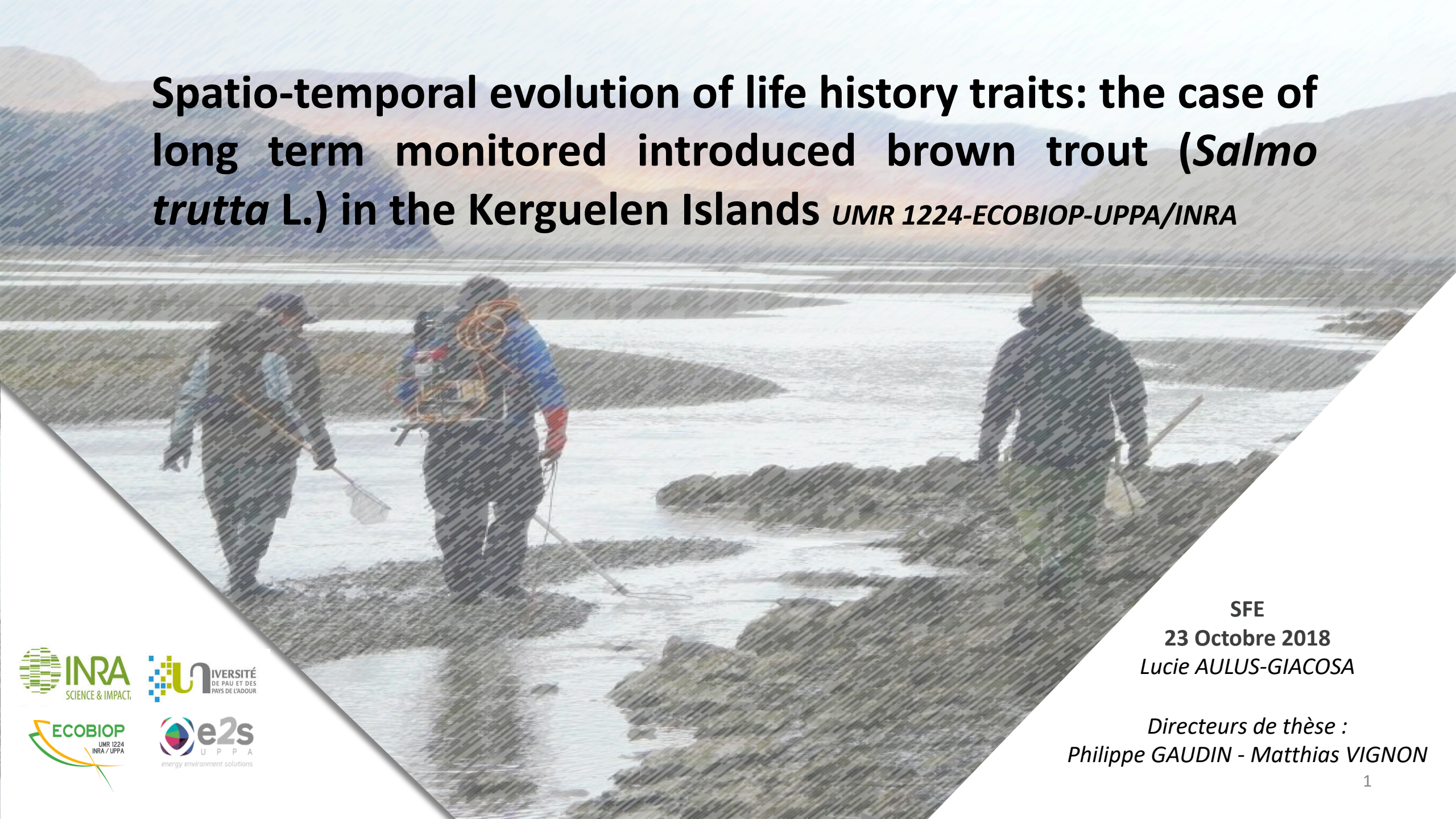


Spatio-temporal evolution of life history traits: the case of long term monitored introduced brown trout (*Salmo trutta* L.) in the Kerguelen Islands *UMR 1224-ECOBIOIP-UPPA/INRA*



SFE

23 Octobre 2018

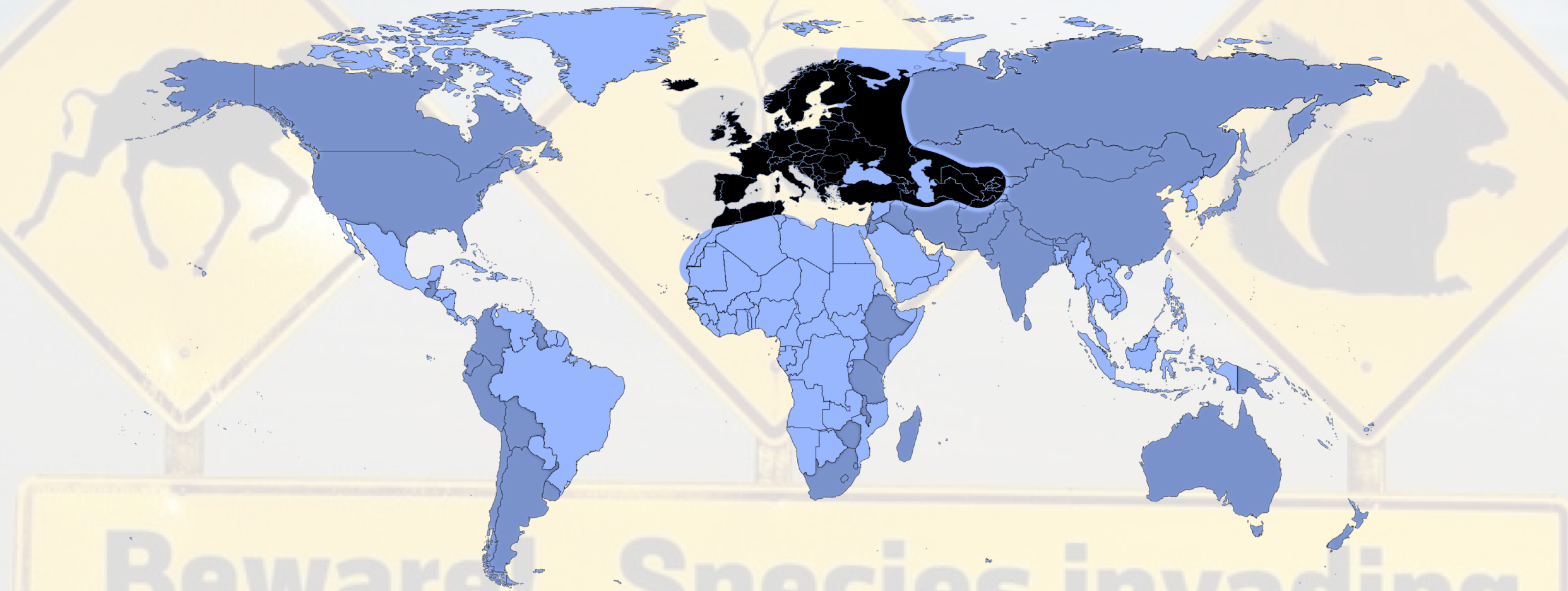
Lucie AULUS-GIACOSA

Directeurs de thèse :

Philippe GAUDIN - Matthias VIGNON

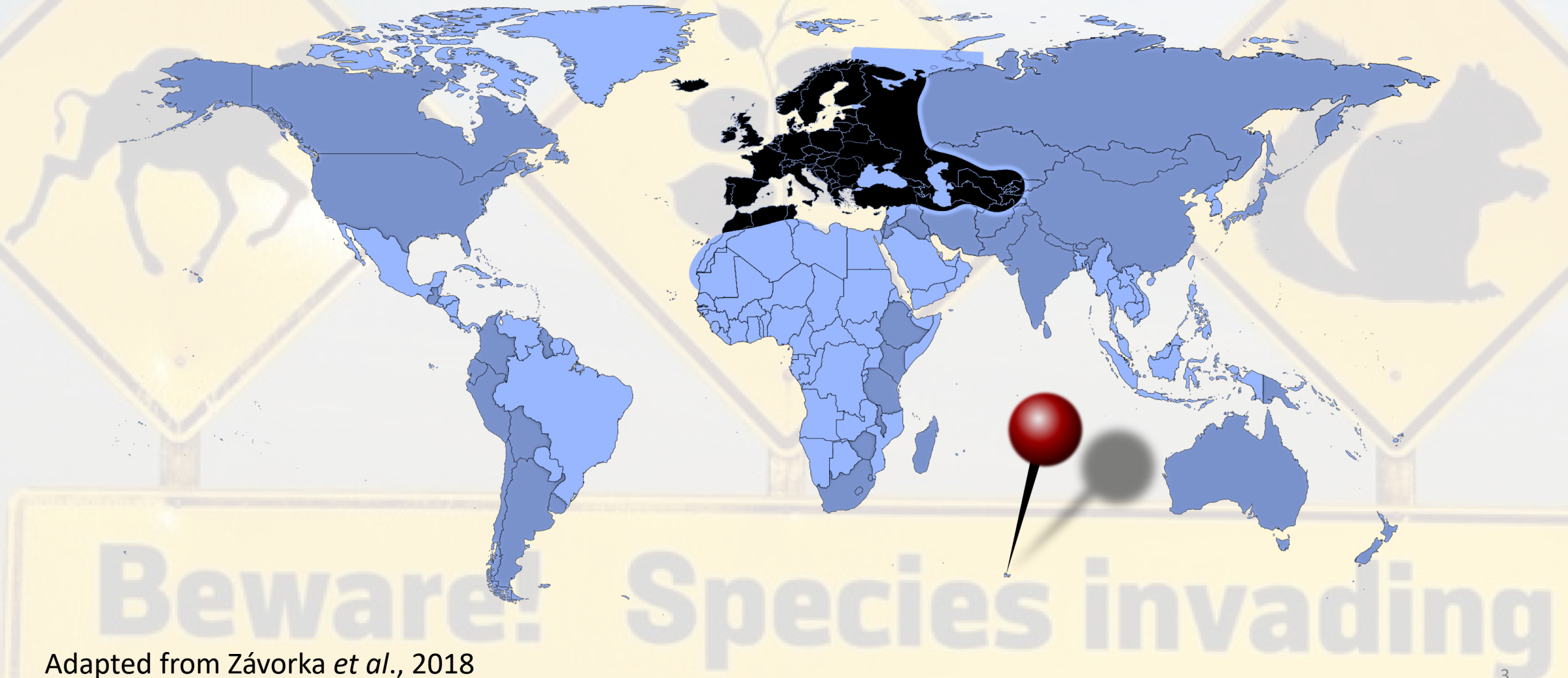


Worldwide distribution of Brown trout

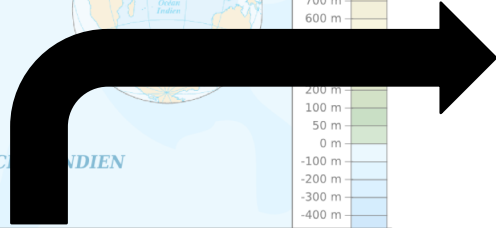
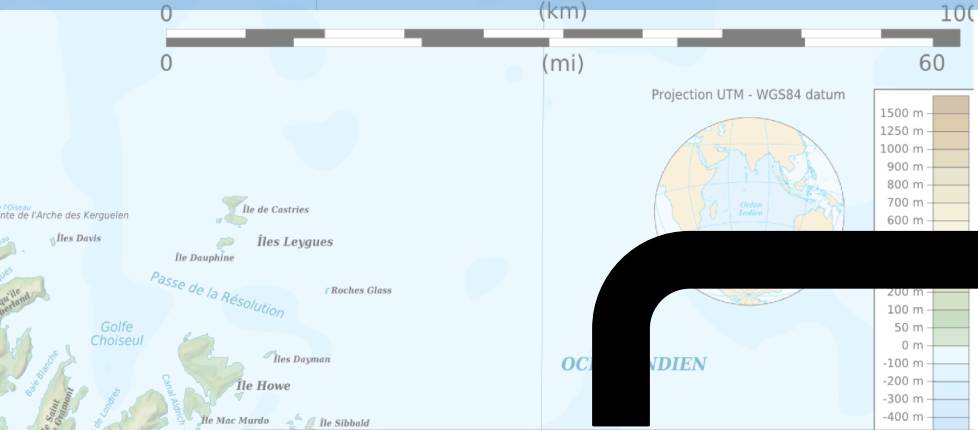


Adapted from Závorka *et al.*, 2018

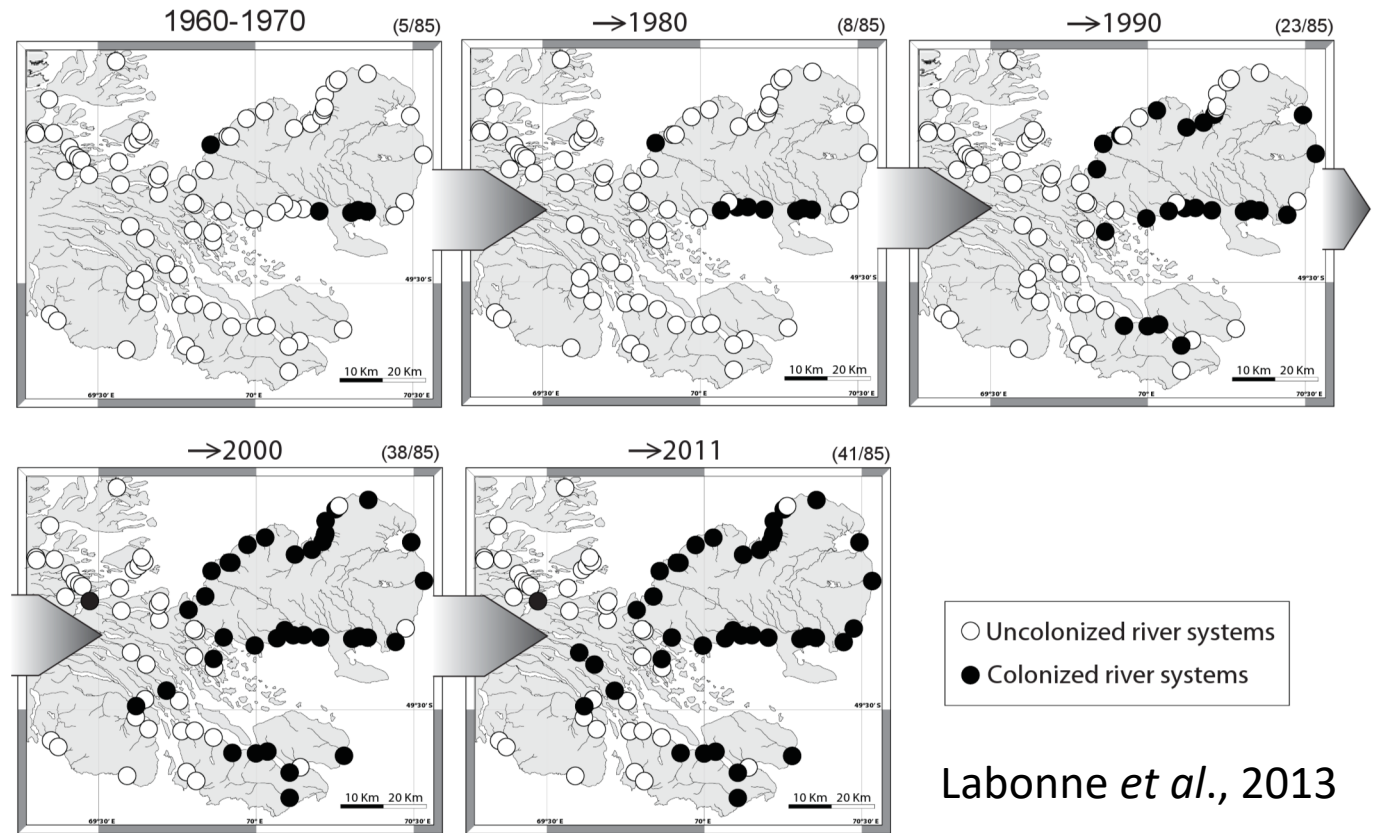
Introduction of Brown trout in Kerguelen Islands in the 50's



Adapted from Závorka *et al.*, 2018



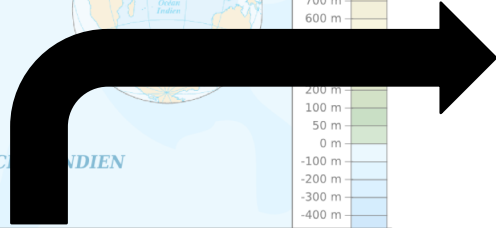
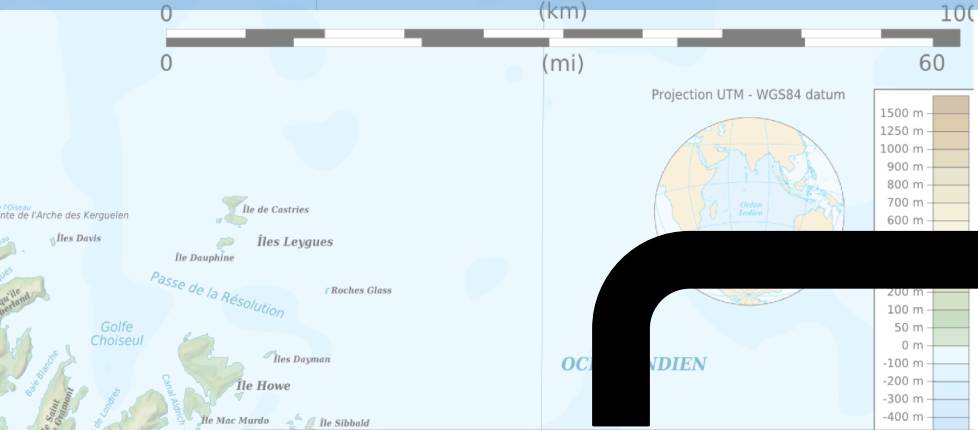
And invasion is proven



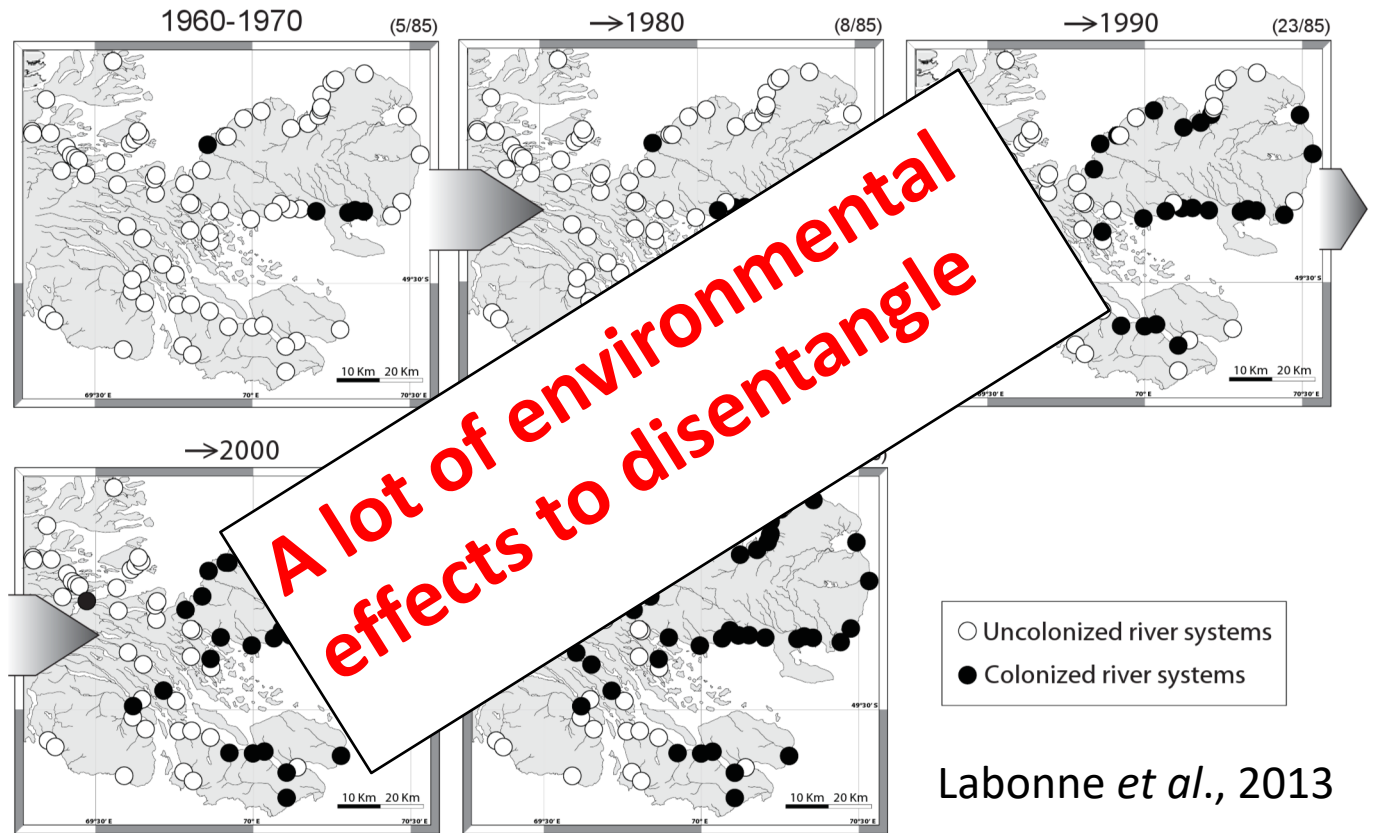
Labonne *et al.*, 2013

	All fish species	<i>Salmo trutta</i> L.
Fish	> 52000	> 37 000
Sample of scale	> 30 000	> 24 000

With long term monitoring



And invasion is proven



A lot of environmental effects to disentangle

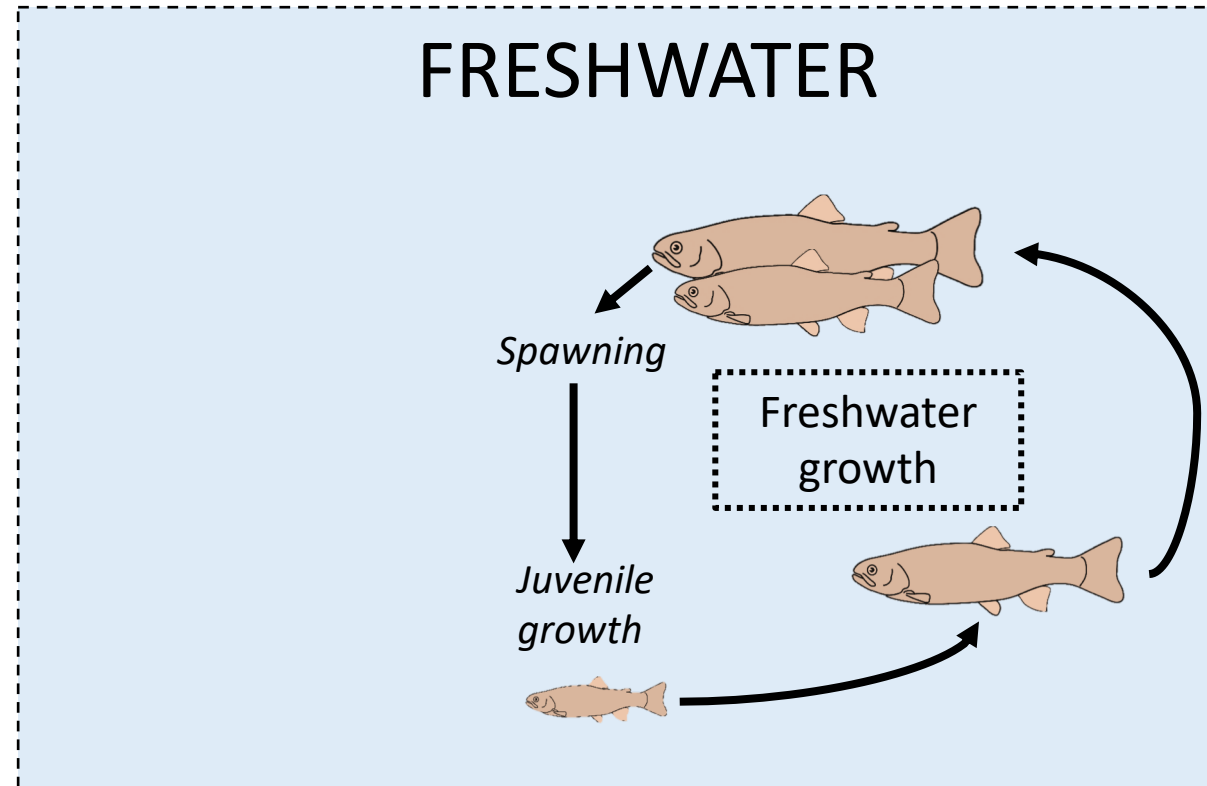
- Uncolonized river systems
- Colonized river systems

Labonne *et al.*, 2013

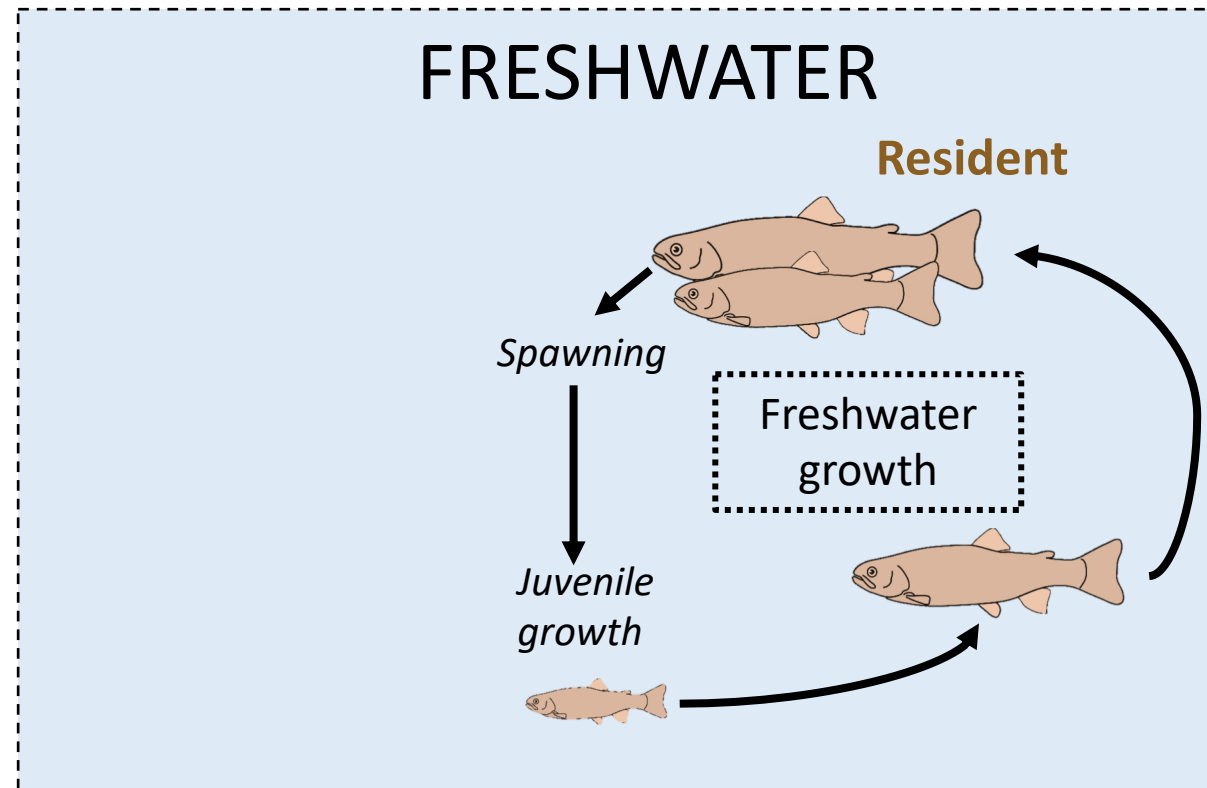
	All fish species	<i>Salmo trutta</i> L.
Fish	> 52000	> 37 000
Sample of scale	> 30 000	> 24 000

With long term monitoring

Brown trout as a facultative anadromous species

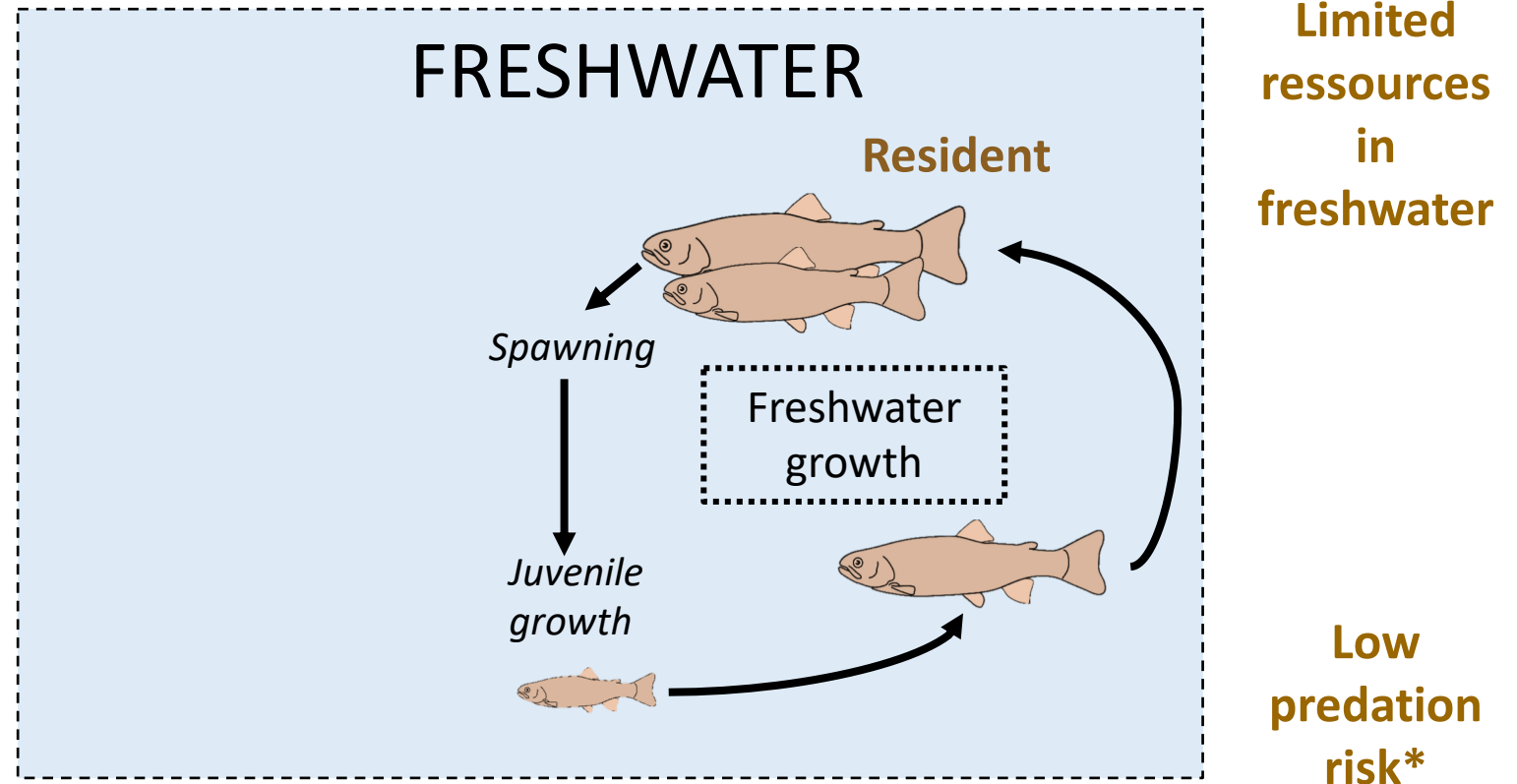


Brown trout as a facultative anadromous species

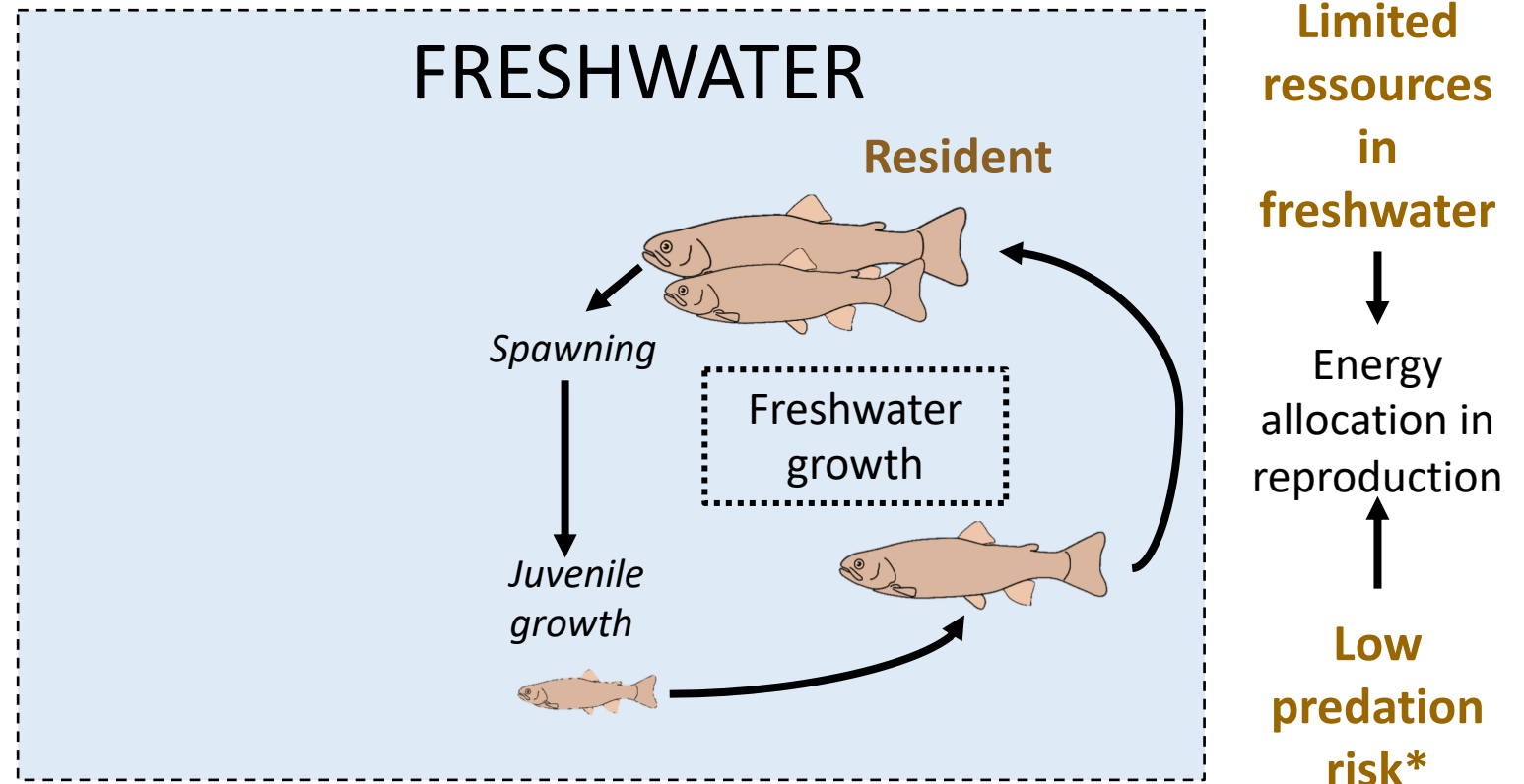


**Limited
ressources
in
freshwater**

Brown trout as a facultative anadromous species

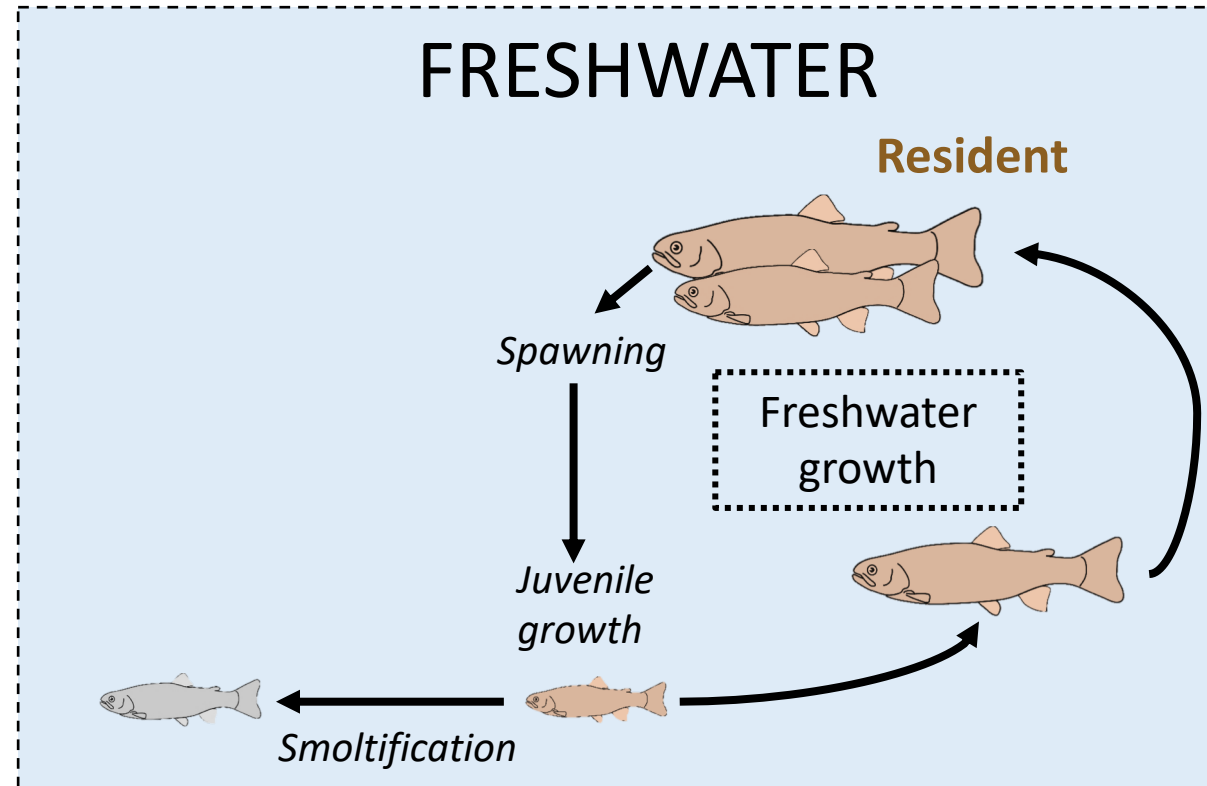


Brown trout as a facultative anadromous species

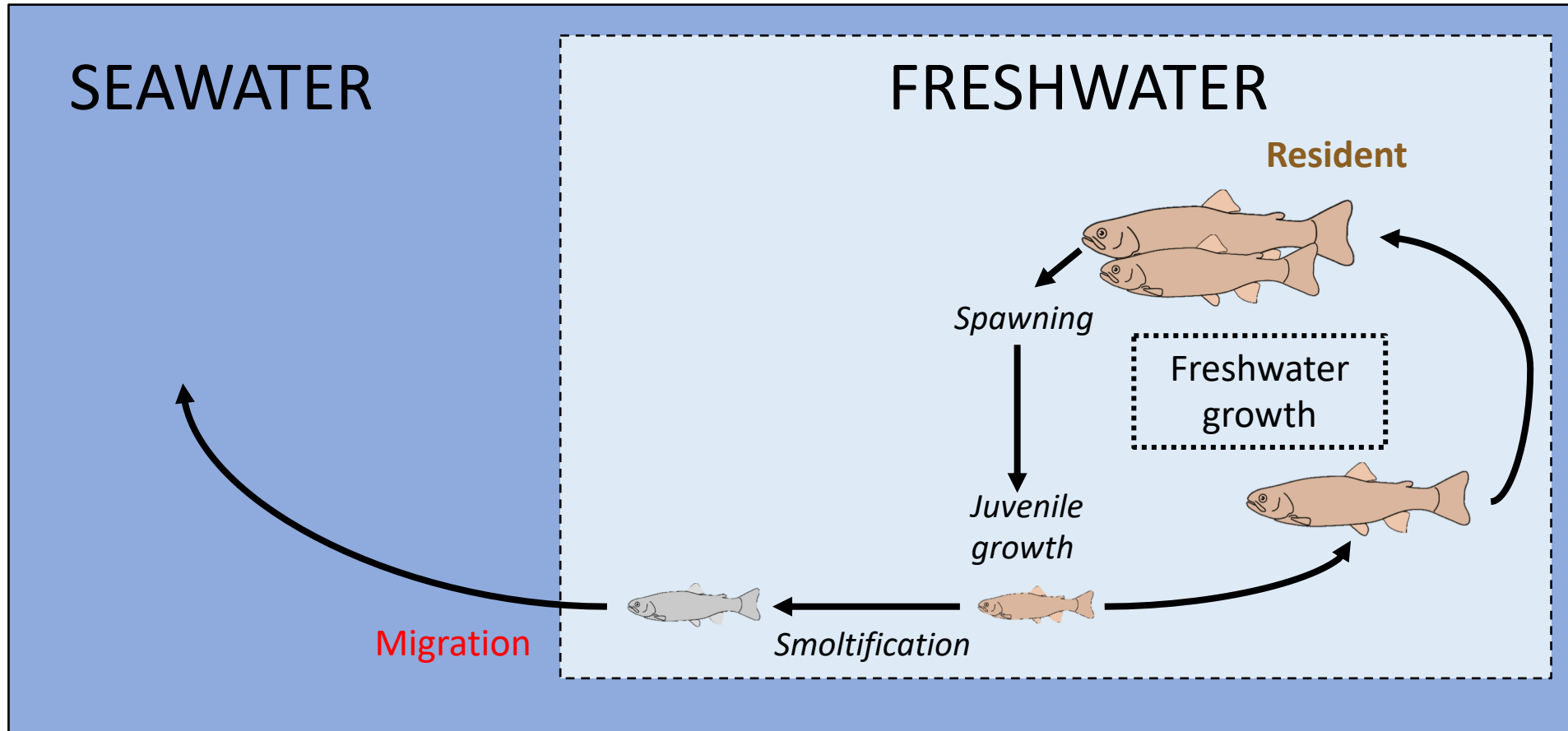


*Predation risks are hypothesized

Brown trout as a facultative anadromous species

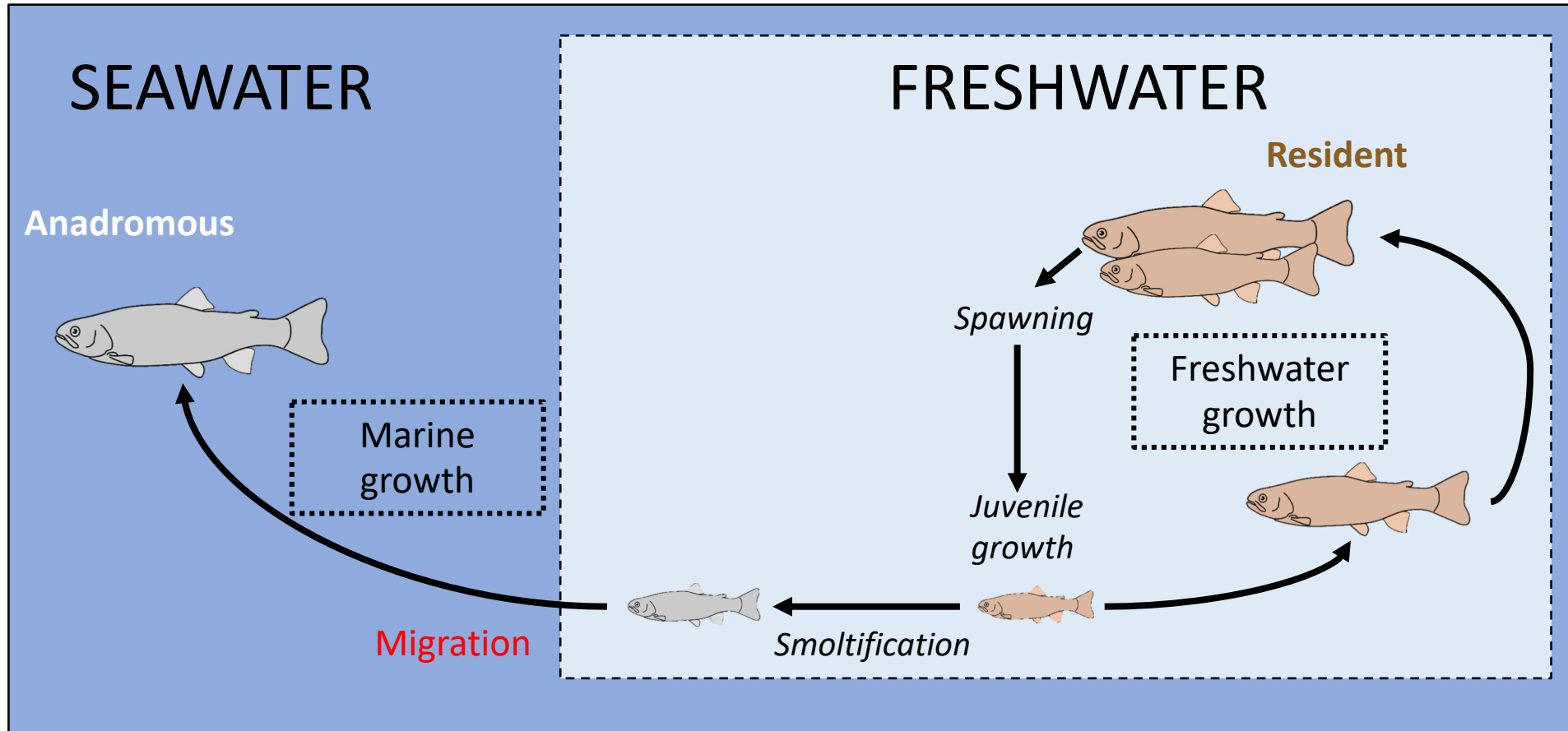


Brown trout as a facultative anadromous species

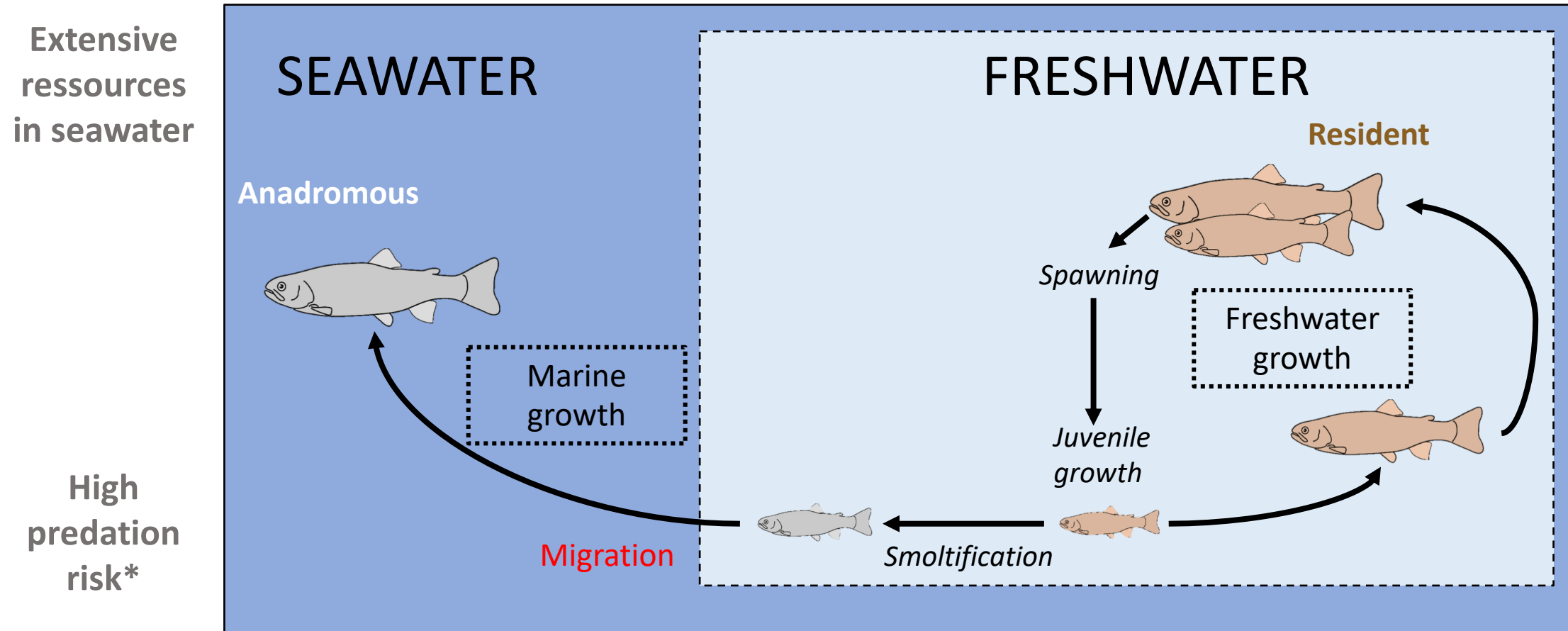


Brown trout as a facultative anadromous species

Extensive
ressources
in seawater

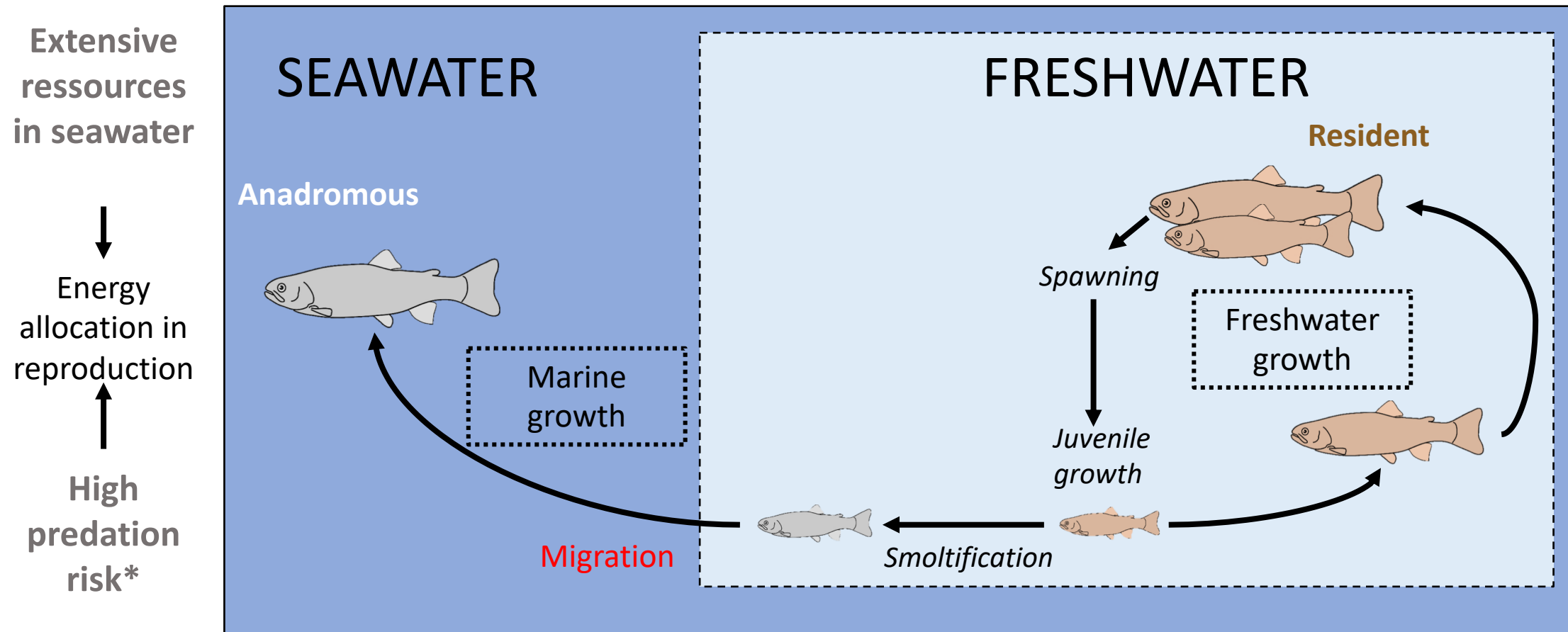


Brown trout as a facultative anadromous species



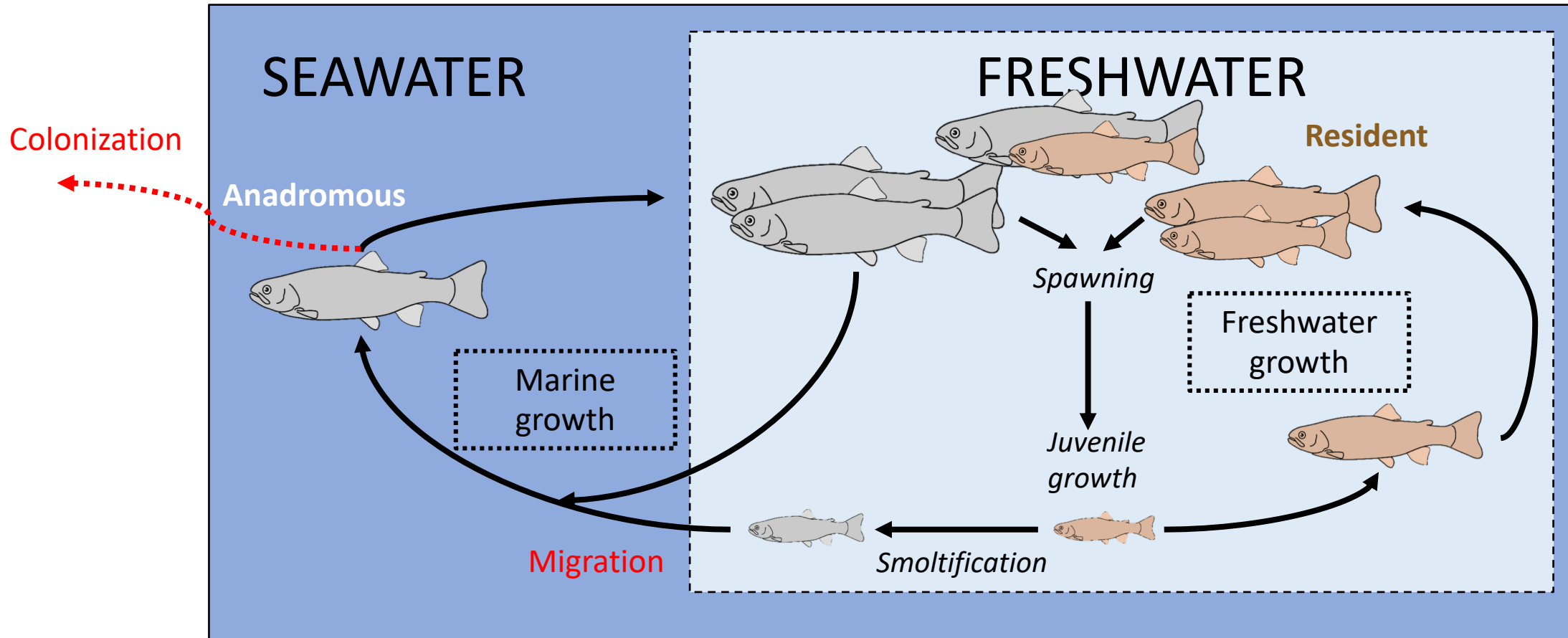
*Predation risks are hypothesized

Brown trout as a facultative anadromous species

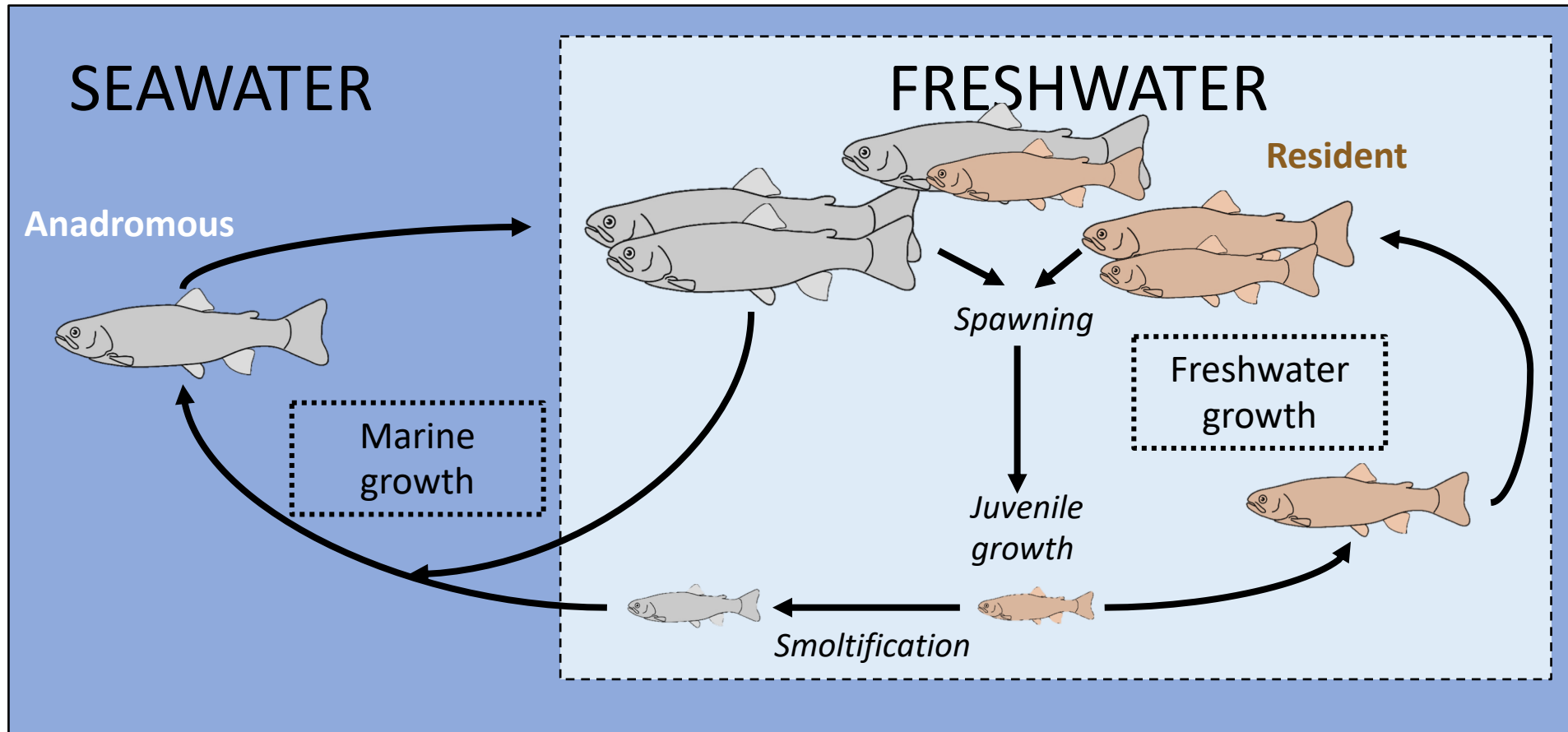


*Predation risks are hypothesized

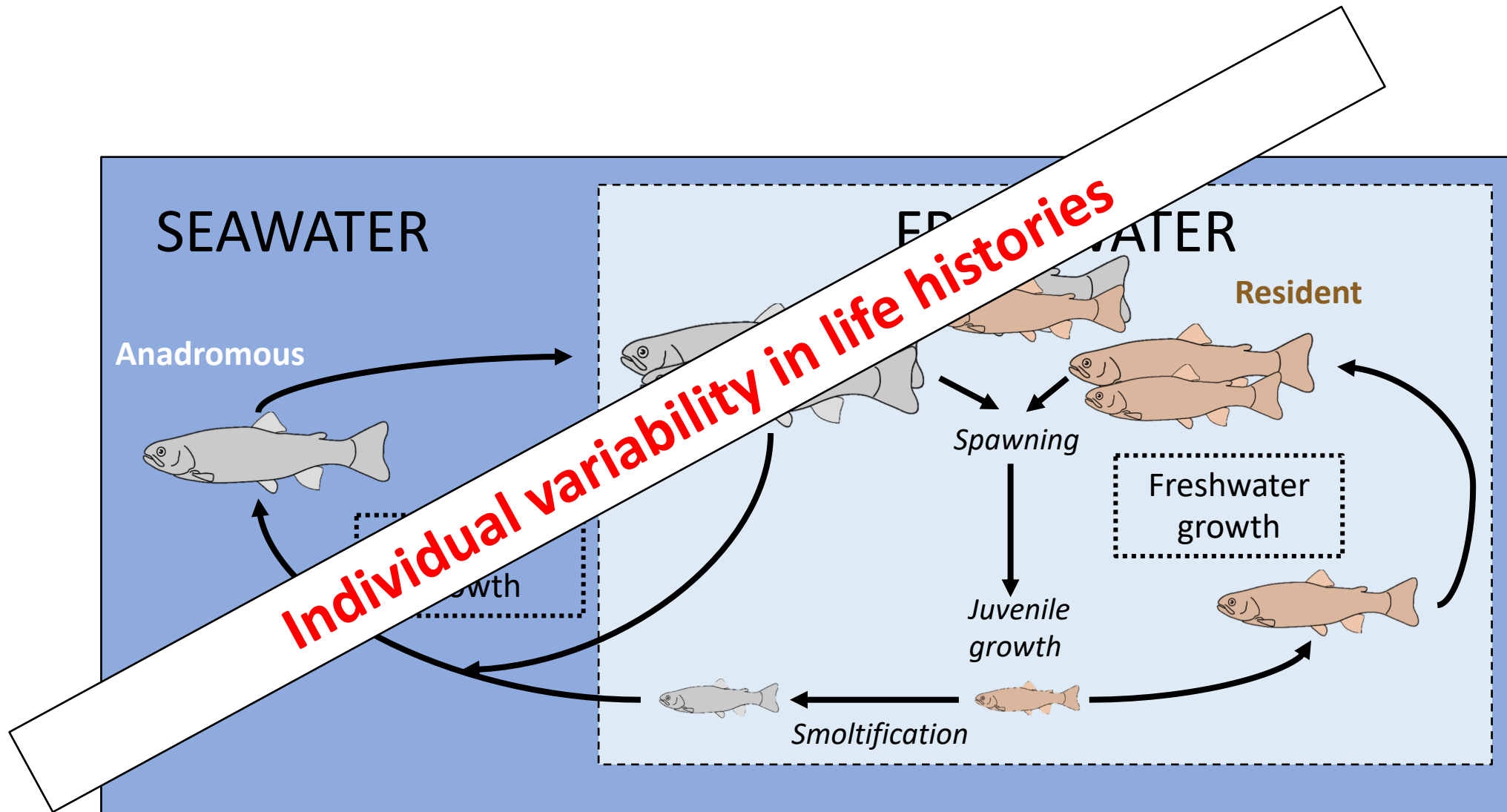
Brown trout as a facultative anadromous species



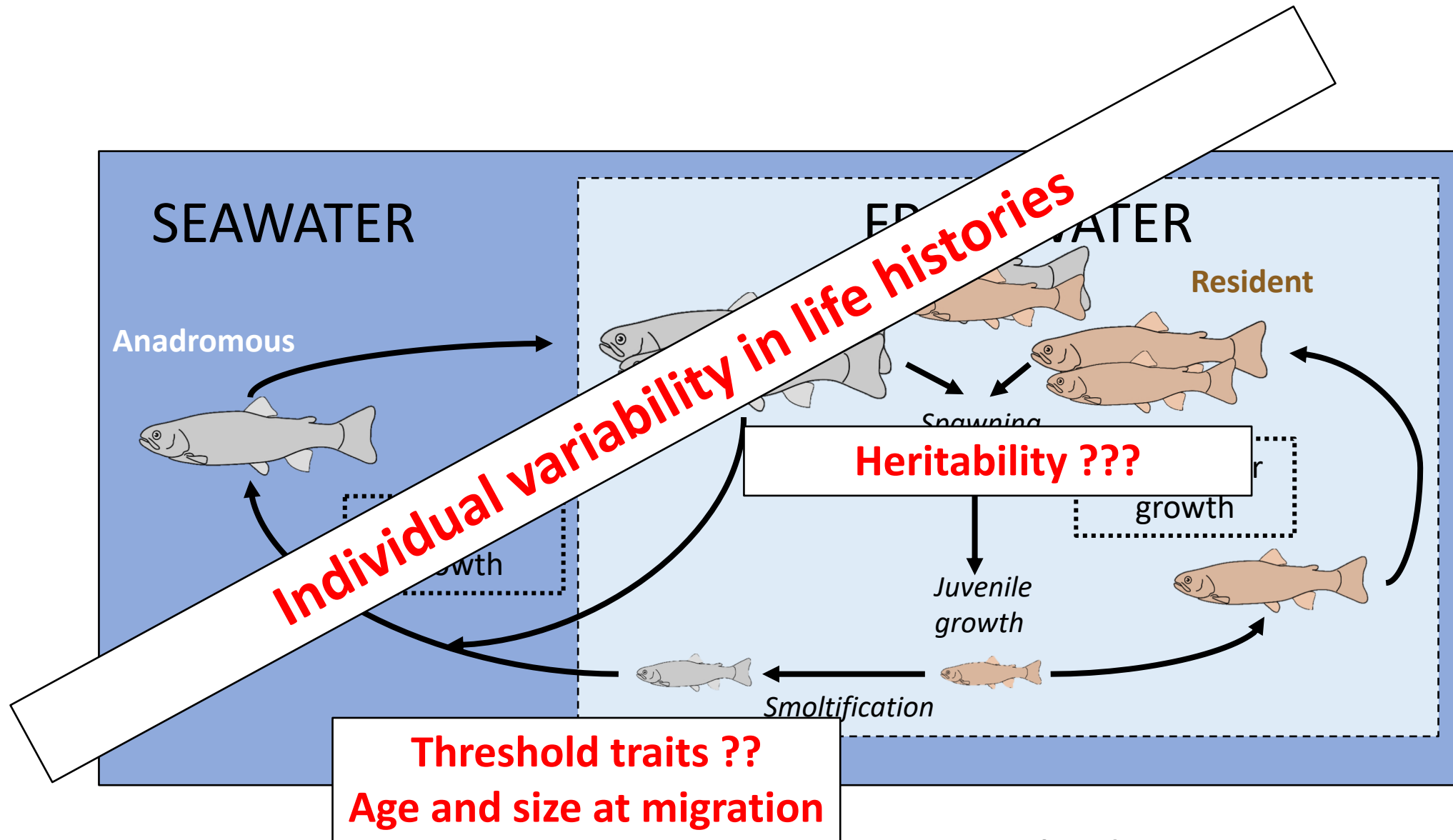
Brown trout as a facultative anadromous species



Life history traits related to
FITNESS = SURVIVAL × REPRODUCTION



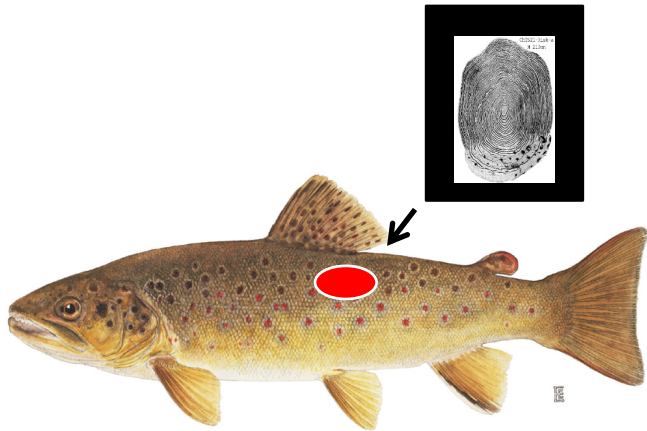
Life history traits related to
FITNESS = SURVIVAL × REPRODUCTION

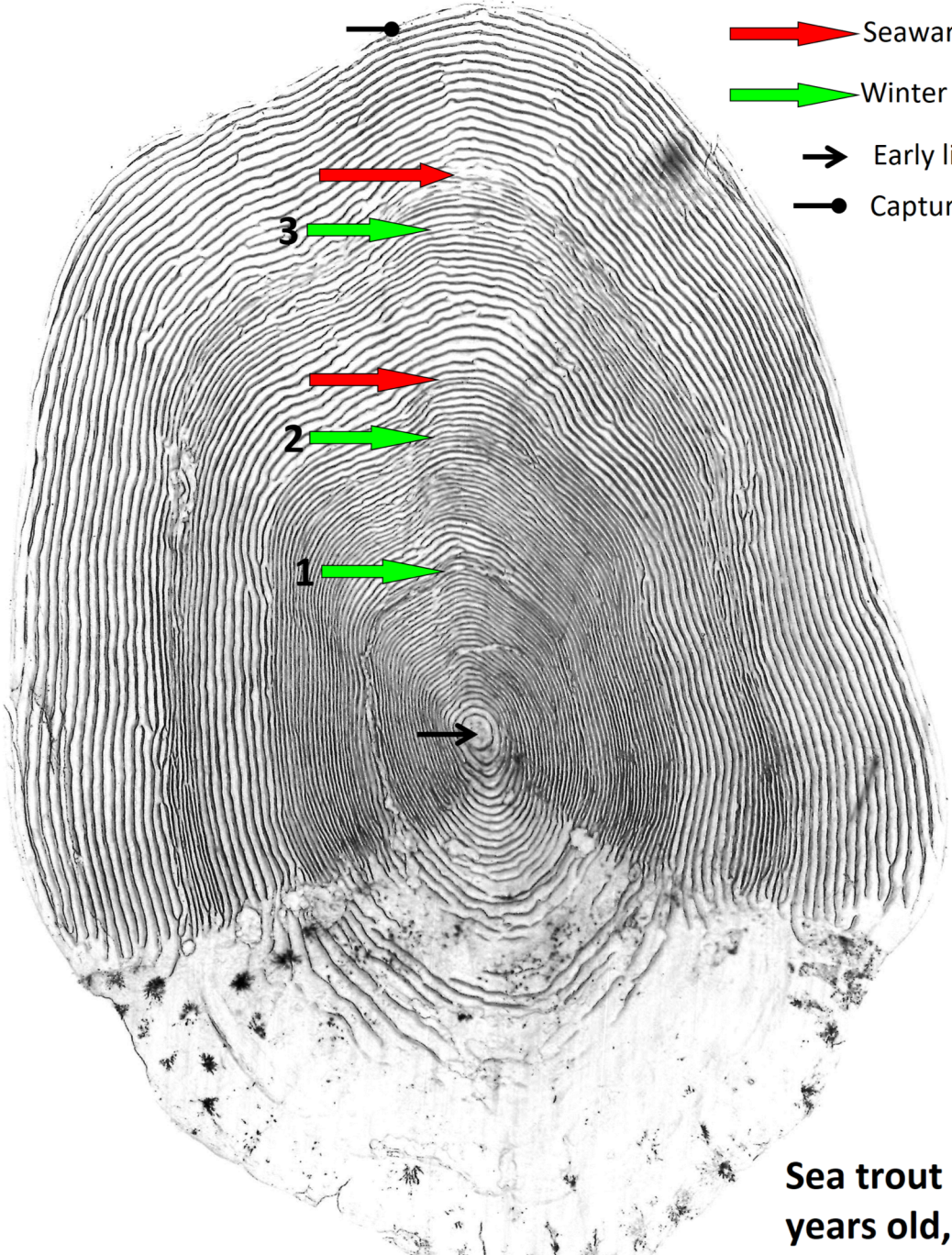






Life history traits related to

$$\text{FITNESS} = \text{SURVIVAL} \times \text{REPRODUCTION}$$

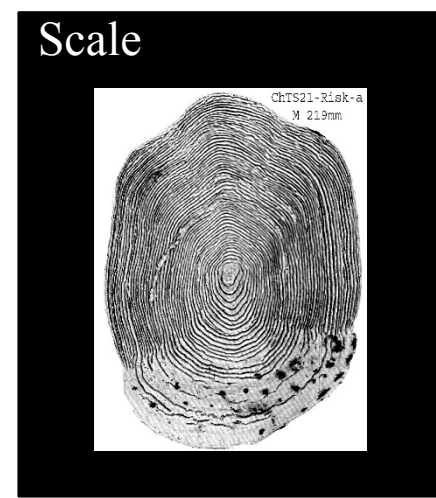
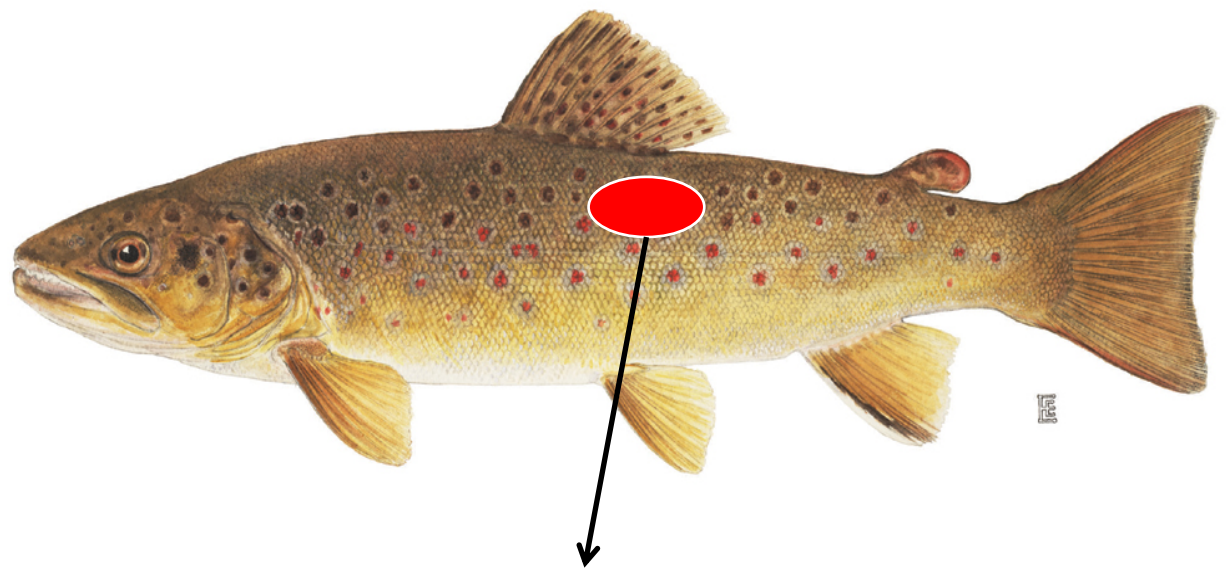
Modeling spatio-temporal evolution of age and size at migration. Life history traits have to be rebuilt !

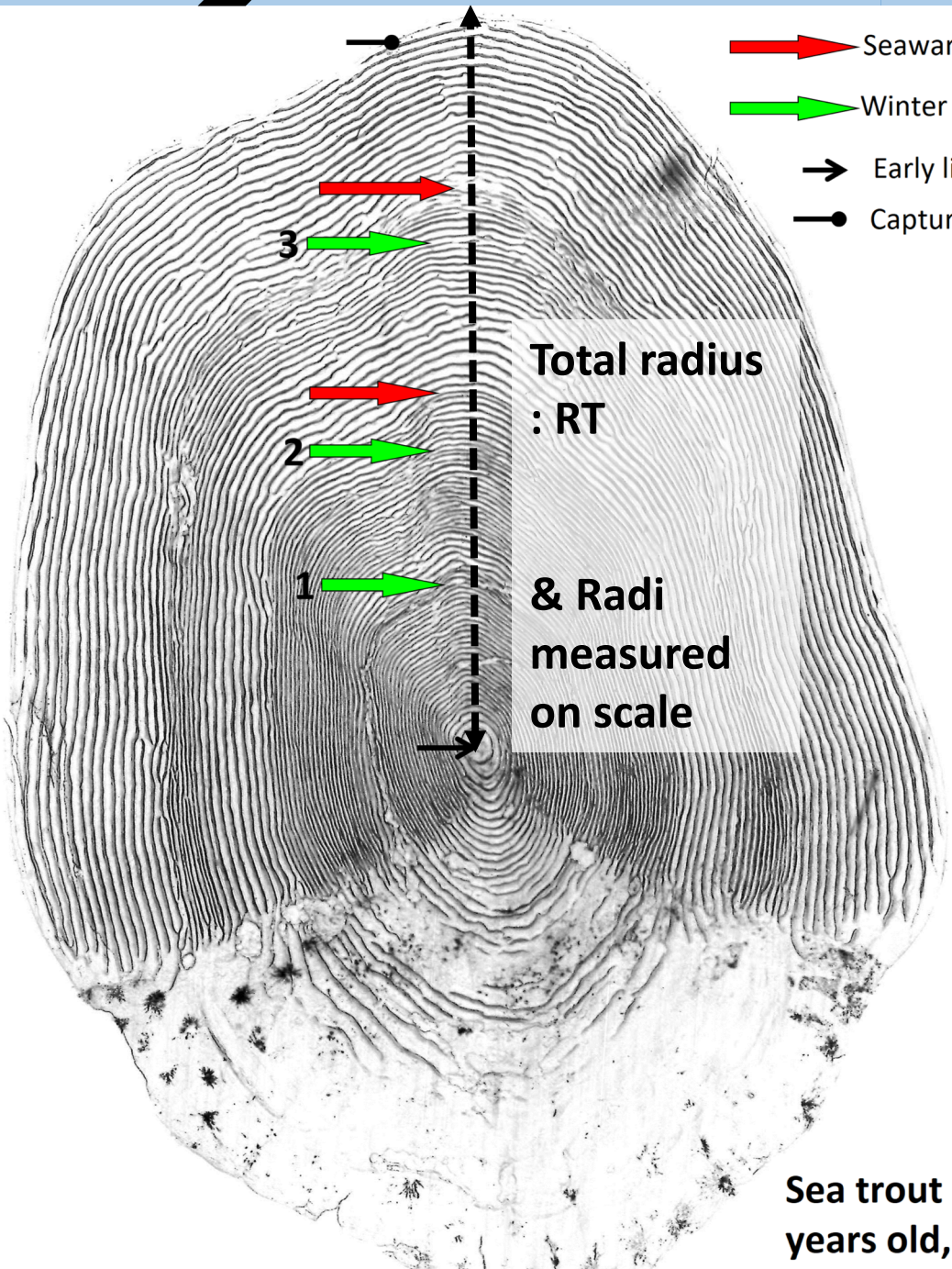








-  Seaward migration
-  Winter annulus
-  Early life
-  Capture

Sea trout scale, 3 years old, 57cm

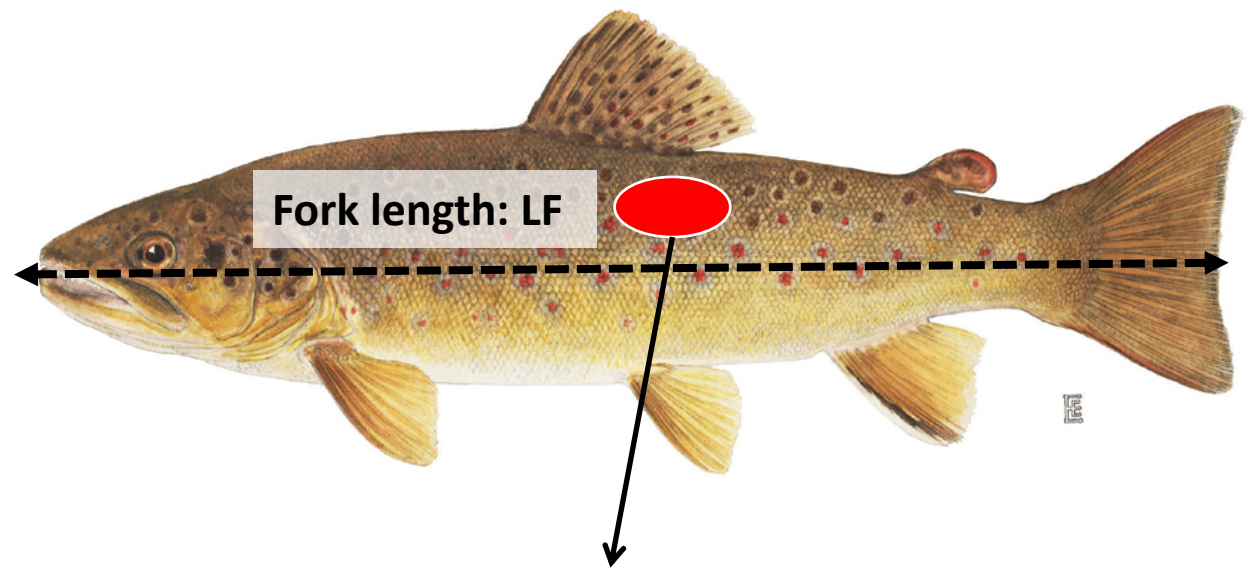




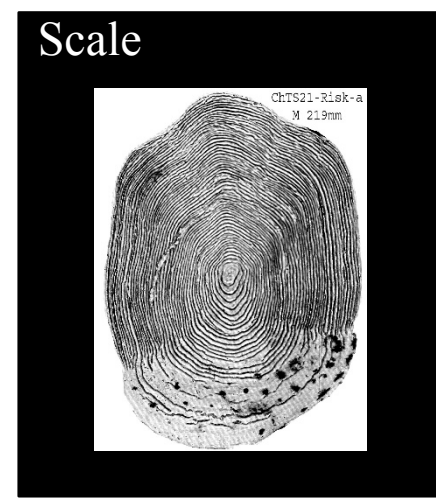
-  Seaward migration
-  Winter annulus
-  Early life
-  Capture

Total radius
: RT
& Radi
measured
on scale

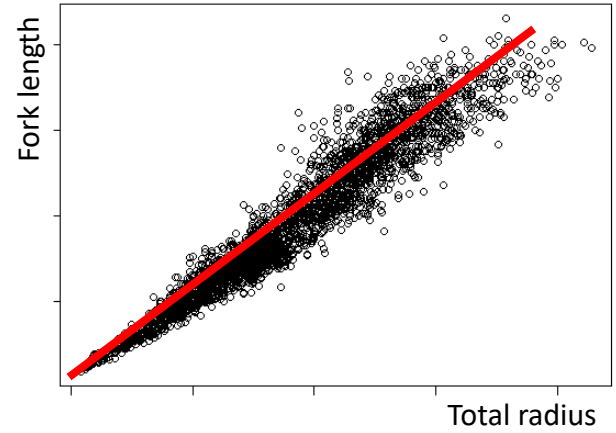
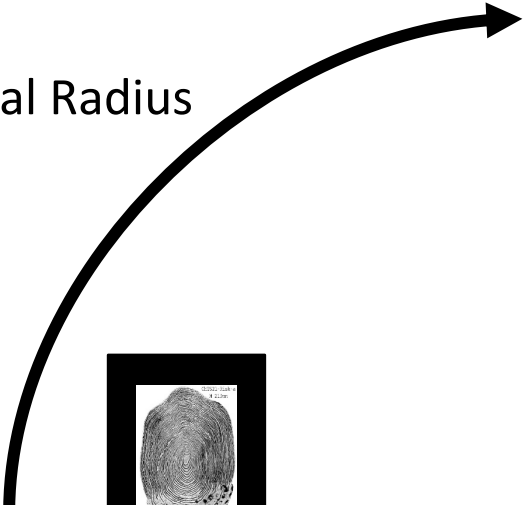
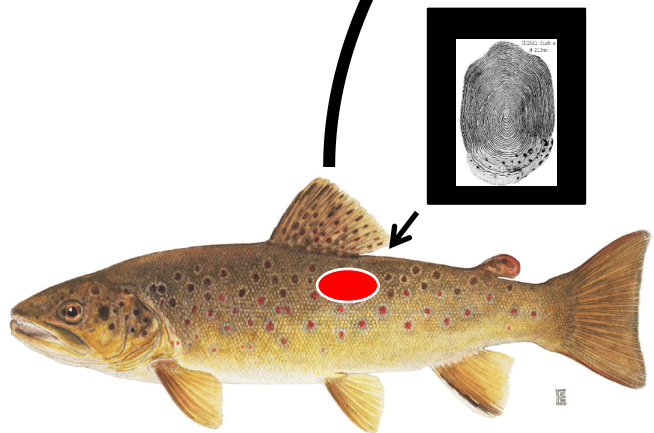
Sea trout scale, 3 years old, 57cm



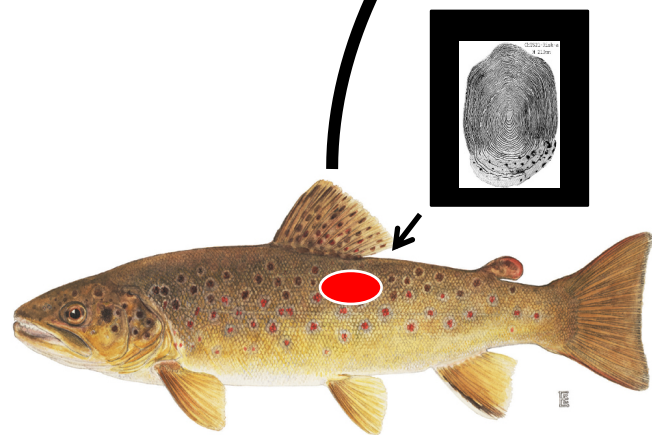
Fork length: LF



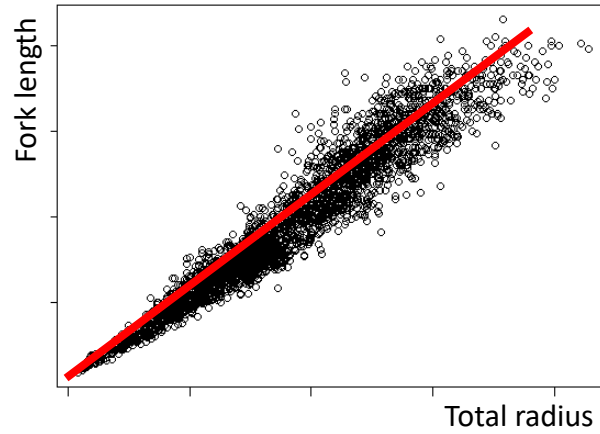
Relation
Fork length ~ Total Radius



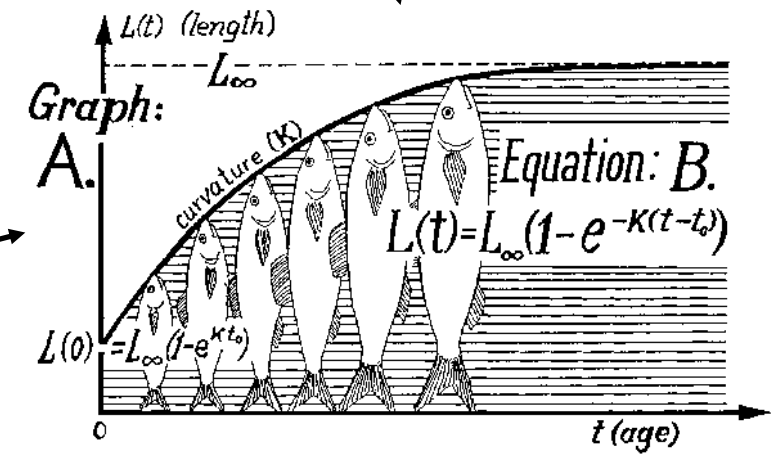
Average relation used to backcalculate fish length at age



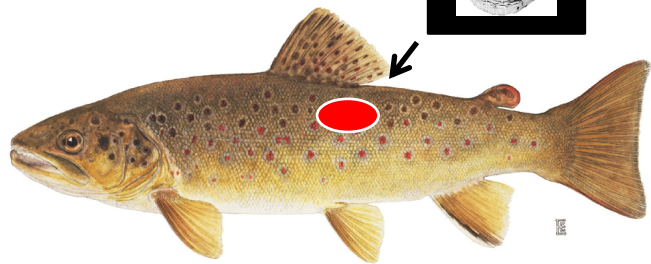
Direct capture (CMR)



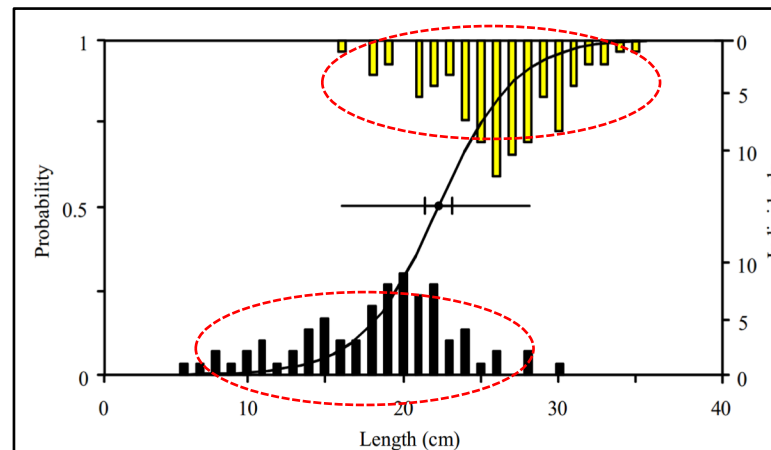
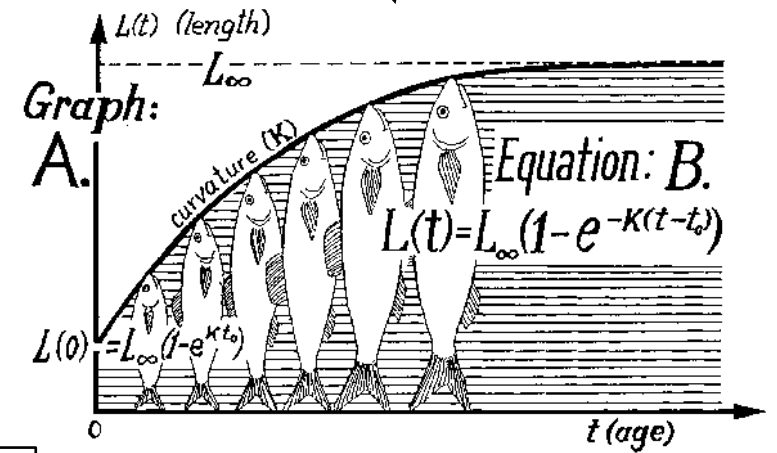
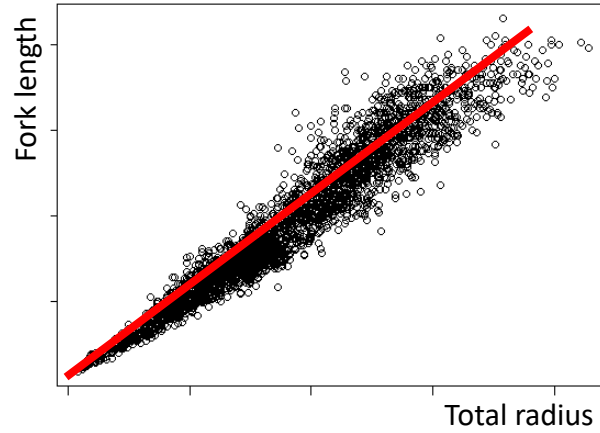
Growth on scales
reflects somatic growth



Model average growth of
fish within populations

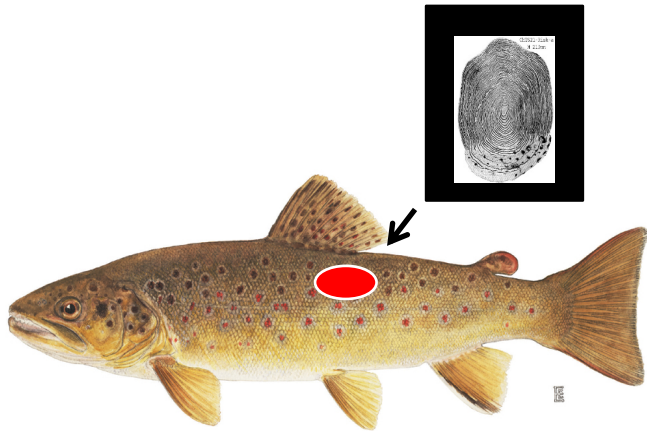


Probability of fish to migrate given their size: threshold size for migration

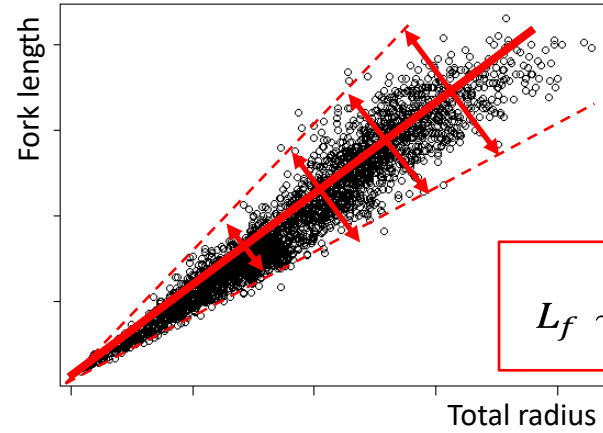
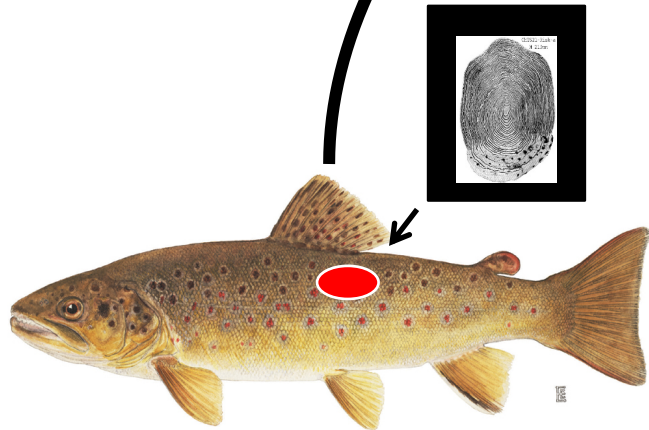


Somatic growth explains the propensity of a fish to migrate

Despite ... propagation of variability at each step !



Relation
Fork length \sim Total Radius

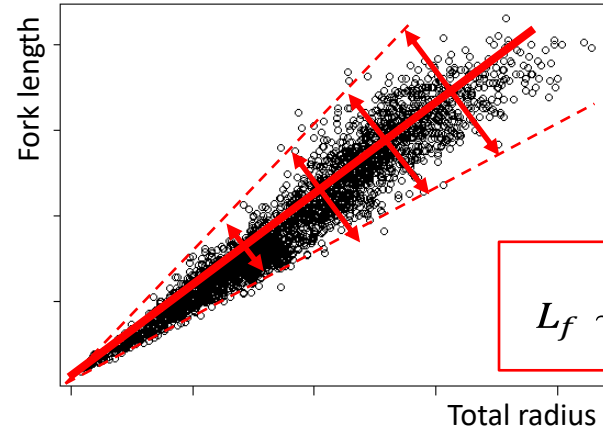
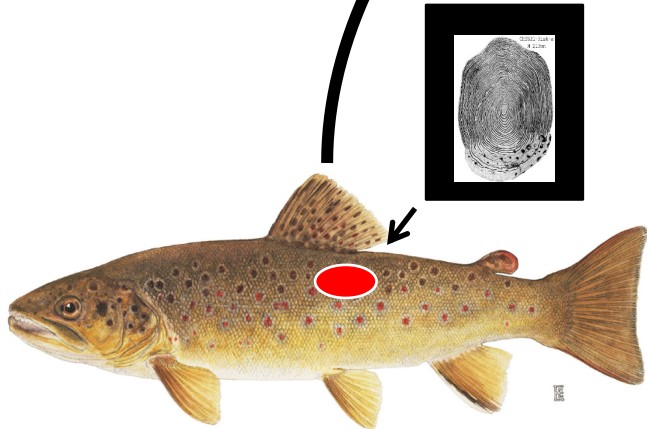


$$L_f \sim w + uR_T^v$$

Average ~~relation~~ used to
backcalculate fish length at age

Parameters in the relation can be variable !!!!

Relation
Fork length \sim Total Radius



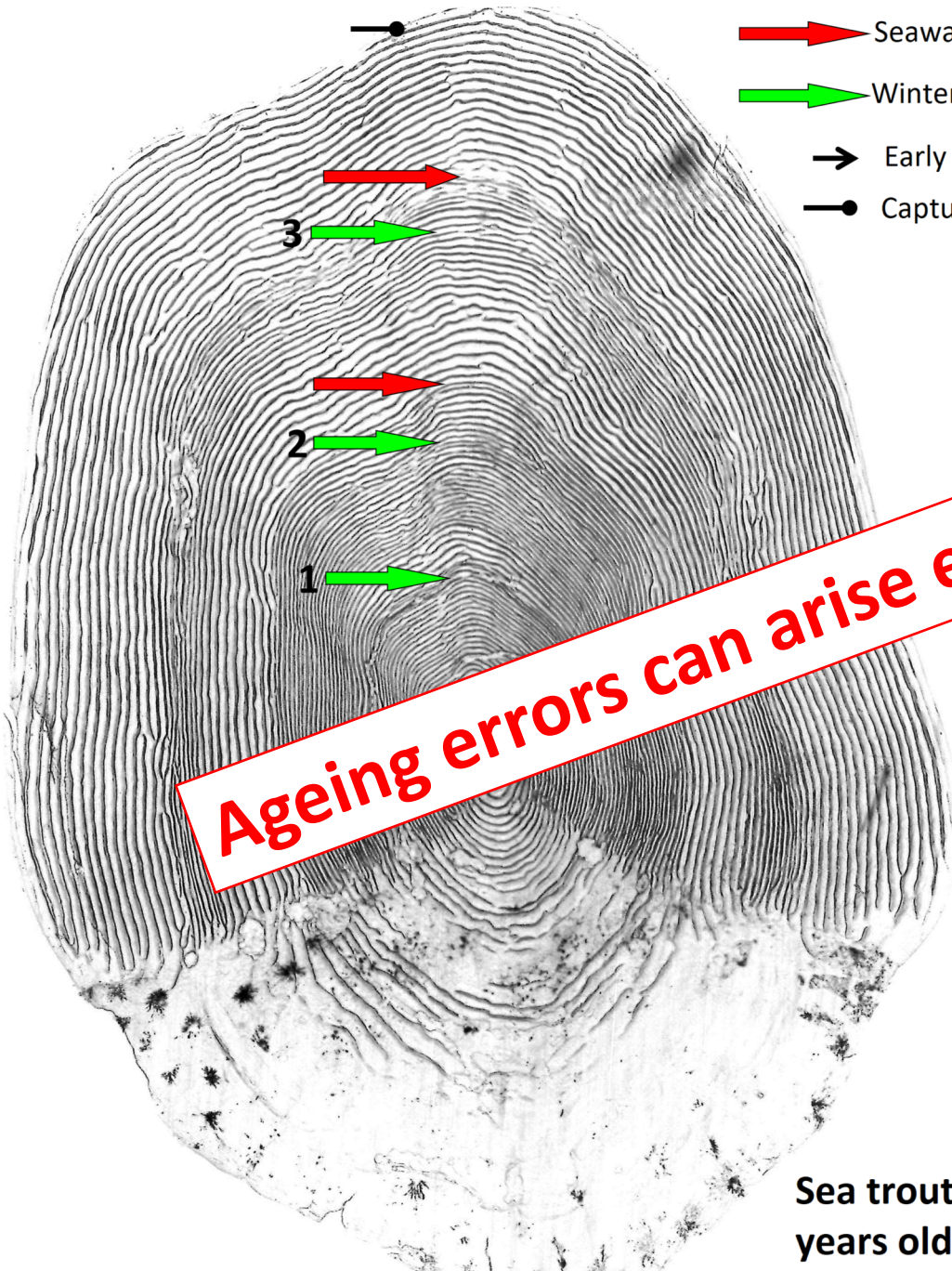
Average ~~relation~~ used to
backcalculate fish length at age





$$L_f \sim w + uR_T^v$$

Parameters in the relation can be variable !!!!

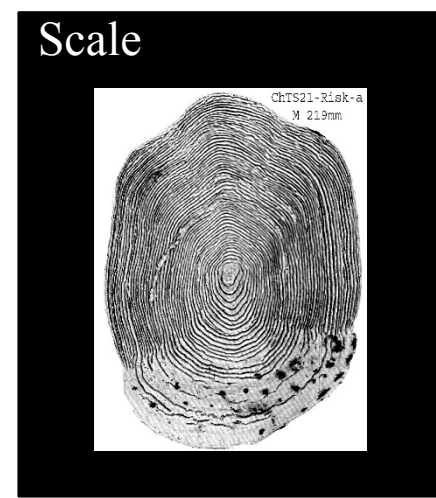
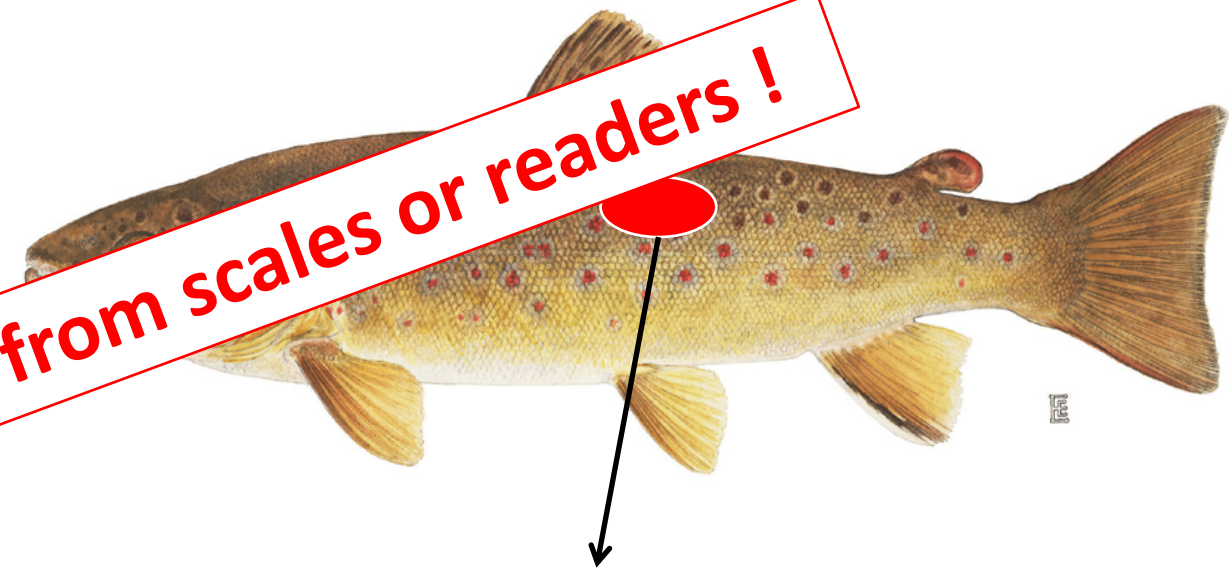
$$L_f \sim w + uR_T^v \quad ; \quad L_t \sim w + (L_f - w) \left(\frac{R_t}{R_T} \right)^v$$

And biases on age and radi read/measured on scale !!!!



-  Seaward migration
-  Winter annulus
-  Early life
-  Capture

Ageing errors can arise either from scales or readers !



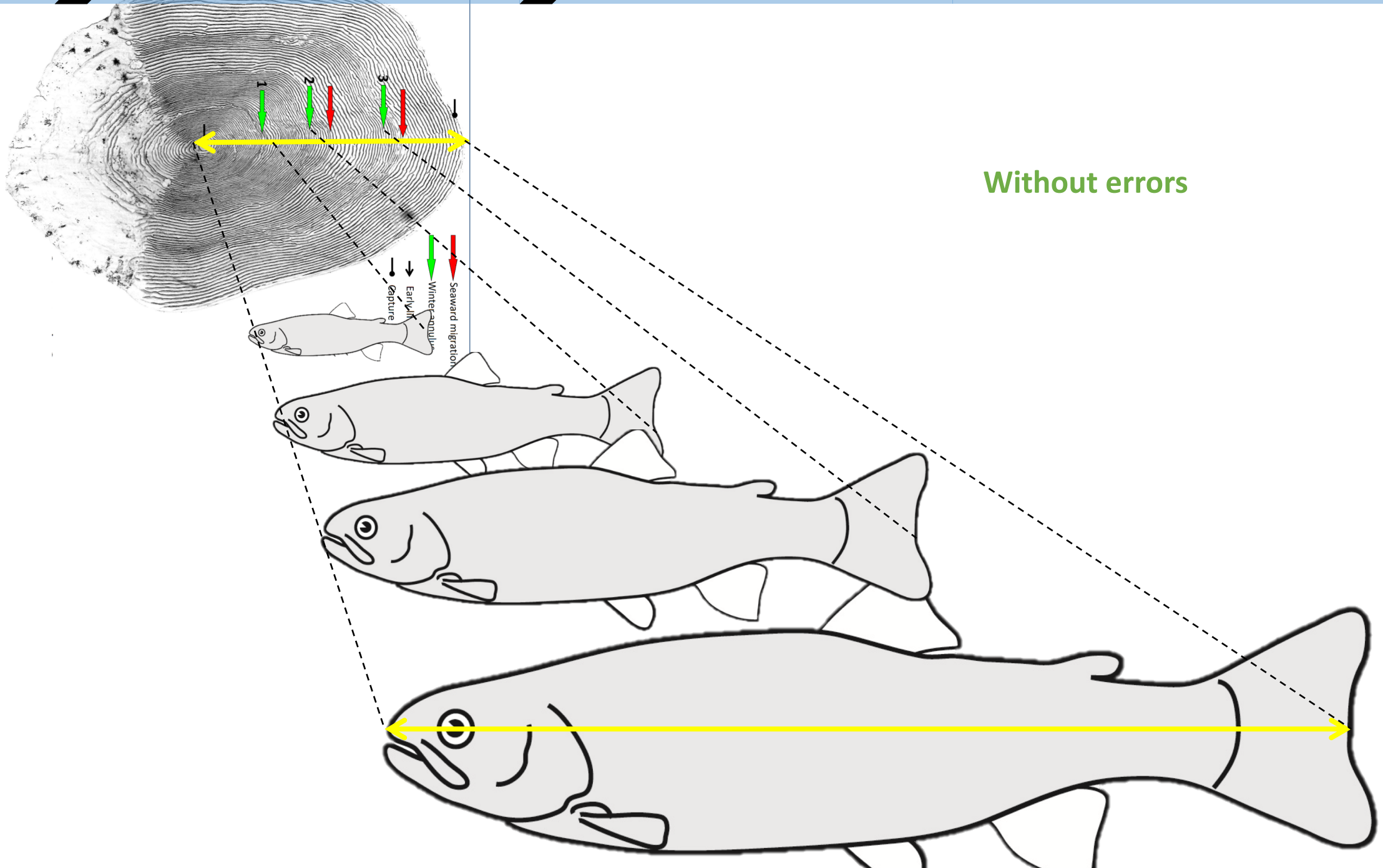
Sea trout scale, 3 years old, 57cm

CONTEXT

REBUILD LIFE HISTORY TRAITS

DESPITE ... VARIABILITY

PERSPECTIVE



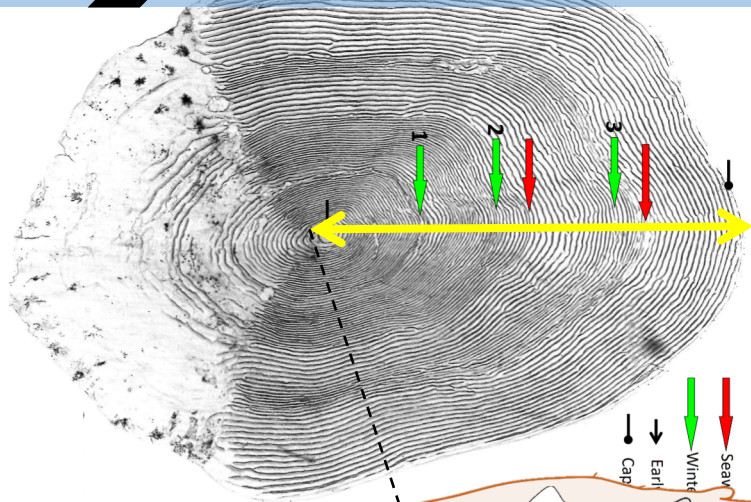
Without errors

CONTEXT

REBUILD LIFE HISTORY TRAITS

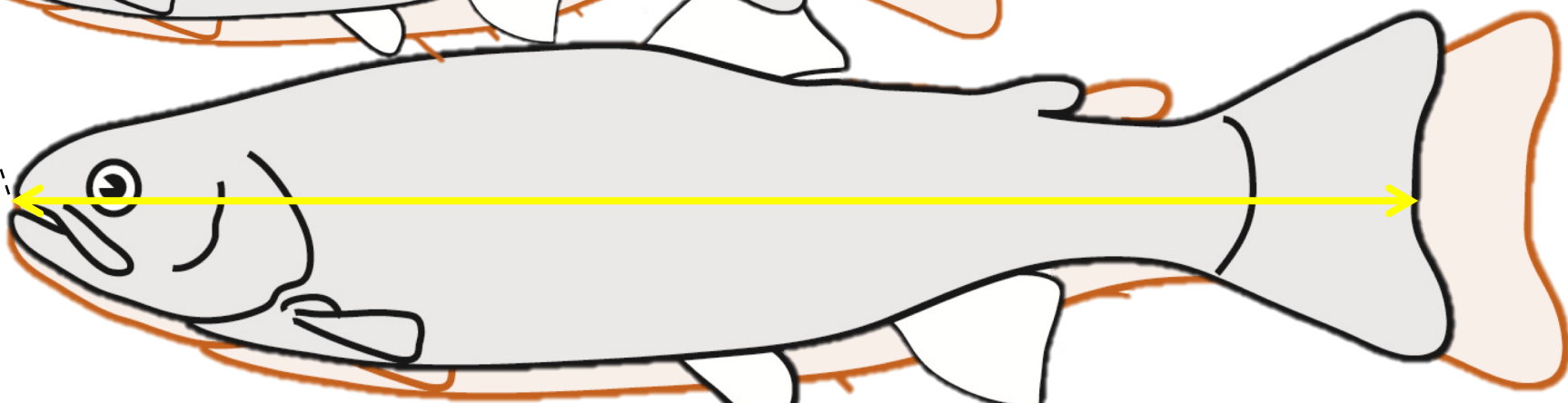
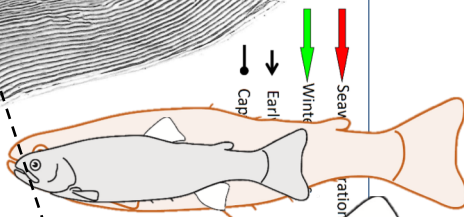
DESPITE ... VARIABILITY

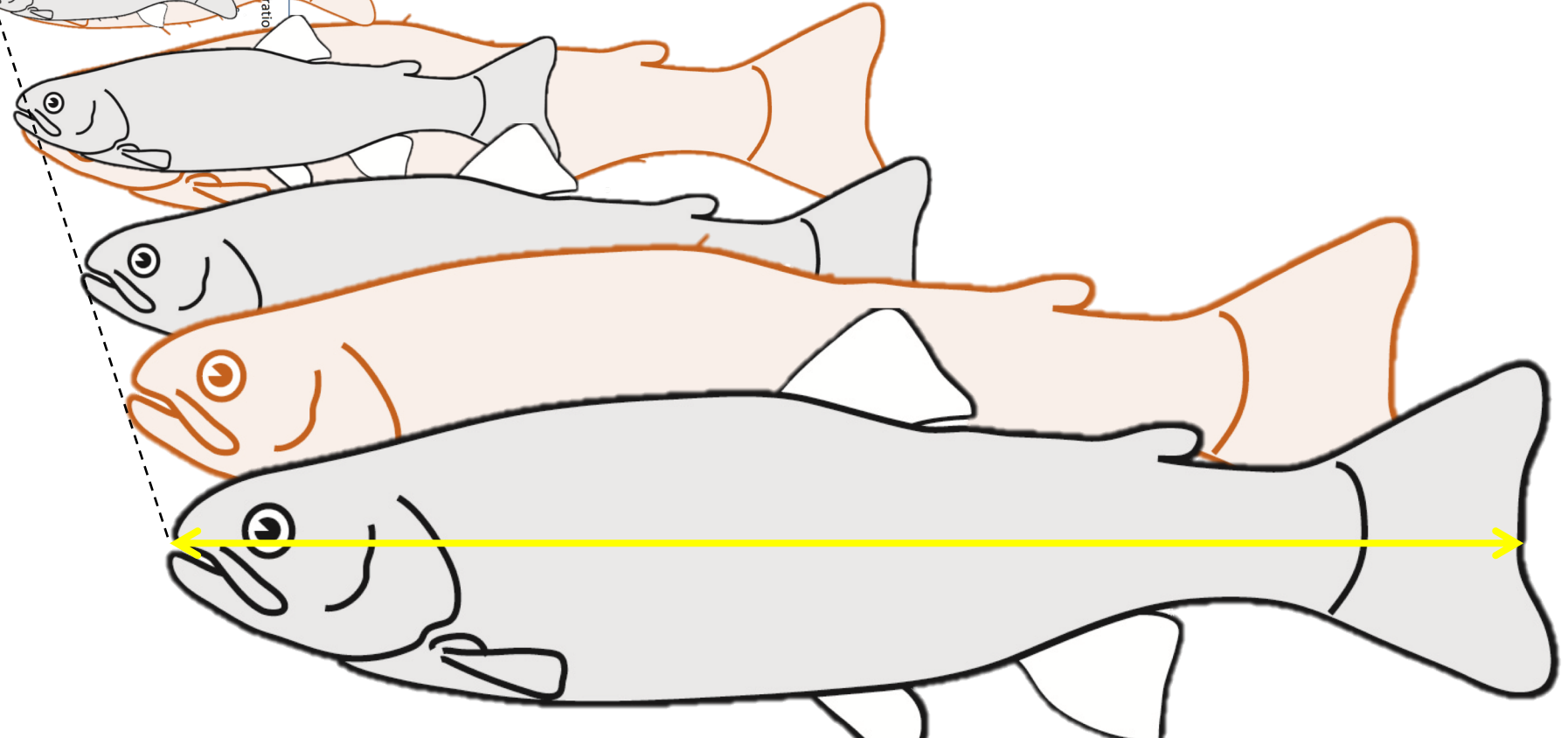
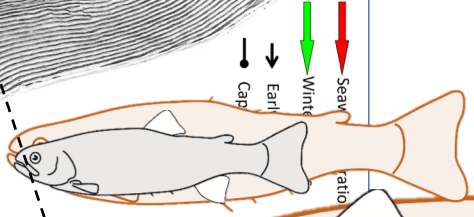
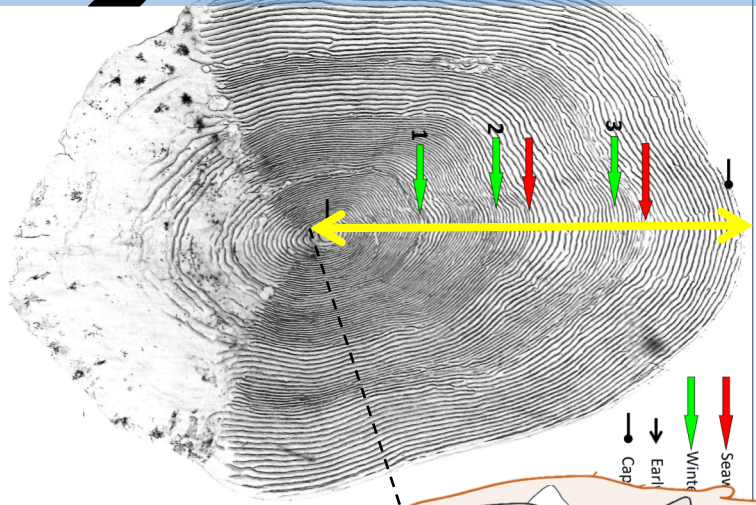
PERSPECTIVE



Without errors

With error in radi measures





Without errors

With error in radi measures
Or even ageing errors !

Even backcalculation models are numerous and give variable values of length at age

Models adjusted with linear model: $RT \sim a+bL_f$ & $L_f \sim c+dRT$

Fraser Lee (FL) $L_t \sim c + \frac{R_t}{RT} (L_f - c)$ (eq.1)

Whitney & Carlander (WC) $L_t \sim \frac{c+dR_t}{c+RT} L_f$ (eq. 2)

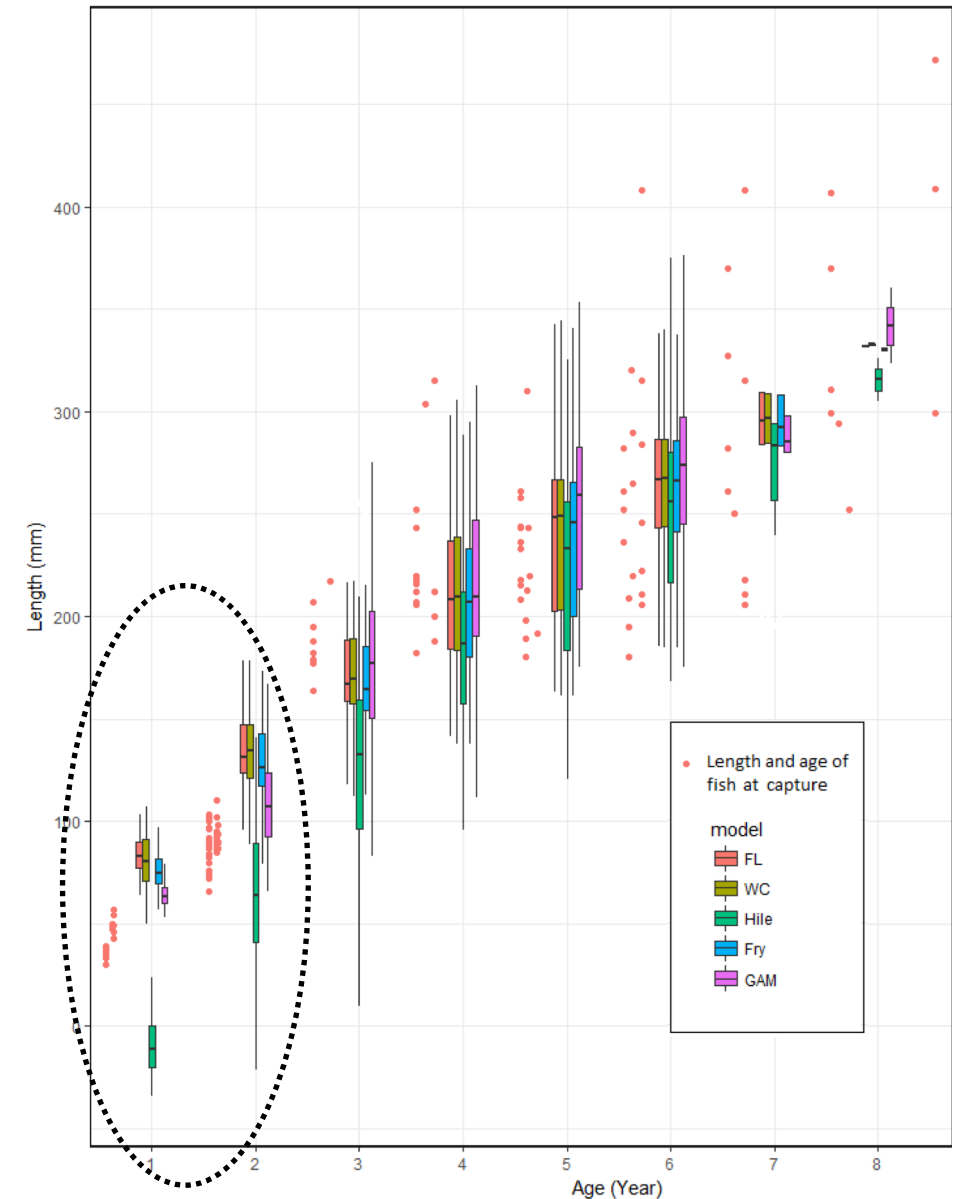
Hile (H) $L_t \sim -\left(\frac{a}{b}\right) + \frac{R_t}{RT} \left(L_f + \frac{a}{b}\right)$ (eq.3)

Model fitted with nonlinear adjustment in R (nls)

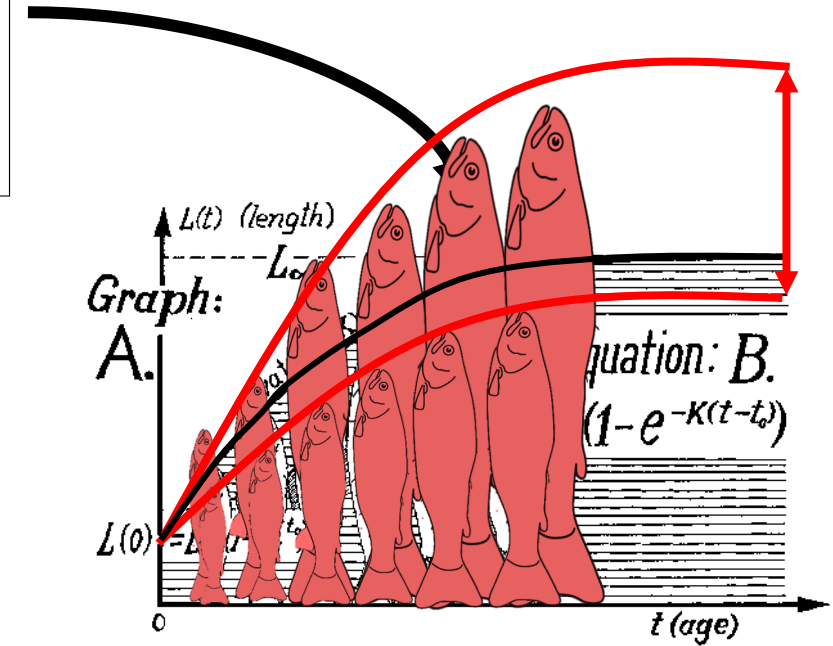
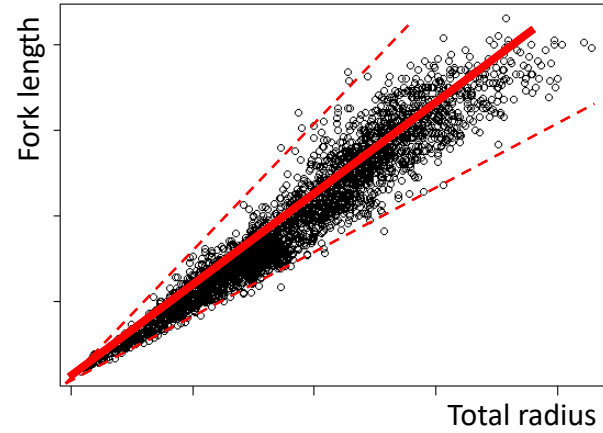
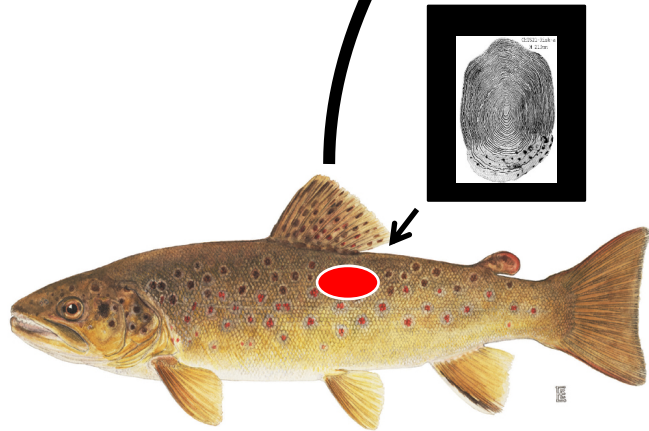
Fry * $L_f \sim w + uR_T^v$; $L_t \sim w + (L_f - w) \left(\frac{R_t}{RT}\right)^v$ (eq. 4)

Generalized additive models:

GAM $L_f \sim s(R_T, k=8, bs="cr")$ (eq. 5)

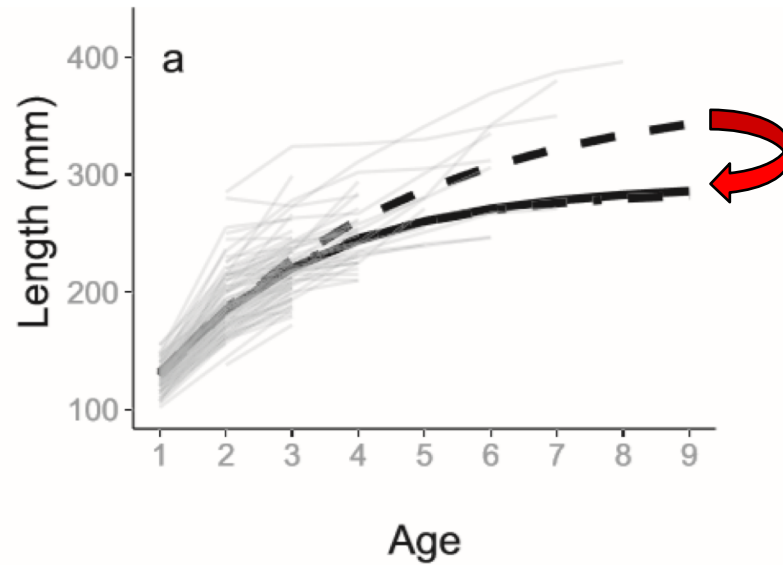


Relation
Fork length \sim Total Radius



➡ Models more accurate with individual random effect taken into account

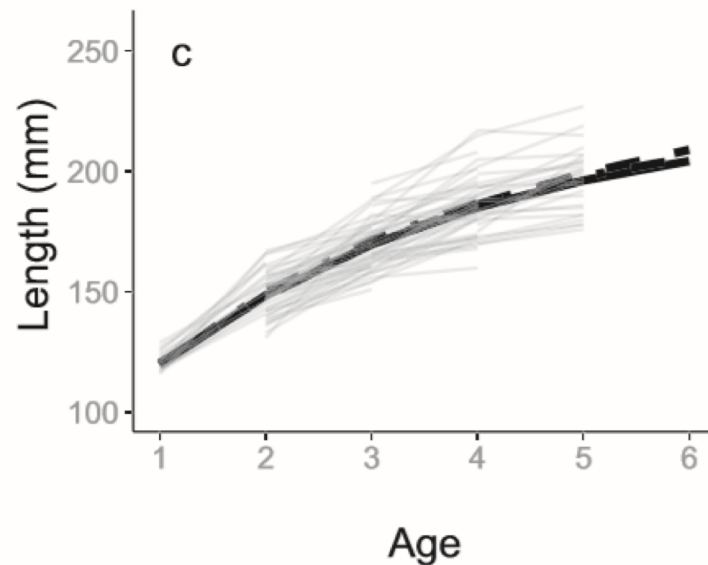
Escati *et al.*, 2010 ; Shelton and Mangel 2012 ; Vincenzi *et al.*, 2014 ; Vincenzi *et al.*, 2016 ;
Javier E. Contreras-Reyes *et al.*, 2018



- Dashed lines : no random effect
- Dash dotted and plain line : with random effects

Prediction is highly dependant on data
Interest in bayesian analysis

Adapted from Vincenzi *et al.*, 2016

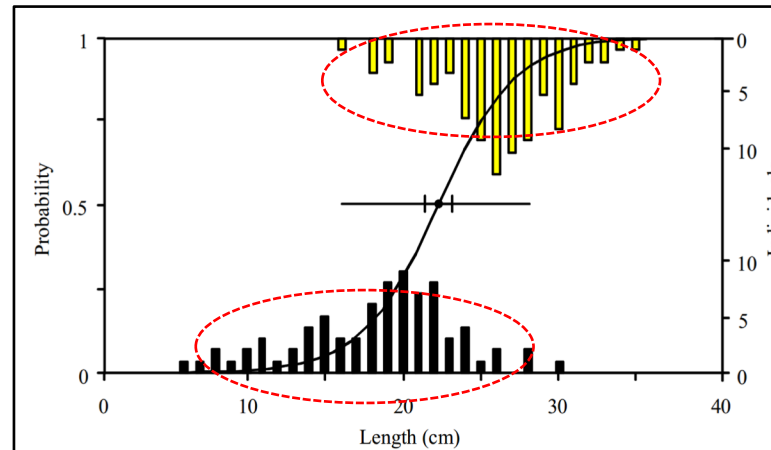
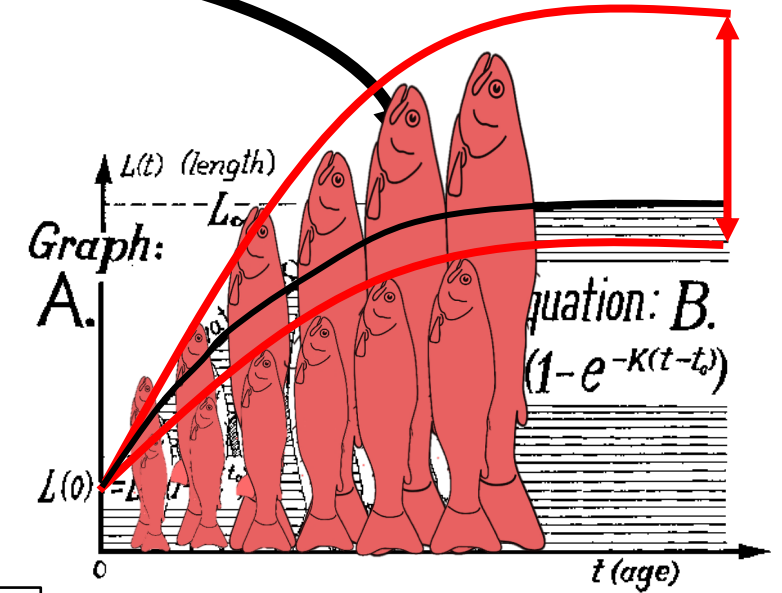
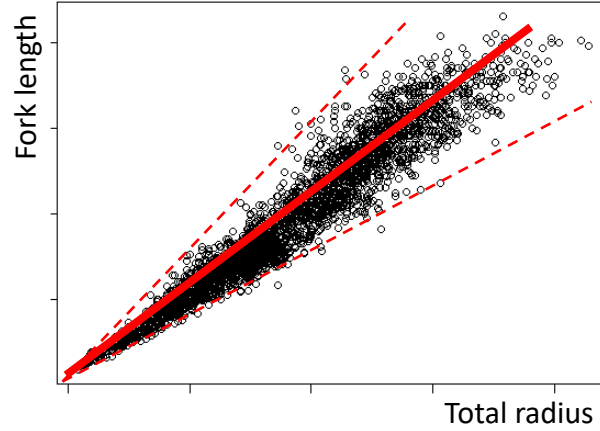
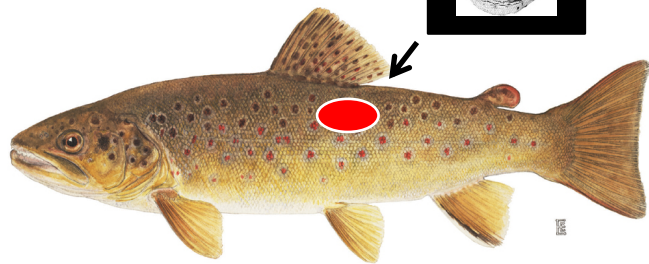


Development of a bayes model in a single framework accounting for the propagation of errors at each step

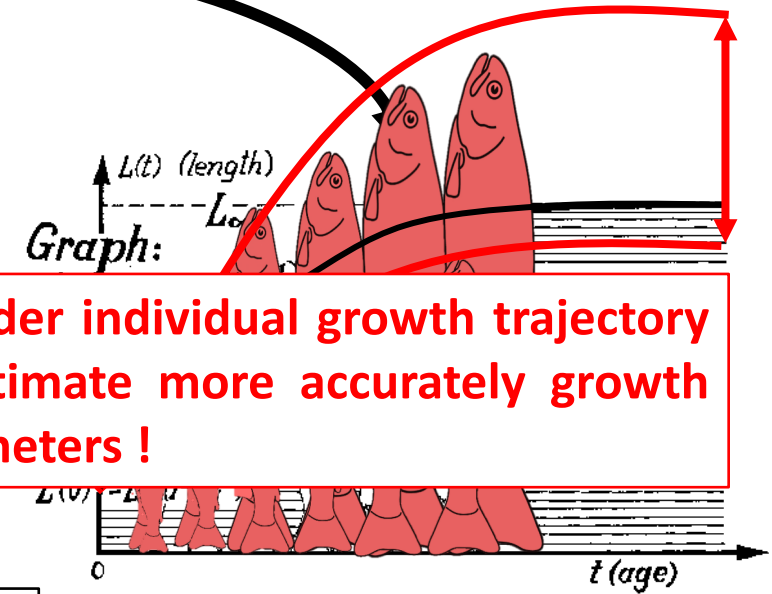
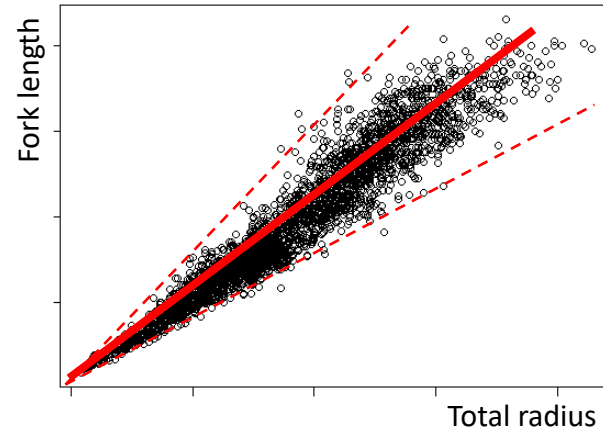
How to accurately describe evolution of life history traits related to migration while taking into account

- Methodological variability
- Individual variability
- and
- Environmental factors ?

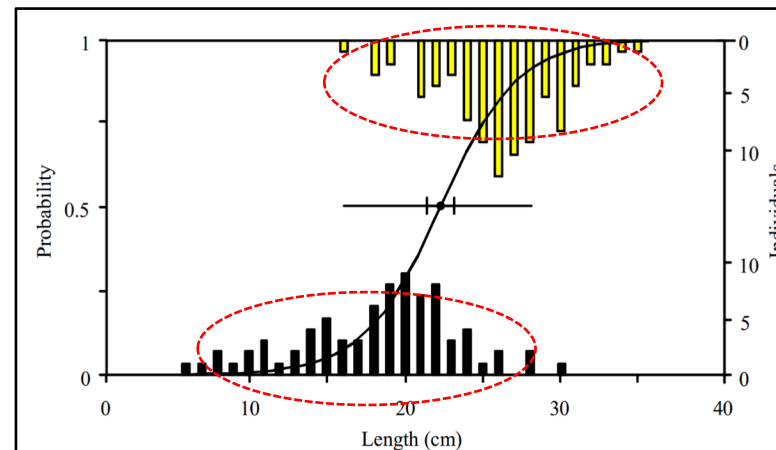
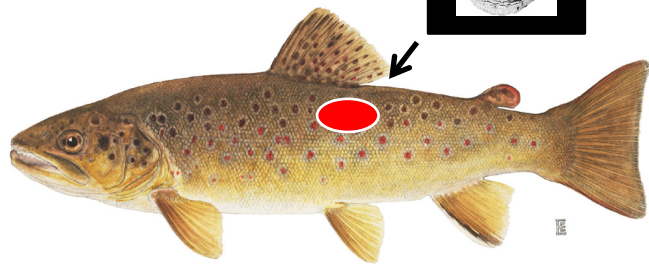
Bayes approach to take biological information and ageing errors into account.
 Fontez and Cavalli, 2014



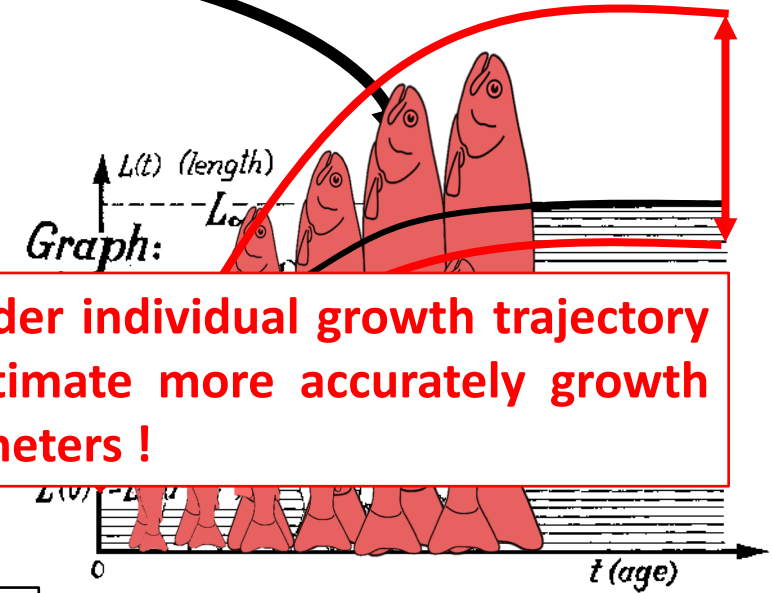
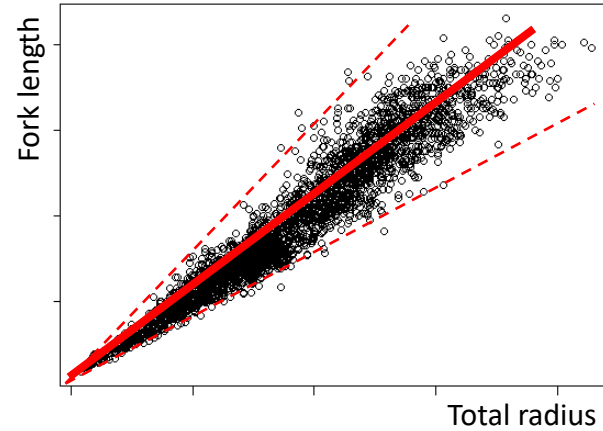
Bayes approach to take biological information and ageing errors into account.
Fontez and Cavalli, 2014



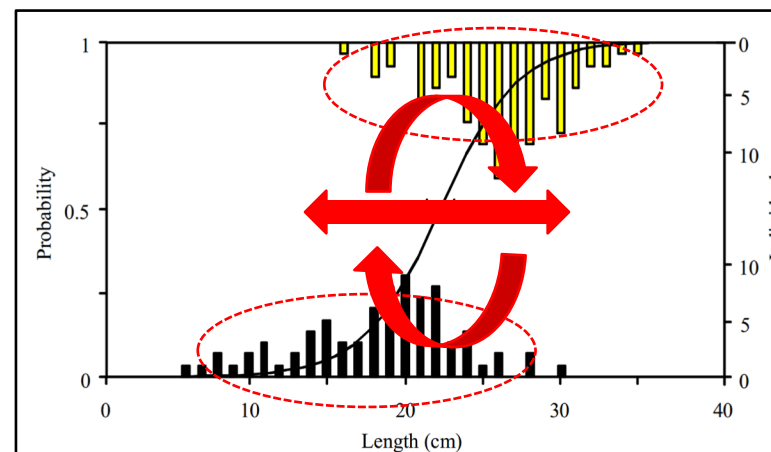
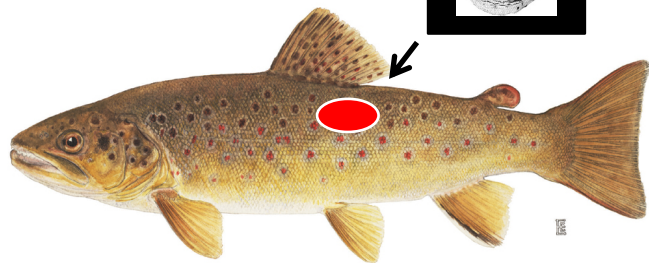
Consider individual growth trajectory to estimate more accurately growth parameters !



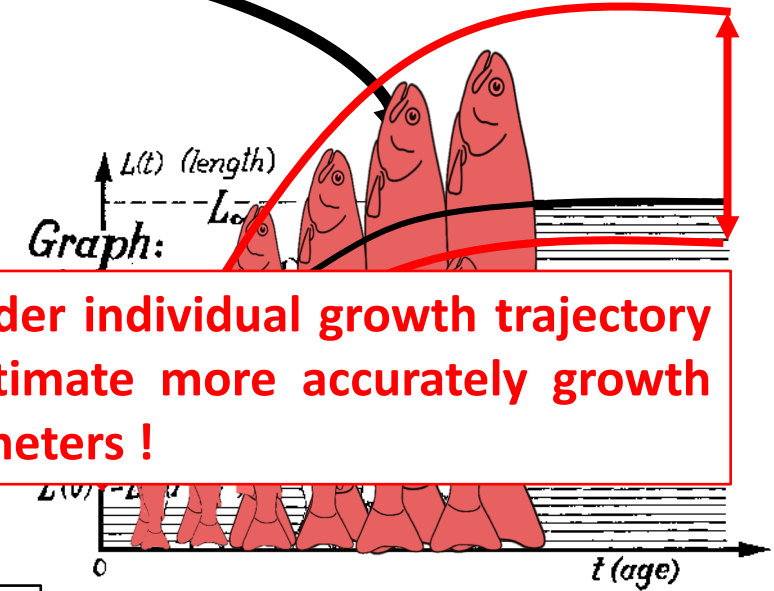
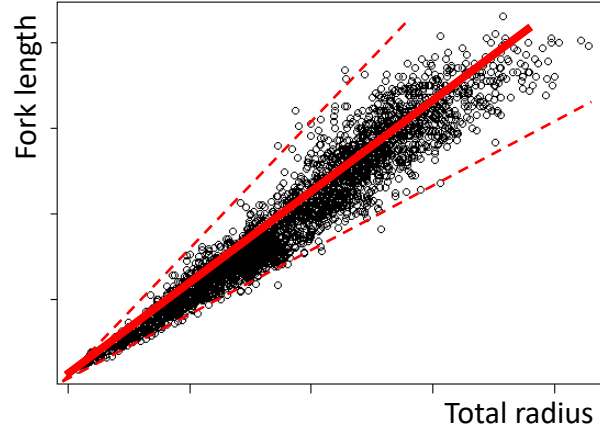
Bayes approach to take biological information and ageing errors into account.
Fontez and Cavalli, 2014



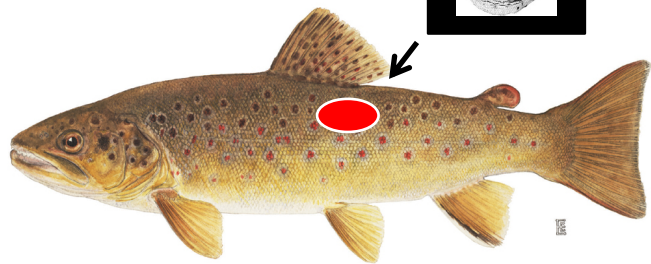
Consider individual growth trajectory to estimate more accurately growth parameters !



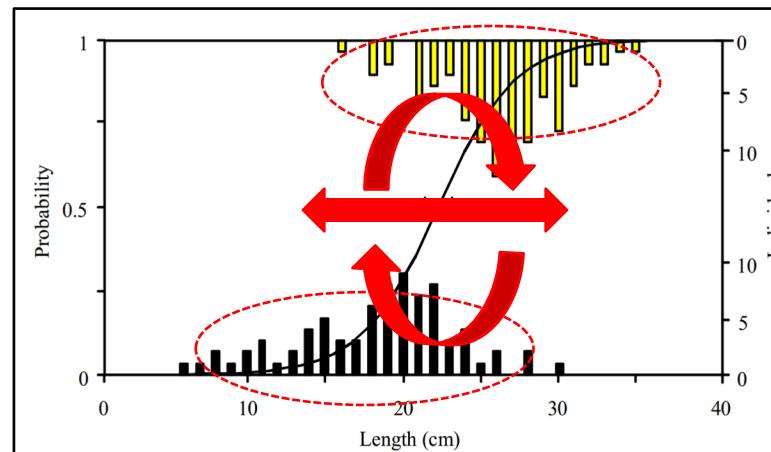
Bayes approach to take biological information and ageing errors into account.
 Fontez and Cavalli, 2014



Consider individual growth trajectory to estimate more accurately growth parameters !



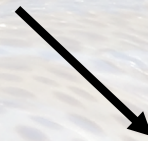
EVOLUTION along a colonization front ?????



Study of Life history traits related to
MIGRATION



AGE AT MIGRATION
SIZE AT MIGRATION



SPATIO TEMPORAL EVOLUTION
ALONG A COLONIZATION FRONT ???



IMPACT ON THE INVASION DYNAMIC ???

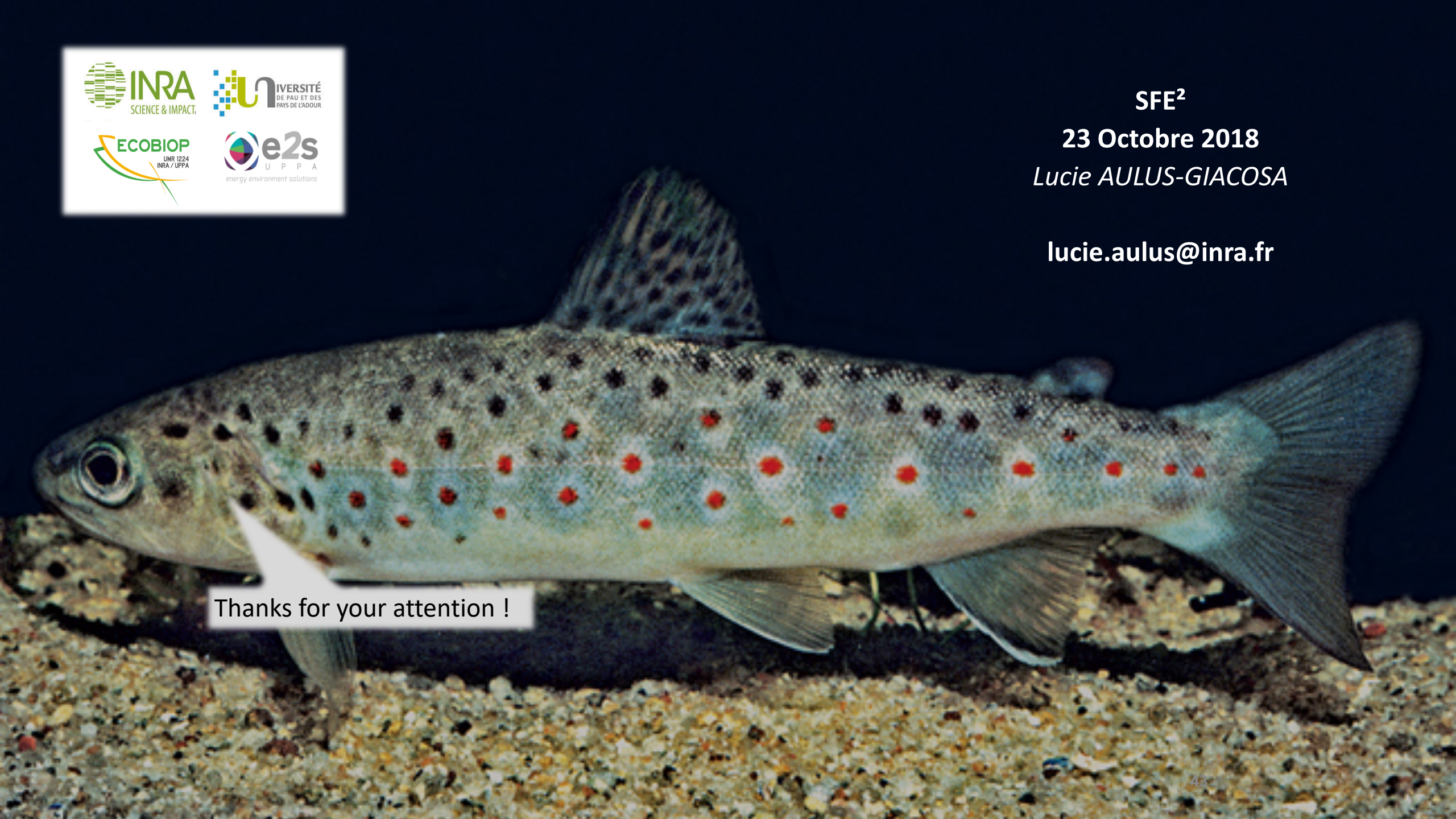


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23 Octobre 2018

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Thanks for your attention !