Será o pescado afetado pelas alterações climáticas?

Maulvault, A.L., Barbosa, V., Anacleto, P., Rosa, R., Pousão-Ferreira, P., Marques, A.M.

1. *Introduction*
2. *Organic mercury (OHg)*
3. *Pharmaceuticals*
4. *Paralytic shellfish toxins (PSTs)*
5. *Mixtures of contaminants*
6. *Mitigation measures*
7. *Conclusions and recommendations*

❖ *Marine ecosystems have been under strong and constant anthropogenic pressure since the Industrial Revolution*

1.2. CLIMATE CHANGE

WARMING   ACIDIFICATION

1 .1. CHEMICAL CONTAMINATION

Climate change scenarios

❖ *Marine ecosystems have been under strong and constant anthropogenic pressure since the Industrial Revolution*

1.2. CLIMATE CHANGE

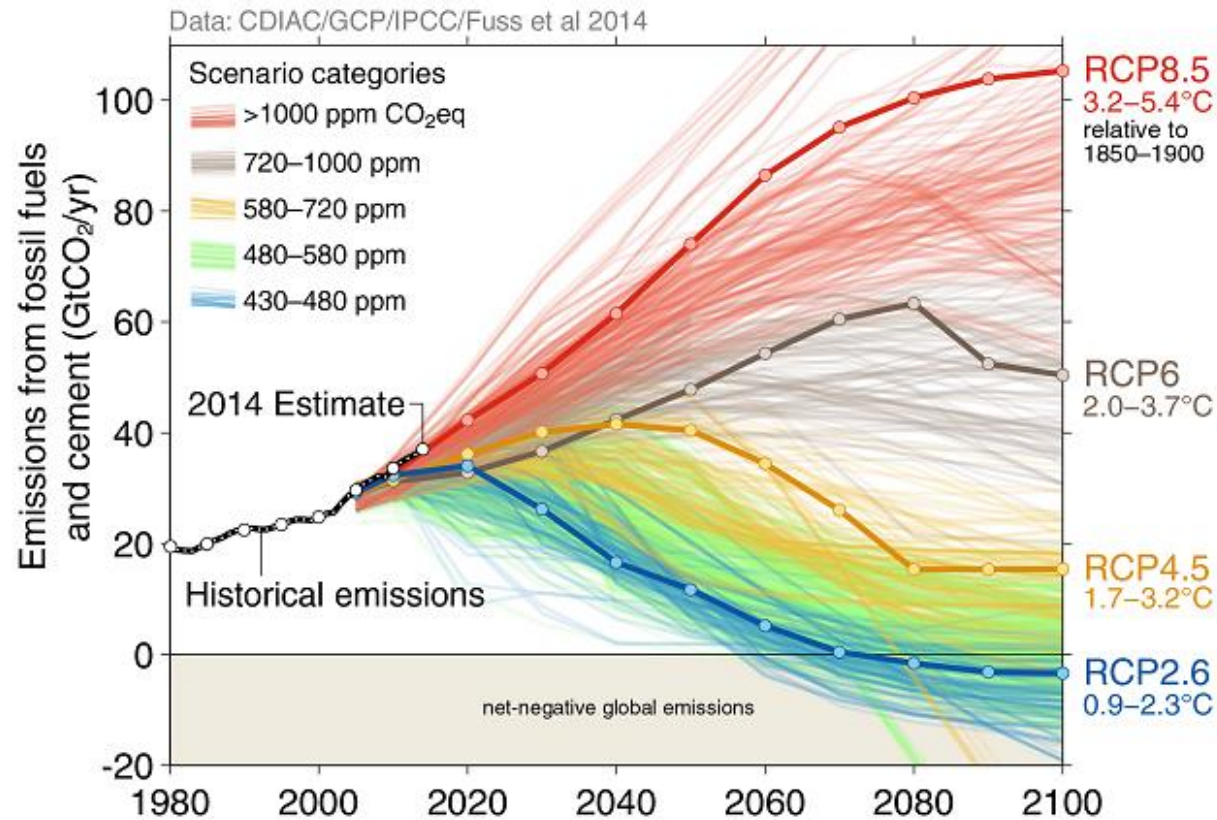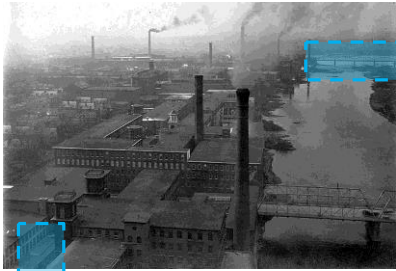WARMING   ACIDIFICATION

REMARKABLE IMPACTS IN COASTAL ENVIRONMENTS!

1.1. CHEMICAL CONTAMINATION

Monitoring of regulated pollutants
(e.g. Hg, Cd and Pb)

Species physiological status, metabolism, welfare and survival

What about non-regulated ones?

Non-Regulated contaminants

Endocrine disruptors

http://www.serioplast.com/our-products-and-services-6/our-products/

Toxins from HAB

https://www.whitehouse.gov/sites/default/files/microsites/ostp/jsost-assess_12-08.pdf

Personal care products

http://www.dreamstime.com/stock-photos-personal-hygiene-products-image13534493

Marine litter and others

http://70degreeswest-explore.com/2013/05/16/a-plastic-ocean/

Pharmaceuticals

http://www.speciation.net/News/New-Seychelle-study-Mercury-and-autism-not-linked-;~/2013/07/28/6844.html

Toxic metals speciation

http://www.speciation.net/News/New-Seychelle-study-Mercury-and-autism-not-linked-;~/2013/07/28/6844.html
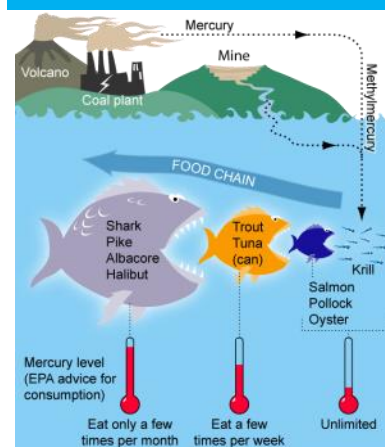
Brominated flame retardants

http://saferchemicals.org/chemicals/flame-retardants/

Perfluorinated compounds

http://saferchemicals.org/chemicals/pfcs/

Linking climate change and pollution...

WARMING **ACIDIFICATION** **HYPOXIA**

CONTAMINANTS AVAILABILITY

GEE FRANK, THE HOTTUB IS SUPPOSED TO MAKE YOU RELAX !
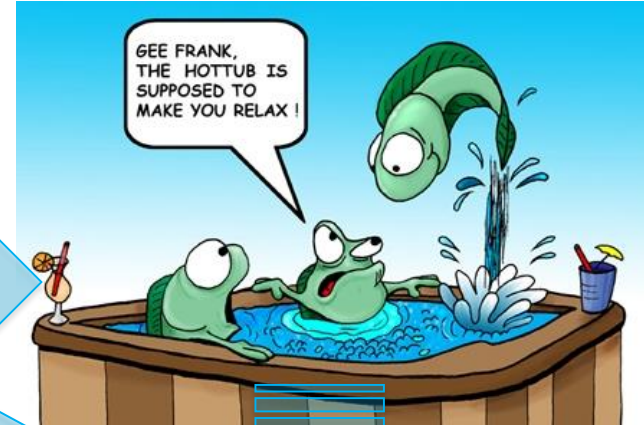
WILL SPECIES' ABILITY TO COPE WITH CHEMICAL CONTAMINANTS BE AFFECTED?

✓ **Speciation**
✓ **Fate and transfer from water collumn to sediment and vice-versa**
✓ **Toxicity**
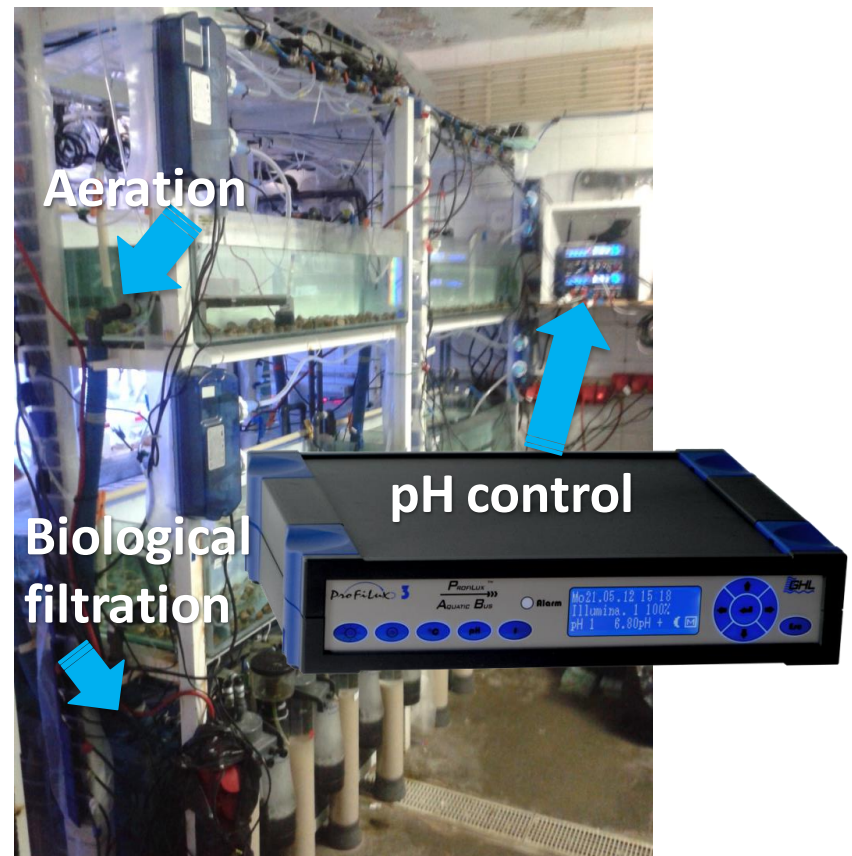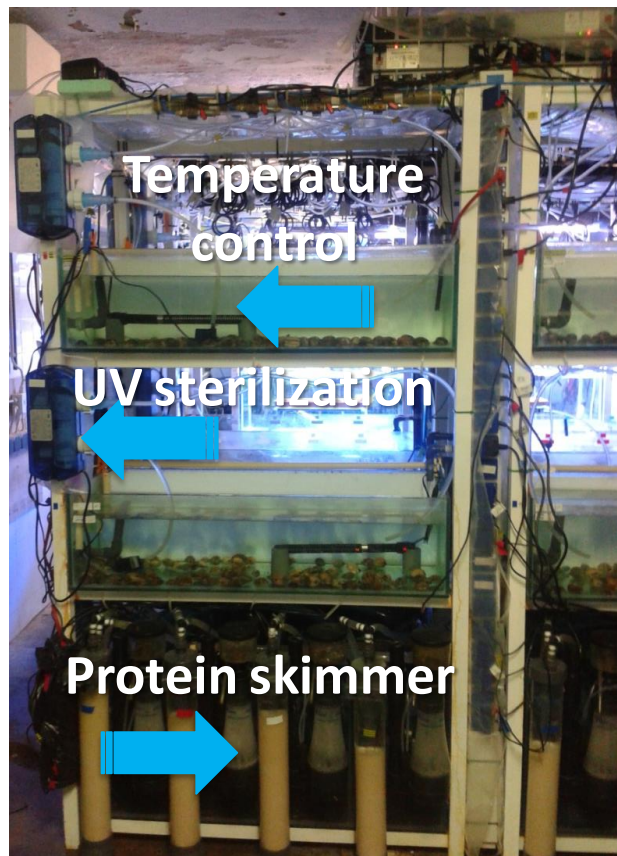
HUMAN PERSPECTIVE...

WILL WE EAT THE SAME?

IPMA
Instituto Português do Mar e da Atmosfera

RISEGAL
Rede Galega de Riscos Emerxentes en Seguridade Alimentaria

How to simulate Climate change scenarios?

Recirculation system to simulate climate change effects

Temperature control

UV sterilization

Protein skimmer

Aeration

Biological filtration

pH control

2. Organic Mercury

Organic Hg is the most toxic form of Hg and the main route of exposure is through seafood consumption

Juvenile seabass muscle - warming

Maulvault, A.L. et al. (2016). Environmental Research
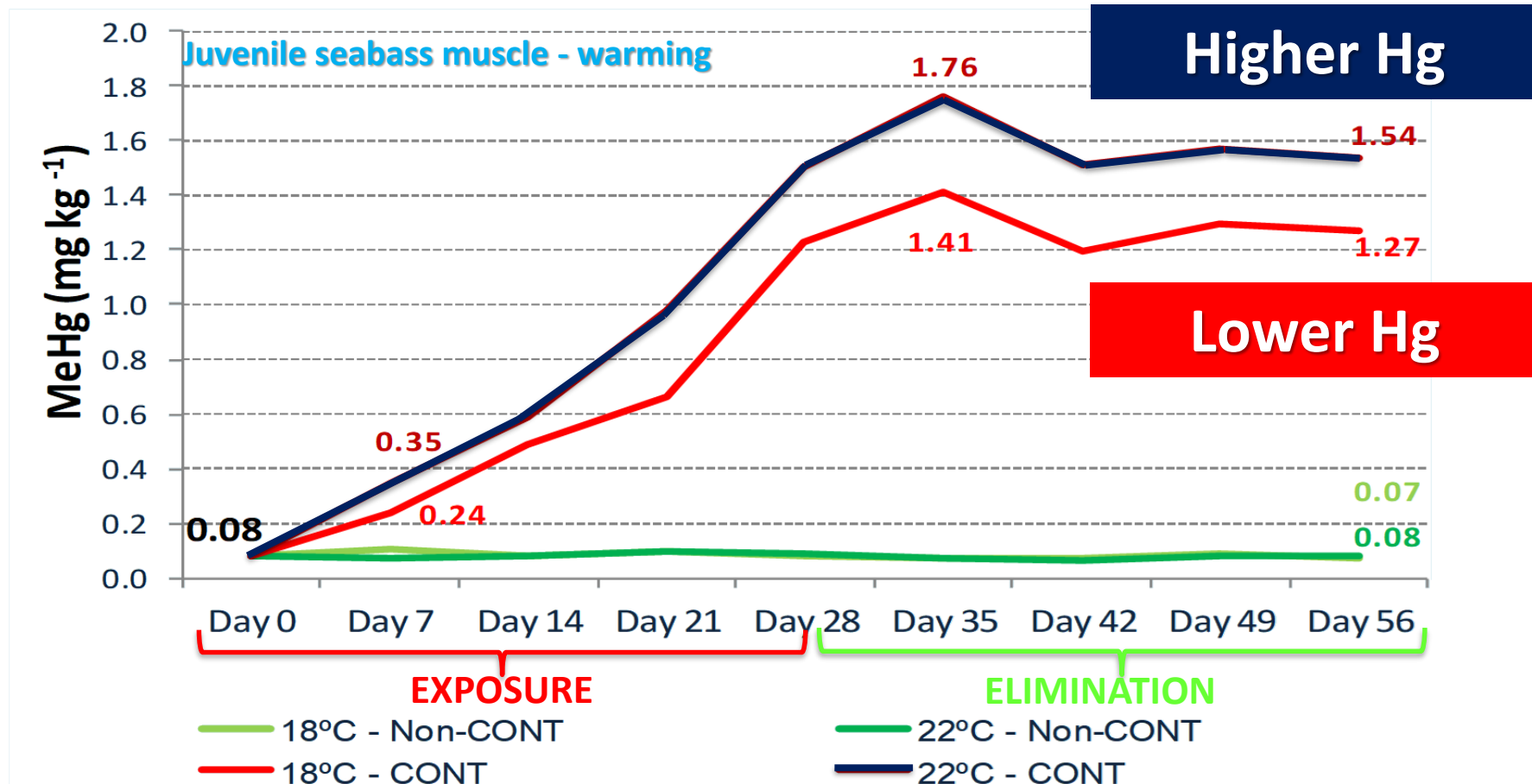
Anti-inflamatory drug widely detected in sewage treatment plant effluents

Juvenile seabass – warming/acidification

Muscle

Chart — x-axis: Day 0, Day 7, Day 14, Day 28, Day 35, Day 42; y-axis: µg kg^{-1} (ww), 0 to 3

Legend:
- Control
- T1pH1_DCF-enriched
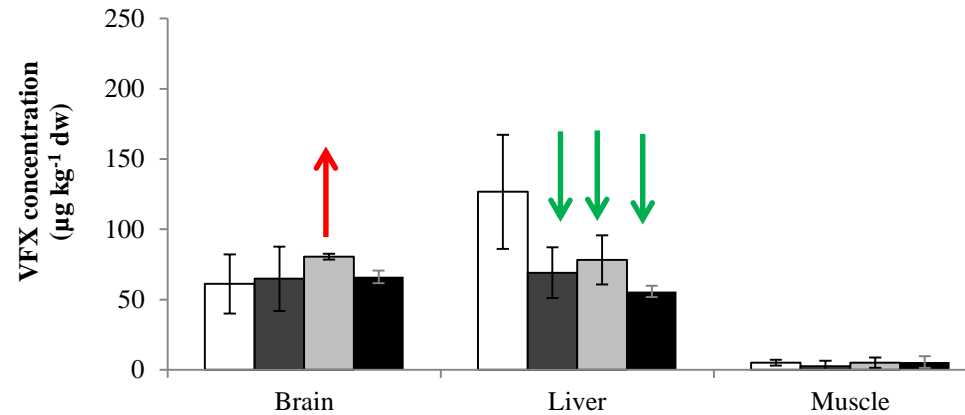- T1pH2_DCF-enriched
- T2pH1_DCF-enriched
- T2pH2_DCF-enriched
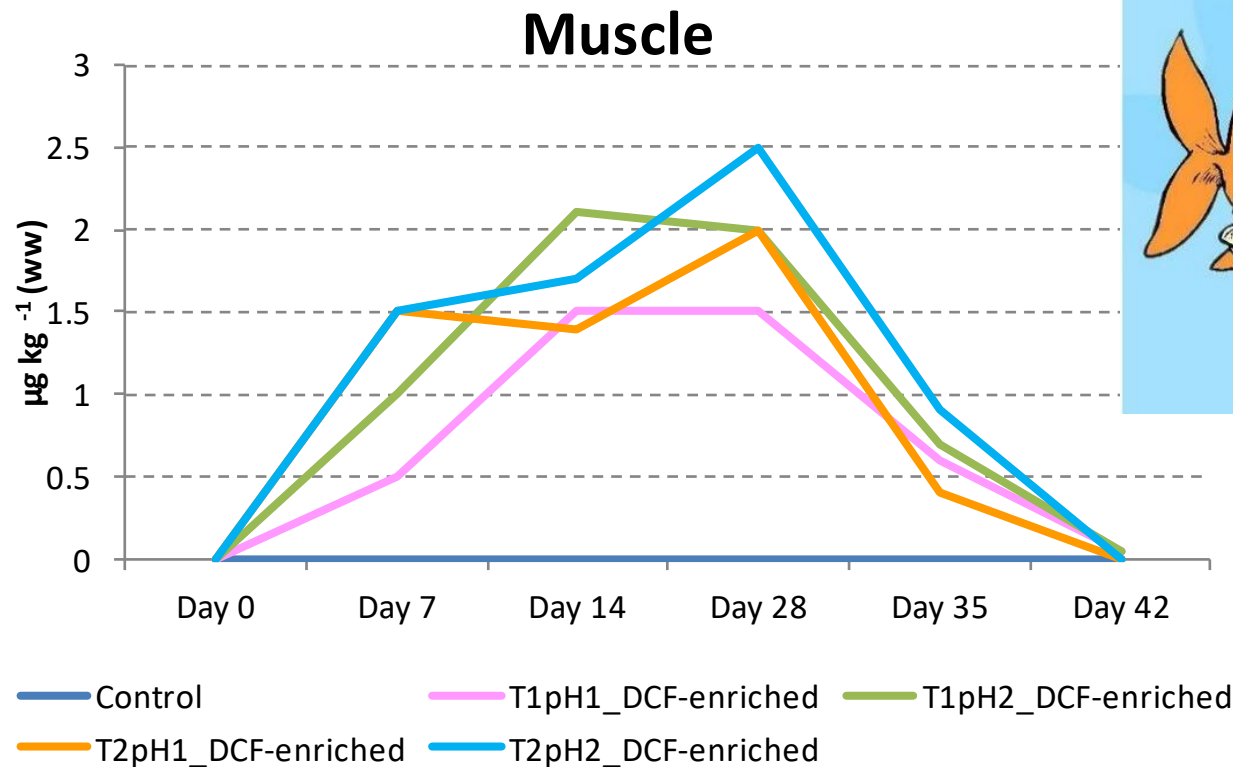
✓**DCF bioaccumulation and elimination data inconclusive – DCF metabolization data required!**

3. Pharmaceuticals (VFX)

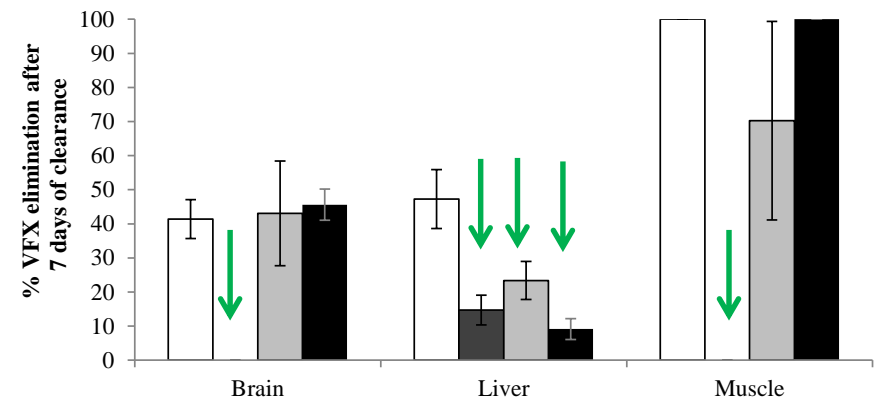## Antidepressant frequently detected in the environment

Juvenile meagre – warming/acidification

Day 28

Day 35

Legend:
- ☐ VFX
- ■ VFX + Acidification
- ☐ VFX + Warming
- ■ VFX + Acidification + Warming

✓ **Warming and Acidification decreased [VFX] in liver**
✓ **Warming alone increased [VFX] in brain**
✓ **No differences in muscle**
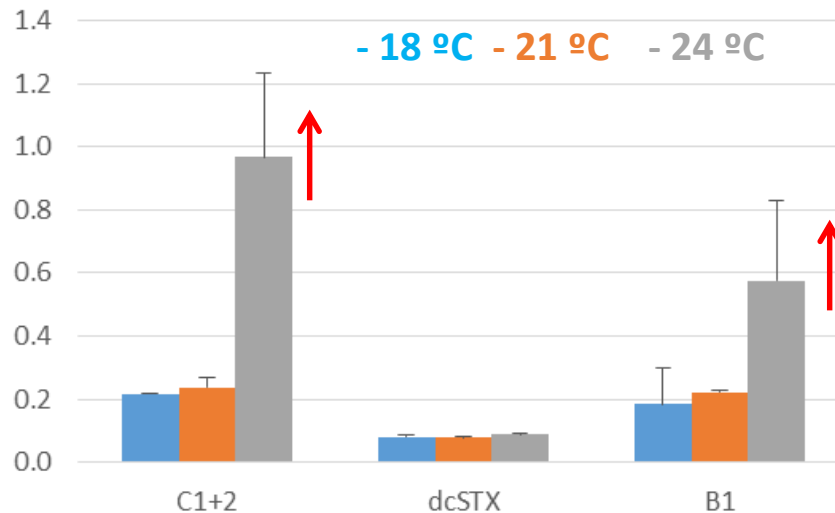✓ **No elimination in brain and muscle under Acidification and lower elimination in liver**

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4. Paralytic shellfish toxins (PSTs)

Potent neurotoxins

Accumulation in seabream - warming

- day 1, 2 and 3 PSTs not detected
- PSTs only detected at day 4 & 5 (maximum exposure period)

Day 5:

- **18 ºC** - **21 ºC** - **24 ºC**

Higher accumulation at 24ºC

C1+2 and B1 most abundant PST's analogues

⇩

The most abundant toxin analogues in seabream were the same as in feed

Depuration	⇨	day 1, 2,3 and 5 PSTs not detected	⇨	rapidly eliminated within 24h

Barbosa, V. et al. (Submitted).
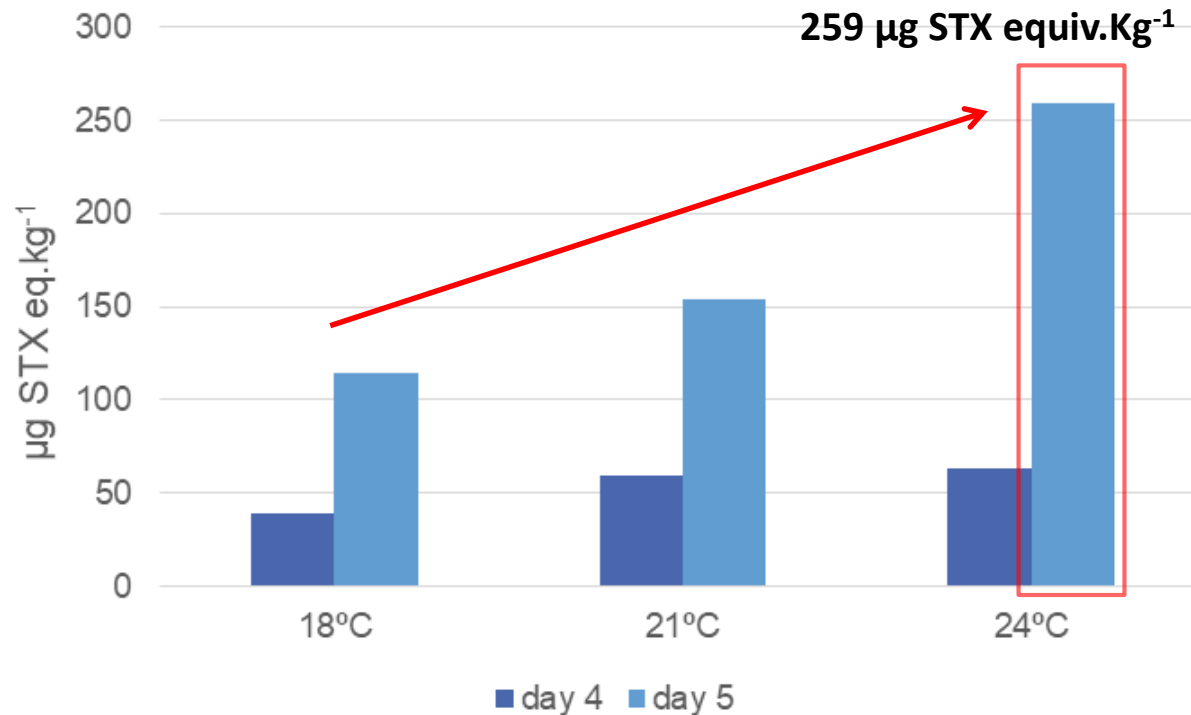
4. Paralytic shellfish toxins (PSTs)

STX-group toxins toxicology: based on toxicity equivalency factors (TEFs) the toxicity of the detected analogues were calculated and expressed as as STX equivalents

	TEFs
C1+2	0.1
dcSTX	1.0
B1	0.1

259 µg STX equiv.Kg⁻¹

< 800 µg STX eq/kg

Commission Regulation (EC) No 853/2004

Barbosa, V. et al. (Submitted).

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5. Contaminant mixtures

Psychiatric drugs mixtures bioaccumulation in mussels

Treatments / Compounds	Control conditions	Water Acidification	Water Warming	Warming plus acidification
Carbamazepine	28	26	35 ↑	26
Venlafaxine	522	224 ↓	409 ↓	208 ↓
Citalopram	2755	1085 ↓	1746 ↓	1005 ↓

Serra-Compte, A. et al. (2018) Environmental Pollution

Psychiatric drugs mixtures metabolization in mussels

Serra-Compte, A. et al. (2018) Environmental Pollution
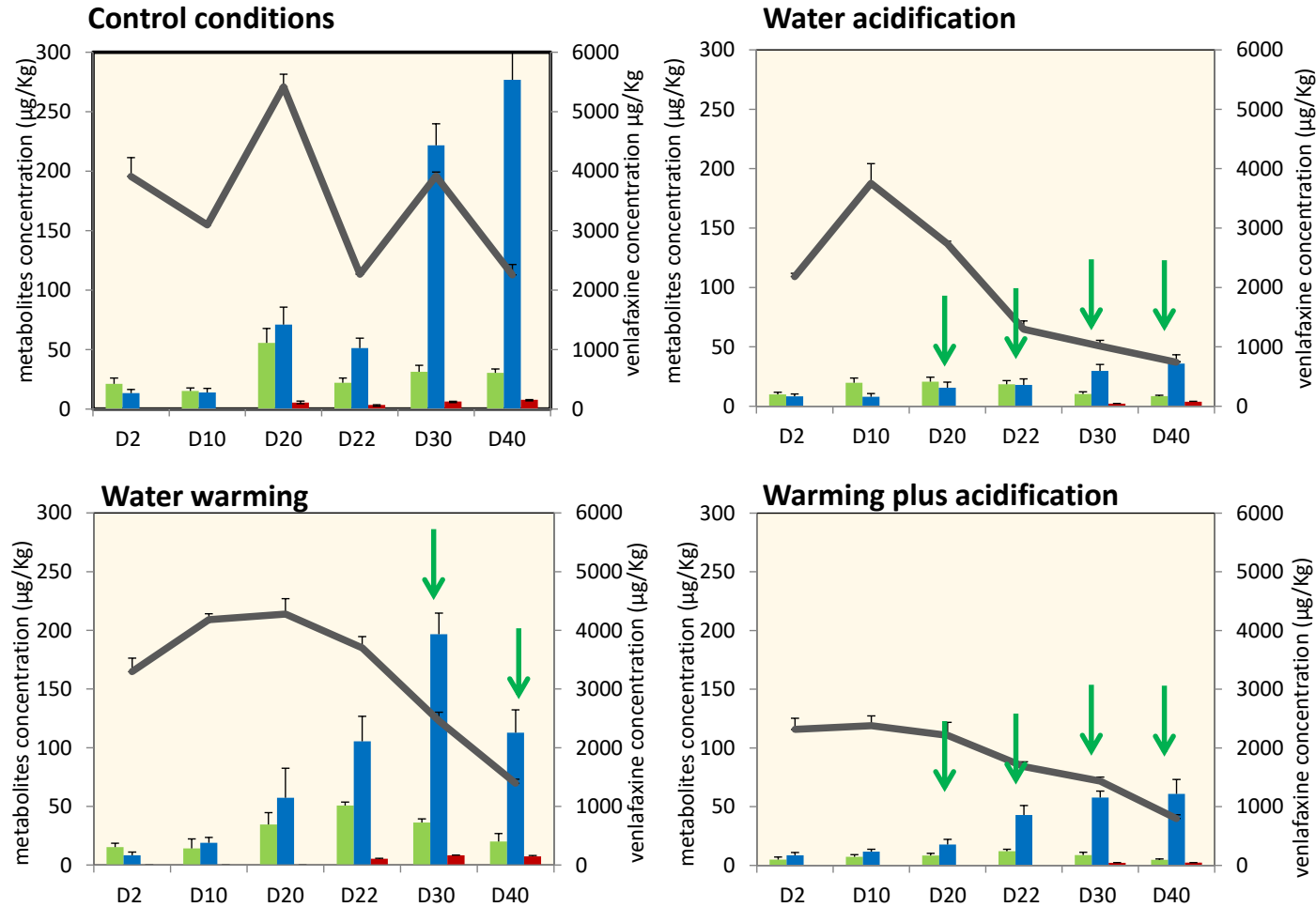
5. Contaminant mixtures

Psychiatric drugs mixtures depuration in mussels

Serra-Compte, A. et al. (2018) Environmental Pollution
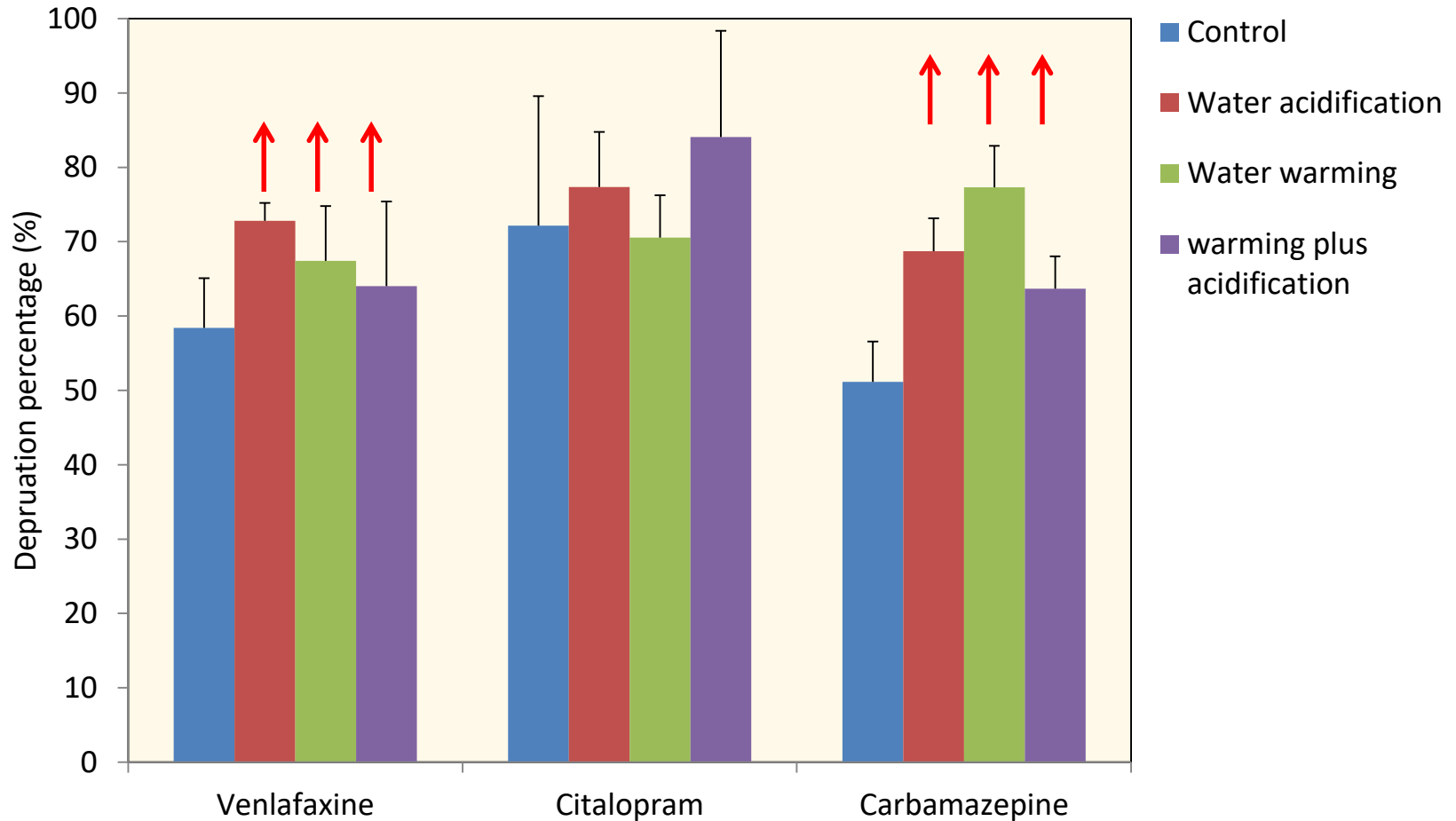
5. Contaminant mixtures

Dechloranes accumulation in mussels – warming/acidification

Maulvault, A.L. et al. (2018) Environmental Research
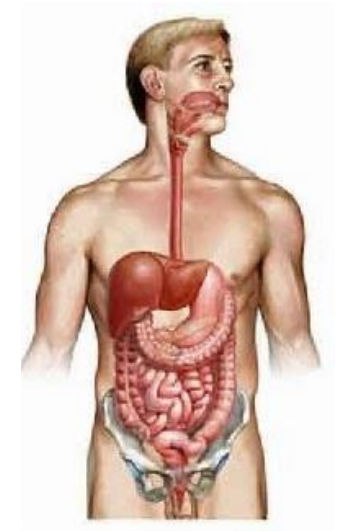
17
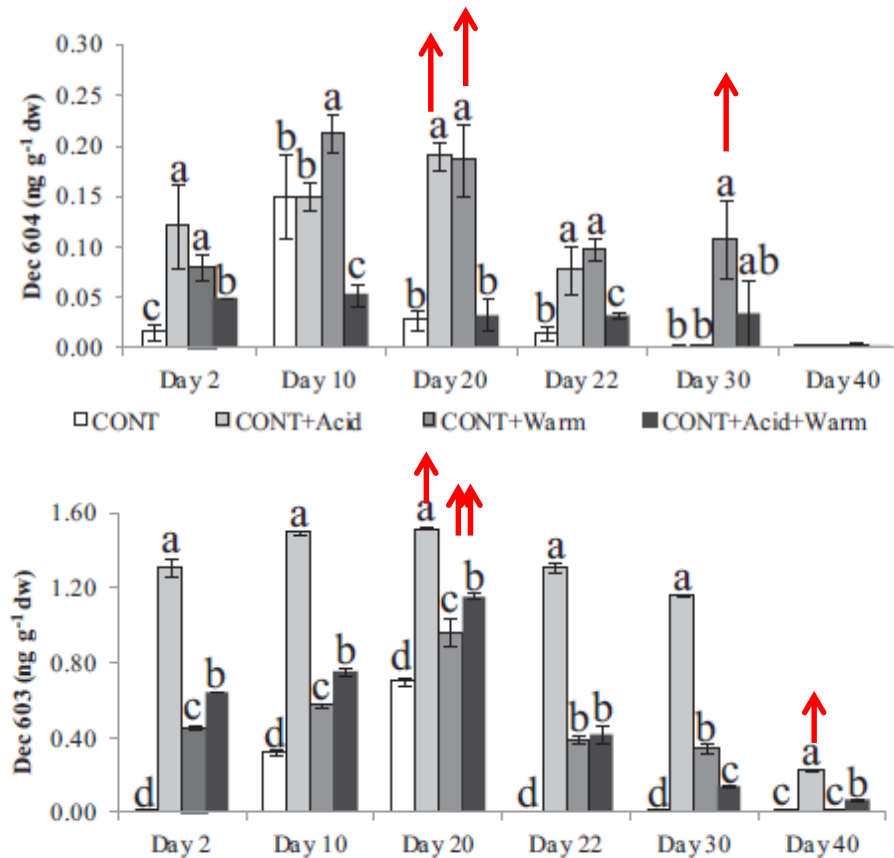
5. Contaminant mixtures

TBBPA, iAs, PFOA and PFOS accumulation in mussels – Warming/acidification
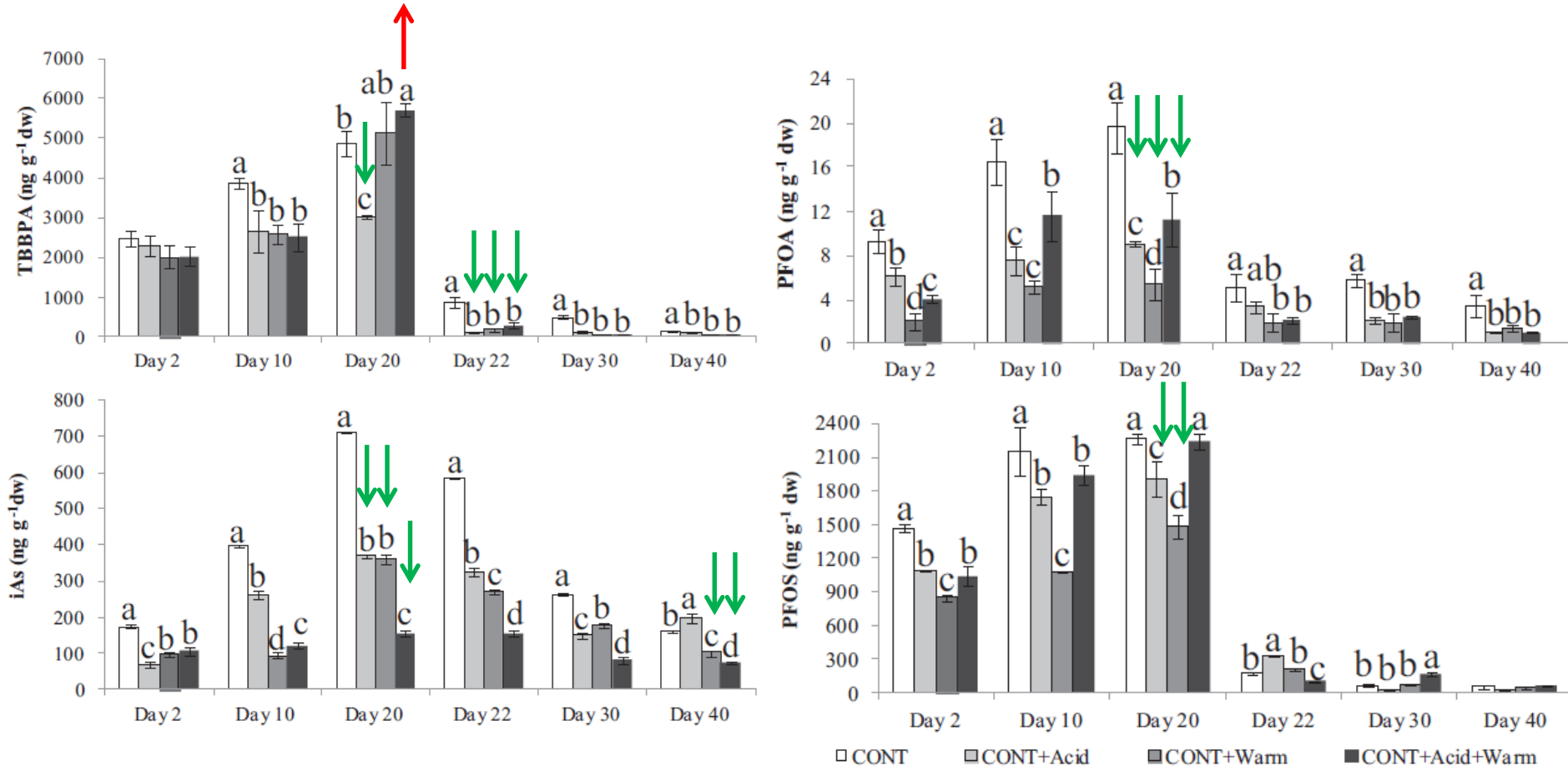
6. Mitigation measures

High bioaccessibility % (> 50)	Low bioaccessibility % (< 50)
MeHg (tuna, mackerel, octopus)	MeHg (hake, monkfish)
As (all species)	Cd (tuna)
Cd (mussel, shrimp)	BDE47/BDE100 (all species)
PFCs (all species)	α-HBCD (bivalves)
α-HBCD (fish)	
PPCPs (all species)	

Bioaccessibility can be affected by steaming (depending on food matrix) – decreased after steaming – Good choice to consume seafood

- MeHg
- Cd (shellfish)
- PBDEs (shellfish)
- Venlafaxine (fish)

Alves, R. et al. (2017) Food & Chemical Toxicology

Nutritious, safe and sustainable seafood for consumers of tomorrow

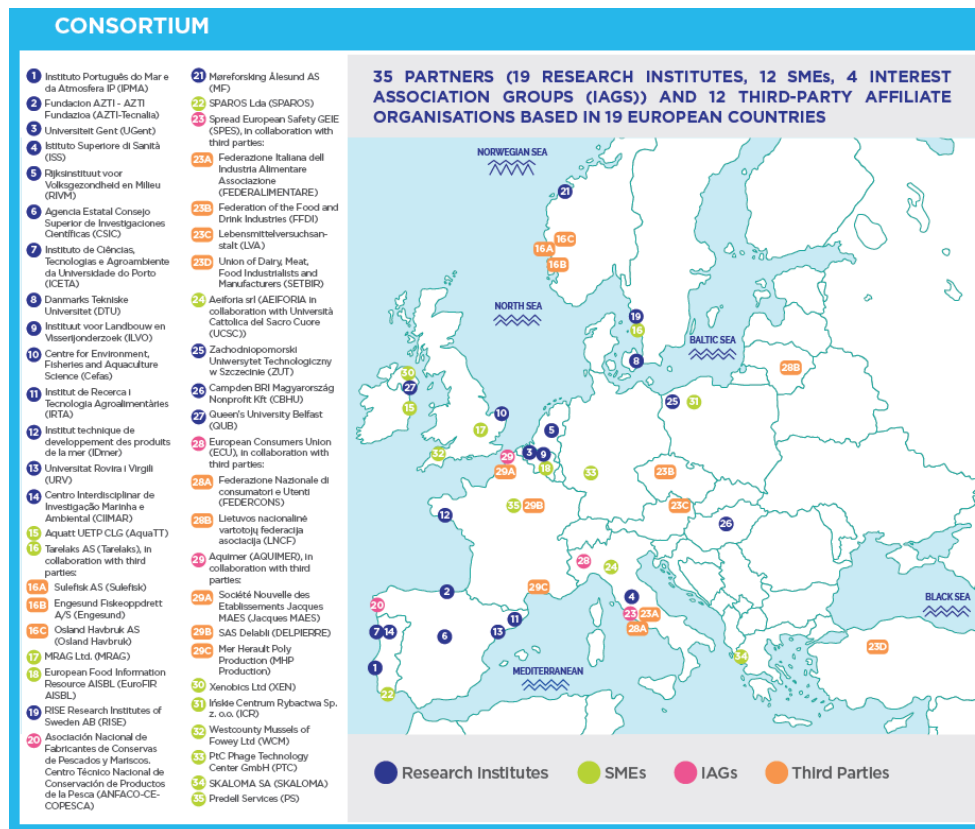**www.seafoodtomorrow.eu**

PROGRAMME
H2020 (EC)

INSTRUMENT
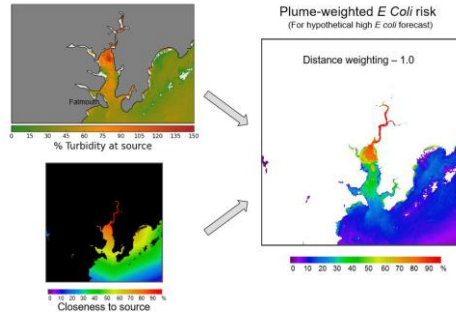Innovation Action

TOTAL BUDGET
€7.5 million

DURATION
Nov 17 – Oct 18 (36M)

COORDINATOR
IPMA

Aims to develop innovative sustainable solutions for improving the safety and dietary value of seafood in Europe at the production and processing levels

6. Mitigation measures

Buffer zones in shellfish production areas

Integrated Multi trophic Aquaculture

Multi contaminant detection sensors

Seafood Production

FISHCHOICE 2.0
Your personal fish calculator
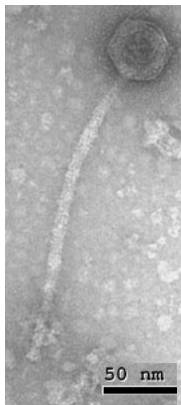
Benefit-risk communication tool

Quality certification

Seafood Processing

Toxins/ processing

Listeriaphages/ RTE fish

Norovirus/ depuration

7. Conclusions and Recommendations

✓ **The changes elicited by warming and acidification will promote the exposure to some contaminants (OHg, PSTs, dechloranes), but not for others (diclofenac, venlafaxine, iAs, TBBPA, PFCs)**

✓ **The distinct patterns observed strengthen the need to carry out greater research efforts to understand how multiple environmental (warming, acidification and pollution) interact with each other, and to consider these variables in future studies and regulations/recommendations**

✓ **Broad development and use of validated monitoring and early warning systems (e.g. biosensors)**

✓ **Adopt solutions to reduce contaminant load (e.g. processing seafood, cooking, phycoremediation, etc.)**

✓ **Develop predictive modeling tools for stakeholders**

Acknowledgments

Ana Luísa Maulvault

Vera Barbosa

Pedro Pousão-Ferreira

Patrícia Anacleto

Rui Rosa

THANK YOU

And many others....