

# Impactos da Poluição por Lixo em Animais Marinhos

A importância do Monitoramento Intensivo  
do Ambiente

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**PMP-BS**  
PROJETO DE MONITORAMENTO  
DE PRAIAS – BACIA DE SANTOS

# Lixo nos oceanos



<https://4ocean.com/blogs/blog/when-did-marine-debris-become-a-problem>

- ▶ Problema reconhecido globalmente
- ▶ Preocupação vem aumentando
- ▶ Afeta diferentes ecossistemas

# Lixo nos oceanos

- ▶ Ocorre em todos os locais
  - ▶ Costa
  - ▶ Mar aberto



<https://marinedebris.noaa.gov/occurrence-and-health-effects-anthropogenic-debris-ingested-marine-organisms>



<http://www.solomonstarnews.com/index.php/news/regional/item/20259-tackling-marine-debris>

# Lixo nos oceanos

## ► O que é o “lixo marinho”?

Qualquer material sólido manufaturado ou processado e que foi, direta ou indiretamente, intencionalmente ou não, lançado ou abandonado no ambiente marinho

<https://marinedebris.noaa.gov>

# Lixo nos oceanos

- ▶ O que é o “lixo marinho”?



# Lixo nos oceanos

- O que é o “lixo marinho”?



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# Lixo nos oceanos

- O que é o “lixo marinho”?



# Lixo nos oceanos

- O que é o “lixo marinho”?



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≡ Google Scholar      marine debris      

Articles      About 771,000 results (0.05 sec) ← 771.000 trabalhos!

Any time      Since 2021      Since 2020      Since 2017      Custom range...  
Sort by relevance      Sort by date  
 include patents       include citations  
 Create alert

**Marine debris & plastics: environmental concerns, sources, impacts and solutions**  
SB Sheavly, KM Register - Journal of Polymers and the Environment, 2007 - Springer  
Marine debris (marine litter) is one of the most pervasive and solvable pollution problems plaguing the world's oceans and waterways. Nets, food wrappers, cigarette filters, bottles, resin pellets, and other debris items can have serious impacts on wildlife, habitat, and ...  
☆ 99 Cited by 454 Related articles All 12 versions

**JBOOK Marine debris: sources, impacts, and solutions**  
JM Coe, D Rogers - 2012 - books.google.com  
Marine debris is a global pollution problem affecting marine life, maritime commerce and environmental quality. Scientists, policymakers and the public must be knowledgeable about the source, impact and control efforts if effective solutions are to be developed. Marine ...  
☆ 99 Cited by 372 Related articles All 6 versions

**[HTML] The impact of debris on marine life**  
SC Gall, RC Thompson - Marine pollution bulletin, 2015 - Elsevier  
Marine debris is listed among the major perceived threats to biodiversity, and is cause for particular concern due to its abundance, durability and persistence in the marine environment. An extensive literature search reviewed the current state of knowledge on the ...  
☆ 99 Cited by 1129 Related articles All 11 versions

**Life in the "plastisphere": microbial communities on plastic marine debris**  
ER Zettler, TJ Mincer... - Environmental science & ..., 2013 - ACS Publications  
Plastics are the most abundant form of marine debris, with global production rising and documented impacts in some marine environments, but the influence of plastic on open ocean ecosystems is poorly understood, particularly for microbial communities. Plastic ...  
☆ 99 Cited by 1212 Related articles All 21 versions

Gerado interesse na comunidade científica

### Trabalhos sobre lixo marinho no Google Acadêmico



Gerado  
interesse na  
comunidade  
científica

# Lixo x Plástico

- ▶ Se é processado, é lixo
  - ▶ Menor preocupação para alguns tipos



<https://phys.org/news/2014-10-rottnest-marine-debris.html>

# Lixo x Plástico

- ▶ Se é processado, é lixo
- ▶ Menor preocupação para alguns tipos

## REGULATIONS FOR GARBAGE DISPOSAL AT SEA (ANNEX V OF MARPOL 73/78)

GARBAGE TYPE	OUTSIDE SPECIAL AREAS	IN SPECIAL AREAS
Plastics - includes synthetic ropes and fishing nets and plastic garbage bags	DISPOSAL IS PROHIBITED	DISPOSAL IS PROHIBITED
Floating dunnage, lining and packing materials	DISPOSAL IS PERMITTED ONLY IF THE DISTANCE FROM THE NEAREST LAND IS MORE THAN 25 NAUTICAL MILES	DISPOSAL IS PROHIBITED
Paper, rags, glass, metal, bottles, crockery and similar refuse	DISPOSAL IS PERMITTED ONLY IF THE DISTANCE FROM THE NEAREST LAND IS MORE THAN 12 NAUTICAL MILES	DISPOSAL IS PROHIBITED
All other garbage including paper, rags, glass, etc. comminuted or ground*	DISPOSAL IS PERMITTED ONLY IF THE DISTANCE FROM THE NEAREST LAND IS MORE THAN 3 NAUTICAL MILES	DISPOSAL IS PROHIBITED
Food waste not comminuted or ground	DISPOSAL IS PERMITTED ONLY IF THE DISTANCE FROM THE NEAREST LAND IS MORE THAN 12 NAUTICAL MILES	DISPOSAL IS PERMITTED ONLY IF THE DISTANCE FROM THE NEAREST LAND IS MORE THAN 12 NAUTICAL MILES
Food waste comminuted or ground*	DISPOSAL IS PERMITTED ONLY IF THE DISTANCE FROM THE NEAREST LAND IS MORE THAN 3 NAUTICAL MILES	DISPOSAL IS PERMITTED ONLY IF THE DISTANCE FROM THE NEAREST LAND IS MORE THAN 12 NAUTICAL MILES
Mixed refuse types	**	**

\* : Comminuted or ground garbage must be able to pass thought a screen with mesh size no larger than 25mm.

\*\* : When garbage is mixed with other harmful substances having different disposal or discharge requirements, the more stringent disposal requirements shall apply.

# Lixo x Plástico

- Se é processado, é lixo
- Menor preocupação para alguns tipos

Garbage type <sup>1</sup>	All ships except platforms <sup>4</sup>		Regulation 5 Offshore platforms located more than 12 nm from nearest land and ships when alongside or within 500 metres of such platforms <sup>4</sup>
	Regulation 4 Outside special areas and Arctic waters (Distances are from the nearest land)	Regulation 6 Within special areas and Arctic waters (Distances are from nearest land, nearest ice-shelf or nearest fast ice)	
Food waste comminuted or ground <sup>2</sup>	$\geq 3$ nm, en route and as far as practicable	$\geq 12$ nm, en route and as far as practicable <sup>3</sup>	Discharge permitted
Food waste not comminuted or ground	$\geq 12$ nm, en route and as far as practicable	Discharge prohibited	Discharge prohibited
Cargo residues <sup>5, 6</sup> not contained in washwater		Discharge prohibited	
Cargo residues <sup>5, 6</sup> contained in washwater	$\geq 12$ nm, en route and as far as practicable	$\geq 12$ nm, en route and as far as practicable (subject to conditions in regulation 6.1.2 and paragraph 5.2.1.5 of part II-A of the Polar Code)	Discharge prohibited
Cleaning agents and additives <sup>6</sup> contained in cargo hold washwater	Discharge permitted	$\geq 12$ nm, en route and as far as practicable (subject to conditions in regulation 6.1.2 and paragraph 5.2.1.5 of part II-A of the Polar Code)	Discharge prohibited
Cleaning agents and additives <sup>6</sup> in deck and external surfaces washwater		Discharge permitted	
Animal Carcasses (should be split or otherwise treated to ensure the carcasses will sink immediately)	Must be en route and as far from the nearest land as possible. Should be $>100$ nm and maximum water depth	Discharge prohibited	Discharge prohibited
All other garbage including plastics, synthetic ropes, fishing gear, plastic garbage bags, incinerator ashes, clinkers, cooking oil, floating dunnage, lining and packing materials, paper, rags, glass, metal, bottles, crockery and similar refuse	Discharge prohibited	Discharge prohibited	Discharge prohibited

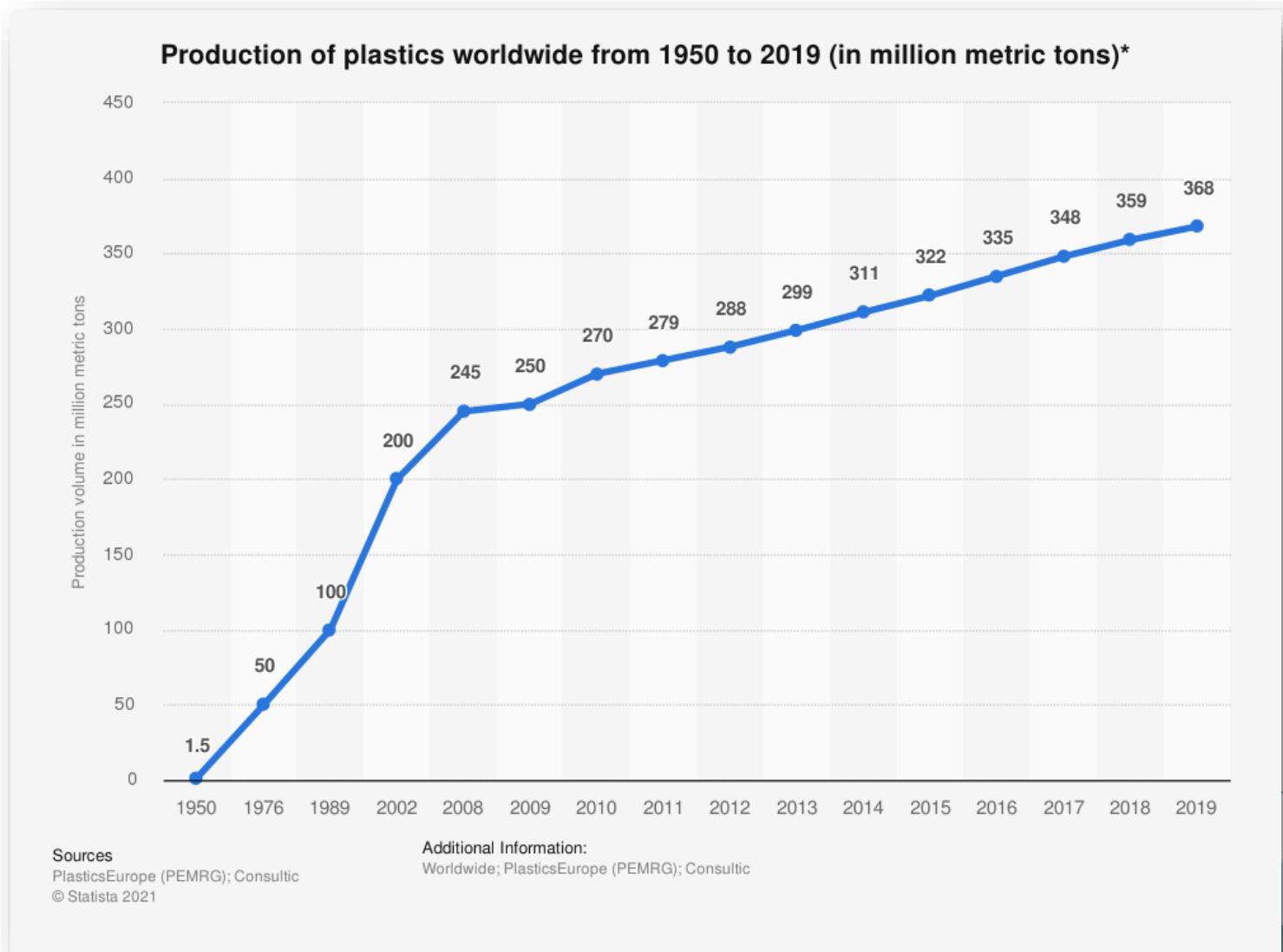
# Lixo x Plástico

- ▶ Plástico tem maior permanência
  - ▶ Produção em massa a partir da década de 1940
  - ▶ Ausência de biodegradação aumenta o acúmulo
  - ▶ Flutuam



<https://marinedebris.noaa.gov/multimedia/photos/types#prettyPhoto>

# Lixo Plástico



# Categorias

## Microplásticos

- ▶ < 5mm
- ▶ Varia entre autores
- ▶ Primários: fabricados neste tamanho
- ▶ Secundários: fragmentos de pedaços maiores
- ▶ Ingeridos



## Macroplásticos

- ▶ > 5mm
- ▶ Diferentes efeitos na fauna



# Efeitos na fauna

- Diversos tipos de efeitos possíveis

Vegten et al. (2014) Endang Species Res 25: 225–247.  
doi: 10.3354/esr00623



Fig. 3. Top left to bottom right — magnificent frigatebird *Fregata magnificens* carcass from Battowia Island, Grenadines, with orange foam contained within stomach (courtesy Jennifer Lavers); Antarctic fur seal *Arctocephalus gazella*, with plastic ring entanglement at King George Island, Antarctica (courtesy Juliana Ivar do Sul); juvenile green turtle *Chelonia mydas* trapped in discarded crab trap and plastic fragments recovered from the gut of a juvenile green turtle (bottom 2 photos: courtesy Kathy Townsend)

# Efeitos na fauna

- ▶ Diversos tipos de efeitos possíveis

A deceased Laysan Albatross lies on the ground in Midway Atoll, with an exposed stomach filled with debris it consumed around its coastal habitat. Marine animals cannot digest debris and often die due starvation.

<https://marinedebris.noaa.gov/multimedia/photos/impacts#>



# Avaliação dos efeitos



Concepts & Synthesis | Full Access

## The ecological impacts of marine debris: unraveling the demonstrated evidence from what is perceived

Chelsea M. Rochman , Mark Anthony Browne, A. J. Underwood, Jan A. van Franeker, Richard C. Thompson, Linda A. Amaral-Zettler

First published: 07 March 2016 | <https://doi.org/10.1890/14-2070.1> | Citations: 205

# Avaliação dos efeitos

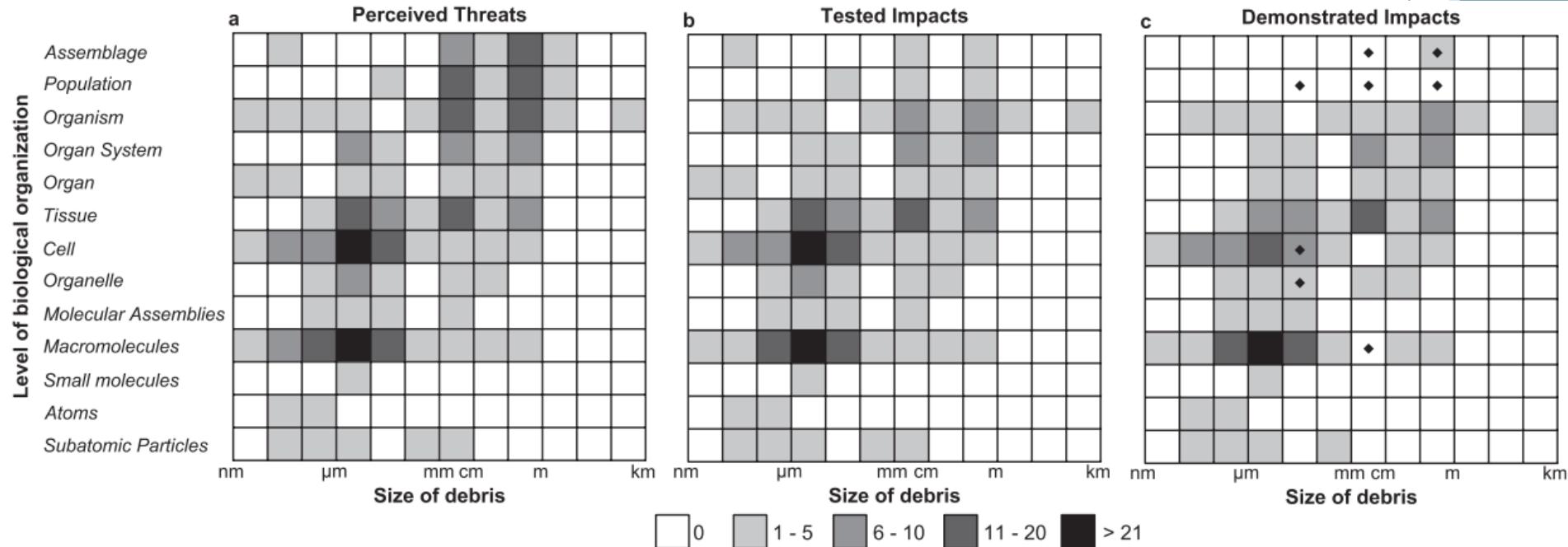
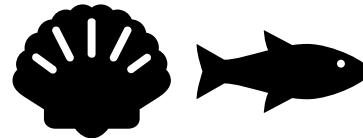


FIG. 2. Perceived, tested, and demonstrated impacts of debris. Rows in each matrix represent different levels of biological organization from subatomic particles, atoms, small molecules, macromolecules, molecular assemblies, organelle, cell, tissue, organ, organ system, organism, and population to assemblage. Columns represent order-of-magnitude sizes of debris from smallest (left) to largest (right). Shading in the individual cells of the matrix represent the magnitude of (a) perceived, (b) tested, and (c) demonstrated impacts of debris in peer-reviewed literature identified using the search terms *plastic debris* and *marine debris*. Shading represents the number of impacts. Diamonds in the matrix in panel (c) correspond to cells where at least one impact has been demonstrated by correlative evidence. All impacts described at multiple size ranges and levels of biological organization are represented such that there are more impacts than there are papers.

# Redução dos efeitos

- ▶ Para se propor medidas de mitigação efetivas é preciso saber a magnitude dos efeitos

- ▶ Quais espécies?



- ▶ Qual a frequência?



- ▶ Onde ocorre?





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# Projeto de Monitoramento de Praias da Bacia de Santos



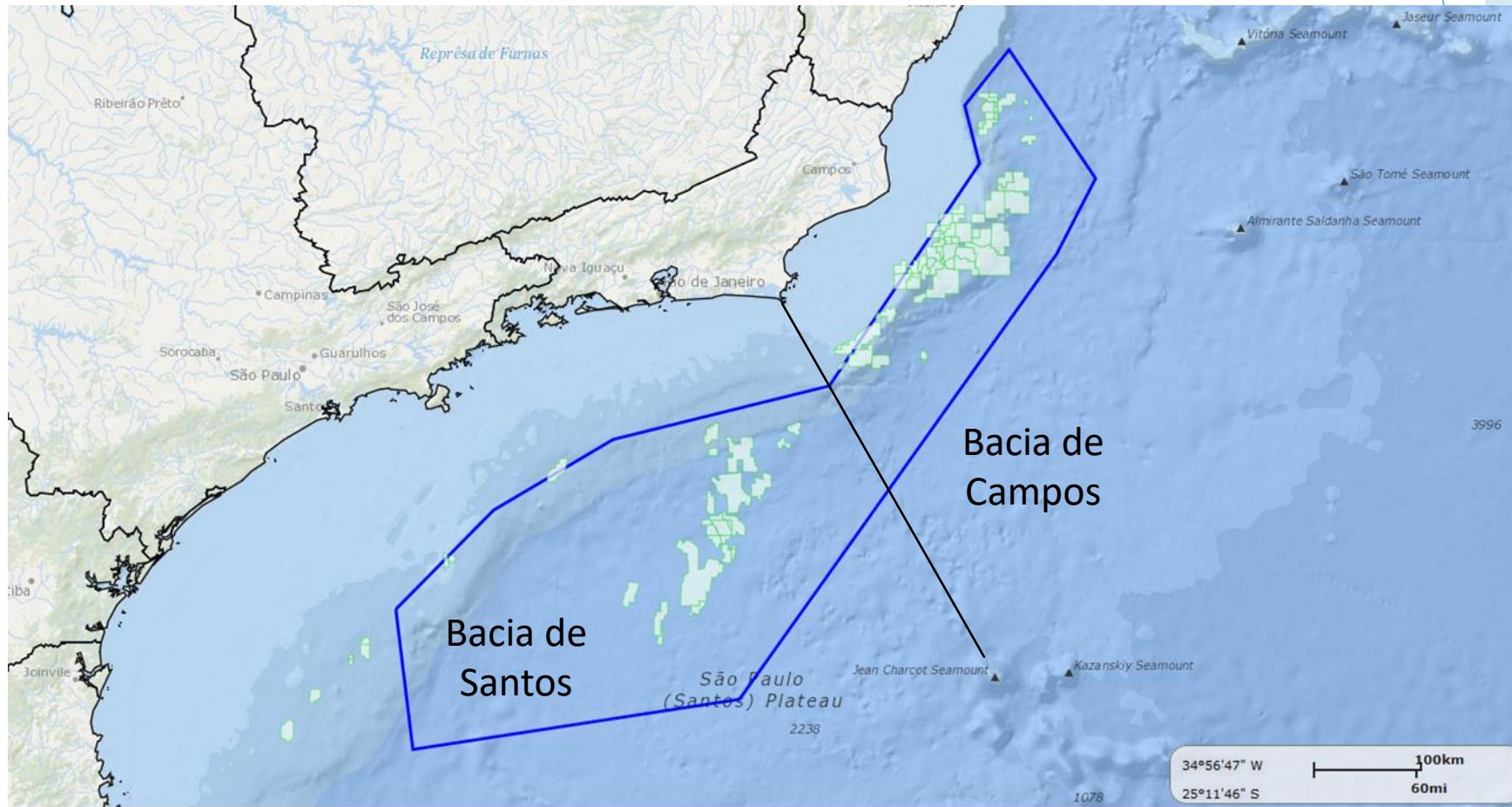
**PMP-BS**  
PROJETO DE MONITORAMENTO  
DE PRAIAS – BACIA DE SANTOS

- ▶ O Projeto de Monitoramento de Praias da Bacia de Santos (PMP-BS) é uma atividade desenvolvida para o atendimento de condicionante do licenciamento ambiental federal conduzido pelo IBAMA, das atividades da PETROBRAS de produção e escoamento de petróleo e gás natural na Bacia de Santos.



# PMP-BS

## PROJETO DE MONITORAMENTO DE PRAIAS – BACIA DE SANTOS





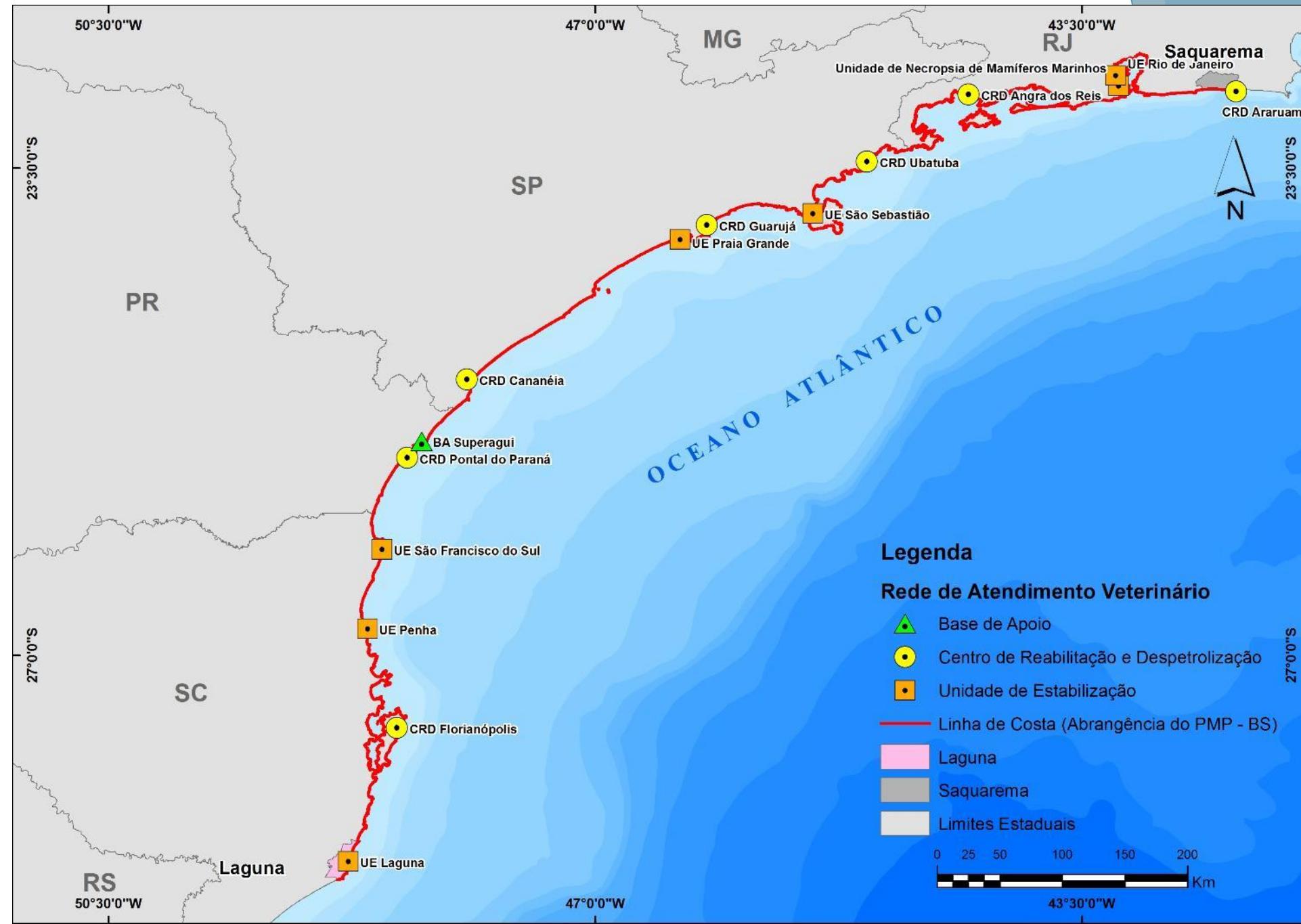
# Objetivo do PMP-BS

- ▶ Avaliar os possíveis impactos das atividades de produção e escoamento de petróleo sobre as aves, tartarugas e mamíferos marinhos, através do monitoramento das praias
- ▶ Prestar atendimento veterinário aos animais vivos
- ▶ Necropsiar os animais encontrados mortos para identificar a causa de morte.



# Atividades desenvolvidas

- ▶ Monitoramento de Praias
  - ▶ De Laguna/SC até Saquarema/RJ
  - ▶ 2.013km de praias atendidas
    - ▶ 1.674 km monitoradas ativamente
    - ▶ 339 km por acionamento
- ▶ Rede de Atendimento Veterinário
  - ▶ 7 Centros de Reabilitação
  - ▶ 7 Unidades de Reabilitação
  - ▶ 2 Bases de Apoio





# Atividades desenvolvidas

- ▶ Registro de animais vivos e mortos nas praias
  - ▶ Fauna Alvo e Não-Alvo
- ▶ Análises para identificar a causa mortis
  - ▶ Análises clínicas
  - ▶ Histopatologia
  - ▶ Contaminantes



# Resultados em 5 anos do PMP-BS (2015-2020)

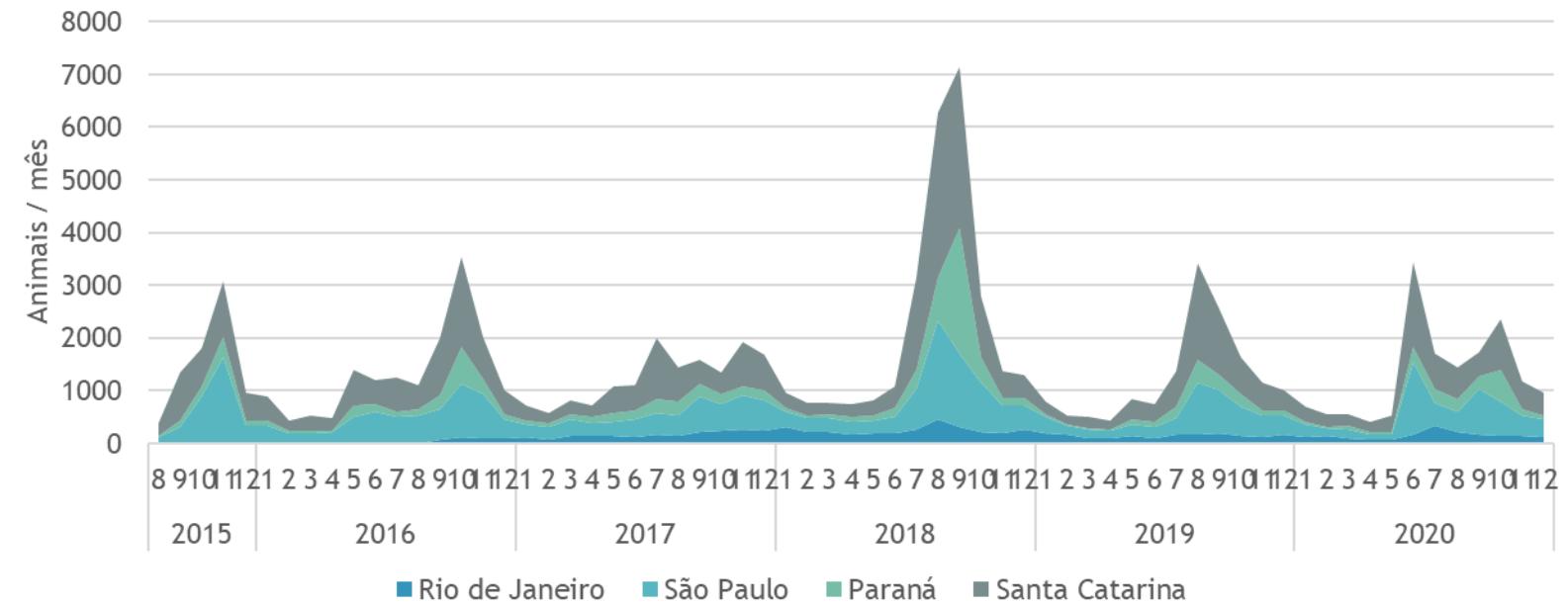
- ▶ Mais de 1,5 milhão de Km de praias monitoradas
  - ▶ SC - 31%
  - ▶ PR - 8%
  - ▶ SP - 28%
  - ▶ RJ - 24%





# Resultados em 5 anos do PMP-BS (2015-2020)

- ▶ 95.900 animais registrados
  - ▶ Aprox. 86% mortos





# Resultados em 5 anos do PMP-BS (2015-2020)

- ▶ Mais de 12.000 animais enviados para tratamento
  - ▶ 4.024 animais reabilitados e devolvidos à natureza





# Resultados em 5 anos do PMP-BS (2015-2020)

- ▶ 34.945 necropsias realizadas



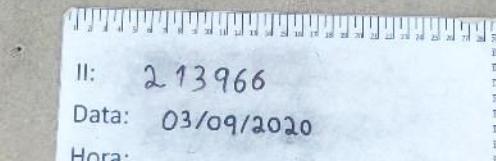


# Interação com lixo

- ▶ Registro de interação dos animais com lixo faz parte das informações registradas em campo e nas necropsias



II: 213966  
Data: 03/09/2020  
Hora:





# Interação com lixo

- ▶ Em campo
  - ▶ Aves: 130
  - ▶ Mamíferos: 14
  - ▶ Tartarugas: 779





# Interação com lixo



- ▶ Necropsias
  - ▶ Aves: 1324
  - ▶ Mamíferos: 157
  - ▶ Tartarugas: 4009



# Interação com lixo

- ▶ Não houve interação em todas as espécies

	Número de Espécies	
	Registradas em campo	Com interação com lixo
Aves	78	38
Mamíferos	34	14
Tartarugas	5	5



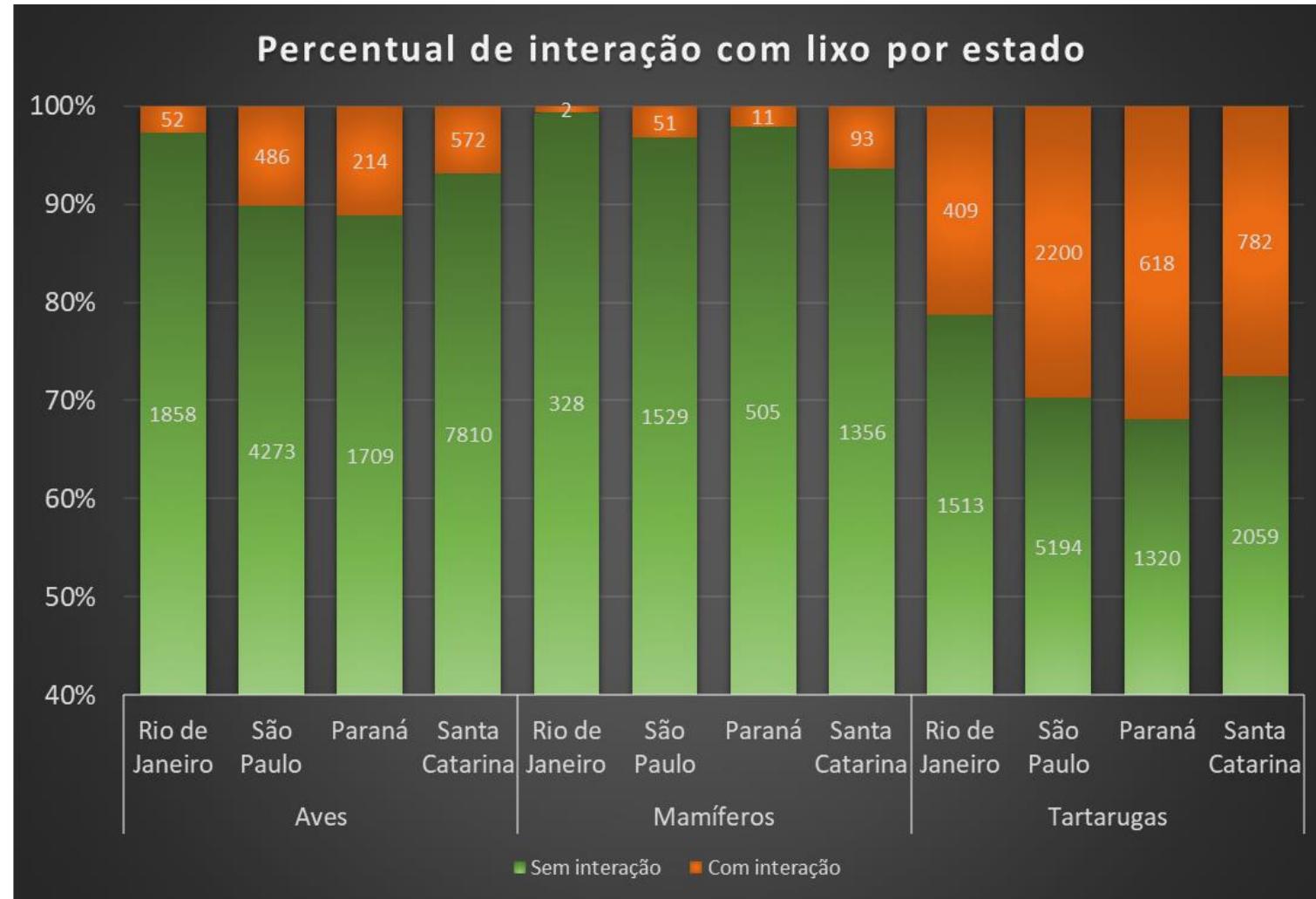
# Interação com lixo

► Importância é diferente entre espécies

Espécie	Sem interação	Com interação	Total de animais
Tartaruga-cabeçuda ( <i>Caretta caretta</i> )	91,3%	8,7%	1.873
Tartaruga-verde ( <i>Chelonia mydas</i> )	66,9%	33,1%	11.441
Tartaruga-de-couro ( <i>Dermochelys coriacea</i> )	78,8%	21,2%	118
Tartaruga-de-pente ( <i>Eretmochelys imbricata</i> )	82,2%	17,8%	118
Tartaruga-oliva ( <i>Lepidochelys olivacea</i> )	96,5%	3,5%	486



# Variação espacial





Contributed Paper

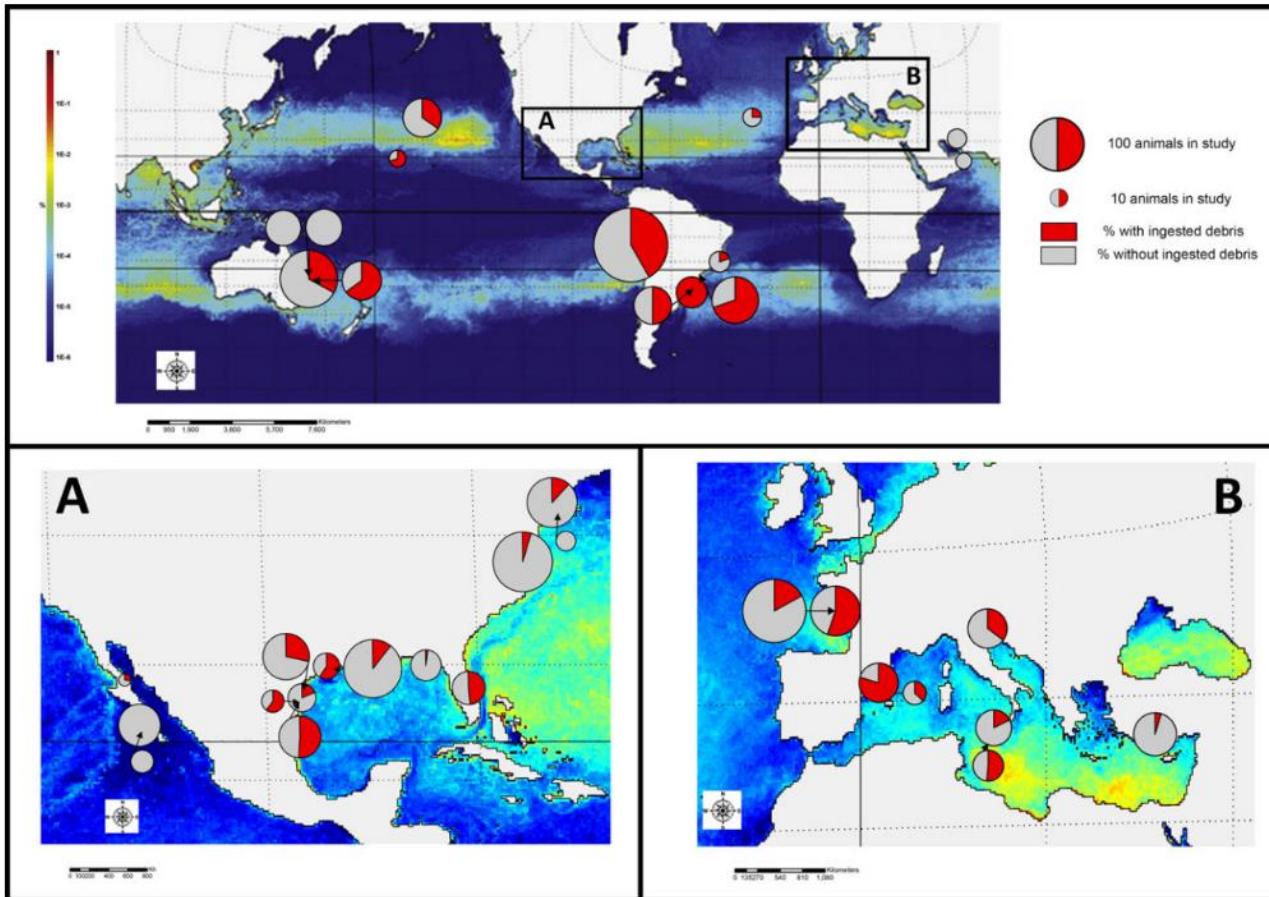
Open Access



## Global Analysis of Anthropogenic Debris Ingestion by Sea Turtles

QAMAR SCHUYLER✉, BRITTA DENISE HARDESTY, CHRIS WILCOX, KATHY TOWNSEND

First published: 05 August 2013 | <https://doi.org/10.1111/cobi.12126> | Cited by: 59



*Figure 3. Locations of studies of ingested debris by sea turtles worldwide (enlargements: [a] the Gulf of Mexico and [b] the Mediterranean) overlaid on a 30-year model of global debris distribution (red and yellow areas on maps, high debris concentration) (Lebreton et al. 2012). Circles are sized relative to the total number of turtles necropsied (large, 100 turtles; small, 10 turtles). Red areas in circles indicate the percentage of turtles in each study found with ingested debris. All species have been amalgamated. (Background map reprinted from Marine Pollution Bulletin [Vol. 64], L. C.-M. Lebreton, S. D. Greer, and J. C. Borrero. Numerical Modelling of Floating Debris in the World's Oceans. Pages 653–661. Copyright 2012, with permission from Elsevier.)*



# Brasil e o mundo

Indivíduos: 2569  
(Brasil: 141)

Contributed Paper | Open Access |

## Global Analysis of Anthropogenic Debris Ingestion by Sea Turtles

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First published: 05 August 2013 | <https://doi.org/10.1111/cobi.12126> | Citations: 142

**Table 1.** Articles published since 1985 that report on studies in which a systematic survey of turtles ( $n \geq 7$  animals) was conducted and necropsies were performed to determine contents of the gastrointestinal system.

Reference	Study dates	Country or region	Number of turtles in study	Species	Turtles with ingested debris (%)
Bjorndal et al. (1994)	1988–1993	USA	51	multiple	49
Boyle and Limpus (2008)	2002–2006	Australia	54	green, loggerhead	65
Bugoni et al. (2001)	1997–1998	Brazil	50	multiple	50
Burke et al. (1994)	1985–1989	USA	18	Kemp's ridley	0
Cannon (1998)	1994	USA	158	multiple	11
Casale et al. (2008)	2001–2005	central Mediterranean	33	loggerhead	52
Duguy (1997)	1978–1995	France	141	multiple	17
Duguy et al. (2000)	1979–1999	France	87	leatherback	55
Duronslet et al. (1991)	1987–1989	USA	32	multiple	59
Foley et al. (2007)	2000–2001	USA	44	green	2
Frick et al. (2009)	1986–2001	Azores	12	loggerhead	25
Garnett et al. (1985)	1979	Australia	44	green	0
Guebert-Bartholo et al. (2011)	2004–2007	Brazil	76	green	70
Hasbun et al. (2000)	1997	UAE	13	green	0
Kaska et al. (2004)	2001	Turkey	65	loggerhead	5
Lazar and Gracan (2011)	2001–2004	Eastern Adriatic	54	loggerhead	35
Limpus et al. (2001)	1989–1998	Australia	47	loggerhead	0
Lopez-Mendilaharsu (2005)	2000–2002	USA	24	green	0
Mrosovsky et al. (2009)	1885–2007	Global	408	leatherback	34
Parker et al. (2005)	1990–1992	northern Pacific	52	loggerhead	35
Parker et al. (2011)	1990–2004	USA	10	green	70
Peckham et al. (2011)	2003–2007	USA	82	loggerhead	0
Plotkin & Amos (1990)	1986–1988	Texas	23	green, hawksbill	61
Plotkin et al. (1993)	1986–1988	Texas	82	loggerhead	51
Quinones et al. (2010)	1987	Peru	192	green	42
Revelles et al. (2007)	2002–2004	Mediterranean	19	loggerhead	37
Ross (1985)	1977–1979	Oman	9	green	0
Russo et al. (2003)	1994–1998	Mediterranean	45	green, loggerhead	18
Sadove and Morreale (1989)	1979–1988	USA	116	multiple	12
Santos et al. (2011)	2007–2008	Brazil	15	green	20
Schuyler et al. (2012)	2006–2011	Australia	115	multiple	33
Seminoff et al. (2002)	1995–1999	Mexico	7	green	29
Seney and Musick (2007)	1983–2002	USA	166	loggerhead	0
Shaver (1991)	1983–1989	USA	101	Kemp's ridley	29
Shaver (1998)	1984	USA	37	Kemp's ridley	19
Tomas et al. (2002)	N/A	Spain	54	loggerhead	80
Tourinho et al. (2010)	2006–2007	Brazil	34	green	100

## Reviews

## **Plastic and marine turtles: a review and call for research**

Sarah E. Nelms<sup>1†</sup>, Emily M. Duncan<sup>1†</sup>, Annette C. Broderick<sup>1</sup>, Tamara S. Galloway<sup>2</sup>, Matthew H. Godfrey<sup>3,4,5</sup>, Mark Hamann<sup>6</sup>, Penelope K. Lindeque<sup>7</sup>, and Brendan J. Godley<sup>1\*</sup>

**Table 1.** Summary of all studies on plastic ingestion by marine turtles.

**Indivíduos: 3366  
(Brasil: 372)**

ICES Journal of Marine Science (2016), 73(2), 165–181. doi:10.1093/icesjms/fsv165

## Reviews

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Matthew H. Godfrey<sup>3,4,5</sup>, Mark Hamann<sup>6</sup>, Penelope K. Lindeque<sup>7</sup>, and Brendan J. Godley<sup>1\*</sup>

	N total	N ingestão	% ingestão
<i>Caretta caretta</i>	1251	317	25,3%
Outros países	1241	316	25,5%
Brasil	10	1	10,0%
<i>Chelonia mydas</i>	939	384	40,9%
Outros países	597	215	36,0%
Brasil	342	169	49,4%
<i>Dermochelys coriacea</i>	592	204	34,5%
Outros países	590	203	34,5%
Brasil	2	1	50,0%
<i>Eretmochelys imbricata</i>	24	13	54,1%
Outros países	9	8	88,9%
Brasil	15	5	33,3%
<i>Lepidochelys olivacea</i>	3	3	100,0%
Brasil	3	3	100,0%

# Importância de Amostragens Amplas



ELSEVIER

Marine Pollution Bulletin

Volume 93, Issues 1–2, 15 April 2015, Pages 37-43

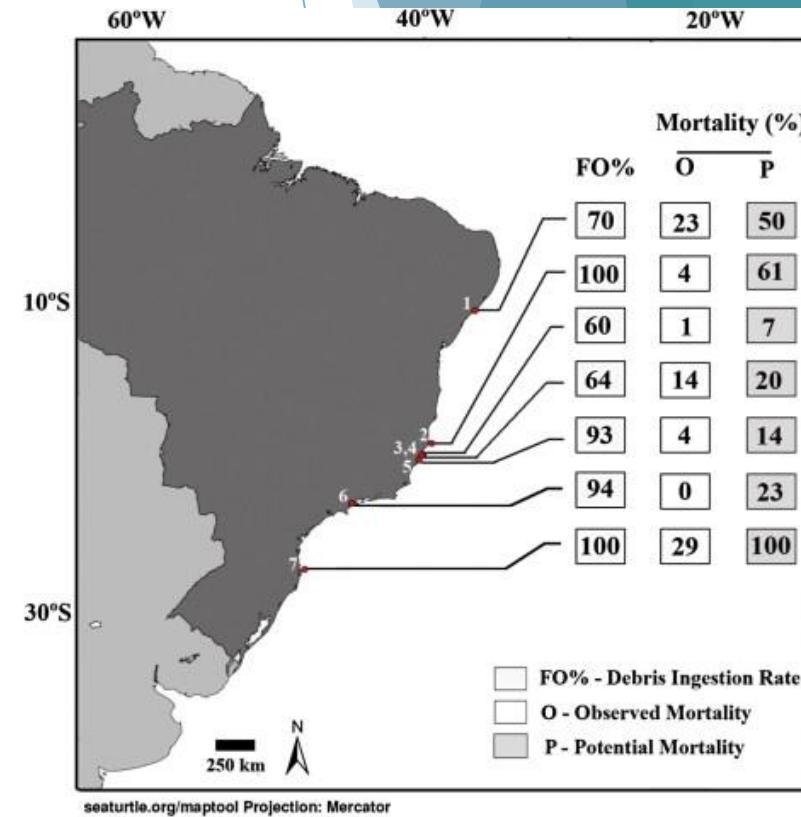


Debris ingestion by juvenile marine turtles: An underestimated problem

Robson Guimarães Santos , Ryan Andrades , Marcillo Altoé Boldrini , Agnaldo Silva Martins

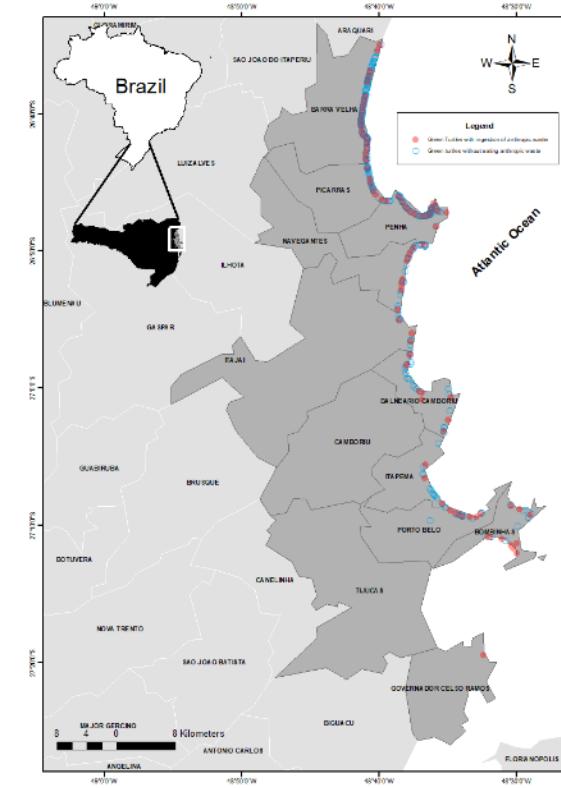
<https://doi.org/10.1016/j.marpolbul.2015.02.022>

- ▶ Animais coletados em outros PMP
  - ▶ 265 tartarugas-verde
  - ▶ 70% havia ingerido resíduos de origem humana
    - ▶ Plástico em 89% destas



# Importância de Amostragens Amplas

- Análise detalhada em Santa Catarina
    - 473 tartarugas coletadas pelo PMP-BS
    - 34% possuía resíduos de origem humana no estômago ou intestino



Cor	Material										Total Geral
	Barbante	Bexiga	Elástico	Fio dental	Isopor	Linha de costura	Fios de poliamida	Papel Alumínio	Plástico	Poliéster	
Total de fragmentos	19	2	2	2	1	2	275	1	170	1	475
(%)	4,0%	0,4%	0,4%	0,4%	0,2%	0,4%	57,9%	0,2%	35,8%	0,2%	100%
Peso Total (g)	2,6	0,78	0,07	0,03	0,01	0,01	4,08	0,09	11,38	0,10	19,21

# Compreensão do ambiente

- ▶ Monitorar
  - ▶ Regularidade: reduz variabilidade ambiental
- ▶ Registrar
  - ▶ Padronização do modo de coleta
- ▶ Armazenar
  - ▶ Disponibilidade dos dados para uso
    - ▶ Poder público
    - ▶ Pesquisadores



# Compreensão do ambiente

- ▶ Monitorar
  - ▶ Esforço diário nas praias
- ▶ Registrar
  - ▶ Protocolos comuns a todas as instituições
- ▶ Armazenar
  - ▶ Sistema de gestão de dados com acesso público



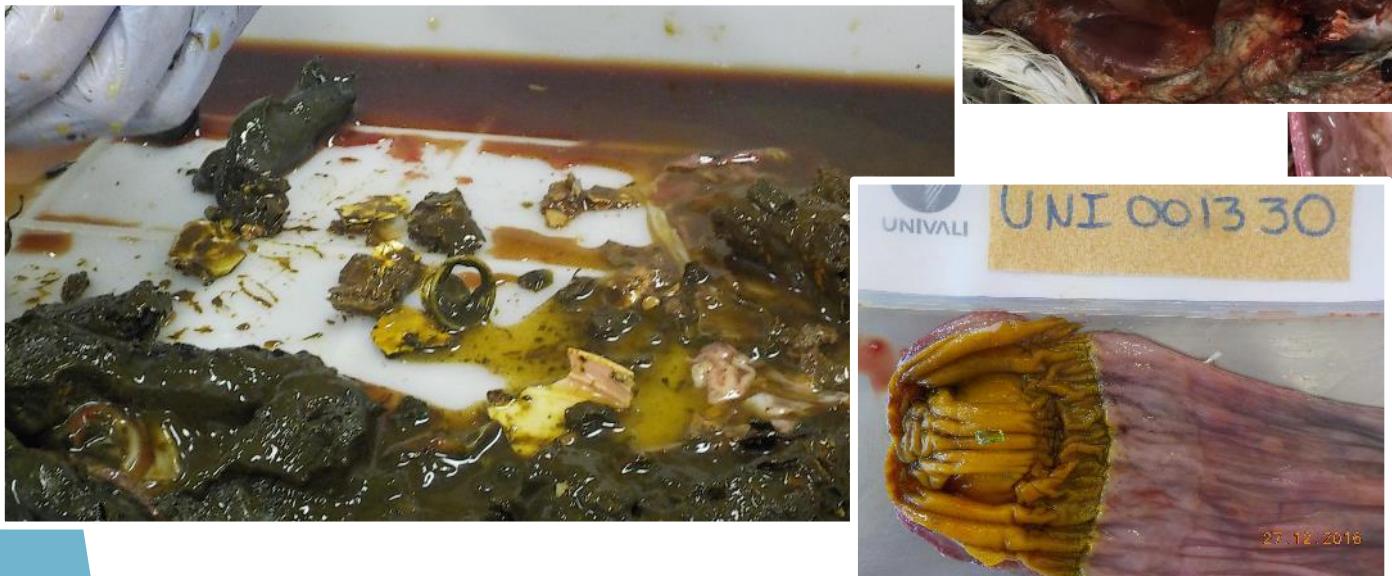


# Ocorrência de lixo em animais marinhos

## - PMP-BS

- ▶ Não é novidade
- ▶ O que impressionou é a magnitude do problema:

	Sem lixo	Com lixo	Total Geral
Aves	15.650	1.324	16.974
Mamíferos	3.718	157	3.875
Tartarugas	10.086	4.009	14.095
<b>Total Geral</b>	<b>29.454</b>	<b>5.490</b>	<b>34.944</b>



# Instituições Atualmente Envolvidas no PMP-BS



**ISBio**  
Intelligent Solutions



# Obrigado

Dr. André S. Barreto

Lab. Informática da Biodiversidade e Geomática

Escola do Mar, Ciência e Tecnologia

UNIVALI

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