APPLYING A DEB MODEL TO UNDERSTAND NEMATODE PARASITES INFLUENCE ON THE BIOENERGETICS, REPRODUCTION AND CONDITION OF FISH

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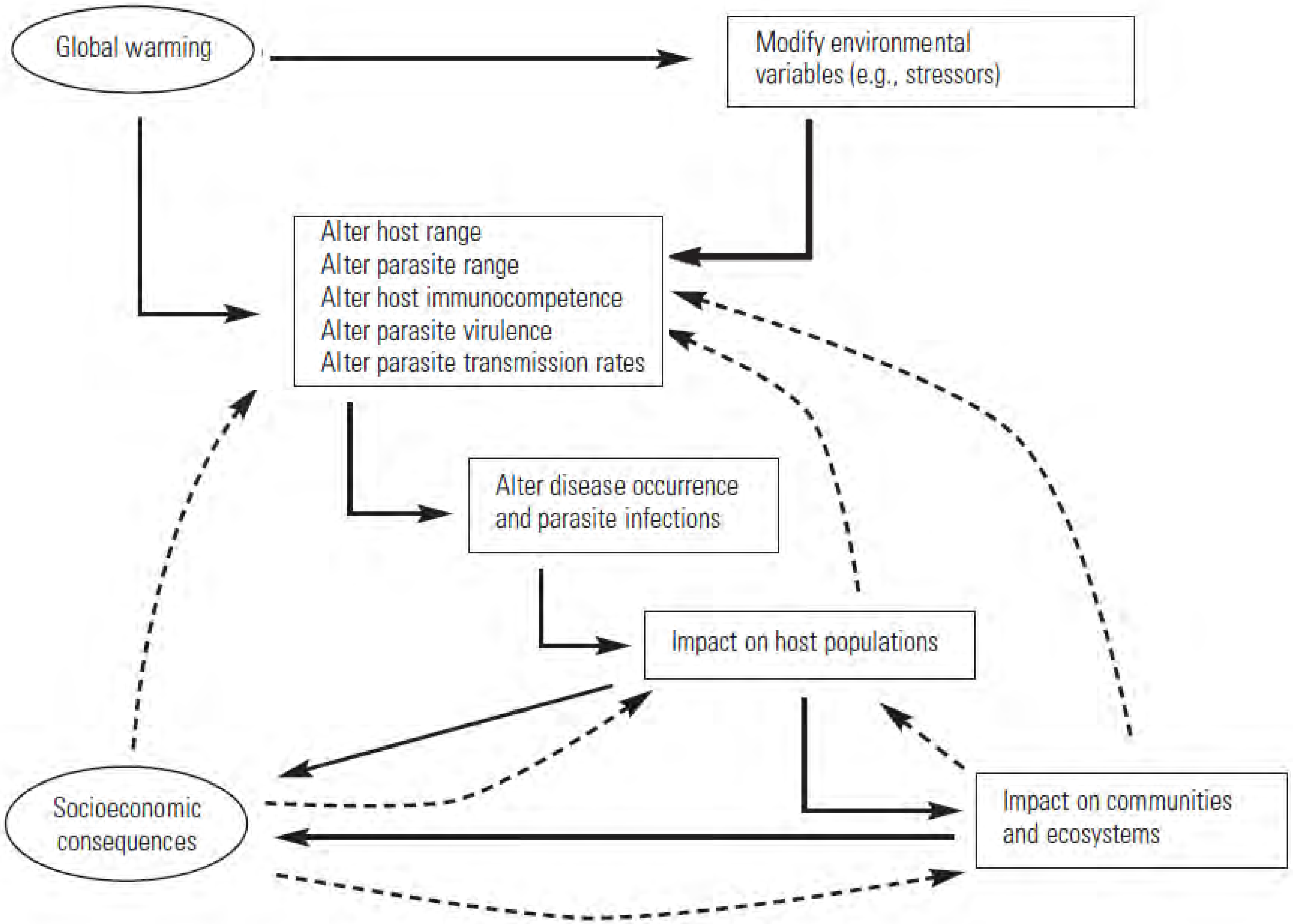
GR MAR

IMEDEA CSIC

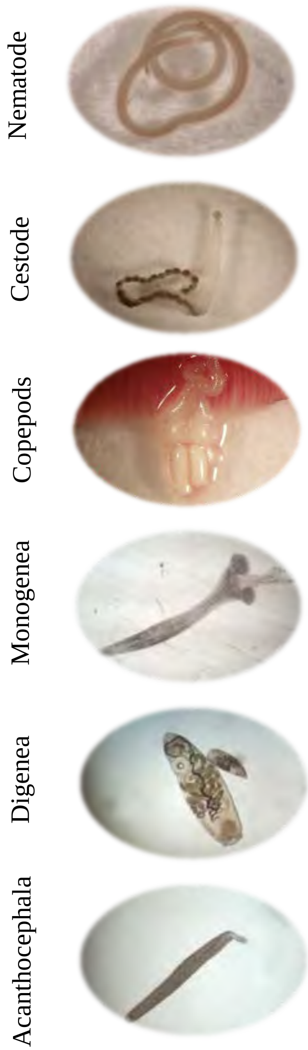
PARASITES
AND CLIMATE CHANGE

“Temperature is one of the strongest abiotic environmental factors modifying host-parasite interaction”
Lazzaro & Little 2009

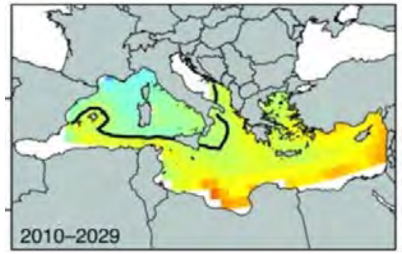


Marcogliese, 2008

Metazoan parasites:



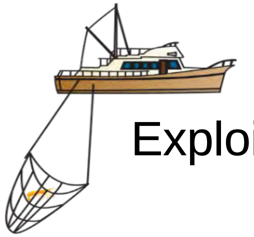
AIM: HOW METAZOAN PARASITES INFECTION MAY AFFECT THE FISH FLOW AND BALANCE OF ENERGIES, CONDITION AND REPRODUCTION?



NW Mediterranean

+

+



Exploited species

+

Abundance decline

CASE STUDY:

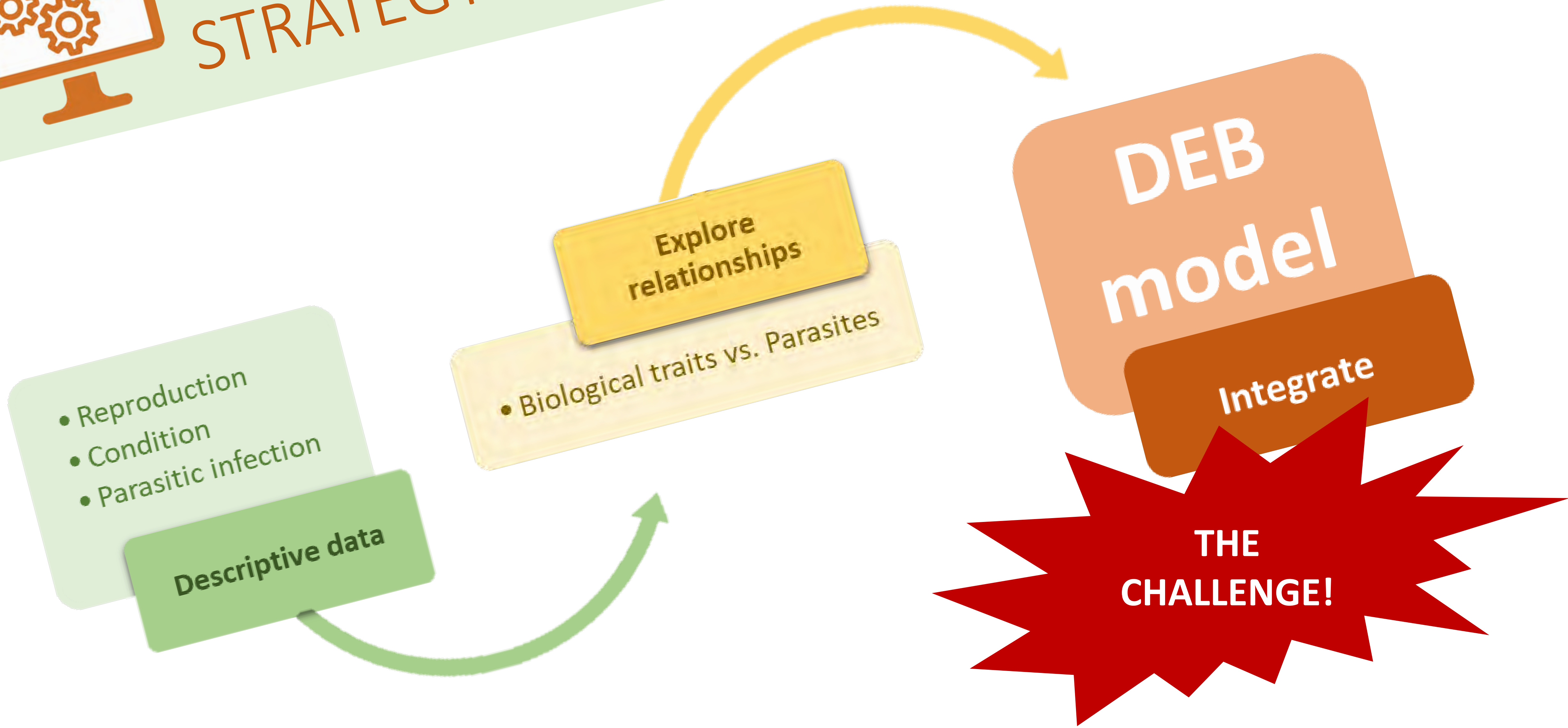
Nematodes

Micromesistius poutassou

Pelagic

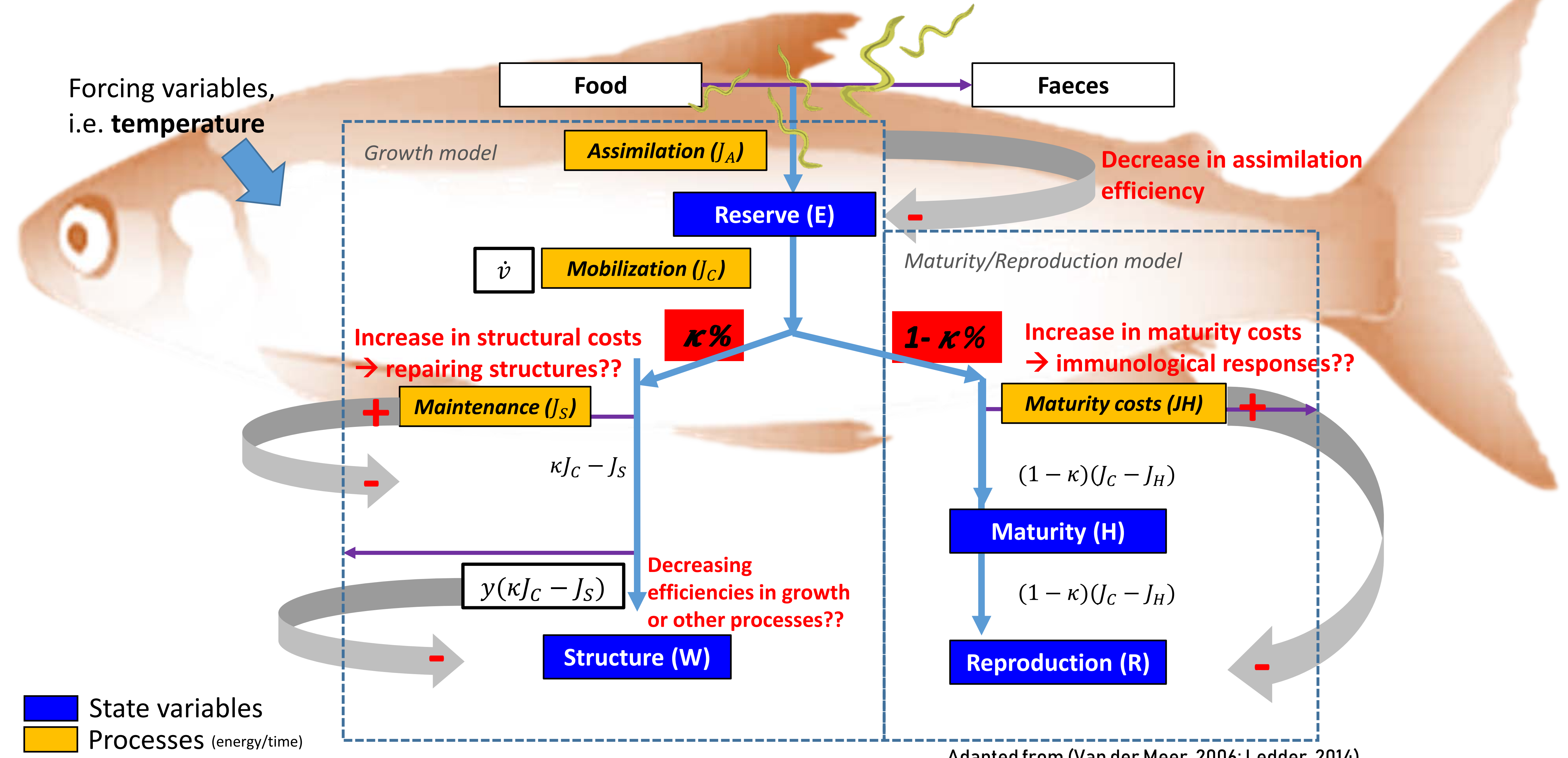
150-3000 m

STRATEGY


• Reproduction
• Condition
• Parasitic infection
Descriptive data
Explore relationships
• Biological traits vs. Parasites
DEB model
Integrate
THE CHALLENGE!

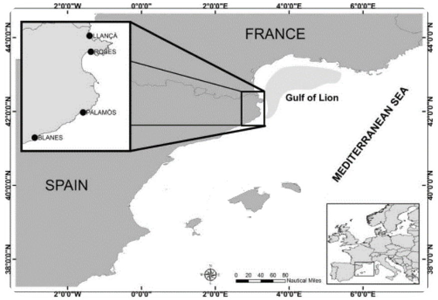
How DEB theory predicts the dynamics of internal state variables dealing with the major mass/energy fluxes.

Is PARASITISM affecting this network of energy flows?



Adapted from (Van der Meer, 2006; Ledder, 2014)

SAMPLING SCHEME



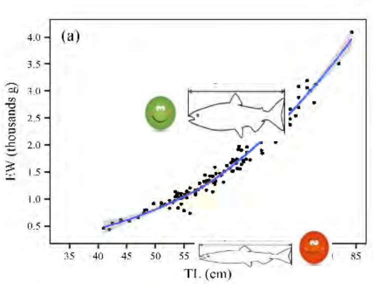
FULL ANNUAL CYCLE:
commercial landings from COSTA BRAVA

…and research vessel surveys

METHODOLOGY

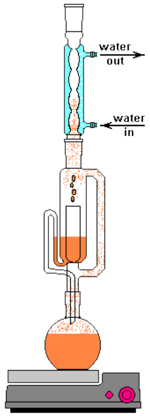
n= 680 specimens

FISH CONDITION

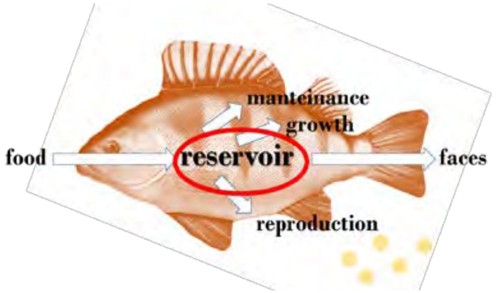


Morphometry:
Le Cren's Factor (Kn)

Hepatosomatic index (HSI)
Spleenosomatic index (SSI)



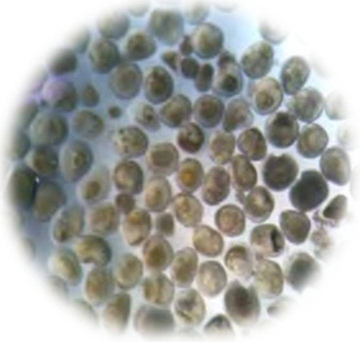
Lipid extraction
(Soxhlet's method)



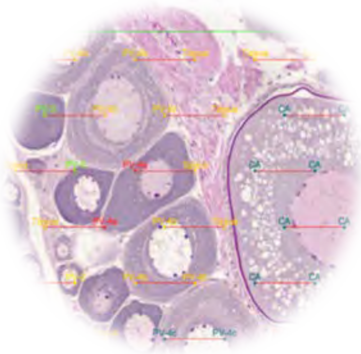
Identification of
reservoires

REPRODUCTIVE POTENTIAL

Gonadosomatic index (GSI)



Batch fecundity
(whole-mounts)

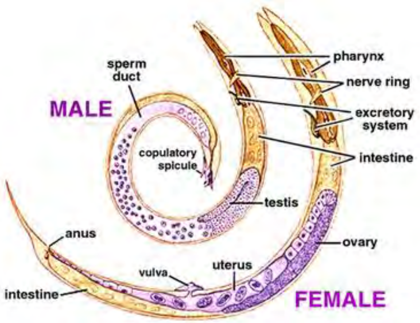


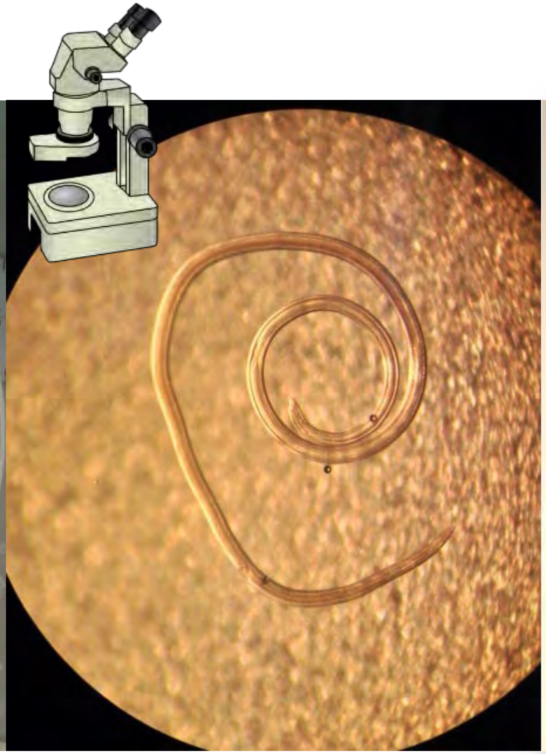
Batch fecundity
(histology)

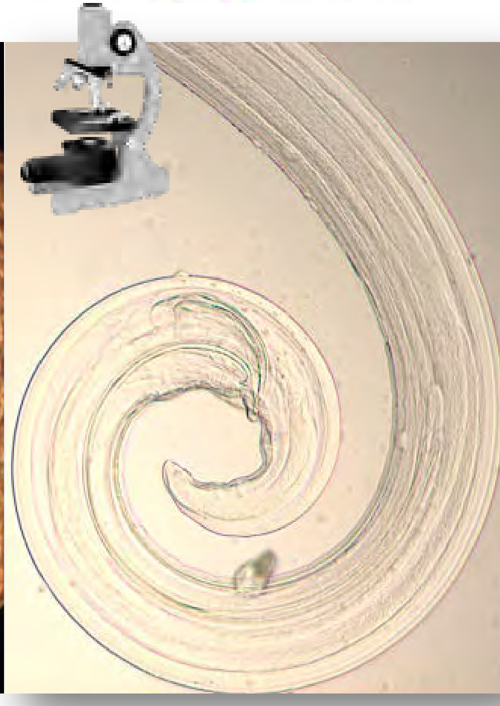
Egg quality
(dry weight)

METHODOLOGY
PARASITES

n= 175 specimens







IDENTIFICATION OF MORPHOTYPES, PREVALENCES (P) AND INTENSITY (I) OF INFECTIONS

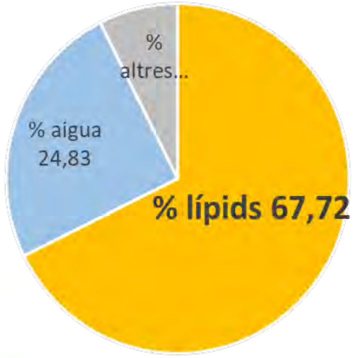
P= 100 x (number of infected hosts / number of examined hosts)
I= number of parasites / number of infected hosts

Quantitative Parasitology (QPweb)

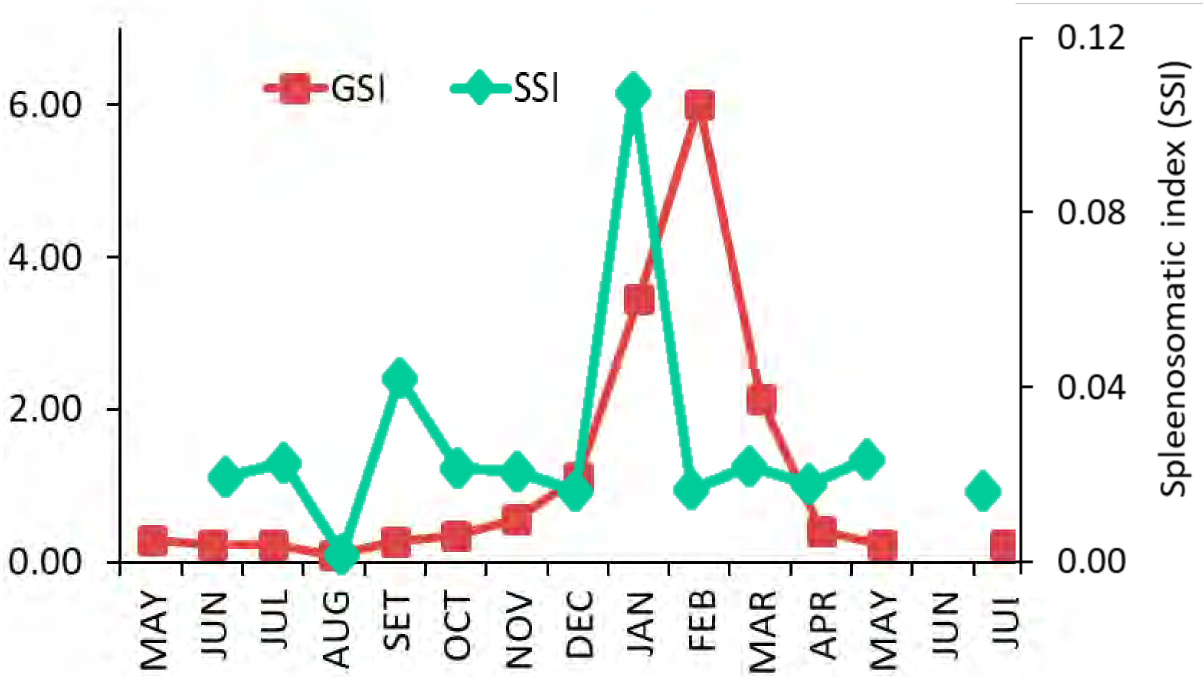
RESULTS: REPRODUCTION & CONDITION

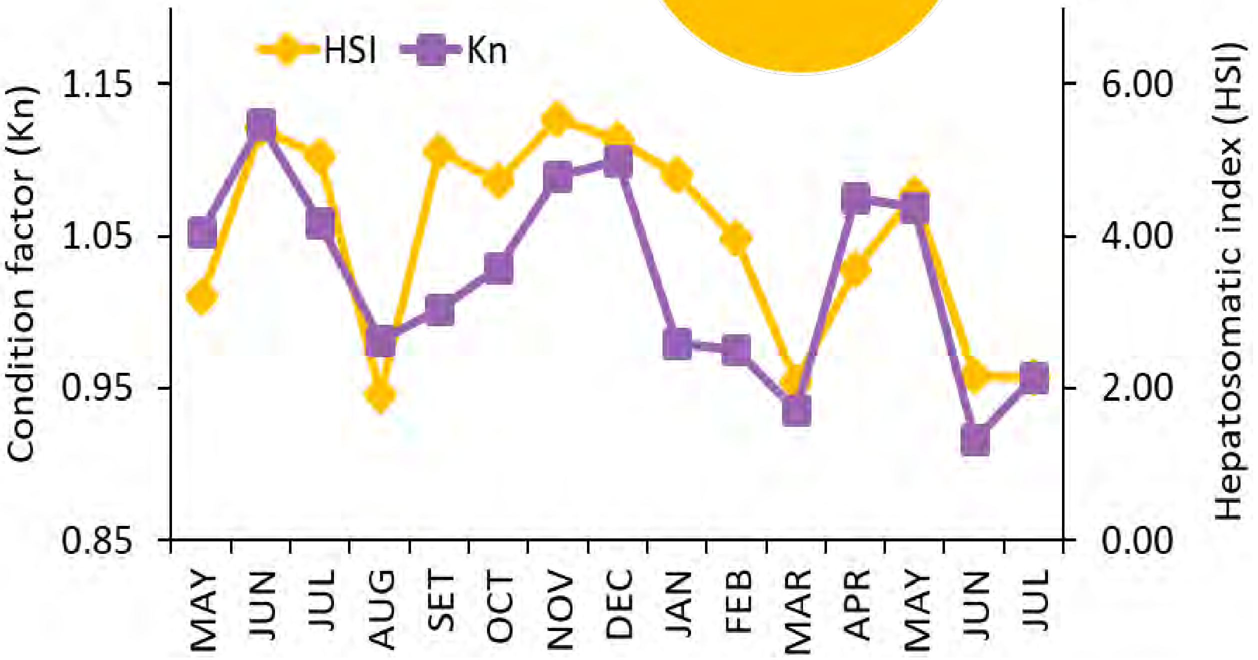
MAIN ENERGY DEPOT: **LIVER**

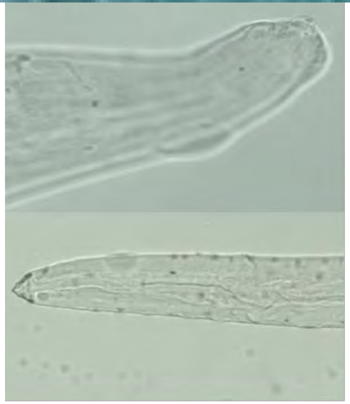
Liver composition (% wet weight)

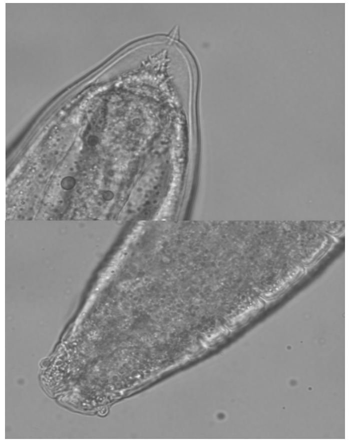


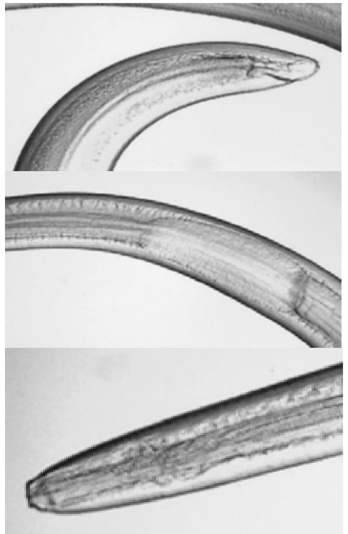
Spleen mass variation may be influenced by several factors such as parasite load, reproductive status, migration, and hormone levels, Smith and Hunt 2004



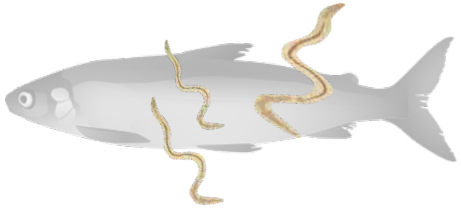








PARASITIC NEMATODE COMMUNITY



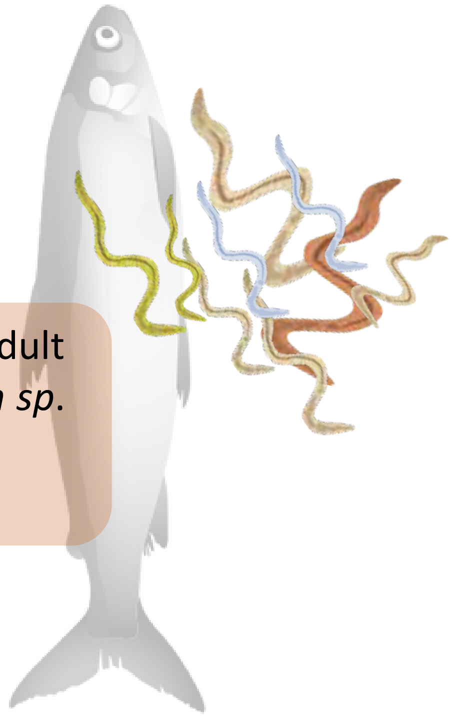
70%
(n=174)

Morphotype	Prevalence (%)	Intensity	
		Mean	Median
MFT1: *Anisakis pegreffii* L3	48.9	5.72	2
MFT2: *Hysteortilacium aduncum* L3	28.7	2.82	1
MFT3: *Anisakis physeteris* L3	23	1.55	1
MFT4: *Hysteorthylacium aduncum* L4	6.3	1.91	1
MFT 5: *Cysticolidae* sp.	4	1	1
MFT 6: *Hysteorthylacium* sp. L2	3.4	8.5	4.5
MFT 7: *Spinitectus* sp.	2.9	1	1
MFT 8: NI1	2.3	1.5	1
MFT 9: NI2	1.7	1.33	1
MFT 10: NI3	1.1	1	1
MFT 11: *Hysteorthylacium aduncum* adu	0.6	1	1
MFT 12: *Contracaecum* sp.	0.6	1	1
MFT 13: *Camallanus* sp.	0.6	1	1
MFT 14: *Cucullanus* sp	0.6	1	1
MFT 15: NI 4	0.6	1	1
NI: no identified			
Tetraphyllidae plerocercoid	41.4	70.89	

DIFFERENCES BETWEEN SEXES

♀

H. aduncum adult
Contracaecum sp.
MFT8
MFT9



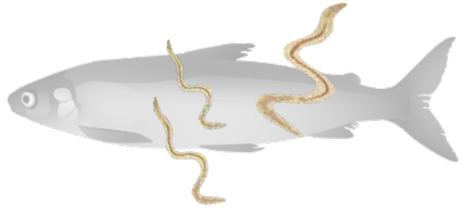
♂

Cucullanus sp.
Camallanus sp.

		♀	♂
Nematodes	Intensity	5.3	2.8
	Abundance	3.9	1.9
	Richness	13	9

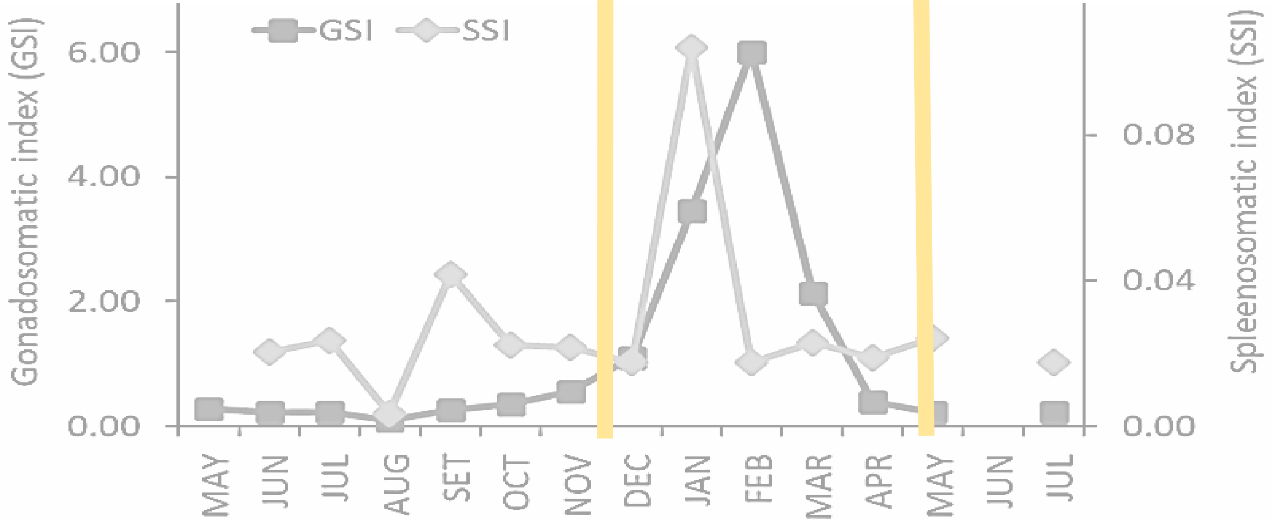
Mean values. Significantly different ($p<0.05$) by bootstrap 2-sample t-test.

DIFFERENCES BETWEEN OVARY DEVELOPMENT PHASES



	Parameter	Immature	Developing	Spawning capable	Actively spawning	Regressing	Regenerating
		Ovary development phase					
General	Prevalence	50.0	75.7	72.7	46.2	75.0	80.0
	Mean intensity	1.2	5.5	5.4	3.2	4.7	6.2
	Relative specific richness	0.3	0.2	0.5	0.3	0.2	0.2
	n	10	37	22	13	24	15
Specific prevalence	*Anisakis pegreffii*	20.0	59.5	63.6	23.1	66.7	53.3
	Anisakis physeteris	0.0	27.0	18.2	0.0	45.8	26.7
	Hysteorthylacium aduncum L4	0.0	0.0	9.1	7.7	20.8	0.0
	MFT8: NI1	0.0	0.0	4.5	15.4	0.0	0.0
	Tetraphyllidae plerocercoid	10.0	29.7	54.5	30.8	58.3	26.7

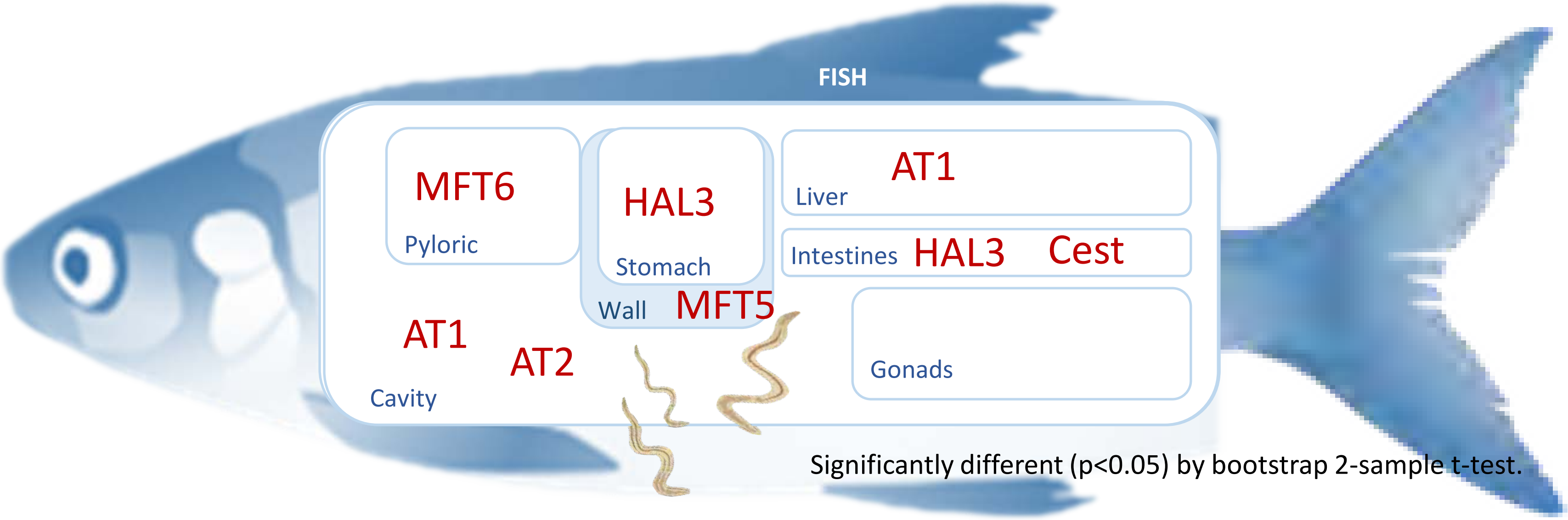
Mean values. Significantly different ($p<0.05$) by bootstrap 2-sample t-test.



ANATOMICAL DISTRIBUTION OF INFECTION

TISSUE	Prevalence (%)	Nematode richness	Mean intenstiy
CAVITY	45.40	0.58	2.33
LIVER	29.30	0.33	2.86
STOMACH	26.40	0.32	1.63
STOMACH WALL	16.70	0.25	1.50
INTESTINES	11.50	0.13	1.65
PYILORIC CAECA ext	10.90	0.17	3.89
PYLORIC CAECA int	5.60	0.06	1.33
MUSCLE	4.40	0.04	1.00
GONADS	4.30	0.09	2.00

Sites of highest prevalence of the morphotypes showing significant differences:



AT1: *Anisakis pegreffii*; AT2; *Anisakis physeteris*; HAL3: *Hysterothylacium aduncum* L3; MFT6: *Hysterotyilacium* sp. L2; MFT5: *Cysticoldae*; Cest: *Tetraphyllidae* plerocercoid

SOMATIC INDICES & PARASITES

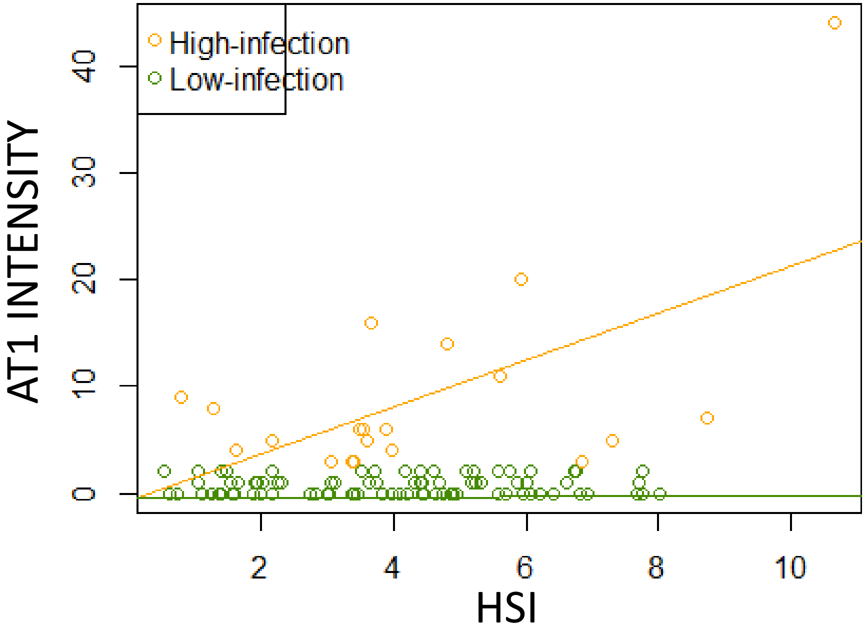
Significant differences between infected and uninfected fish

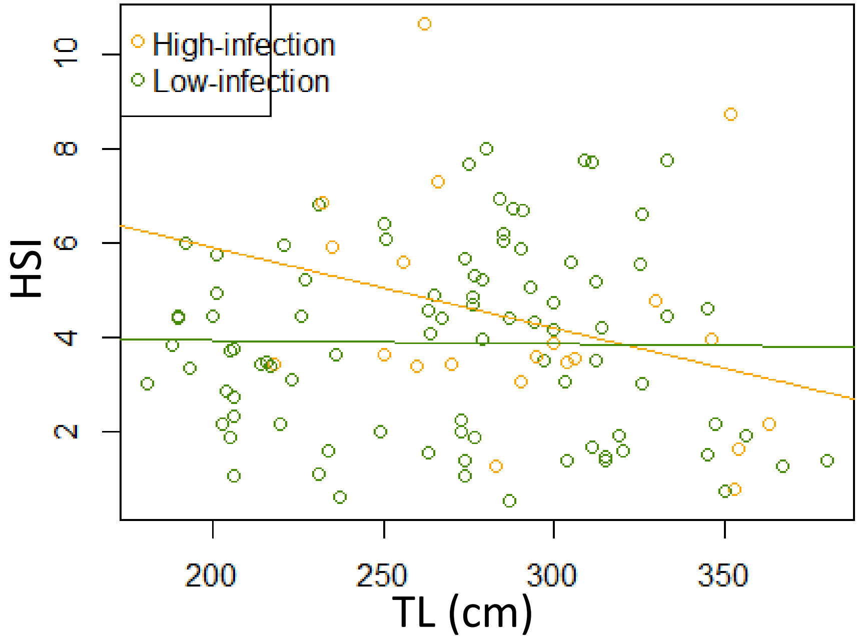
Significantly different (p<0.05) by Mann–Whitney *U* test and/or least square contrasts.

Nematodes	TL	HSI	GSI	SSI	Kn
All				Higher	
AT1	Higher				
HAL3					
AT2	Higher		Higher		
HAL4					Lower
MFT5				Higher	

Higher
Lower
No significant

Observed trends





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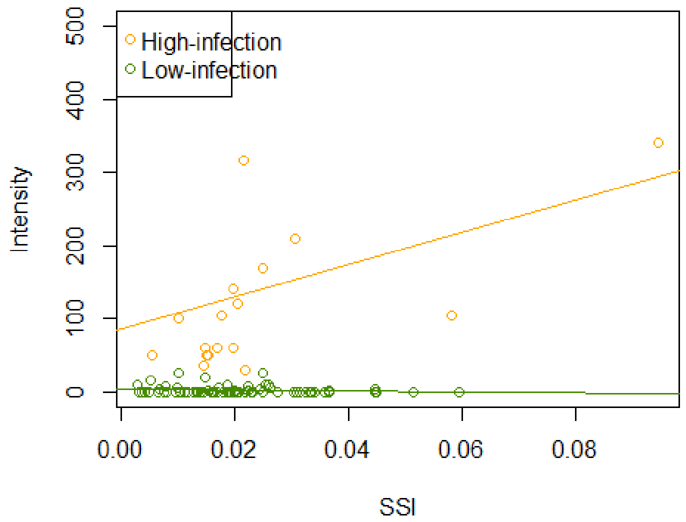
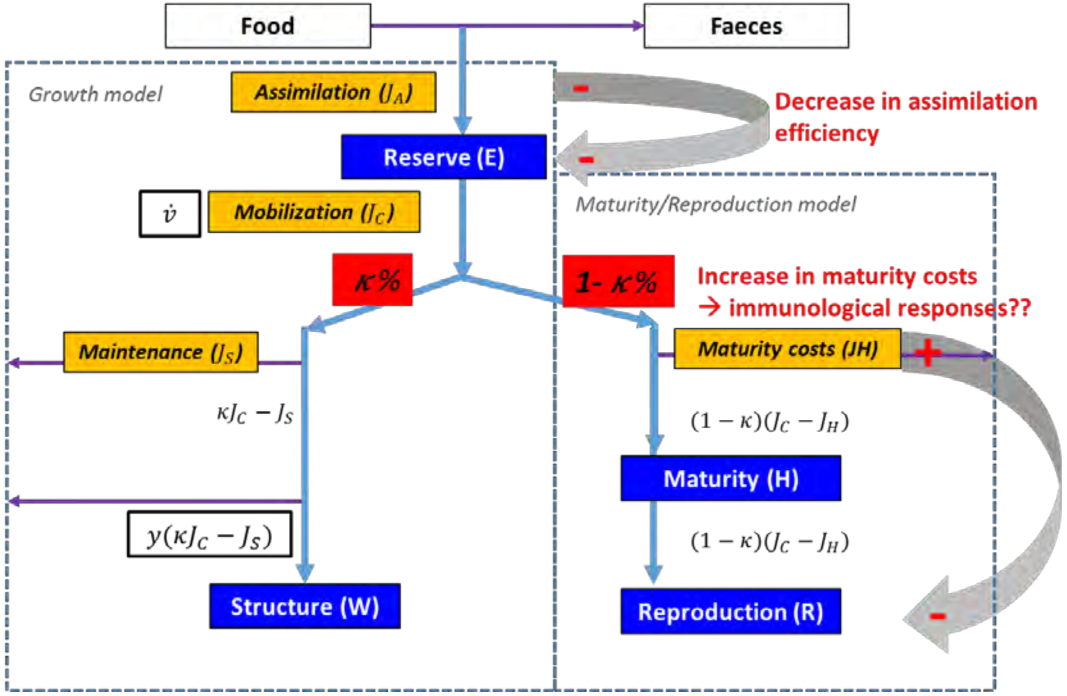
LET'S PLAY!

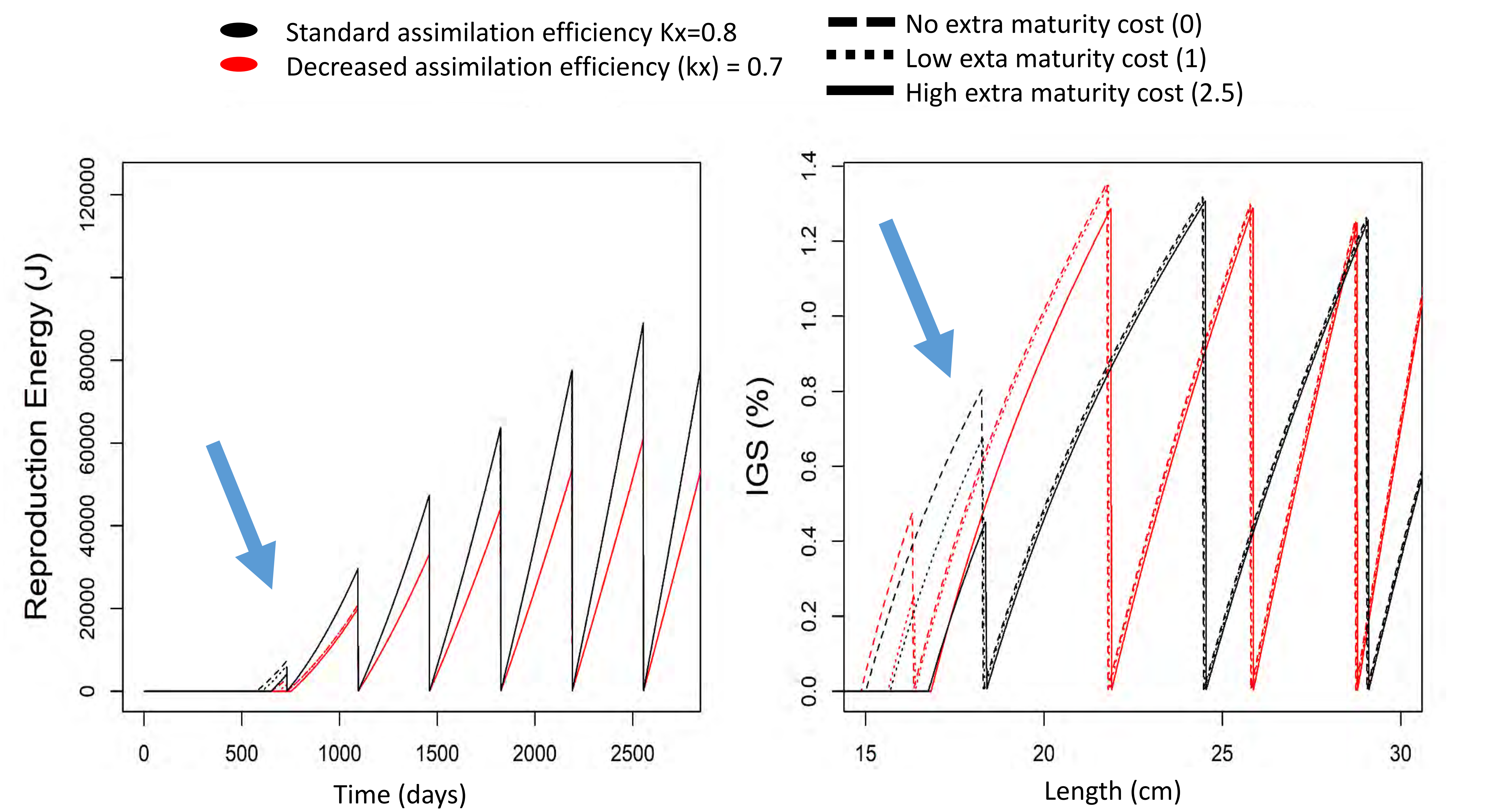
Tetraphyllidean plerocercoid

- Infect digestive system (active mode)-> **Direct competition for food** or feeding from…
- Positive relation btw intensity of infection and SSI-> **Immune response**



Work hypothesis:
Tetraphillidean plerocercoids are affecting the host assimilation efficiency and the maturity cost





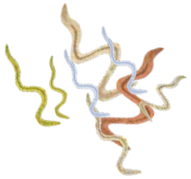
Standard assimilation efficiency Kx=0.8
Decreased assimilation efficiency (kx) = 0.7
No extra maturity cost (0)
Low exta maturity cost (1)
High extra maturity cost (2.5)
Reproduction Energy (J)
0
20000
40000
60000
80000
120000
0
500
1000
1500
2000
2500
Time (days)
IGS (%)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
15
20
25
30
Length (cm)

NEXT STEPS:

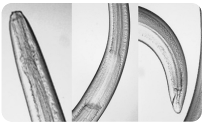
1. **Simulations** to **tests different hypothesis** (based on biological exploration)

   "What would happen if….?"

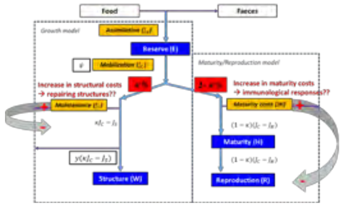
...the model will be performed separately for each host sex



.... the effect on the host life history traits and the site of infection are parasite-specific, so we will choose one morphotype to focus on



... *Anisakis pegreffii* for being the most common and intense infection. Also the cestod *Tetraphyllidean* plerocercoid



2. Re-estimating parameters of the model. **Could infected and non-infected individuals behave energetically different?**

Ideas and suggestions are WELCOME! ☺

THANK YOU!

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