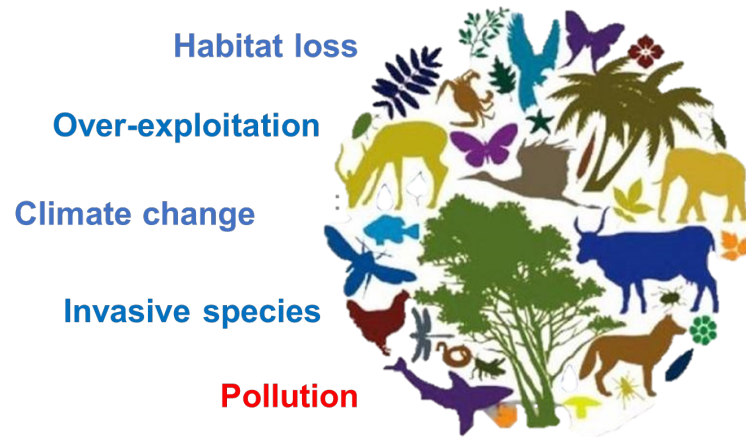


ToxSeaBird : Les polluants éternels (PFAS) chez les oiseaux marins de France et d'outre-mer

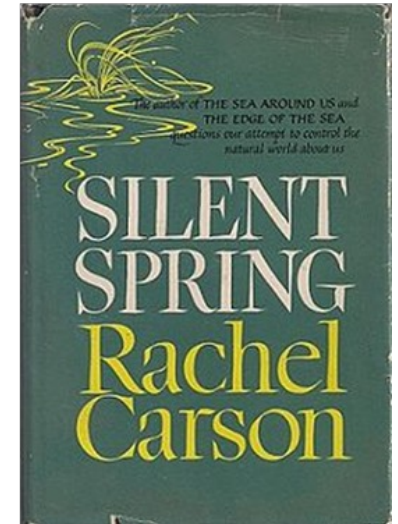
Olivier Chastel



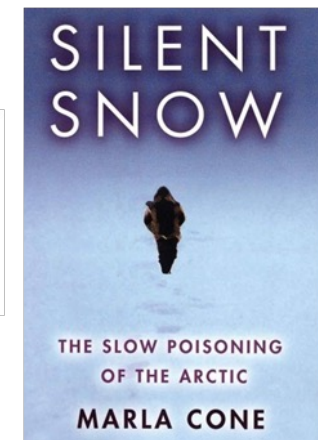
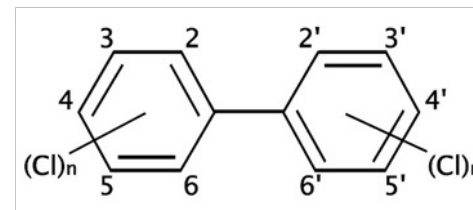
Biodiversity and chemical pollution



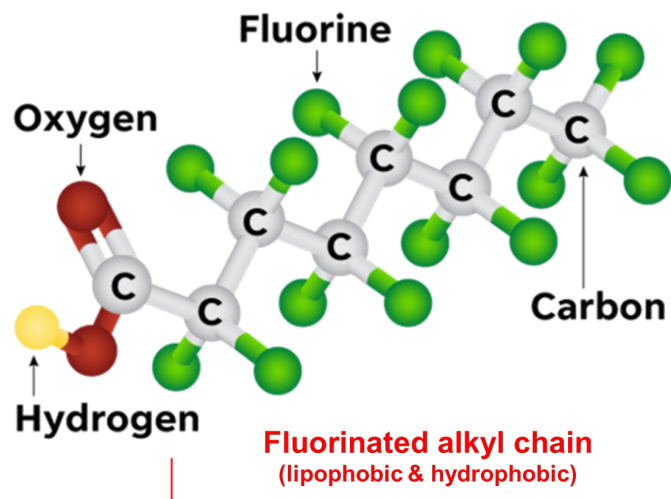
Organochlorine pesticides (OCP)



Polychlorinated biphenyls (PCBs) in the Arctic



Poly-and Per fluoroalkyl Substances (PFAS)



Excellent tensioactive properties



TEFLON (accidentally
discovered in 1938)

Poly-and Per fluoroalkyl Substances (PFAS)

Scotchgard
(1953)

Used in a multitude of manufactured products



PFAS in the environment

Antwerp, Belgium



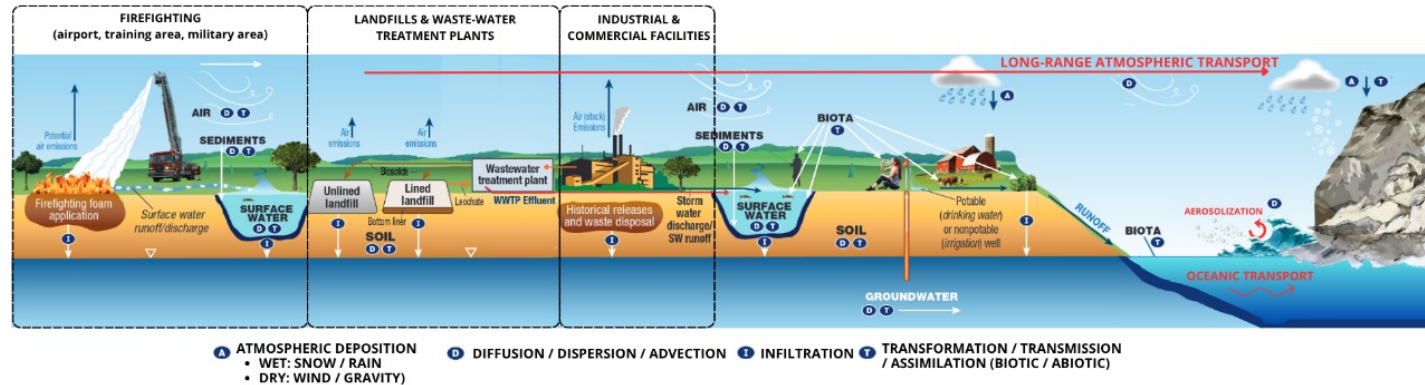
Pierre-Bénite, France



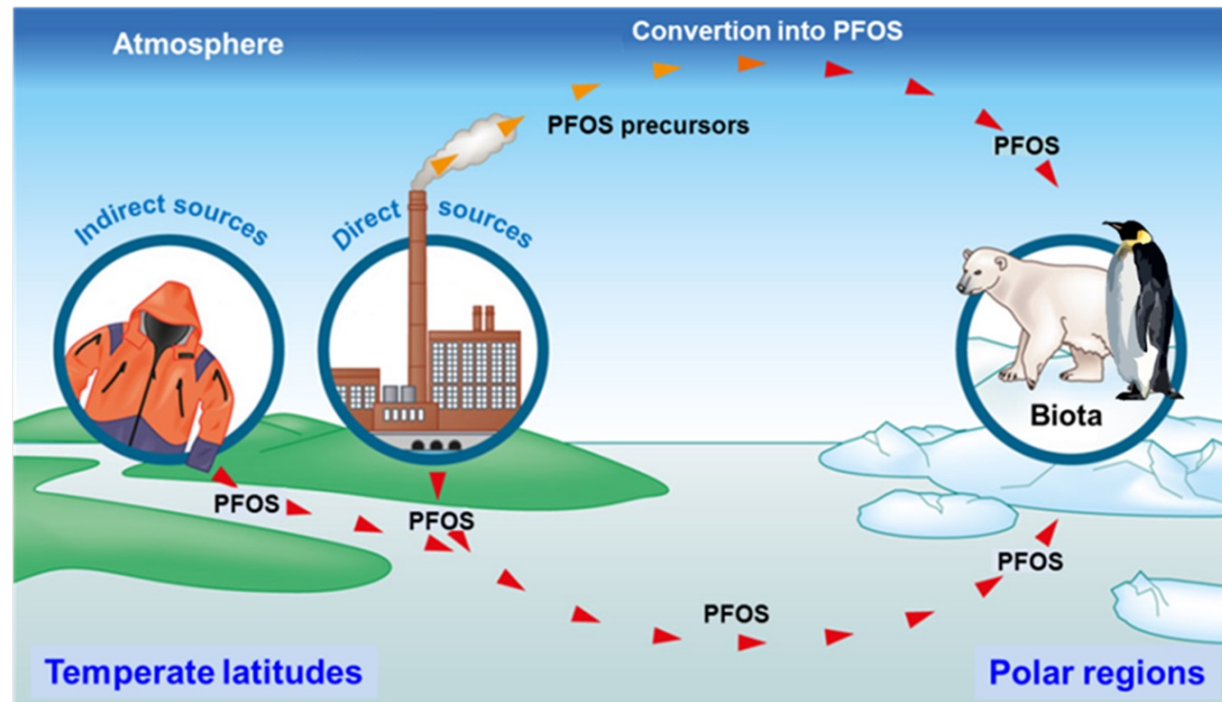
Veneto, Italy



Airports



PFAS long-range transport to the polar areas

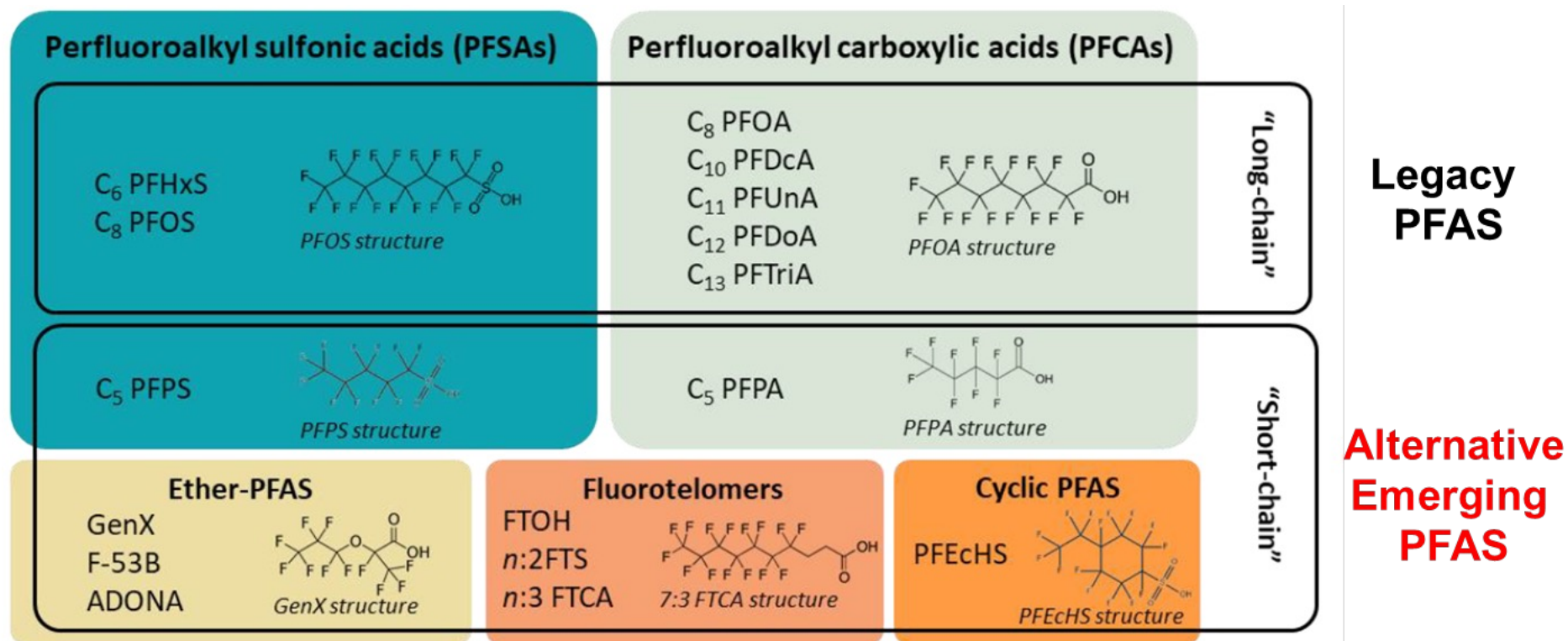


Regulation of PFAS

Perfluorooctane sulfonic acid (PFOS), Perfluorooctanoic acid (PFOA) and Perfluorohexanesulfonic acid (PFHxS) have been included under the Stockholm Convention on POPs. The vast majority of PFAS are not regulated yet.



The PFAS group covers more than 10 000 substances...

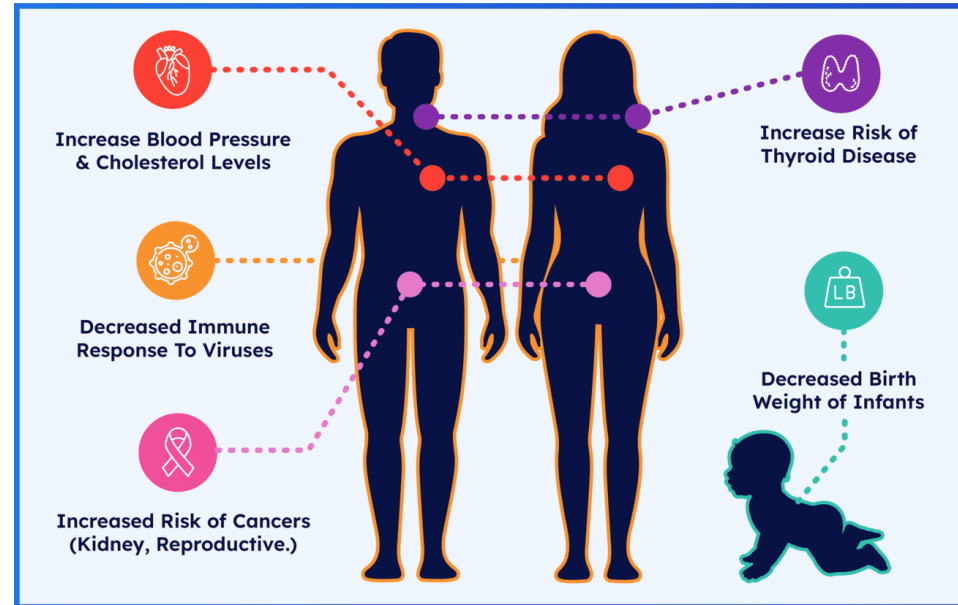
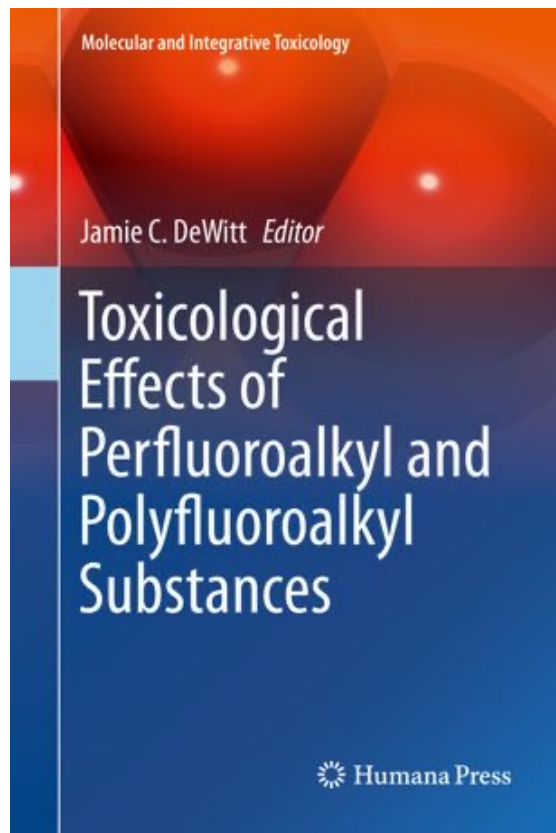


Toxicological effects of PFAS

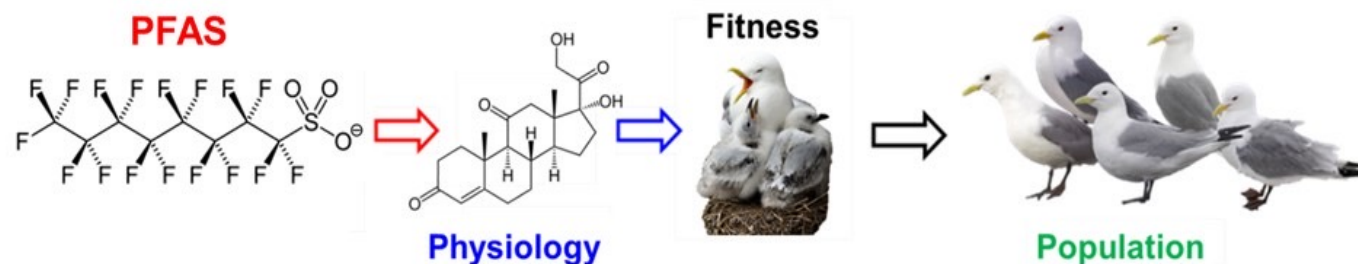
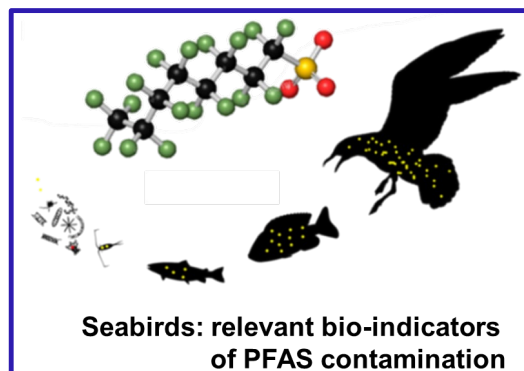
PFAS have high affinity to serum albumin and to liver-type fatty acid binding proteins

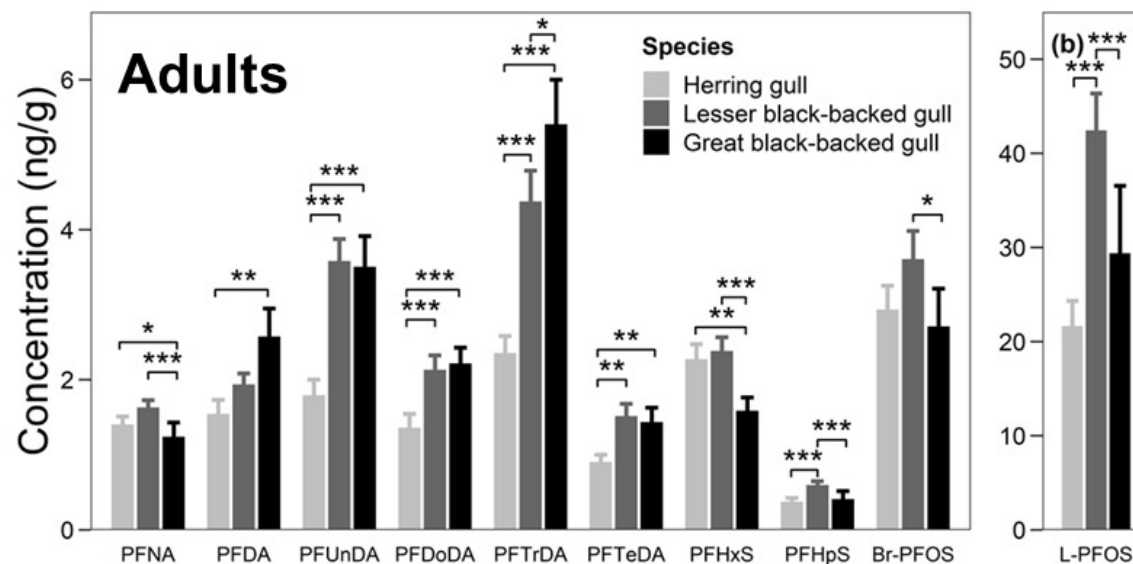
PFAS have no route of degradation, cannot be metabolized under environmental conditions

PFAS are extremely persistent (C-F bound)
“Forever chemicals”



Occurrence and toxicity of PFAS in seabirds





Gulls (Ile de Ré, 4 species):

Lin PFOS most abundant PFAS

Adults > chicks

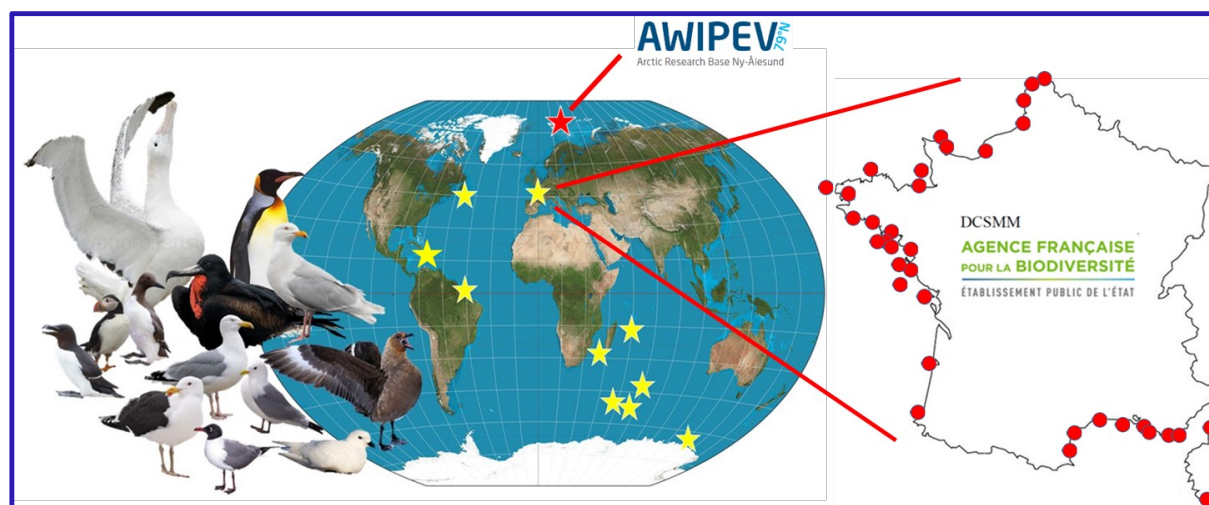
Most individuals at risk of adverse effects for PFOS

Sebastiano, Jouanneau, Blévin, Angelier, Parenteau, Gernigon, Lemesle, Robin, Pardon, Budzinski, Labadie, Chastel (2021) *Sci.Total Environ.*

Sebastiano, Jouanneau, Blévin, Angelier, Parenteau, Pallud, Ribout, Gernigon, Lemesle, Robin, Pardon, Budzinski, Labadie, Chastel (2023) *Sci.Total Environ.*

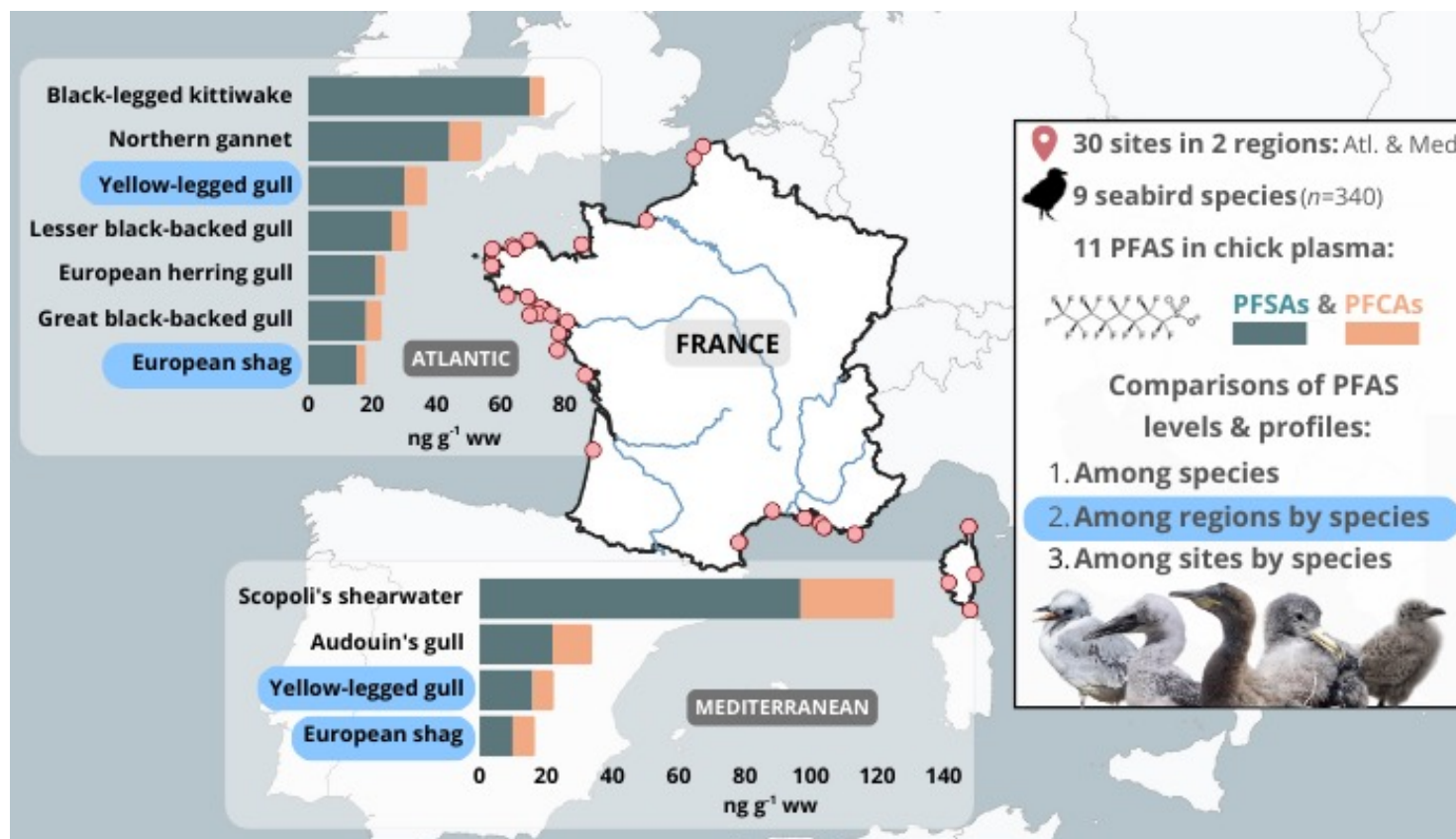
Occurrence and toxicity of legacy and emerging Perfluoroalkyl substances (PFAS) in seabirds: A large-scale survey in overseas and metropolitan France

O. Chastel (coordinator, CEBC), P. Bustamante (LIENSs), Pierre Labadie (EPOC),
D. Costantini (MNHN), S. Massemin (IPHC), C. Barbraud (CEBC)



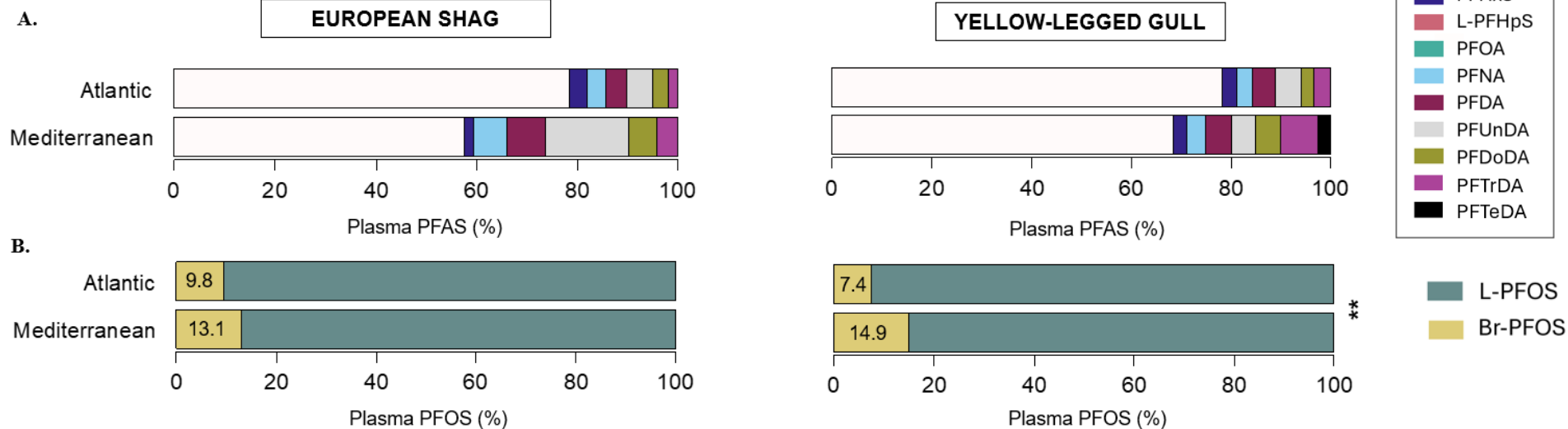


PFAS in French seabirds - Metropolitan France

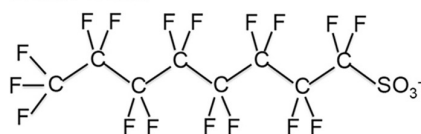


Perfluorooctanesulfonic acid (PFOS) is by far the most abundant PFAS among metropolitan seabirds, and oceanic species show the highest concentrations. 88% of the chicks have PFOS levels above toxicity thresholds.

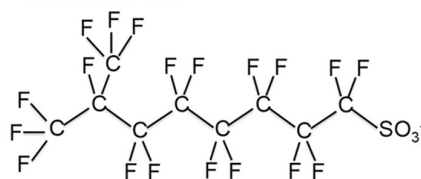
PFAS in French seabirds - Metropolitan France



Linear PFOS



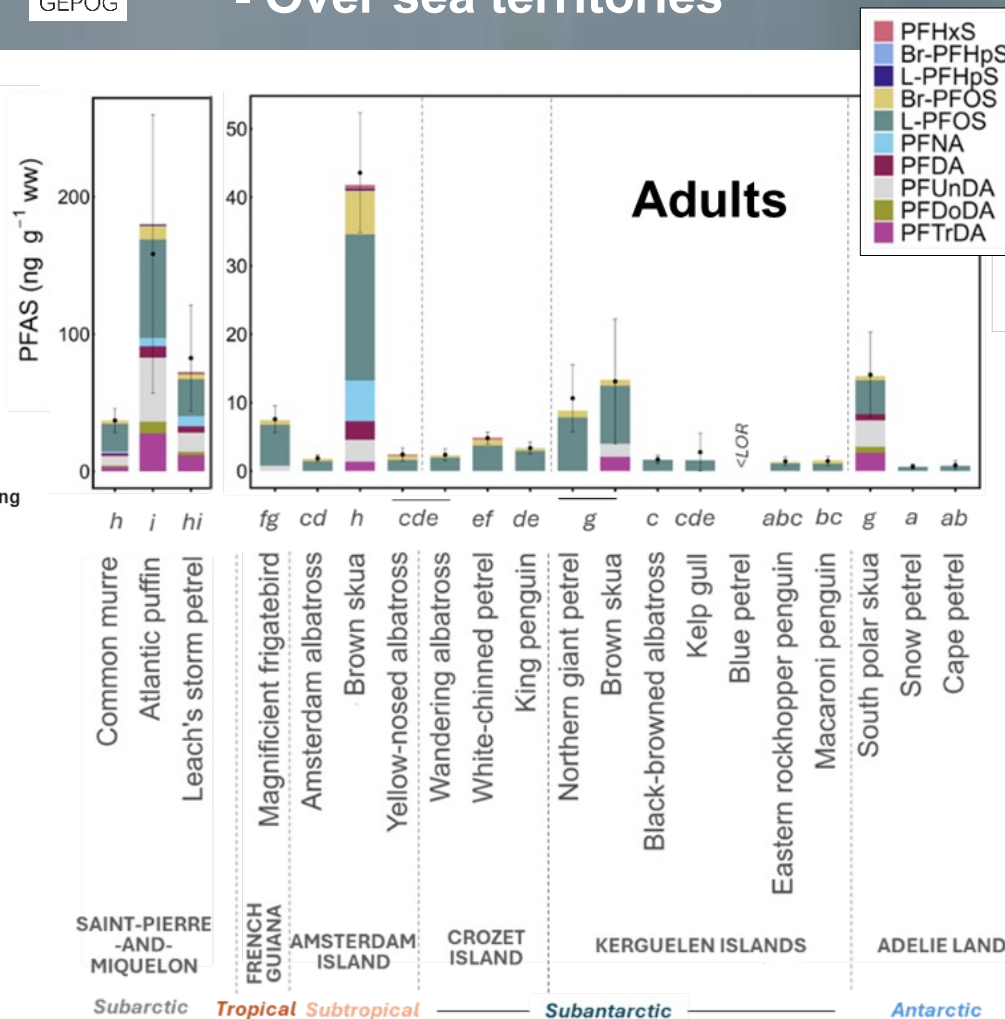
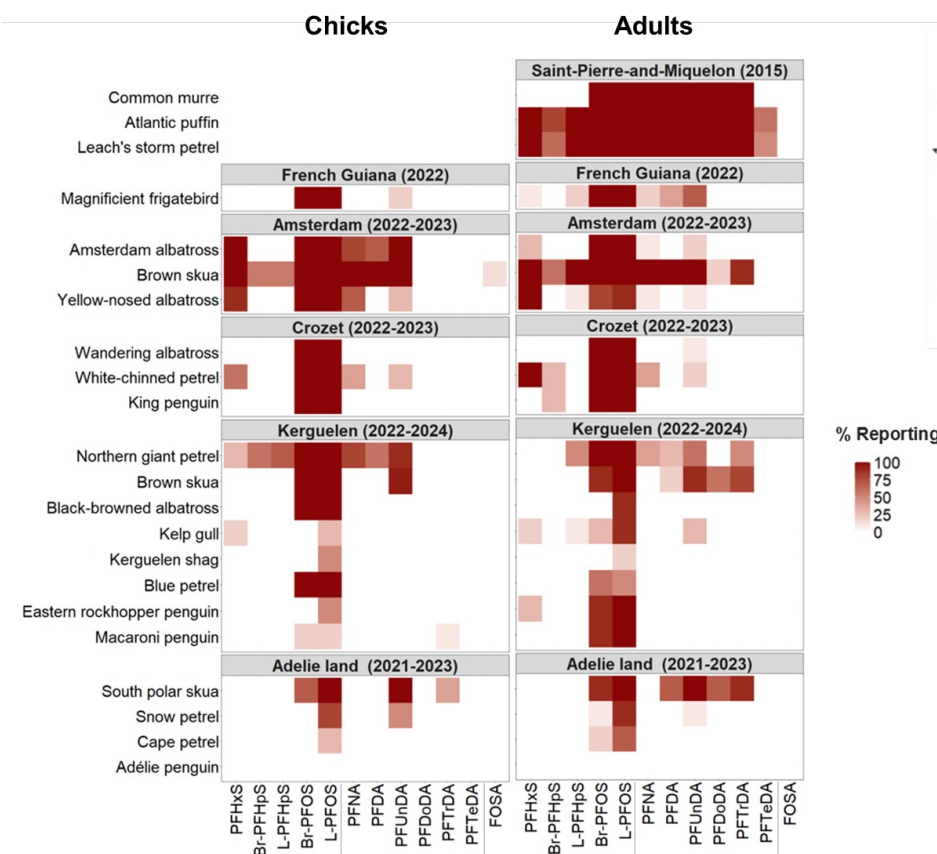
Branched PFOS



Mediterranean seabirds show lower perfluoroalkyl sulfonic acid (PFSAs) and higher perfluoroalkyl carboxylic acid (PFCAs) levels compared to Atlantic ones. Branched isomer of PFOS was more frequent in Mediterranean seabirds which suggests older contamination in the Mediterranean.



PFAS in French seabirds - Over sea territories

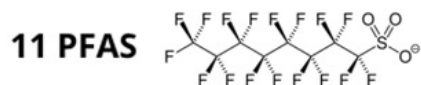


Lemesle et al. *In prep*

The highest PFOS levels found in seabirds from Saint-Pierre-et-Miquelon whereas French Guiana and Southern territories species show overall low PFAS levels. PFAS contamination declines from the subtropics to Antarctica.

Where do seabirds get their PFAS?

Combining ecotoxicology, stable isotopes
and biologging (breeding season)



Foraging ecology



European herring gull

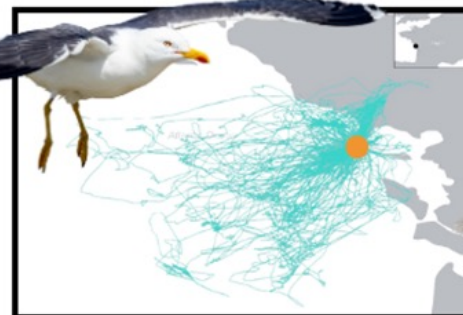


Terrestrial - Coastal

✓ RELATIONS PFAS &
FORAGING ECOLOGY

High trophic &
marine resources
= ↑ PFCAs

Lesser black-backed gull

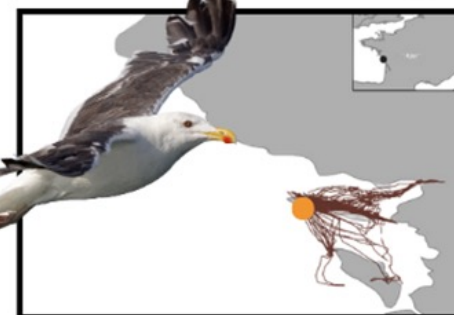


Terrestrial - Coastal - Pelagic

✓ RELATIONS PFAS &
FORAGING ECOLOGY

compound specific

Great black-backed gull



Coastal

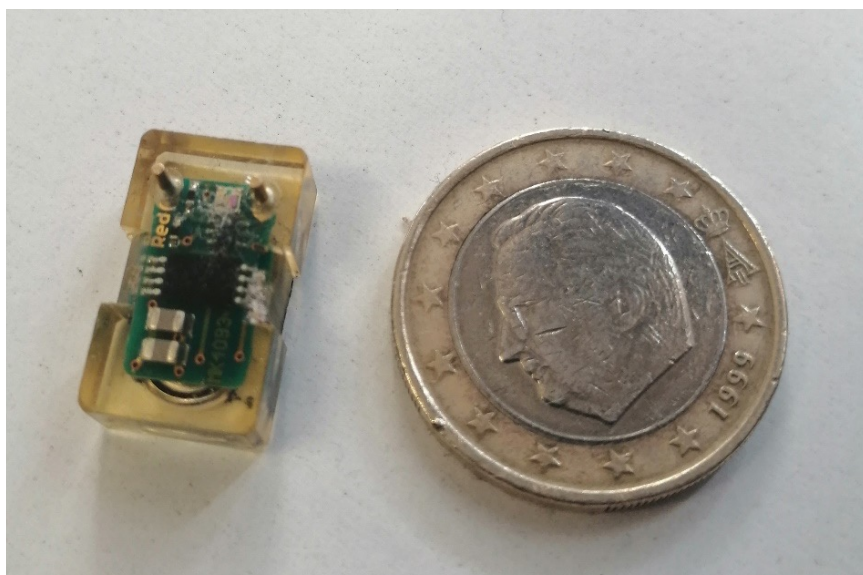


NO RELATION PFAS &
FORAGING ECOLOGY

GPS tracking and isotopy suggest that coastal habitat could be a source of PFCA contamination. Rather than trophic position, foraging habitats used during breeding can influence PFAS levels and compounds.

Where do seabirds get their PFAS?

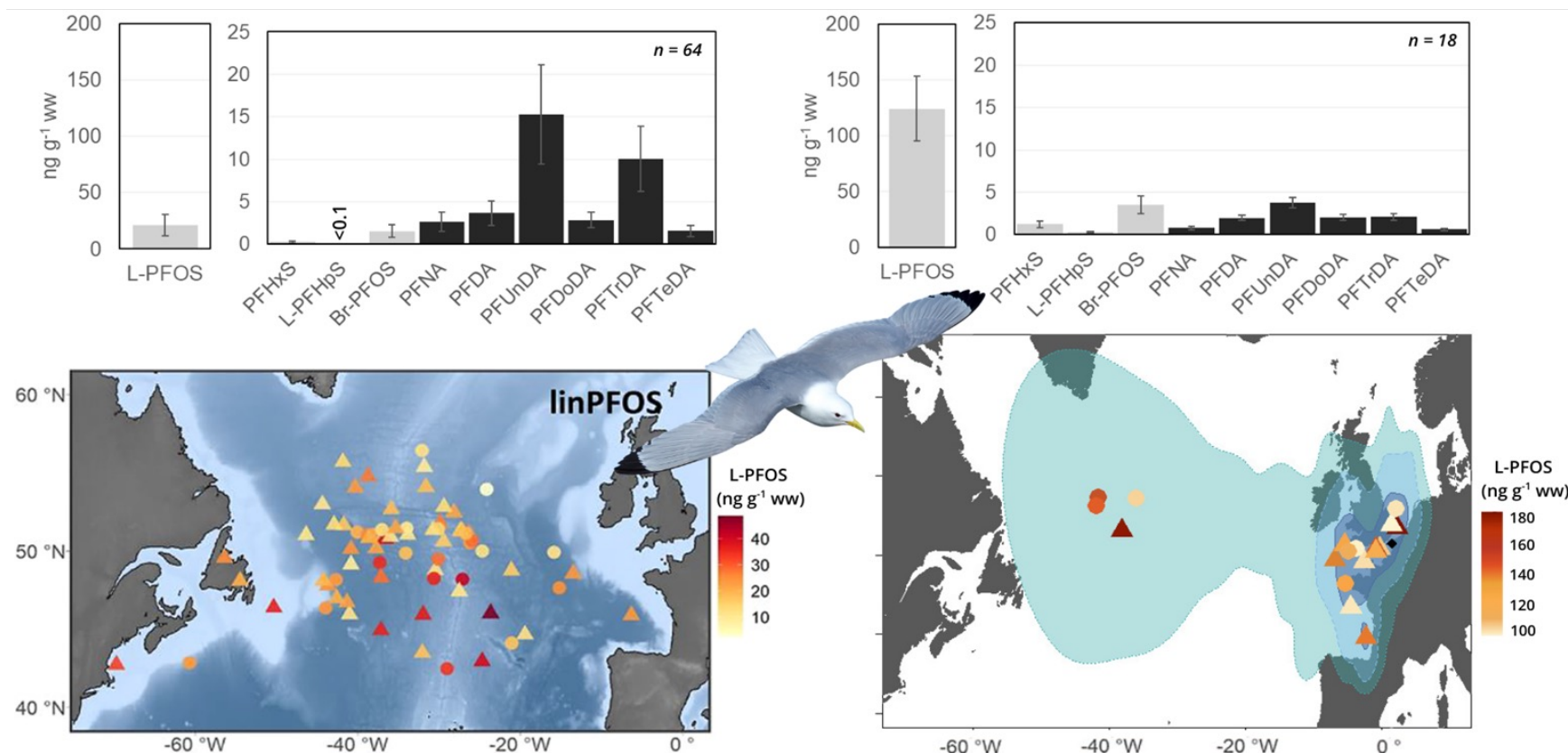
Combining ecotoxicology and biologging (winter)



Salbard (Kongsfjord)



France (Boulogne-sur-Mer)



Lemesle et al. *In prep*

Léandri-Breton, Jouanneau, Legagneux, Tarroux, Moe, Angelier, Blévin, Bråthen, Fauchald, Gabrielsen, Herzke, Nikiforov, Elliott, Chastel (2024) *Environmental Science & Technology*

GLS tracking combined with PFAS measurements suggest that the location of the wintering area can influence PFAS levels and compounds.

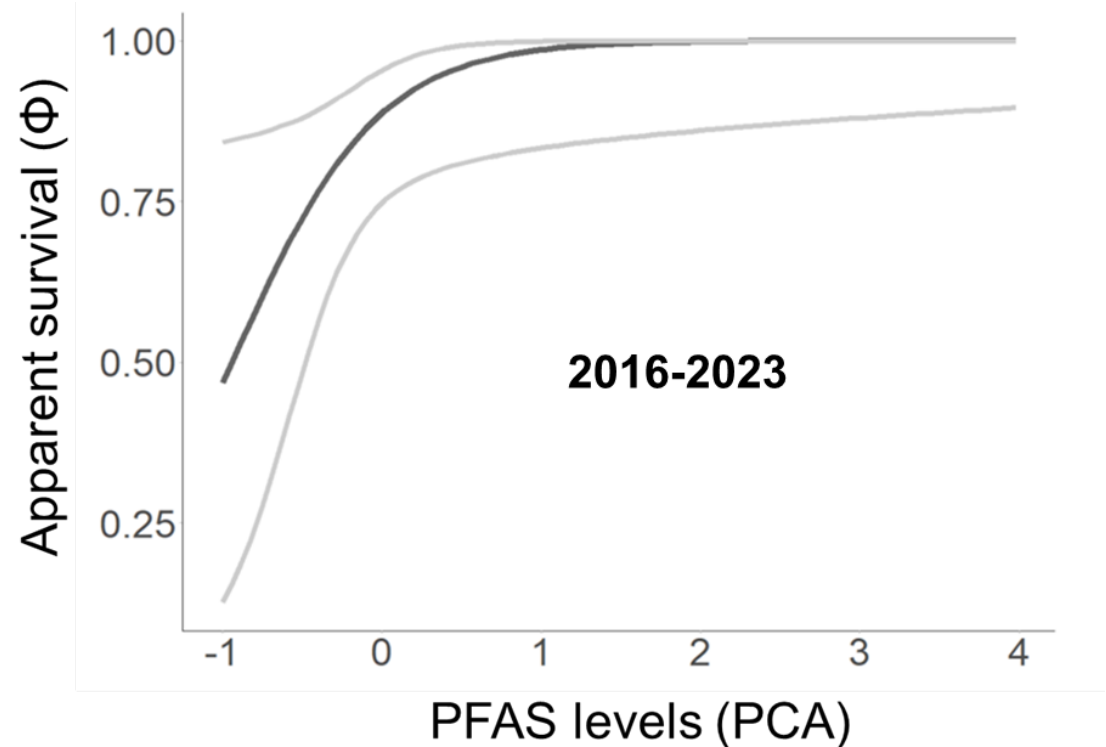
PFAS: Effects on survival



Life history matrix

CMR analysis

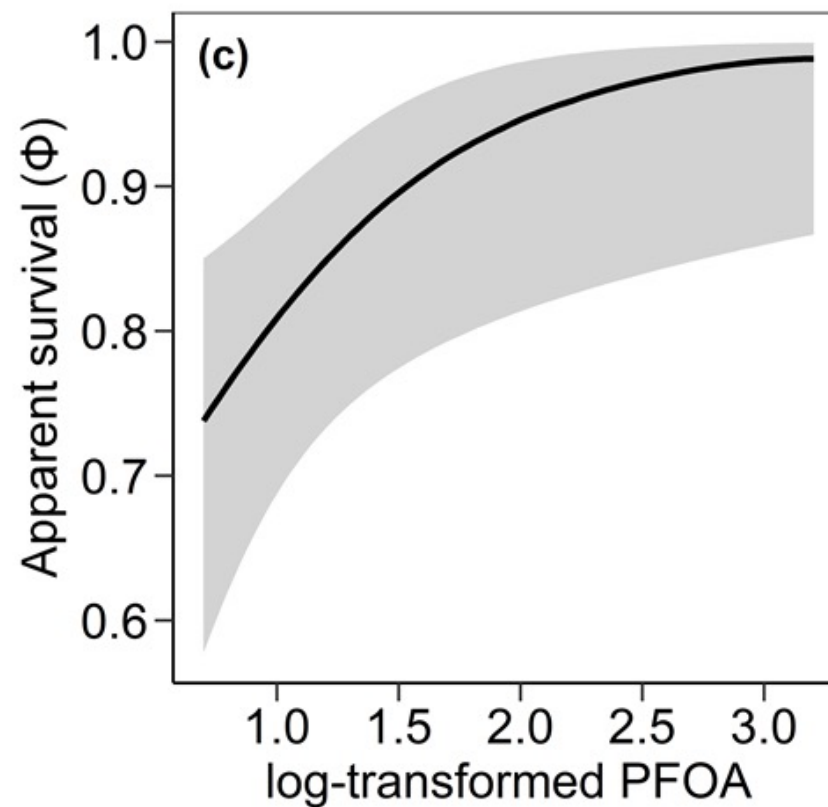
2016	2017	2018	2019	2020	2021	2022	2023
1	0	0	0	0	0	0	0
1	1	1	1	0	0	0	0
1	0	0	0	0	0	0	0
1	0	0	1	1	0	0	0
1	1	1	1	1	0	0	0
1	1	1	1	0	0	0	0
1	1	0	0	0	0	0	0
1	1	0	0	1	0	0	0
1	1	1	1	0	0	0	0
1	1	1	1	0	0	0	0
1	1	1	1	0	0	0	0
1	1	1	0	1	1	0	0
1	1	1	0	1	0	0	0
0	1	0	0	0	0	0	0



**Great- black backed gull (France):
Exposure to PFAS associated with
a higher survival probability (females)**



Sebastiano, Angelier, Blévin, Ribout, Sagerup, Descamps, Herzke, Moe, Barbraud, Bustnes, Gabrielsen, Chastel (2020) *Environmental Science and Technology*



Glaucous gulls (Svalbard):
Exposure to PFOA associated with
a higher adult survival probability

PFAS are maternally transferred (long chain PFCAs)



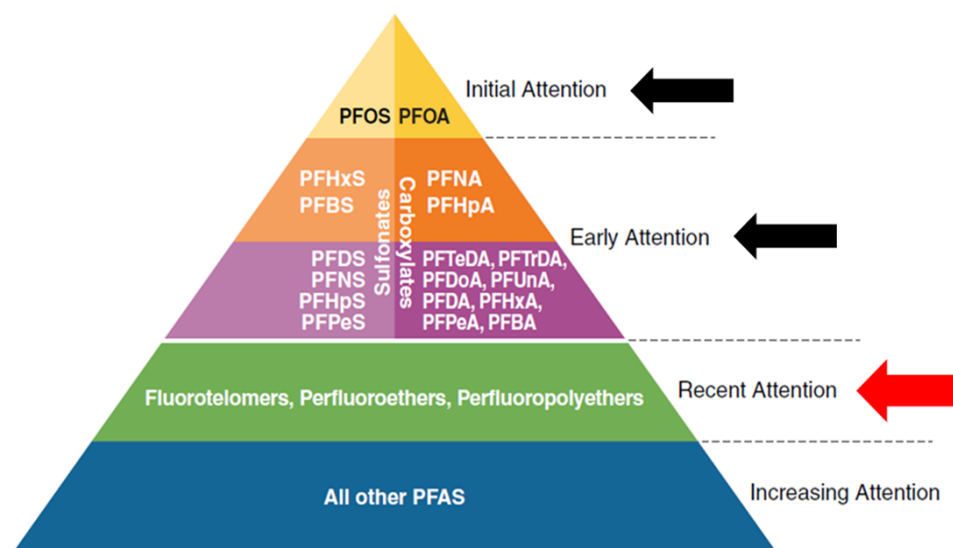
Legacy PFAS

PFHxS
PFHpS
brPFOS
linPFOS
PFOA
PFNA
PFDcA
PFUnA
PFDoA
PFTriA
PFTeA
PFHxDA



Emerging PFAS

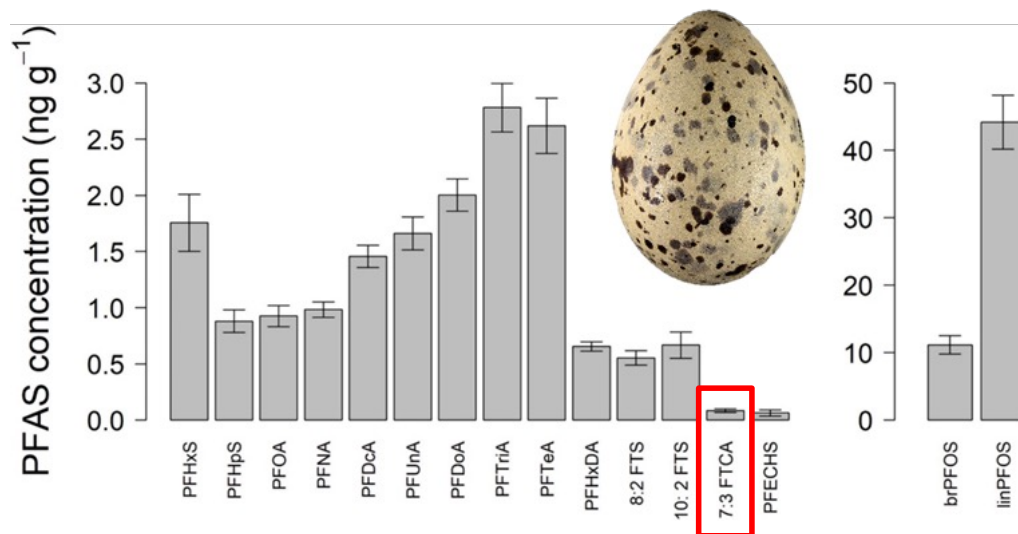
8:2 FTS
10:2 FTS
7:3 FTCA
PFECs
HPFO-TeA (GenX)
ADONA



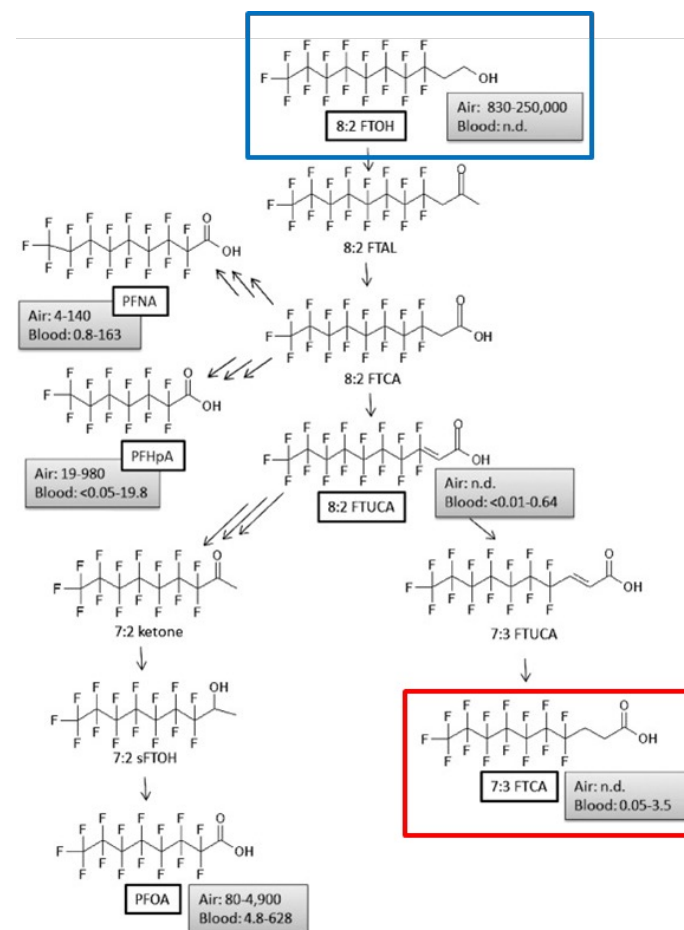
Jouanneau, Leandri-Breton, Corbeau, Herzke, Moe, Nikiforov, Gabrielsen, Chastel O (2022) *Environmental Science & Technology*

Emerging/alternative PFAS:
Largely uncharacterized in terms of risks, despite recent evidences of their environmental occurrence in wildlife tissues

Emerging PFAS in French seabirds

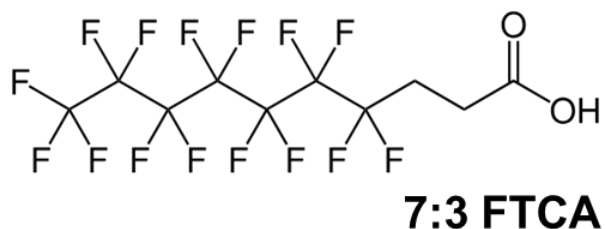


Jouanneau, Boulinier, Herzke, Nikiforov, Gabrielsen, Chastel (2025)
Marine Pollution Bulletin



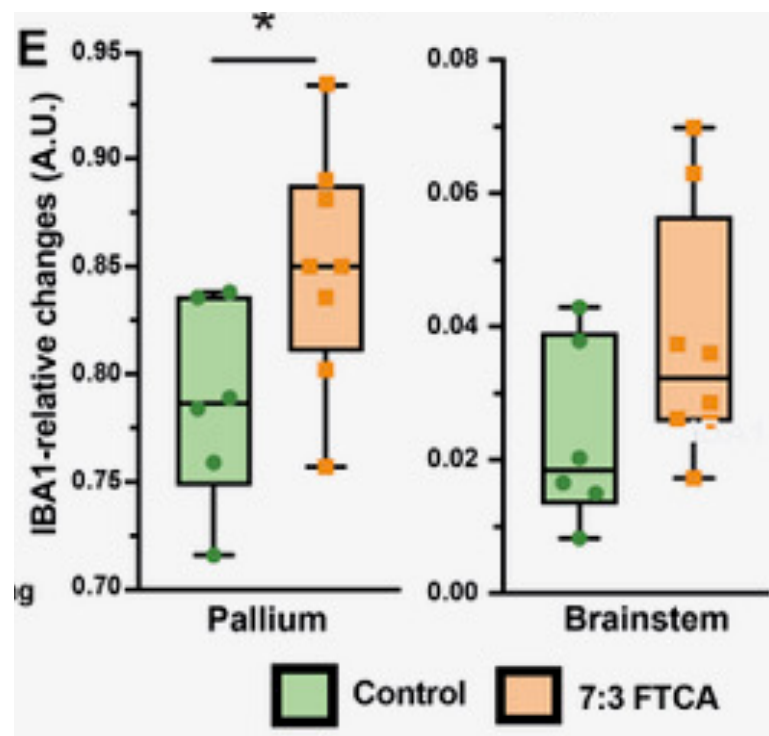
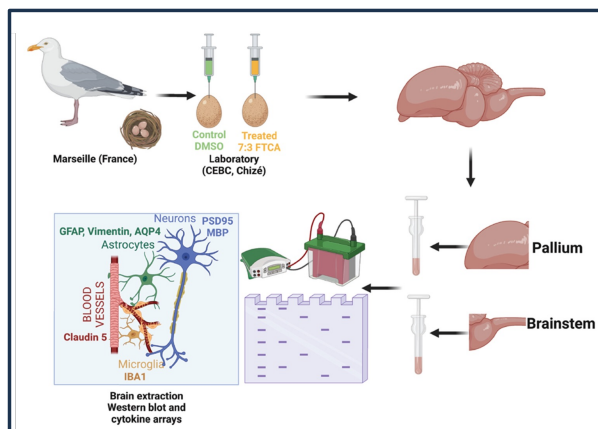
Fluorotelomer alcohols (windshield wash) can biodegrade to perfluorinated carboxylic acids, including 7:3 FTCA which is increasingly detected in wildlife tissues (seabirds, sea mammals, polar bear)

Emerging PFAS in French seabirds



7:3 FTCA detected in eggs of American herring gull and ring-billed gull from Saint Pierre et Miquelon. Eggs from laughing gull (French Guiana) and from Kelp gull (Kerguelen) currently under investigation.

Emerging PFAS: What consequences for seabirds?



Yellow-legged gulls (France):
Exposure to 7:3 FTCA increases
neuroinflammatory activity in embryos

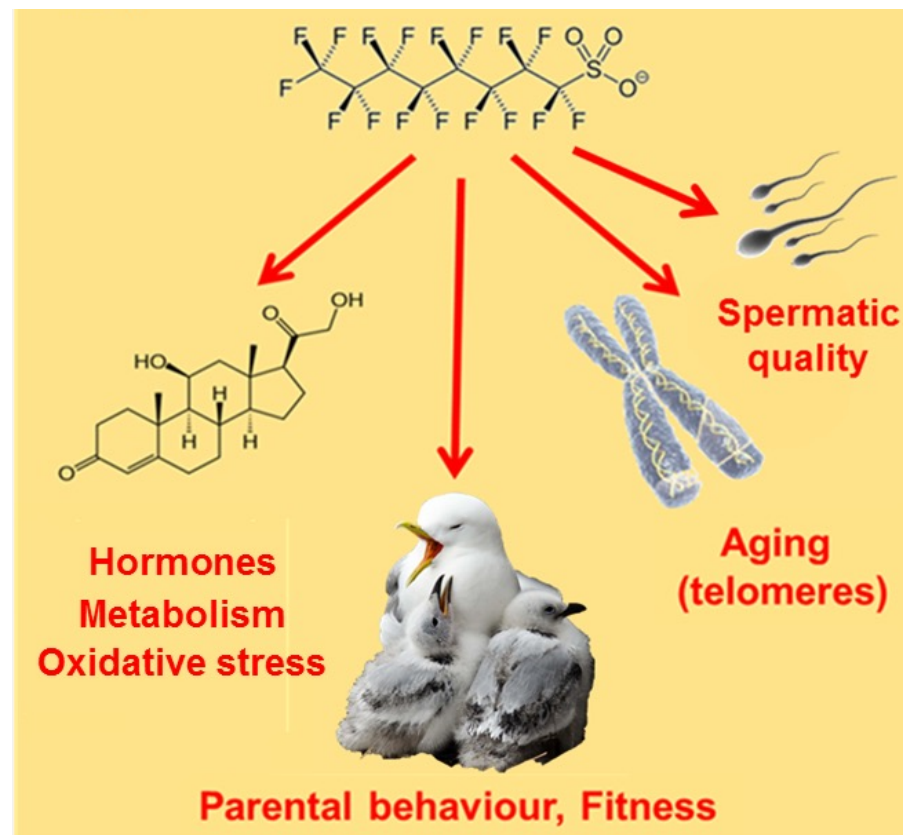
Occurrence and toxicity of PFAS in French seabirds

Highest PFAS levels found in seabirds from Saint-Pierre-et-Miquelon and in piscivorous species in continental France. French Guiana and Southern territories species show overall low PFAS levels.

Telemetry and isotopy suggest that rather than trophic position, habitats used during breeding and location of the wintering area can influence PFAS levels and compounds

Long-chain PCFAs exposure linked to physiology and demography.

Emerging PFAS possibly as harmful as legacy PFAS



Need for long-term monitoring of PFAS in seabirds:

- **Efficiency of regulation measures**
- **Interaction with other contaminants & stressors (food shortage, avian flu)**
- **Detection of emerging PFAS**



**13^{ème} rencontres nationales du réseau
« oiseaux marins »**

**15 au 17 octobre 2025,
à Bonifacio (2A)**

Contact : antoine.chabrolle@mnhn.fr

Organisateurs

- OFB** OFFICE FRANÇAIS DE LA BIODIVERSITÉ
- GRUPPIAMENTU D'INTERESSI SCIENTIFICI OISEAUX MARINS
- MUSÉUM NATIONAL D'HISTOIRE NATURELLE
- COLLETTINGA-CORSICA COLLECTIVE-CORSE
- Office de l'Environnement et du Développement de la Corse

Partenaires locaux

- PIM INITIATIVE**
- Conservatoire d'espaces naturels CORSE



Merci beaucoup!