

PHARMACEUTICALS: Stranded dolphins in the Basque Country's Coast



Unax Lertxundi

PERSPECTIVES

MEDICINE

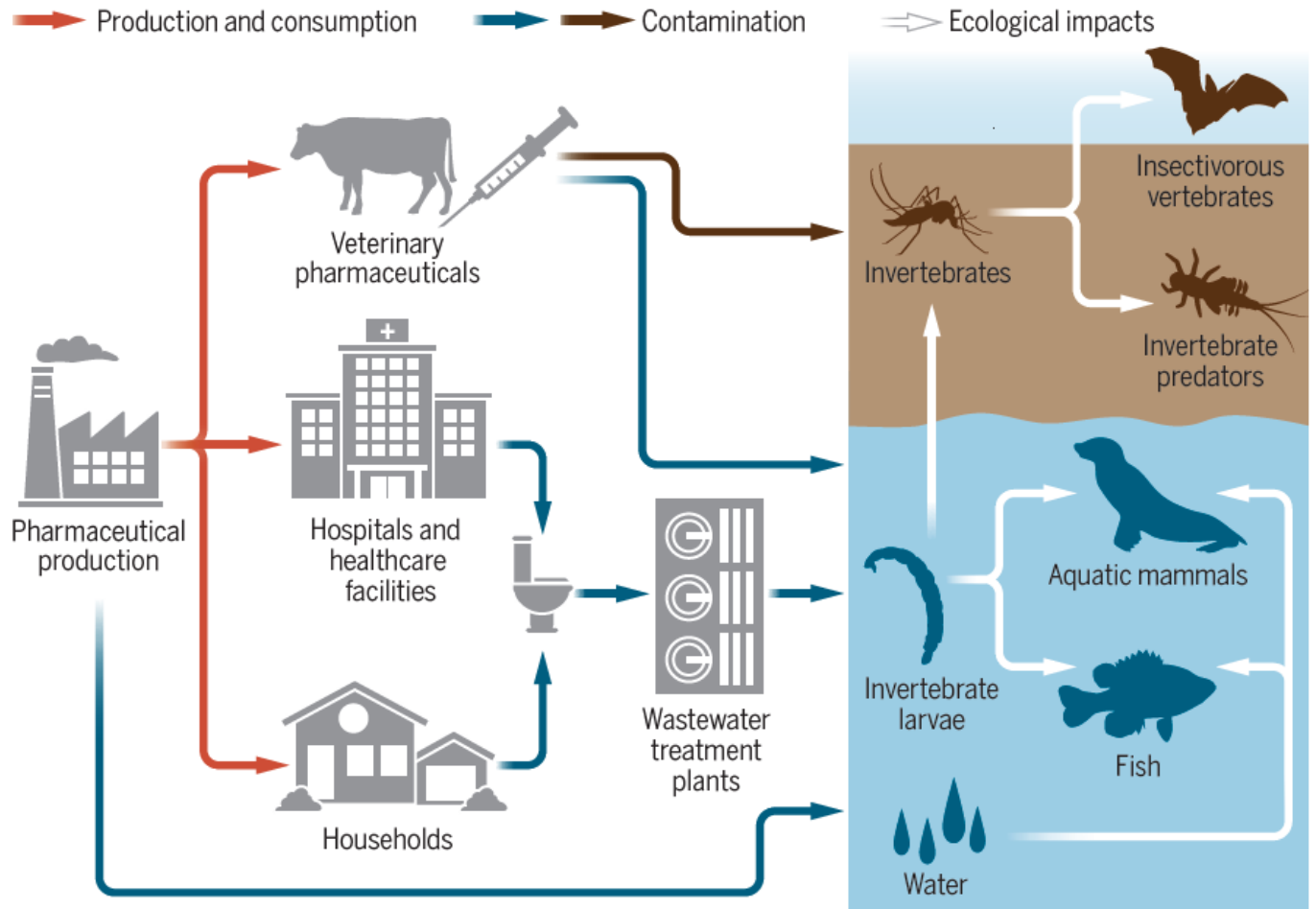
Greening the pharmacy

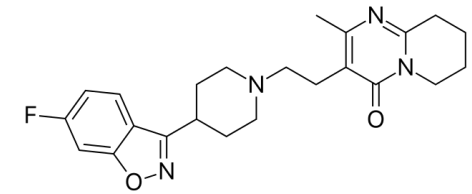
New measures and research are needed to limit the ecological impact of pharmaceuticals

By Gorka Orive^{1,2,3,4}, Unax Lertxundi⁵, Tomas Brodin⁶, Peter Manning^{7,8}

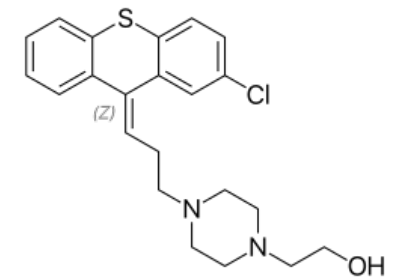
The life cycle of pharmaceutical drugs

Pharmaceuticals are produced by industrial facilities and are consumed in agricultural production, hospitals, healthcare facilities, and households. They are released into the environment, for example, through dung, urine, and wastewater, unless properly regulated and waste products are treated. Pharmaceutical contamination affects organisms directly and indirectly through the food chain, impacting terrestrial and freshwater ecosystems. Measures to reduce the risk of drug pollution can be implemented at all stages of the life cycle.



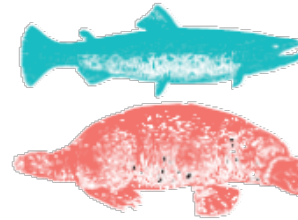
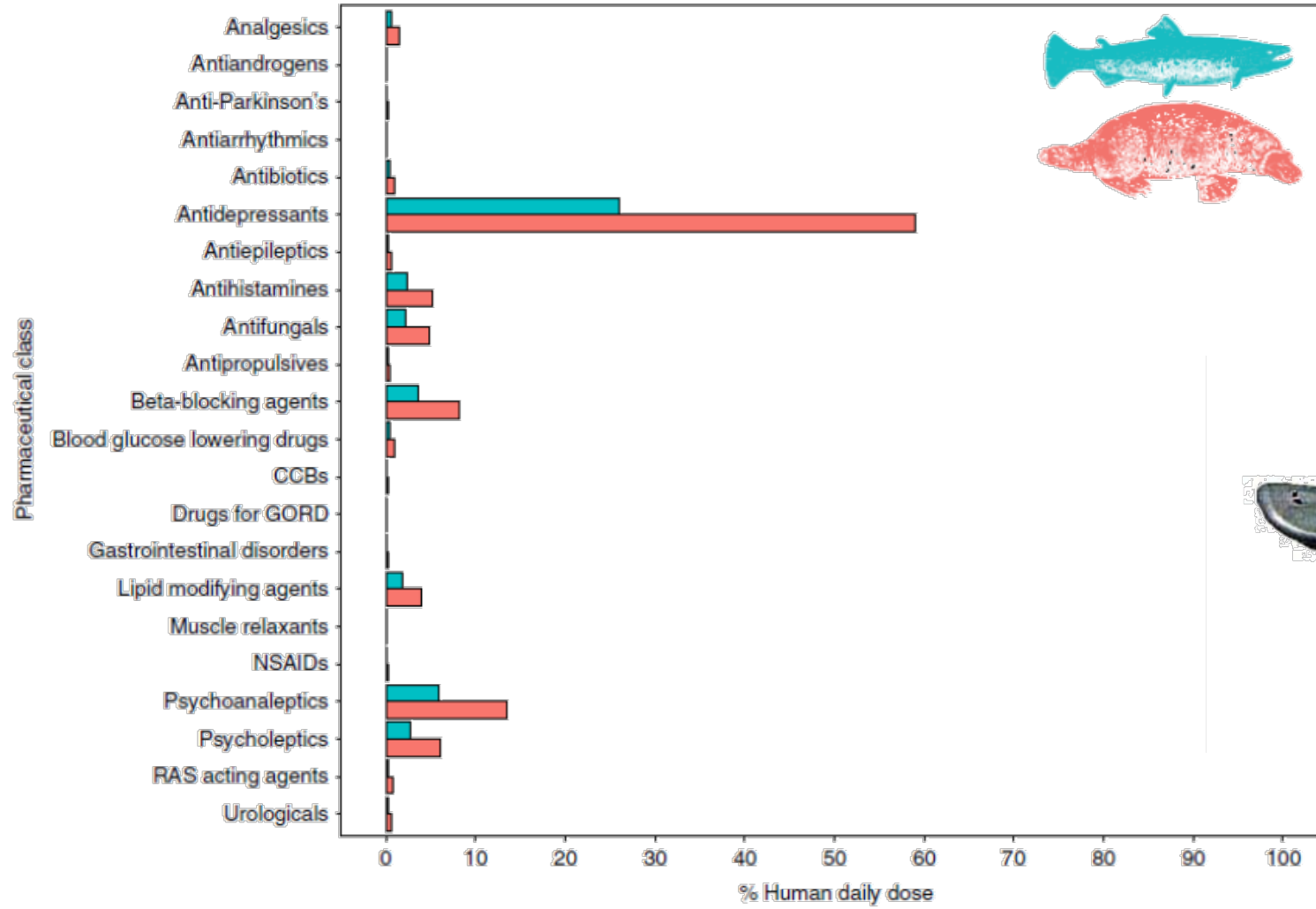


Risperidone



Zuclophentixole

Cervený D, et al. Neuroactive drugs and other pharmaceuticals found in blood plasma of wild European fish. **Environ Int.** 2021 Jan;146:106188. doi: [10.1016/j.envint.2020.106188](https://doi.org/10.1016/j.envint.2020.106188).



ESTUARINE AND COASTAL SCIENCES SERIES: VOLUME 1

Pharmaceuticals in Marine and Coastal Environments

Occurrence, Effects, and Challenges in a Changing World

Edited by

Juan Carlos Durán-Álvarez and Blanca Jiménez-Cisneros



Series Editors

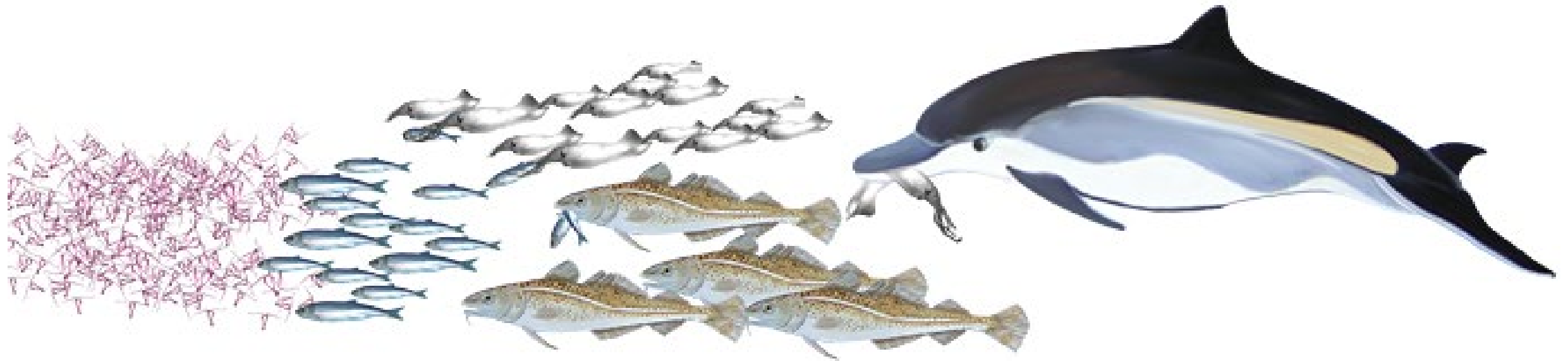
Steve Mitchell and Michael Elliott on behalf of
the Estuarine & Coastal Sciences Association (ECSA)

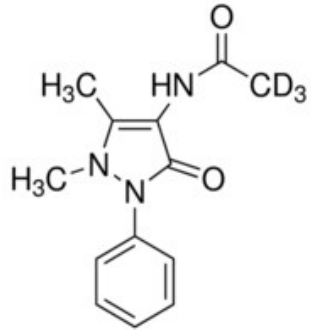


 Umwelt
Bundesamt

200 pharmaceuticals in marine
matrices

What about top predators?





of 4-acetamido-antipyrine



100%

5 stranded Harbour porpoises





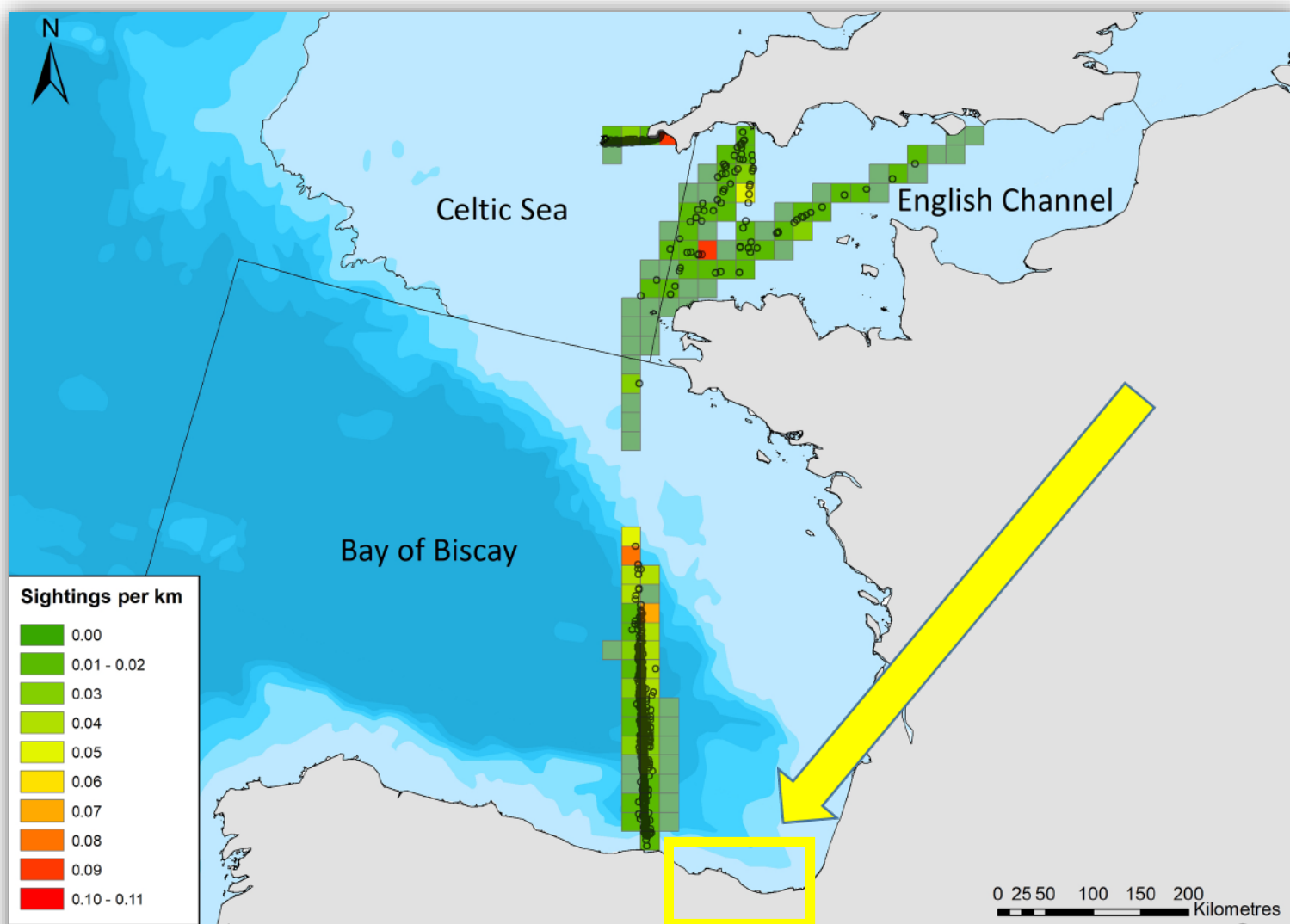
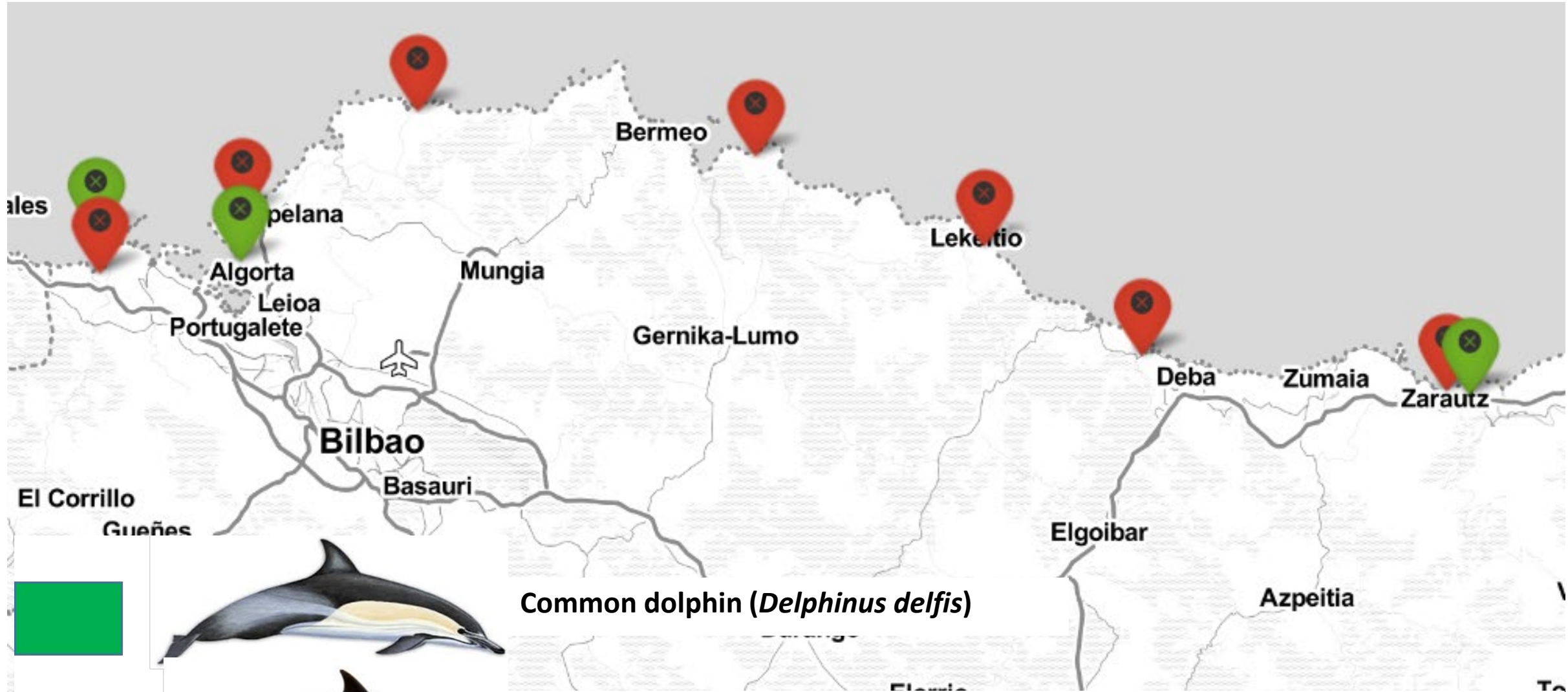


Figure 2 Common dolphin sightings across the study area. Black lines crossing water depict region boundaries for the English Channel, Celtic Sea, and Bay of Biscay. Open circles show locations of common dolphin groups. Grid cell color represents common dolphin groups per km of effort. Bathymetry is shown, with sightings in shallow water (light blue), through to waters up to 4,000 m deep (dark blue). Bathymetry vector courtesy of Natural Earth: www.naturalearthdata.com.



Common dolphin (*Delphinus delphis*)



Striped dolphin (*Stenella coeruleoalba*)

Blubber, liver and muscle samples (n=10)





Laboratory analysis (95 different pharmaceuticals)



Swedish University of Agricultural Sciences

Table S1. List of target pharmaceuticals with instrumental method performance

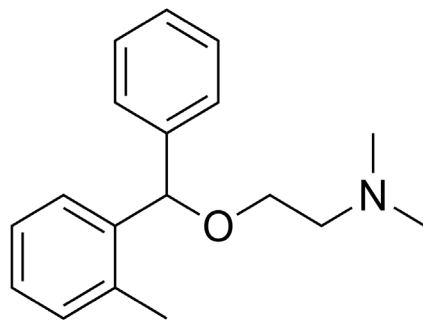
Pharmaceutical name	Group/Classification	LOQ ¹ (ng g ⁻¹)	RSD ² (%)	Recovery ³ (%)
<u>Alfuzosin</u>	Urological	0.01	25%	64%
<u>Alprazolam</u>	Psycholeptic	0.01	29%	70%
<u>Amiodarone</u>	Antiarrhythmic	0.05	29%	47%
<u>Amitriptyline</u>	Antidepressant	0.1	12%	97%
<u>Amitriptyline*</u>	IS	NA	NA	NA
<u>Atenolol</u>	Hypertension	1	13%	48%
<u>Atorvastatin</u>	Statin	0.05	21%	89%
<u>Atracurium</u>	Muscle relaxant	0.01	20%	74%
<u>Azelastine</u>	Antihistamine	0.01	32%	92%
<u>Azithromycin</u>	Antibiotic	0.1	17%	90%
<u>Beclomethasone</u>	Antiinflammatory	1	13%	73%
<u>Bisoprolol</u>	Hypertension	0.05	28%	50%
<u>Bromocriptine</u>	Anti-Parkinson	0.1	30%	47%
<u>Budesonide</u>	Antiinflammatory	0.5	20%	44%
<u>Buprenorphine</u>	Analgesic	0.05	27%	44%
<u>Bupropion</u>	Antidepressant	0.1	24%	70%
<u>Caffeine</u>	Stimulant	5	29%	108%
<u>Caffeine*</u>	IS	NA	NA	NA
<u>Carbamazepin*</u>	IS	NA	NA	NA
<u>Carbamazepine</u>	Psycholeptic	0.01	25%	104%
<u>Chlorpromazine</u>	Psycholeptic	0.01	12%	89%
<u>Chlorprothixene</u>	Psycholeptic	0.01	17%	67%
<u>Cilazapril</u>	Hypertension	0.01	30%	69%
<u>Citalopram</u>	Antidepressant	0.5	17%	31%
<u>Clarithromycin</u>	Antibiotic	0.05	24%	85%
<u>Clemastine</u>	Antidepressant	0.05	11%	75%
<u>Clindamycin</u>	Antibiotic	0.01	25%	89%
<u>Clomipramine</u>	Antidepressant	0.01	14%	86%

Species	Individual	State of the sample	Handling procedures	Stranding location	GPS	Sampling date (dd/mm/yyyy)	Age class	Sex	Size (cm)	Tissue	Concentration (ng/g)		
											Orphenadrine	Pizotifen	Promethazine
 <i>Delphinus delphis</i>	1-20160820_DDE	Recently dead	Necropsy	Arrigunaga(Bizkaia)	43°21'22.3"N 3°01'09.0"W	20/08/2016	Juvenile	Female	151	liver	0.08	-	-
										blubber	-	-	-
	2-20190616_DDE	Recently dead	Necropsy	Muskiz (Bizkaia)	43°21'00.9"N 3°07'01.3"W	16/06/2019	Juvenile	Female	145	liver	-	-	-
										blubber	-	-	-
	5-20210313_DDE	Recently dead	Necropsy	Zarautz (Gipuzkoa)	43°17'18.0"N 2°09'12.5"W	14/03/2021	Pup	Male	105	liver	-	-	-
										blubber	-	-	0.11
 <i>Stenella coeruleoalba</i>	6-20210325_SCO	Recently dead	Necropsy	Ibarrangelua (Bizkaia)	43°24'34.4"N 2°39'19.8"W	25/03/2021	Juvenile	Female	148	liver	-	0.09	-
										blubber	-	-	-
	3-20190901_SCO	Alive	Necropsy	Ibarrangelua (Bizkaia)	43°24'34.4"N 2°39'19.8"W	02/09/2019	Juvenile	Female	178	liver	-	0.11	-
										blubber	-	-	0.22
	4-20200209_SCO	Recently dead	Necropsy	Mutriku (Gipuzkoa)	43°18'28.1"N 2°23'01.5"W	02/09/2020	Pup	Female	138	liver	-	-	-
										blubber	-	-	-
	7-20210513_SCO	Alive	Necropsy	Lekeitio (Bizkaia)	43°21'49.4"N 2°29'42.5"W	13/05/2021	Pup	Male	138	liver	-	-	-
										blubber	-	-	-
	8-20180302_SCO	Recently dead	Necropsy	Zarautz (Gipuzkoa)	43°17'18.0"N 2°09'12.5"W	02/03/2018	Adult	Male	217	liver	-	-	-
										blubber	-	-	0.45
	9-20190111_SCO	Alive	Necropsy	Armintza (Bizkaia)	43°25'58.1"N 2°53'35.7"W	12/01/2019	Adult	Male	221	liver	-	-	-
										blubber	-	-	0.61
10-20190507_SCO	Recently dead	Dissected on the beach		Azkorri (Bizkaia)	43°22'48.0"N 3°01'03.9"W	07/05/2019	Adult	Male	233	liver	0.15	0.13	-
									blubber	-	-	-	

- 7/10 dolphins at least 1 pharmaceutical
- Very low concentrations (<1 ng/g)

Only 3
pharmaceuticals
> LOD

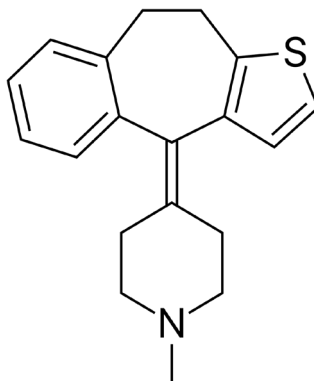
Pharmaceutical	Mechanism of action	Therapeutic uses	Availability in Spain, France, UK	
			Human use	Veterinary use
Orphenadrine	Antimuscarinic, antihistaminic	Parkinsonism, skeletal muscle spasm	-	-
Pizotifen	Antihistaminic, strong serotonin antagonism, weak anticholinergic effects	Migrain , orexigen (appetite stimulant)	Spain	-
Promethazine	Antimuscarinic, antihistaminic, serotonin antagonism	Symptomatic relief of allergic reactions; prevent nausea and vomiting associated with motion sickness; prevent nausea and vertigo in Meniere's disease	Spain, France, UK	France



ORPHENADRINE

B: Log Kow: 4.05

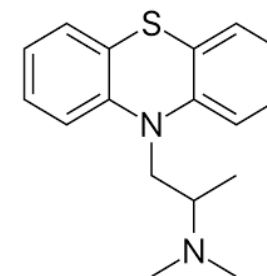
P:?



PIZOTIFEN

B: Log Kow: 4.7







P: Not biodegradable



PROMETHAZINE

B: Log Kow: 4.8

P:?

Pharmaceutical	Umwelt Bundesamt 	Country	WWTP	Concentration (ng/L)
Orphenadrine	Belgium 	Waregem	0.21	
		Ajjinomoto Omnicem	0.21	
		Bayer Antwerpen	0.23	
		Janssen Pharmaceuticals	0.13	
		Shanks Ikeren	0.25	
		Tack Oostrozebeke	3.36	
		Taminco	0.16	
		TWZ Evergem	0.28	
		Deurne	0.62	
		Geel	0.37	
		Agristo	0.22	
		Ronse	0.22	
	Hasselt	1.06		
	France 	-	0.14	
		Givors	0.27	
	Ireland 	Dublin	0.96	
Oberstown		0.23		
Spain 	Ulldecona	0.11		
Portugal 	Parada	0,92		
	Viana Do Castelo	0,28		
Pizotifen	Belgium 	Ajjinomoto Omnicem	1.91	
		Colortex	0.53	
		Tack Oostrozebeke	1.18	
		TWZ Evergem	1.38	
	Spain 	Ulldecona	0.73	

What are the sources?




WWTP? Land runoff?



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<https://doi.org/10.1007/s11686-021-00507-z>

REVIEW

***Toxoplasma gondii* Infection in Marine Animal Species, as a Potential Source of Food Contamination: A Systematic Review and Meta-Analysis**

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Ship wastewater?





Basque Sustainable Pharmacy

<https://sustainablepharmacy.org>



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