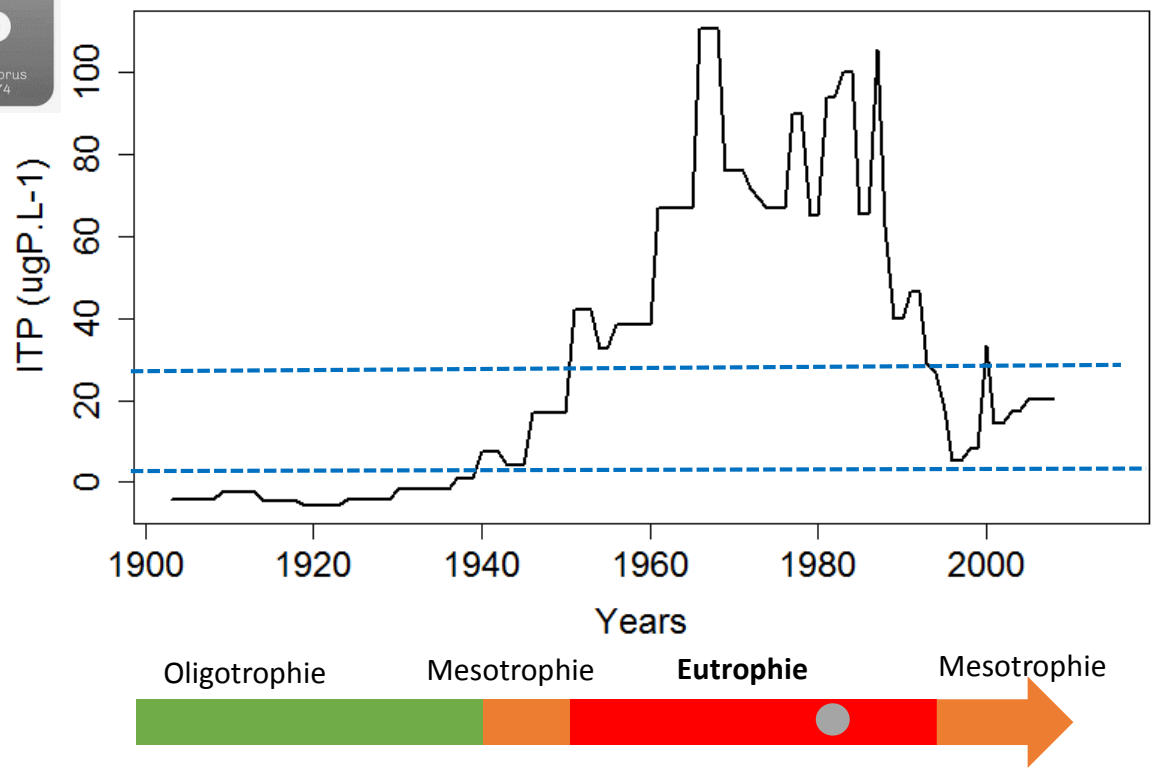




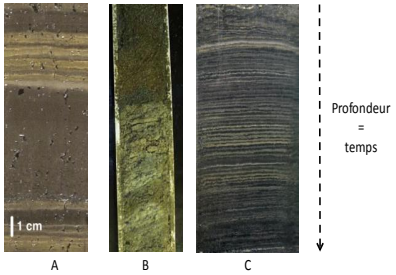
Berthon et al. 2013

Historique

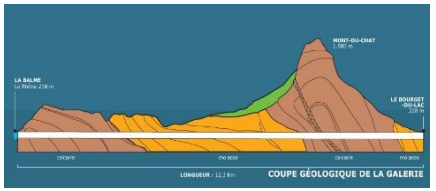
15
P
Phosphorus
30.974



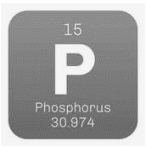
Travaux assainissement



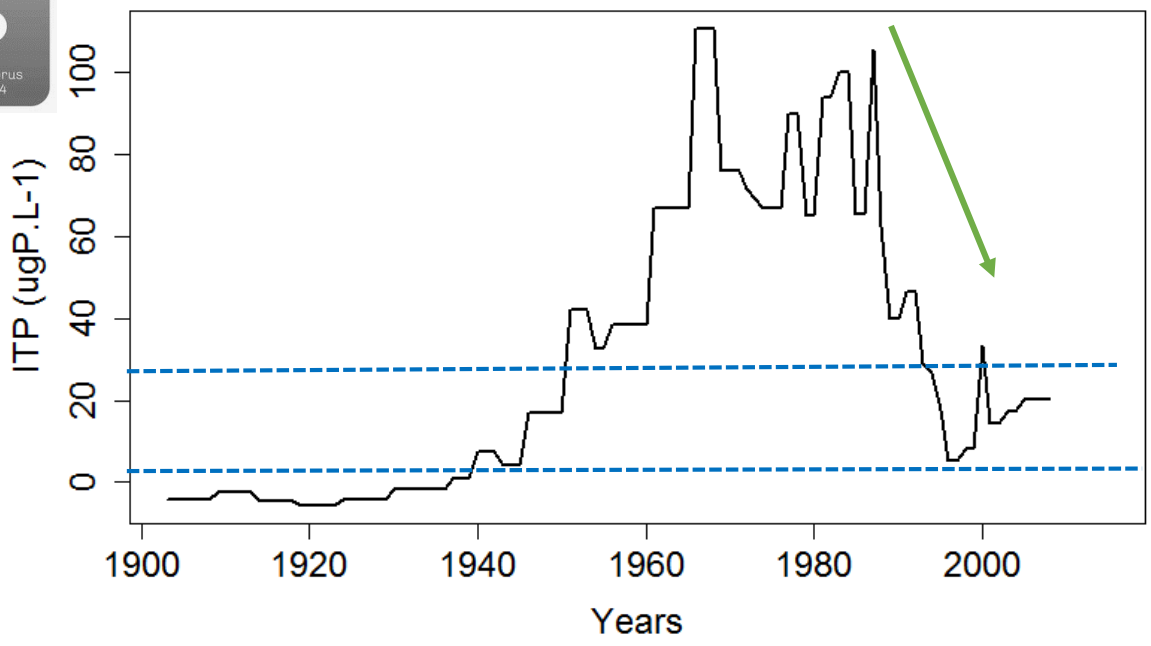
Berthon et al. 2013

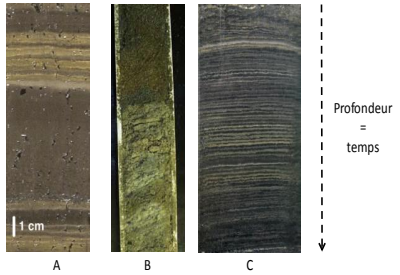


Historique

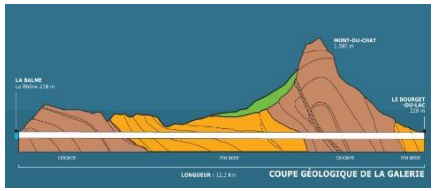


Reoligotrophisation





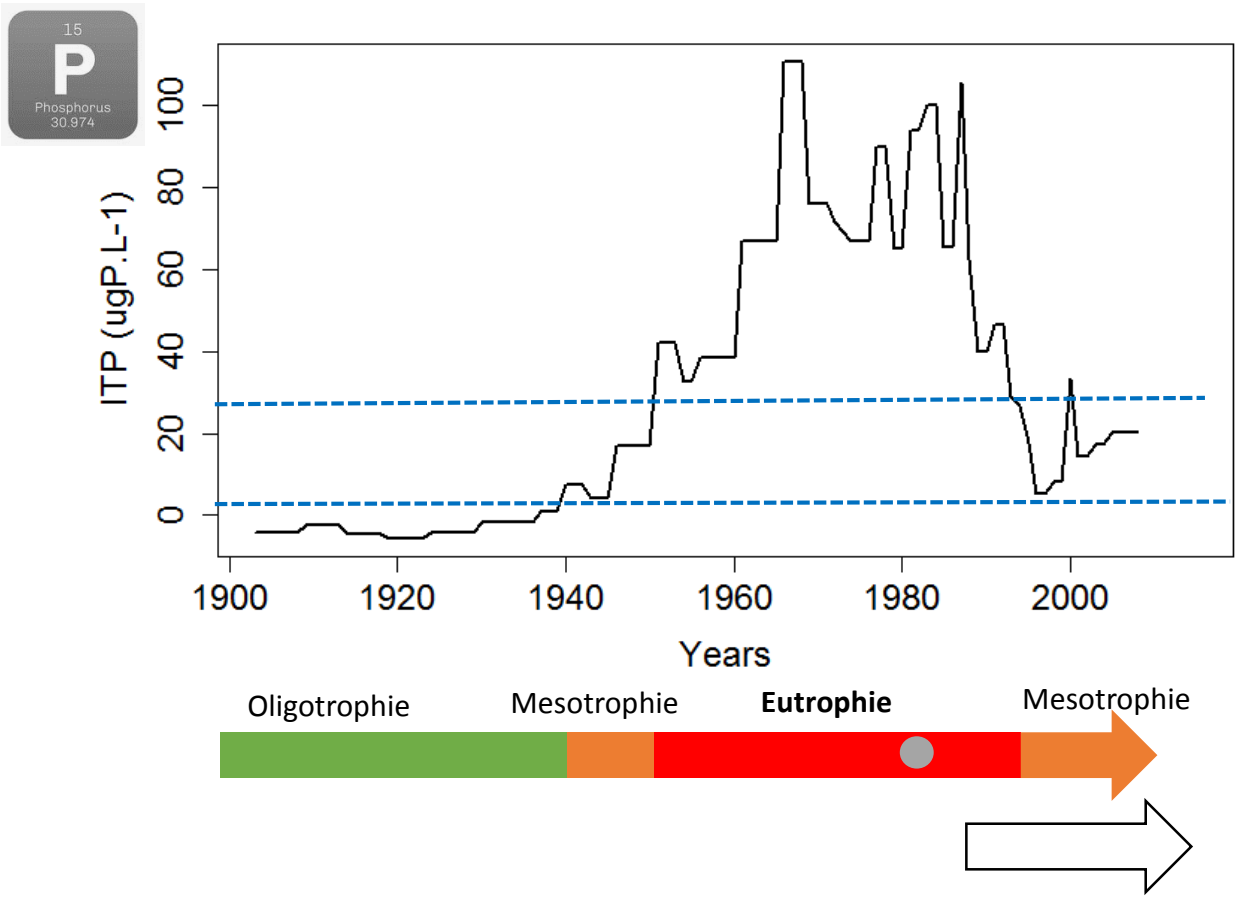
Berthon et al. 2013



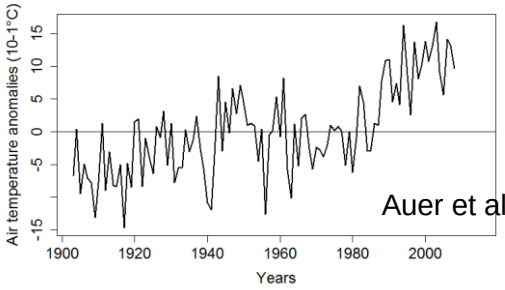
Oligotrophie Mesotrophie **Eutrophie** Mesotrophie

Travaux assainissement

Historique

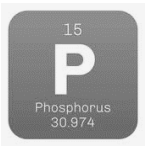


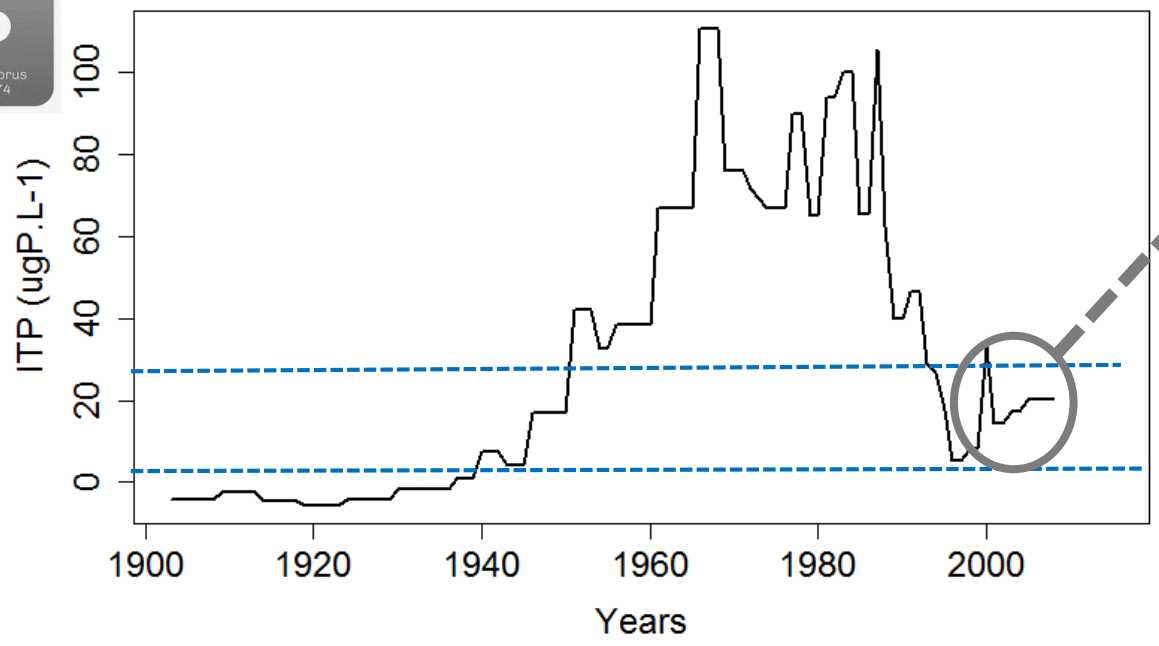
Changement climatique

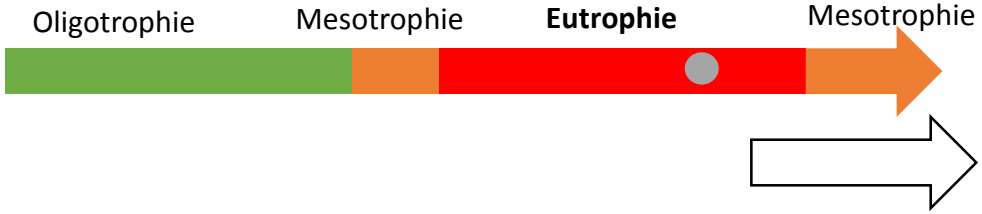


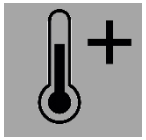
Auer et al., 2007

Historique

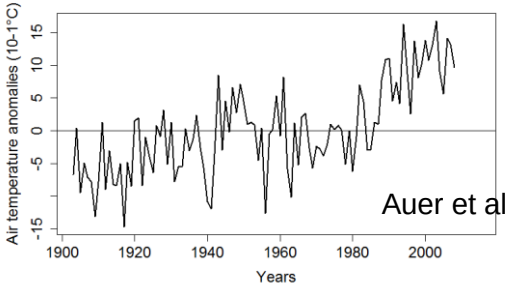






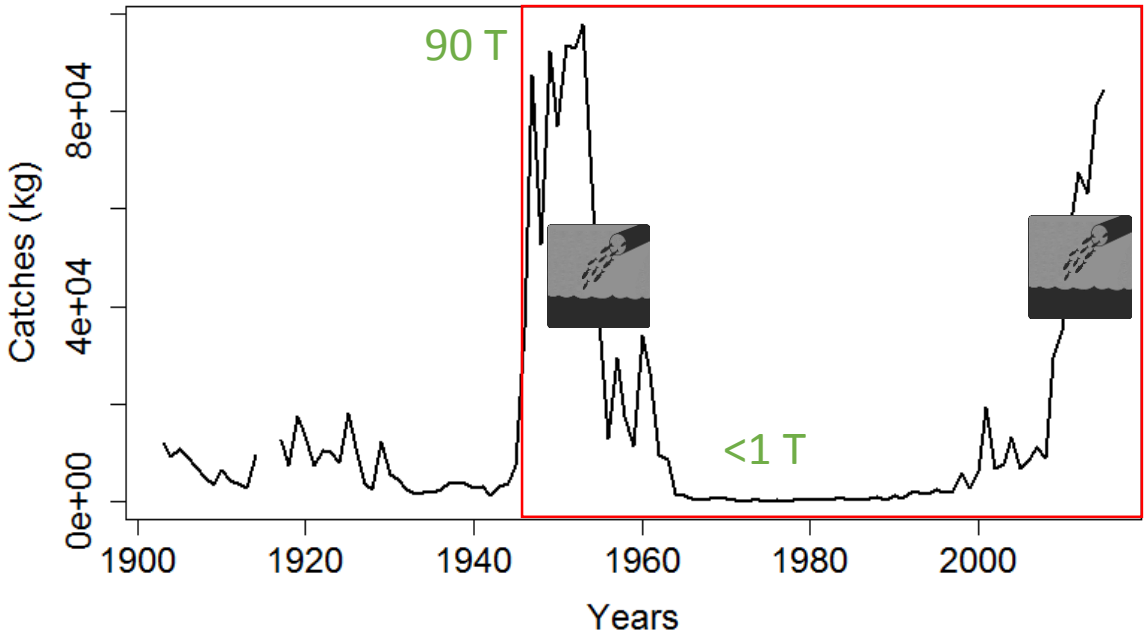


Changement climatique

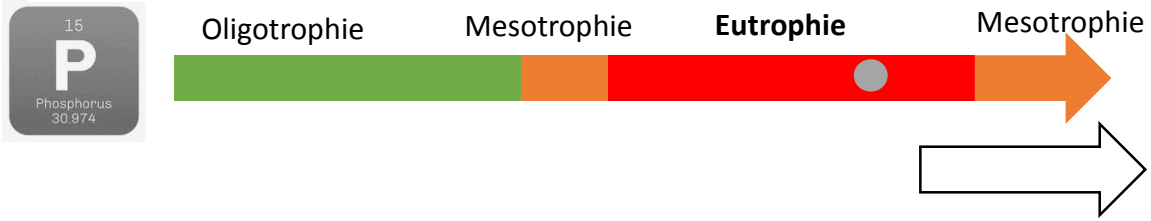


Auer et al., 2007

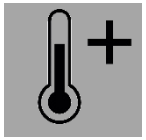
Historique

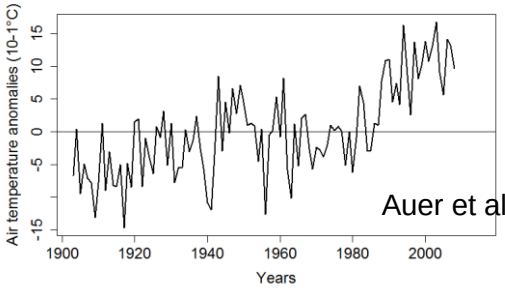


Période d'étude



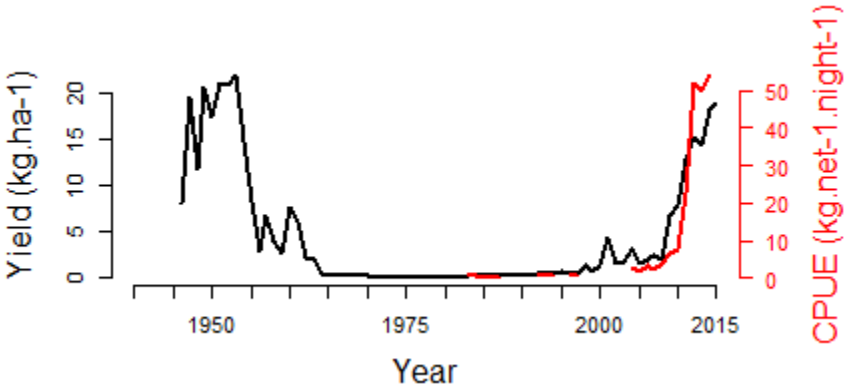
Changement climatique



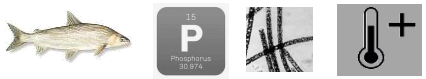


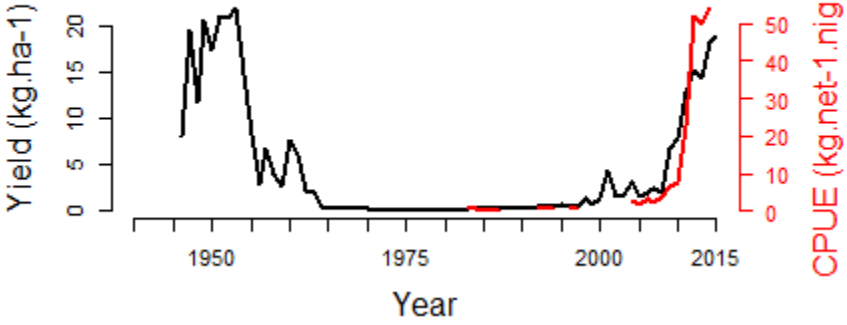
Auer et al., 2007

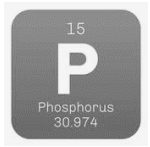
Entrées


Yield (kg.ha-1)
0
5
10
15
20
1950
1975
2000
2015
Year
CPUE (kg.net-1.night-1)
0
10
20
30
40
50

Entrées




Yield (kg.ha-1)
0
5
10
15
20
1950
1975
2000
2015
Year
CPUE (kg.net-1.night-1)
0
10
20
30
40
50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Phosphorus
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ITP
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80
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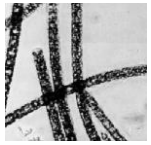

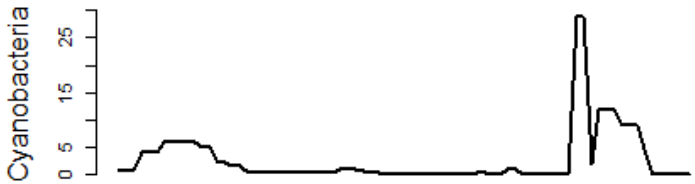
Cyanobacteria
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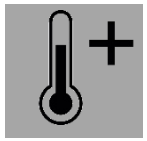
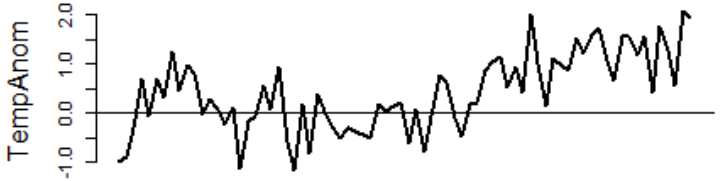
5
15
25

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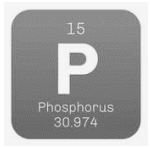
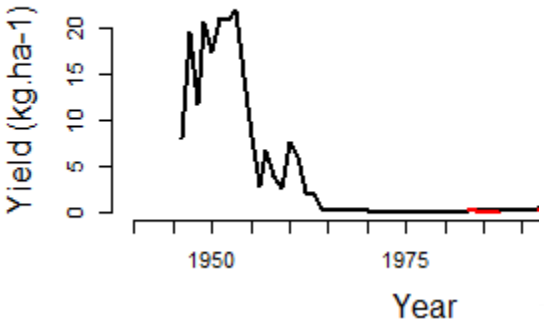
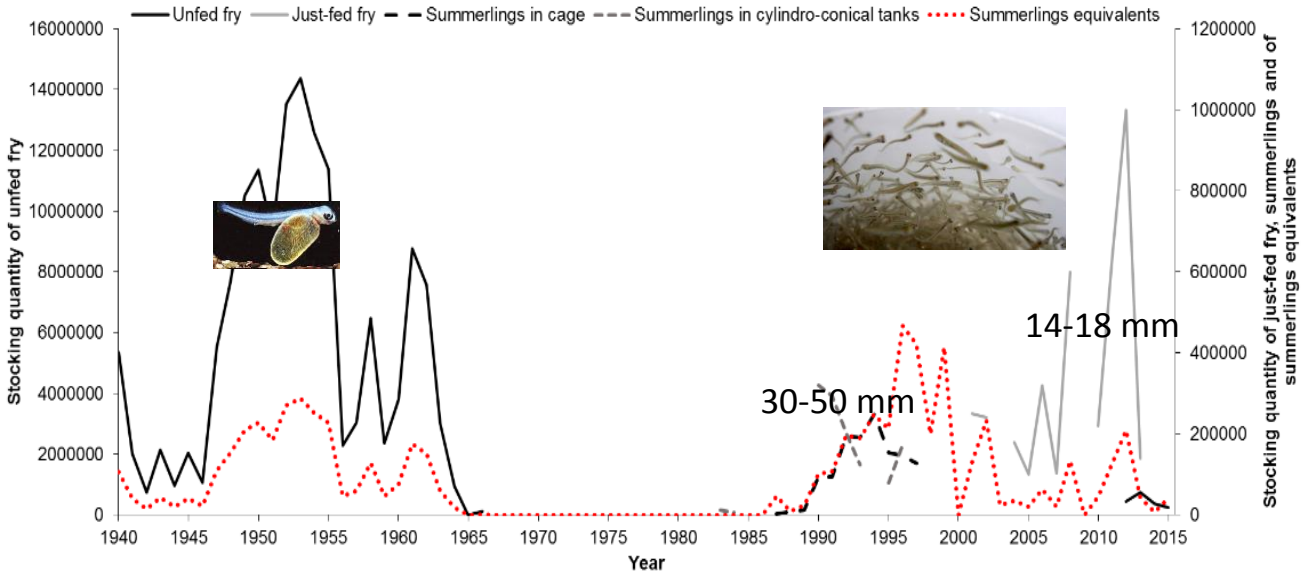
Entrées





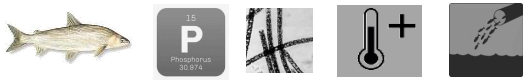


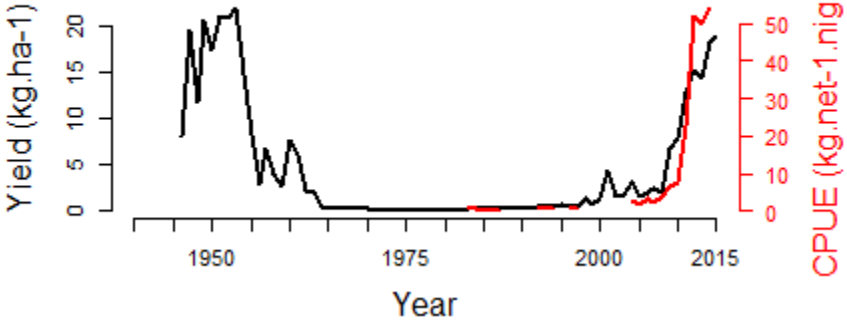


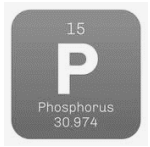


Pratiques d'alevinage pendant la période étudiée. En rouge, la courbe d'équivalents préestivaux : 1 préestival= 5 alevins démarrés = 50 alevins vesiculés (Vilajen, 1988, Champigneulle et Gerdeaux, 2006, Champigneulle et Cachera, 2008)

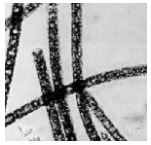
Entrées

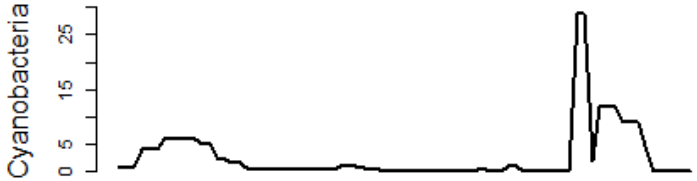


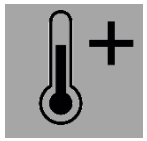

Yield (kg.ha-1)
0
5
10
15
20
CPUE (kg.net-1.night-1)
0
10
20
30
40
50
1950
1975
2000
2015
Year

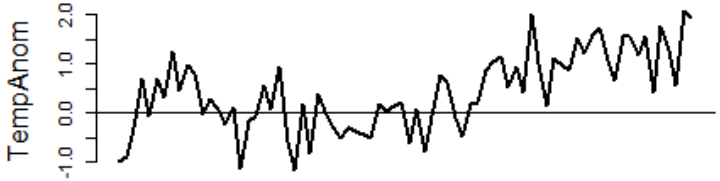

15
P
Phosphorus
30.974

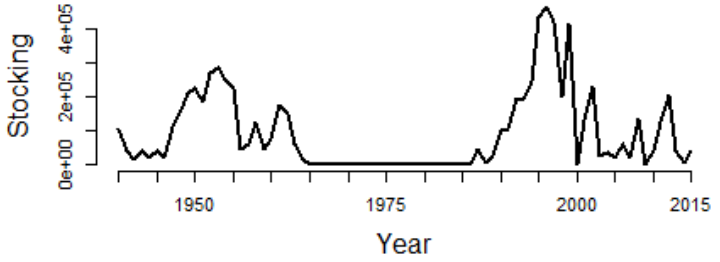

ITP
0
40
80
120

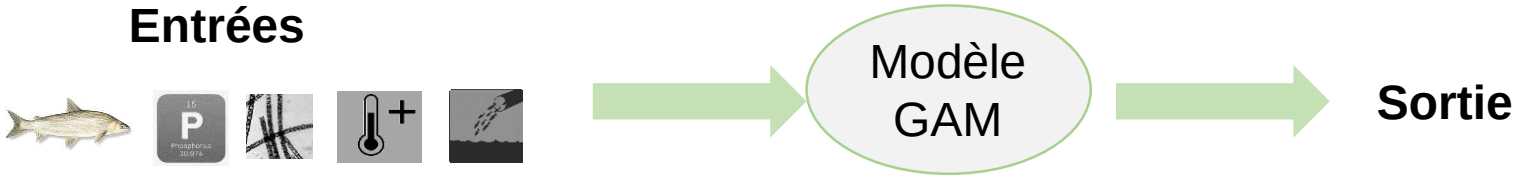



Cyanobacteria
0
5
15
25



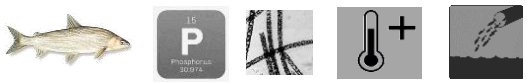

TempAnom
-1.0
0.0
1.0
2.0


Stocking
0e+00
2e+05
4e+05
1950
1975
2000
2015
Year



Conditions environnementales agissent majoritairement pendant la phase larvaire et juvénile (Cushing, 1990, Perrier et al., 2012)

Entrées



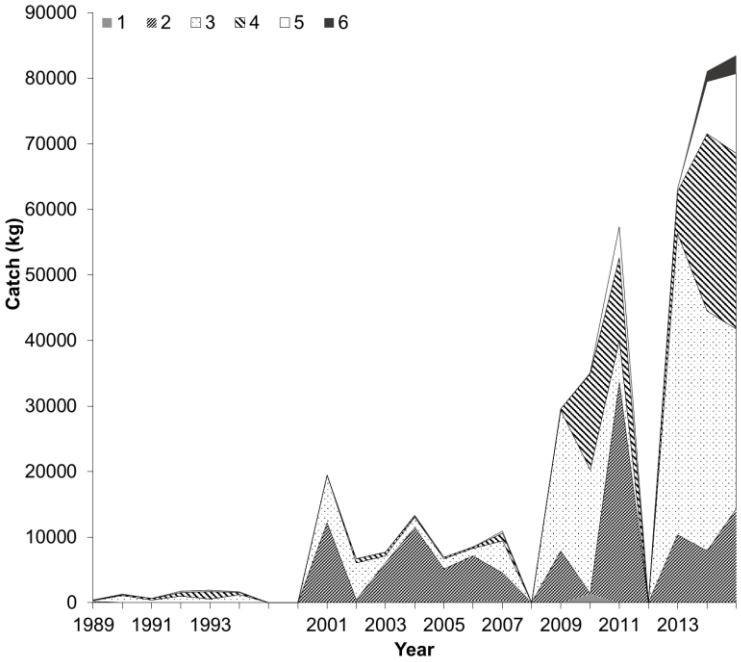
Modèle GAM

Sortie

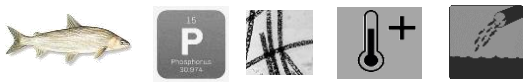
Conditions environnementales agissent majoritairement pendant la phase larvaire et juvénile (Cushing, 1990, Perrier et al., 2012)

AJUSTEMENT : Estimation de la cohorte dominante dans les captures
(modèles à partir de données scalimétriques ou bibliographiques)

Période récente



Entrées



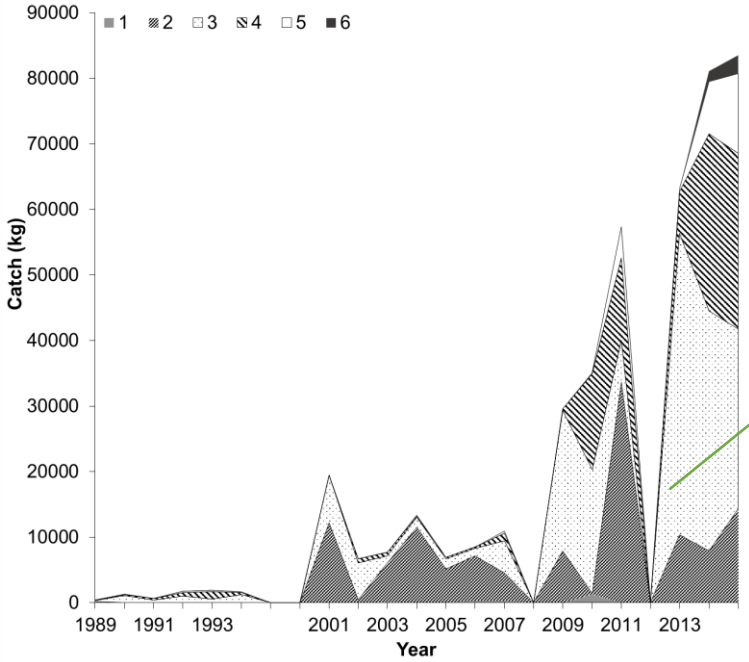
Modèle GAM

Sortie

Conditions environnementales agissent majoritairement pendant la phase larvaire et juvénile (Cushing, 1990, Perrier et al., 2012)

AJUSTEMENT : Estimation de la cohorte dominante dans les captures
(modèles à partir de données scalimétriques ou bibliographiques)

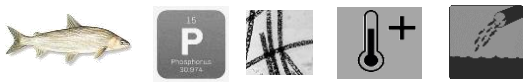
Période récente



3+ dominent

Captures l'année N facteurs de forçages agissants durant l'année de naissance N-3

Entrées



Modèle GAM

Sortie

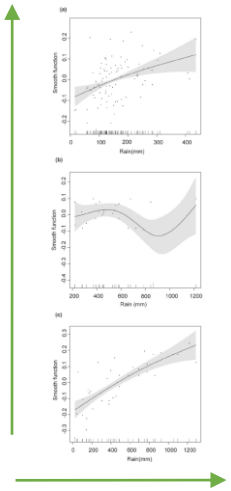
Conditions environnementales agissent majoritairement pendant la phase larvaire et juvénile (Cushing, 1990, Perrier et al., 2012)

AJUSTEMENT : Estimation de la cohorte dominante dans les captures
(modèles à partir de données scalimétriques ou bibliographiques)

Modèle additif généralisé (GAM)

Variable réponse

Année N



Variables explicatives
Année naissance (N-5, N-4, N-2...)

Entrées

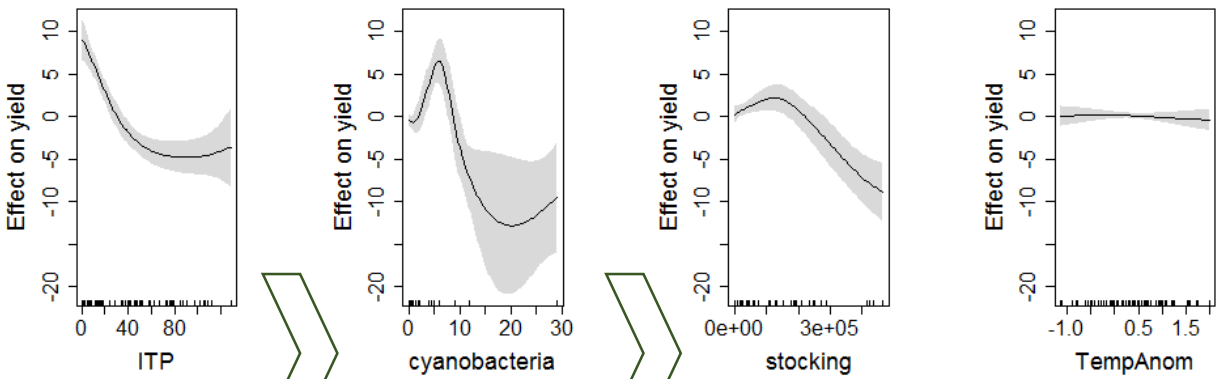
Modèle GAM

Sortie

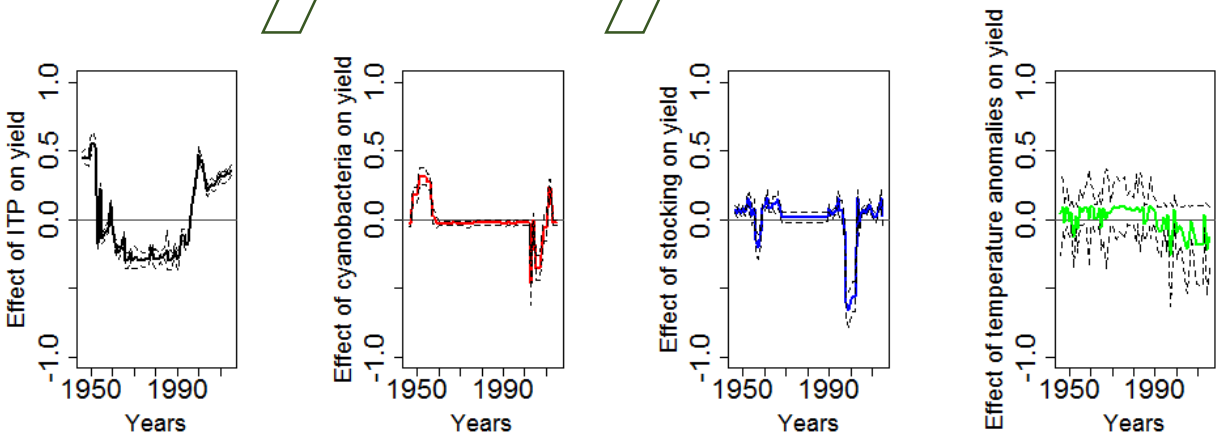
80,7 %

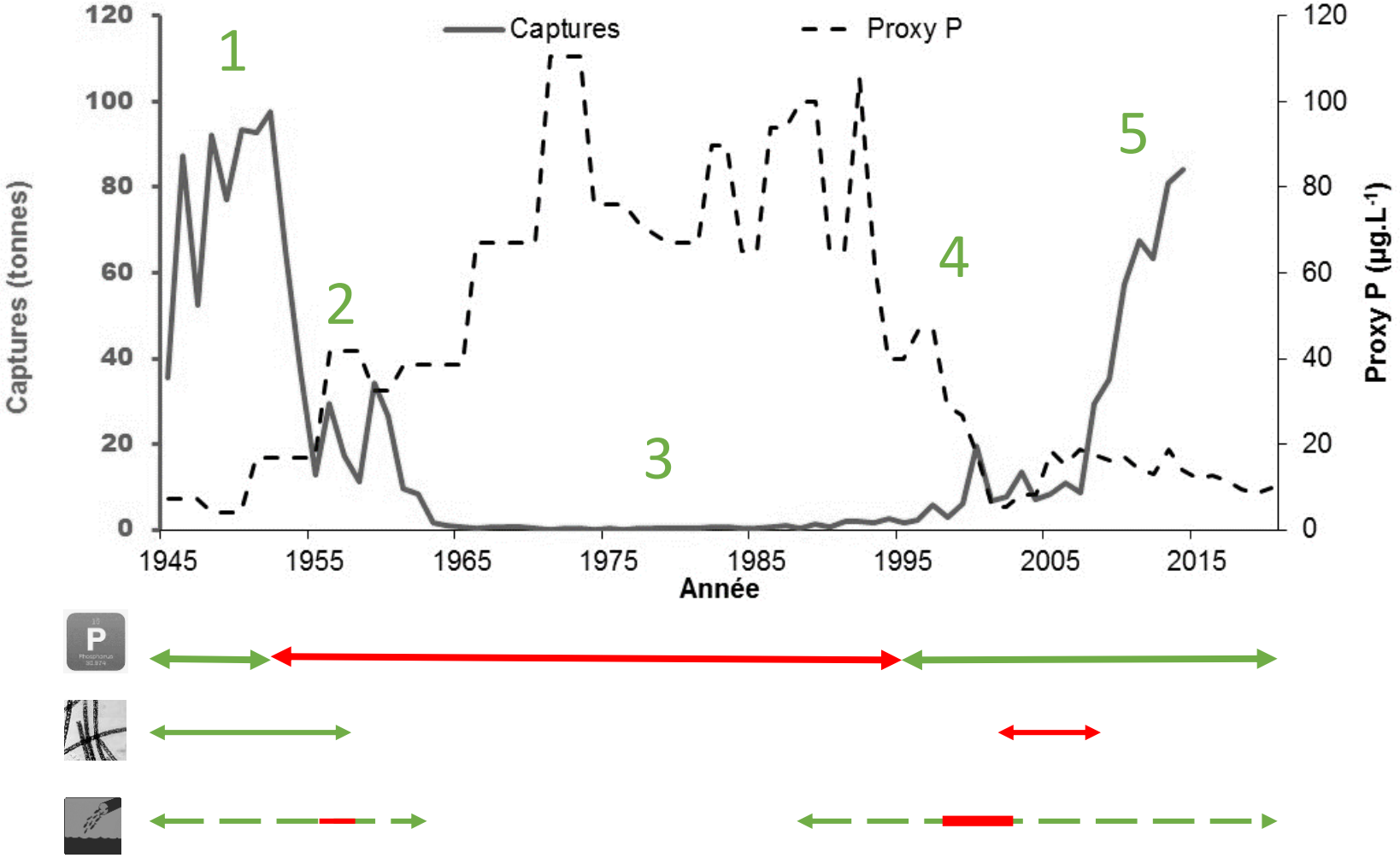
*** *** ***

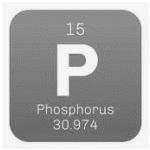
Fonction ajustée



Contribution temporelle des facteurs de forçages

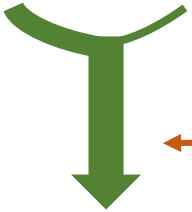


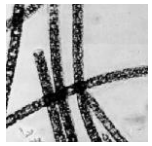

Captures
Proxy P
Captures (tonnes)
Proxy P (µg.L-1)
Année
1
2
3
4
5
120
100
80
60
40
20
0
1945
1955
1965
1975
1985
1995
2005
2015
P



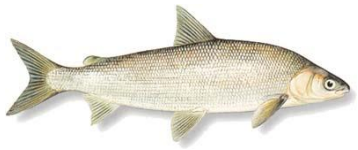
Principal driver

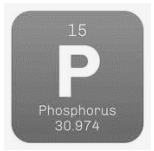
Faible contribution
Effet « sauvegarde » ?





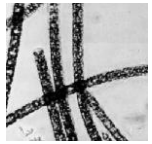
Restauration de la population



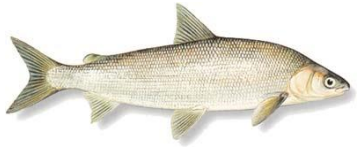


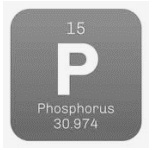
Principal driver

Faible contribution
Effet « sauvegarde » ?

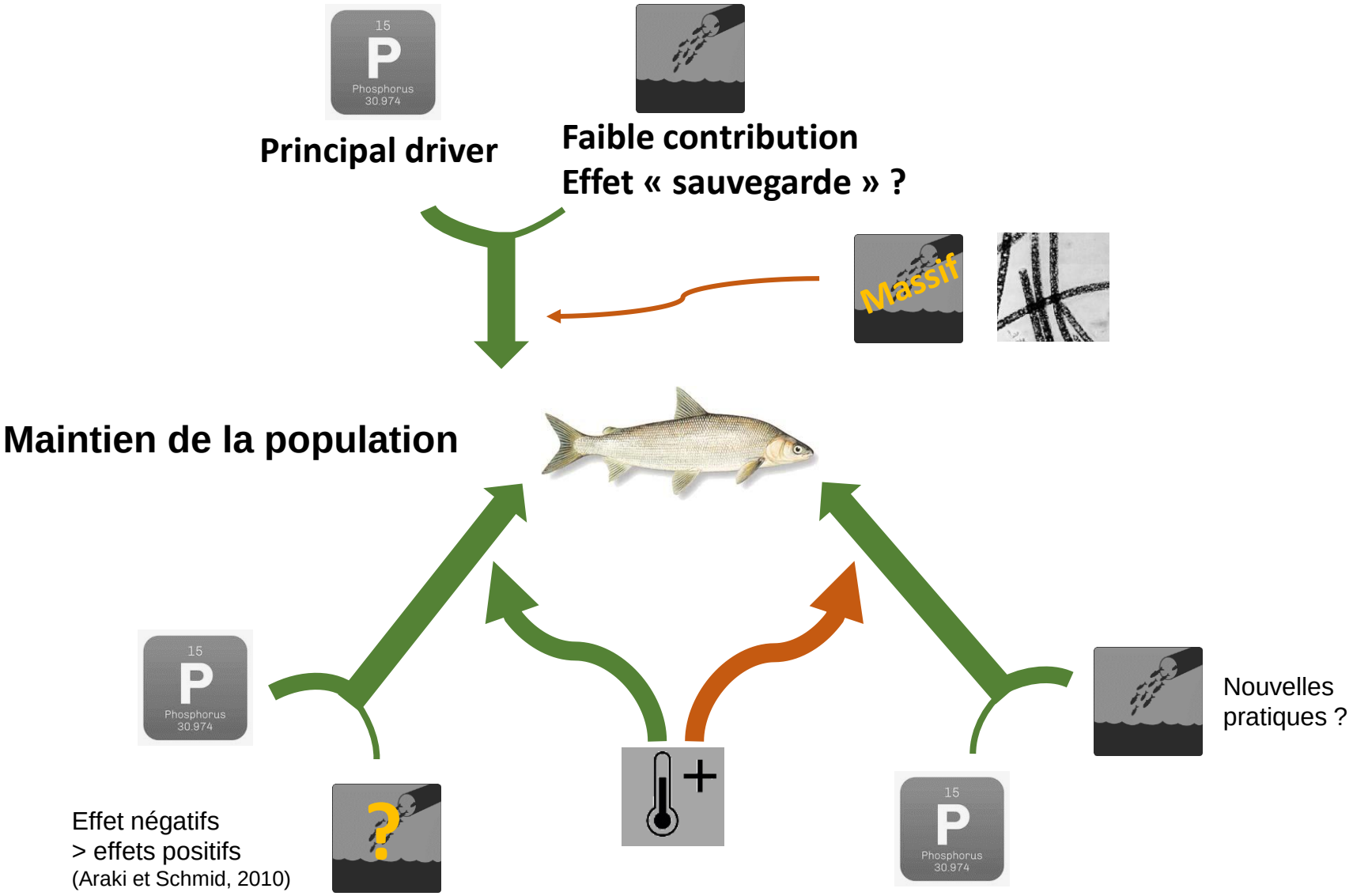


Maintien de la population





Effet négatifs
> effets positifs
(Araki et Schmid, 2010)


15
P
Phosphorus
30.974
Principal driver
Faible contribution
Effet « sauvegarde » ?
Massif
Maintien de la population
15
P
Phosphorus
30.974
?
+
15
P
Phosphorus
30.974
Nouvelles
pratiques ?
Effet négatifs
> effets positifs
(Araki et Schmid, 2010)

MERCI DE VOTRE ATTENTION

1959

2016

To be continued...