



# DRONEMONITORAMENTO da megafauna marinha

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# WORKSHOP OCEAN DATA BOOTCAMP

GESTÃO DE DADOS DE  
MONITORAMENTO COSTEIRO





MARINE MAMMAL SCIENCE, 35(1): 108–139 (January 2019)  
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DOI: 10.1111/mms.12527



## Estimating morphometric attributes of baleen whales with photogrammetry from small UASs: A case study with blue and gray whales

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DOI: 10.1111/2041-210X.13026



Methods in Ecology and Evolution  
BRITISH ECOLOGICAL SOCIETY

Canadian  
Science Publishing  
NRC Research Press journals/Publishing Services

### REVIEW

## Detection errors in wildlife abundance estimates from Unmanned Aerial Systems (UAS) surveys: Synthesis, solutions, and challenges

Ismail V. Brack<sup>1</sup> | Andreas Kindel<sup>2</sup> | Luiz Flamarion B. Oliveira<sup>3</sup>

Polar Biol (2015) 38:619–630  
DOI 10.1007/s00300-014-1625-4

### ORIGINAL PAPER

## A small unmanned aerial system for estimating abundance and size of Antarctic predators

Michael E. Goebel · Wayne L. Perryman ·  
Jefferson T. Hinke · Douglas J. Krause ·  
Nancy A. Hann · Steve Gardner · Donald J. LeRoi



Review

Drones for research on sea turtles and other marine vertebrates – A review

Gail Schofield<sup>a,\*</sup>, Nicole Esteban<sup>b</sup>, Kostas A. Katselidis<sup>c</sup>, Graeme C. Hays<sup>d</sup>

## Drone Up! Quantifying Whale Behavior From a New Perspective Improves Observational Capacity

Leigh G. Torres<sup>1\*</sup>, Sharon L. Nieukirk<sup>2</sup>, Leila Lemos<sup>1</sup> and Todd E. Chandler<sup>1</sup>

<sup>1</sup> Geospatial Ecology of Marine Megafauna Lab, Marine Mammal Institute, Department of Fisheries and Wildlife, Hatfield Marine Science Center, Oregon State University, Newport, OR, United States, <sup>2</sup> Cooperative Institute for Marine Resources Studies, Oregon State University and Pacific Marine Environmental Laboratory, National Oceanic and Atmospheric Administration, Newport, OR, United States

Journal of Unmanned Vehicle Systems  
Revue des systèmes de véhicules télécommandés

EVALUATION OF AN UNMANNED ROTORCRAFT TO MONITOR  
WINTERING WATERBIRDS AND COASTAL HABITATS IN  
BRITISH COLUMBIA, CANADA

Biological Conservation 238 (2019) 108214

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Biological Conservation

journal homepage: [www.elsevier.com/locate/biocon](http://www.elsevier.com/locate/biocon)





Article

## Drone-Monitoring: Improving the Detectability of Threatened Marine Megafauna

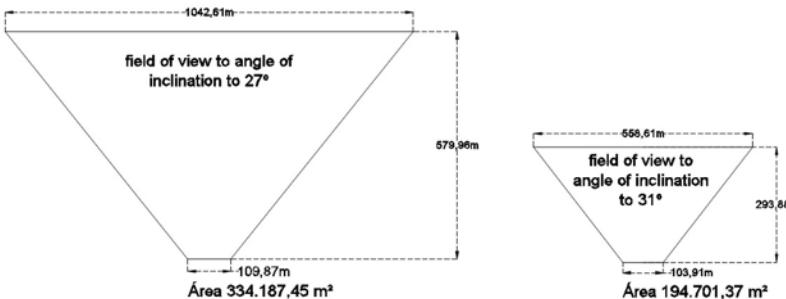
Jonathas Barreto <sup>1,\*</sup>, Luciano Cajaíba <sup>1</sup>, João Batista Teixeira <sup>1</sup>, Lorena Nascimento <sup>1</sup>, Amanda Giacomo <sup>1</sup>, Nelson Barcelos <sup>1</sup>, Ticiana Fettermann <sup>2</sup> and Agnaldo Martins <sup>1</sup>





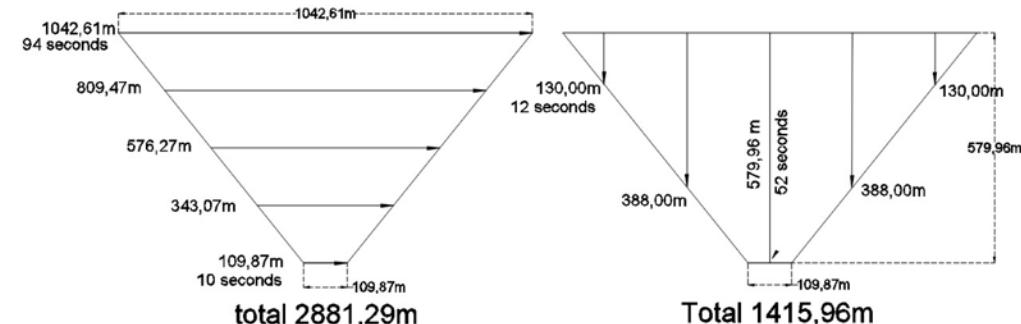
## PADRÃO DE VOO

- Altura do voo
- Ângulo da câmera
- Posição de ataque

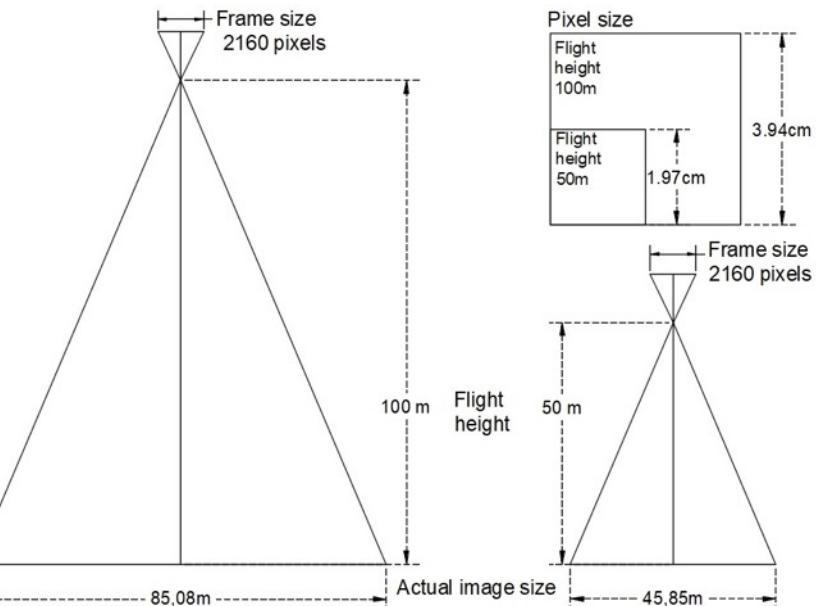


# DRONEMONITORAMENTO SISTEMÁTICO

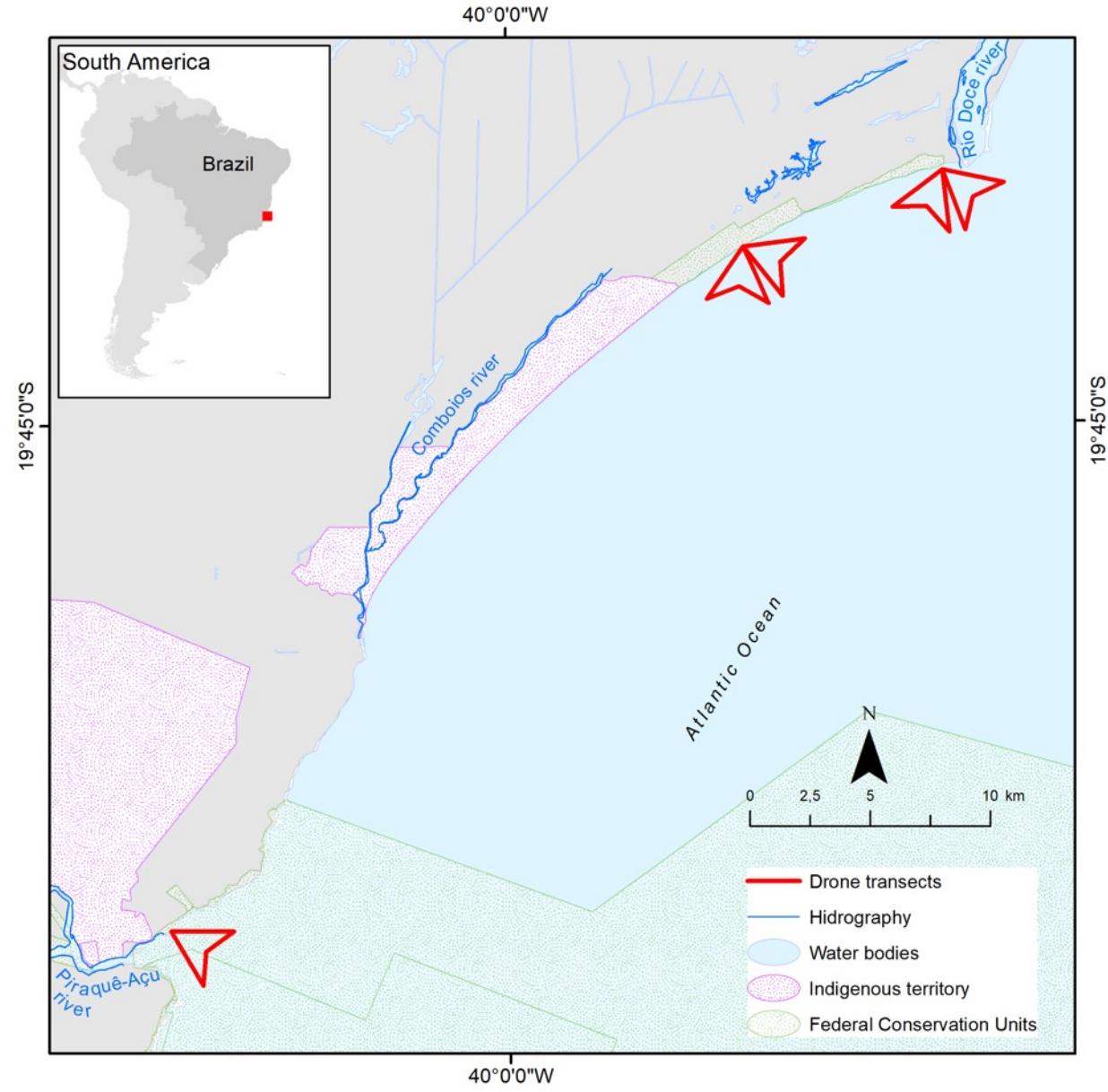
Side flight



Front flight



# WORKSHOP OCEAN DATA BOOTCAMP



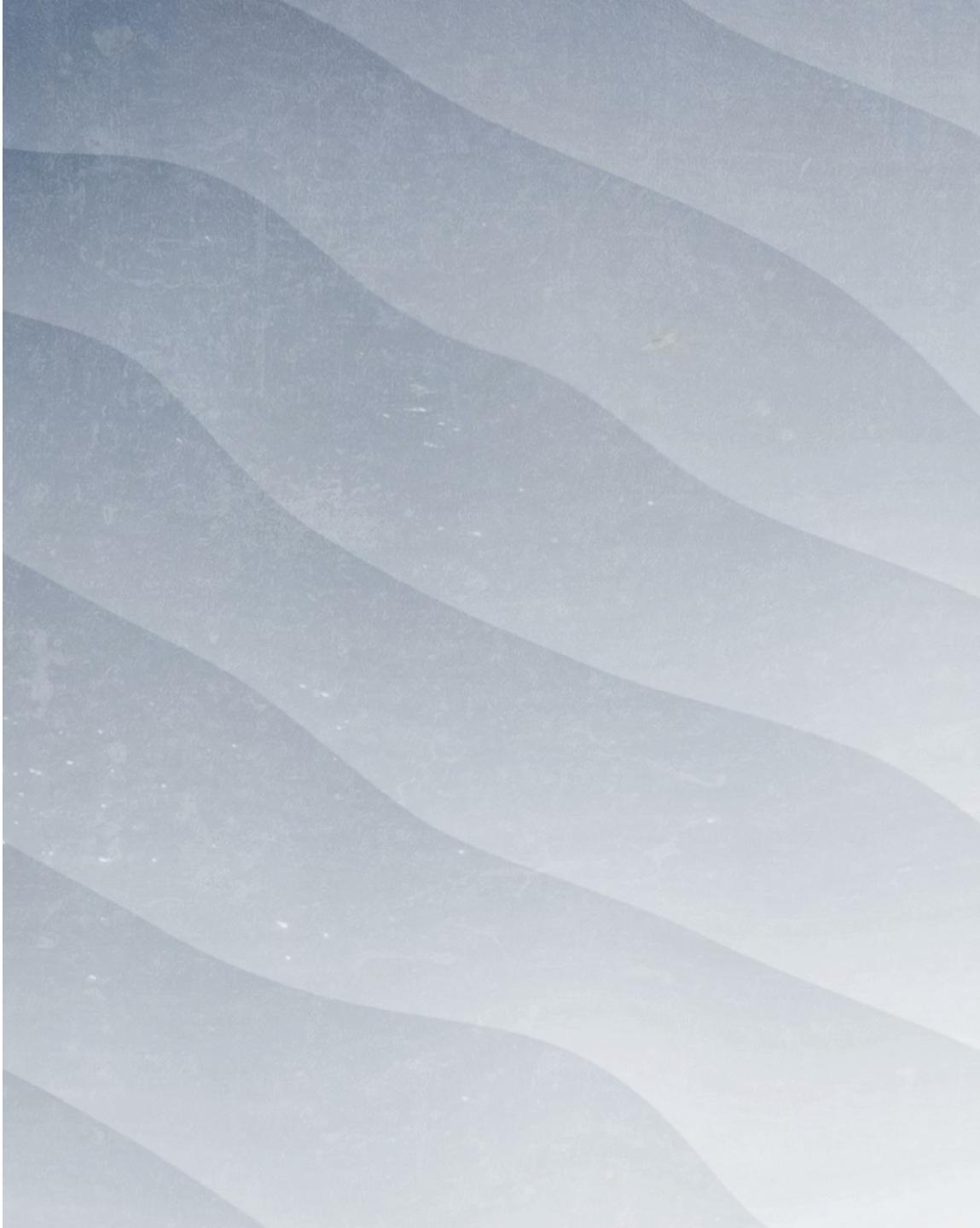


## Operational description for marine megafauna drone-monitoring

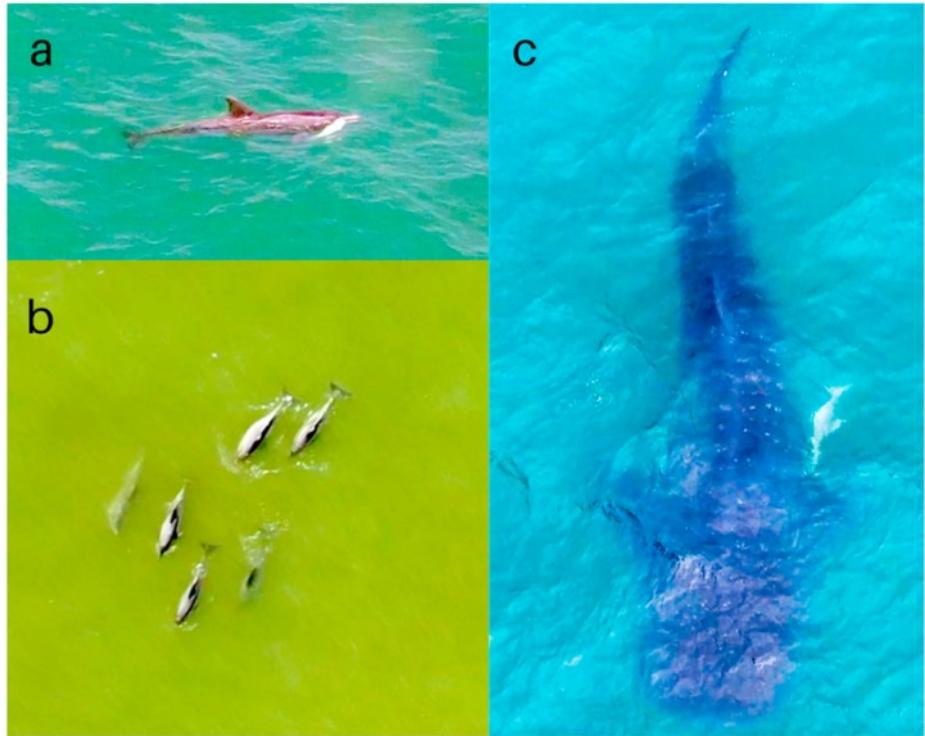
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|                       |   |
|-----------------------|---|
| <b>Equipment</b>      | 3 RPA Mavic 2 Zoom, 2 FPV DJI Goggles Racing Edition, 2 Binoculars Lugan Astronomical Gladiator Triplet 25-125X80, 3 Tablet iPad mini, 10 Memory Cards 128GB, 10 Batteries RPA, 1 Computer iMac Pro 27 ", 2 MacBook Pro, 1 Lens filter kit PL/ND, 1 Weather Station, 10 HD Backup Plus Hub Seagate 8TB. |
| <b>Infrastructure</b> | Tents, tripods, chairs, tables.   |
| <b>Team</b>           | Remote Pilot, Copilot, Drone Observer, Fauna Observer, Logistics Operator.  |
| <b>License</b>        | ICAO (USA), DECEA, ANAC, ANATEL, SISBIO (BRAZIL)  |
| <b>Safety</b>         | EVLOS (3km of radius), VMC (wind 26km/h, no rain, no fire).   |

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# WORKSHOP OCEAN DATA BOOTCAMP



**Figure 8.** Marine megafauna recorded during drone-monitoring. Frames captured from 4k 30fps videos. (a) Rough-toothed Dolphin (*Steno bredanensis*) eating a fish. (b) Group with six adult Guiana Dolphin (*Sotalia guianensis*) individuals. (c) Whale Shark (*Rhincodon typus*) with an associated Common Remora (*Remora* sp.).

| TETRAPODS GROUP | ORDER             | FAMILY         | SPECIES                        | POPULAR NAME            | THREATENED CATEGORY (IUCN) | NUMBER OF SIGHTINGS |
|-----------------|-------------------|----------------|--------------------------------|-------------------------|----------------------------|---------------------|
| SEABIRDS        | SULIFORMES        | FREGATIDAE     | <i>Fregata magnificens</i>     | Magnificent Frigatebird | LEAST CONCERN              | 1                   |
|                 | SULIFORMES        | SULIDAE        | <i>Sula leucogaster</i>        | Brown Booby             | LEAST CONCERN              | 96                  |
|                 | SULIFORMES        | SULIDAE        | <i>Sula dactylatra</i>         | Masked Booby            | LEAST CONCERN              | 2                   |
|                 | PROCELLARIIFORMES | PROCELLARIIDAE | <i>Thalassarche</i> sp.        | Albatross               | LEAST CONCERN              | 1                   |
|                 | CHARADRIIFORMES   | STERNIDAE      | <i>Sterna hirundo</i>          | Common Tern             | LEAST CONCERN              | 30                  |
|                 | CHARADRIIFORMES   | STERNIDAE      | <i>Phaetusa simplex</i>        | Large-billed Tern       | LEAST CONCERN              | 158                 |
|                 | PELECANIFORMES    | ARDEIDAE       | <i>Egretta thula</i>           | Snowy Egret             | LEAST CONCERN              | 1                   |
| SEA TURTLES     | TESTUDINATA       | CHELONIIDAE    | <i>Caretta caretta</i>         | Loggerhead              | VULNERABLE                 | 2                   |
|                 | TESTUDINATA       | CHELONIIDAE    | <i>Lepidochelys olivacea</i>   | Olive Ridley            | VULNERABLE                 | 2                   |
|                 | TESTUDINATA       | CHELONIIDAE    | <i>Chelonia mydas</i>          | Green Turtle            | ENDANGERED                 | 188                 |
|                 | TESTUDINATA       | DERMOCHELYIDAE | <i>Dermochelys coriacea</i>    | Leatherback             | VULNERABLE                 | 2                   |
| MARINE MAMMALS  | CETARTIODACTYLA   | DELPHINIDAE    | <i>Steno bredanensis</i>       | Rough-toothed Dolphin   | LEAST CONCERN              | 10                  |
|                 | CETARTIODACTYLA   | DELPHINIDAE    | <i>Sotalia guianensis</i>      | Guiana Dolphin          | NEAR THREATENED            | 640                 |
|                 | CETARTIODACTYLA   | PONTOPORIIDAE  | <i>Pontoporia blainvilliei</i> | Franciscana             | VULNERABLE                 | 153                 |
| LARGE FISHES    | PERCIFORMES       | CARANGIDAE     | <i>Caranx lugubris</i>         | Black Jack              | LEAST CONCERN              | 2                   |
|                 | PERCIFORMES       | ECHENEIDAE     | <i>Remora</i> sp.              | Common Remora           | LEAST CONCERN              | 1                   |
|                 | ORECTOLOBIFORMES  | RHINCODONTIDAE | <i>Rhincodon typus</i>         | Whale Shark             | ENDANGERED                 | 1                   |
|                 | MYLIOBATIFORMES   | MYLIOBATIDAE   | <i>Aetobatus narinari</i>      | Spotted Eagle Ray       | NEAR THREATENED            | 1                   |
|                 | MYLIOBATIFORMES   | RHINOPTERIDAE  | <i>Rhinoptera bonasus</i>      | American Cownose Ray    | NEAR THREATENED            | 8                   |



LABNECTON



# De onde vem esses números?

| A   | B            | C                 | D   | E          | F   | G       | H        | I         | J        | K        | L         |
|-----|--------------|-------------------|---|------------|-----|---------|----------|-----------|----------|----------|-----------|
| 1   | ID_TRANSEC   | ID_VOO            | ID_VIDEO_COMPLETO                                 | DATA       | VOO | REPLICA | LOCAL    | TRANSECTC | PILOTO   | OBS_DRON | OBS_FAUNA |
| 582 | CO_2019_11_b | 2019_11_27_574_06 | 96.MP4/2019_11_27_10_54.DJI_0097.MP4/2019_1       | 27/11/2019 | 574 | 6       | COMBOIOS | NORTE     | LUCIANO  | JOAO     | AMANDA    |
| 583 | DO_2019_12_1 | 2019_12_10_575_01 | _10_06_22DJI_0100.MP4 / 2019_12_10_06_27DJI_0     | 10/12/2019 | 575 | 1       | DOCE     | SUL       | LUCIANO  | LORENA   | JONATHAS  |
| 584 | DO_2019_12_1 | 2019_12_10_576_01 | 04.MP4 / 2019_12_10_07_06DJI_0105.MP4 / 2019_1    | 10/12/2019 | 576 | 1       | DOCE     | NORTE     | LUCIANO  | LORENA   | JOAO      |
| 585 | DO_2019_12_2 | 2019_12_10_577_02 | 07.MP4 / 2019_12_10_07_23DJI_0108.MP4 / 2019_1    | 10/12/2019 | 577 | 2       | DOCE     | SUL       | LUCIANO  | NELSON   | JOAO      |
| 586 | DO_2019_12_2 | 2019_12_10_578_02 | 11.MP4 / 2019_12_10_10_07_44DJI_0112.MP4 / 2019_1 | 10/12/2019 | 578 | 2       | DOCE     | NORTE     | LUCIANO  | JOAO     | JONATHAS  |
| 587 | DO_2019_12_3 | 2019_12_10_579_02 | 2_10_08_11DJI_0117.MP4 / 2019_12_10_08_16DJI_01   | 10/12/2019 | 579 | 3       | DOCE     | SUL       | LUCIANO  | LORENA   | JONATHAS  |
| 588 | DO_2019_12_3 | 2019_12_10_580_03 | 20.MP4 / 2019_12_10_08_44DJI_0121.MP4 / 2019_1    | 10/12/2019 | 580 | 3       | DOCE     | NORTE     | LUCIANO  | JONATHAS | LORENA    |
| 589 | DO_2019_12_4 | 2019_12_10_581_04 | 25.MP4 / 2019_12_10_09_01DJI_0126.MP4 / 2019_1    | 10/12/2019 | 581 | 4       | DOCE     | SUL       | JOAO     | LUCIANO  | NELSON    |
| 590 | DO_2019_12_4 | 2019_12_10_582_04 | 29.MP4 / 2019_12_10_09_23DJI_0130.MP4 / 2019_1    | 10/12/2019 | 582 | 4       | DOCE     | NORTE     | JOAO     | LUCIANO  | LORENA    |
| 591 | DO_2019_12_5 | 2019_12_11_583_05 | 92.MP4 / 2019_12_11_06_08DJI_0093.MP4 / 2019_1    | 11/12/2019 | 583 | 5       | DOCE     | SUL       | LUCIANO  | LORENA   | JONATHAS  |
| 592 | DO_2019_12_5 | 2019_12_11_584_05 | 95.MP4 / 2019_12_11_06_29DJI_0096.MP4 / 2019_1    | 11/12/2019 | 584 | 5       | DOCE     | NORTE     | LUCIANO  | LORENA   | JONATHAS  |
| 593 | DO_2019_12_6 | 2019_12_11_585_06 | 98.MP4 / 2019_12_11_06_48DJI_0099.MP4 / 2019_1    | 11/12/2019 | 585 | 6       | DOCE     | SUL       | LUCIANO  | NELSON   | JONATHAS  |
| 594 | DO_2019_12_6 | 2019_12_11_586_06 | 01.MP4 / 2019_12_11_07_07DJI_0102.MP4 / 2019_1    | 11/12/2019 | 586 | 6       | DOCE     | NORTE     | LUCIANO  | NELSON   | JONATHAS  |
| 595 | DO_2019_12_0 | 2019_12_11_587_00 | 2019_12_11_07_43DJI_0114.MP4                      | 11/12/2019 | 587 | 0       | DOCE     | SUL       | LUCIANO  | JOAO     | FABIACMA  |
| 596 | CO_2019_12_1 | 2019_12_12_588_01 | 37.MP4 / 2019_12_12_06_01DJI_0038.MP4 / 2019_1    | 12/12/2019 | 588 | 1       | COMBOIOS | SUL       | LUCIANO  | LORENA   | JONATHAS  |
| 597 | CO_2019_12_1 | 2019_12_12_589_01 | 40.MP4 / 2019_12_12_06_24DJI_0041.MP4 / 2019_1    | 12/12/2019 | 589 | 1       | COMBOIOS | NORTE     | LUCIANO  | LORENA   | JONATHAS  |
| 598 | CO_2019_12_2 | 2019_12_12_590_02 | _12_06_43DJI_0133.MP4 / 2019_12_12_06_46DJI_01    | 12/12/2019 | 590 | 2       | COMBOIOS | SUL       | JOAO     | NELSON   | FABIACMA  |
| 599 | CO_2019_12_2 | 2019_12_12_591_02 | 43.MP4 / 2019_12_12_07_01DJI_0044.MP4 / 2019_1    | 12/12/2019 | 591 | 2       | COMBOIOS | NORTE     | LUCIANO  | NELSON   | FABIACMA  |
| 600 | CO_2019_12_3 | 2019_12_12_592_03 | _12_07_13DJI_0136.MP4 / 2019_12_12_07_18DJI_03    | 12/12/2019 | 592 | 3       | COMBOIOS | SUL       | JOAO     | LORENA   | JONATHAS  |
| 601 | CO_2019_12_3 | 2019_12_12_593_03 | _12_07_30DJI_0047.MP4 / 2019_12_12_07_35DJI_00    | 12/12/2019 | 593 | 3       | COMBOIOS | NORTE     | LUCIANO  | LORENA   | FABIACMA  |
| 602 | CO_2019_12_4 | 2019_12_12_594_04 | _12_07_44DJI_0139.MP4 / 2019_12_12_07_49DJI_01    | 12/12/2019 | 594 | 4       | COMBOIOS | SUL       | JOAO     | NELSON   | JONATHAS  |
| 603 | CO_2019_12_4 | 2019_12_12_595_04 | _12_08_07DJI_0051.MP4 / 2019_12_12_08_12DJI_00    | 12/12/2019 | 595 | 4       | COMBOIOS | NORTE     | LUCIANO  | NELSON   | FABIACMA  |
| 604 | CO_2019_12_0 | 2019_12_12_596_00 | _12_08_12DJI_0052.MP4 / 2019_12_12_08_14DJI_00    | 12/12/2019 | 596 | 0       | COMBOIOS |           | JOAO     | JONATHAS | LORENA    |
| 605 | CO_2019_12_0 | 2019_12_12_597_00 | 43.MP4 / 2019_12_12_08_30DJI_0144.MP4 / 2019_1    | 12/12/2019 | 597 | 0       | COMBOIOS | SUL       | JOAO     | NELSON   | LORENA    |
| 606 | CO_2019_12_5 | 2019_12_13_598_05 | 23.MP4 / 2019_12_13_06_28DJI_0124.MP4 / 2019_1    | 13/12/2019 | 598 | 5       | COMBOIOS | SUL       | JOAO     | LUCIANO  | JONATHAS  |
| 607 | CO_2019_12_5 | 2019_12_13_599_05 | _13_06_46DJI_0127.MP4 / 2019_12_13_06_51DJI_01    | 13/12/2019 | 599 | 5       | COMBOIOS | NORTE     | JOAO     | LUCIANO  | JONATHAS  |
| 608 | CO_2019_12_6 | 2019_12_13_600_06 | 30.MP4 / 2019_12_13_07_09DJI_0131.MP4 / 2019_1    | 13/12/2019 | 600 | 6       | COMBOIOS | SUL       | LUCIANO  | LORENA   | JONATHAS  |
| 609 | CO_2019_12_6 | 2019_12_13_601_06 | 33.MP4 / 2019_12_13_07_26DJI_0134.MP4 / 2019_1    | 13/12/2019 | 601 | 6       | COMBOIOS | NORTE     | LUCIANO  | JOAO     | JONATHAS  |
| 610 | CO_2019_12_0 | 2019_12_13_602_00 | _13_07_43DJI_0054.MP4 / 2019_12_13_07_55DJI_00    | 13/12/2019 | 602 | 0       | COMBOIOS | SUL       | JOAO     | LUCIANO  | LORENA    |
| 611 | PI_2019_12_1 | 2019_12_14_603_01 | _14_07_15DJI_0148.MP4 / 2019_12_14_07_20DJI_01    | 14/12/2019 | 603 | 1       | PIRAQUE  | UNICO     | JOAO     | LUCIANO  | JONATHAS  |
| 612 | PI_2019_12_2 | 2019_12_14_604_02 | _14_07_37DJI_0152.MP4 / 2019_12_14_07_42DJI_01    | 14/12/2019 | 604 | 2       | PIRAQUE  | UNICO     | JOAO     | LUCIANO  | JONATHAS  |
| 613 | PI_2019_12_3 | 2019_12_14_605_03 | _14_08_00DJI_0156.MP4 / 2019_12_14_08_05DJI_01    | 14/12/2019 | 605 | 3       | PIRAQUE  | UNICO     | LORENA   | NELSON   | JONATHAS  |
| 614 | PI_2019_12_4 | 2019_12_14_606_04 | 60.MP4 / 2019_12_14_08_28DJI_0161.MP4 / 2019_1    | 14/12/2019 | 606 | 4       | PIRAQUE  | UNICO     | LORENA   | NELSON   | JONATHAS  |
| 615 | PI_2019_12_5 | 2019_12_14_607_05 | _14_08_59DJI_0167.MP4 / 2019_12_14_09_04DJI_01    | 14/12/2019 | 607 | 5       | PIRAQUE  | UNICO     | JONATHAS | JOAO     | LUCIANO   |
| 616 | PI_2019_12_6 | 2019_12_14_608_06 | _14_09_24DJI_0171.MP4 / 2019_12_14_09_29DJI_01    | 14/12/2019 | 608 | 6       | PIRAQUE  | UNICO     | JONATHAS | LORENA   | LUCIANO   |
| 617 | DO_2020_01_1 | 2020_01_15_609_01 | 66.MP4 / 2020_01_15_06_15DJI_0057.MP4 / 2020_0    | 15/01/2020 | 609 | 1       | DOCE     | SUL       | JOAO     | BARBARA  | AMANDA    |
| 618 | DO_2020_01_1 | 2020_01_15_610_01 | 15_06_39DJI_0060.MP4 / 2020_01_15_06_44DJI_01     | 15/01/2020 | 610 | 1       | DOCE     | NORTE     | JOAO     | BARBARA  | AMANDA    |
| 619 | DO_2020_01_2 | 2020_01_15_611_02 | _15_07_03DJI_0064.MP4 / 2020_01_15_07_06DJI_01    | 15/01/2020 | 611 | 2       | DOCE     | SUL       | JOAO     | LORENA   | AMANDA    |
| 620 | DO_2020_01_2 | 2020_01_15_612_02 | _17.MP4 / 2020_01_15_07_23DJI_0068.MP4 / 2020_0   | 15/01/2020 | 612 | 2       | DOCE     | NORTE     | POLIANA  | LORENA   | KALIANY   |
| 621 | DO_2020_01_3 | 2020_01_15_613_03 | JI_0070.MP4 / 2020_01_15_07_46DJI_0071 / 2020_0   | 15/01/2020 | 613 | 3       | DOCE     | SUL       | LORENA   | NELSON   | AMANDA    |
| 622 | DO_2020_01_3 | 2020_01_15_614_03 | 13.MP4 / 2020_01_15_08_18DJI_0074.MP4 / 2020_0    | 15/01/2020 | 614 | 3       | DOCE     | NORTE     | BARBARA  | JOAO     | AMANDA    |
| 623 | DO_2020_01_4 | 2020_01_15_615_04 | 16.MP4 / 2020_01_15_08_39DJI_0077.MP4 / 2020_0    | 15/01/2020 | 615 | 4       | DOCE     | SUL       | JOAO     | LORENA   | AMANDA    |
| 624 | DO_2020_01_4 | 2020_01_15_616_04 | 19.MP4 / 2020_01_15_09_06DJI_0080.MP4 / 2020_0    | 15/01/2020 | 616 | 4       | DOCE     | NORTE     | JOAO     | BARBARA  | AMANDA    |
| 625 | DO_2020_01_5 | 2020_01_15_617_05 | 32.MP4 / 2020_01_15_09_30DJI_0083.MP4 / 2020_0    | 15/01/2020 | 617 | 5       | DOCE     | SUL       | JOAO     | KALIANY  | AMANDA    |
| 626 | DO_2020_01_5 | 2020_01_15_618_05 | 15_09_47DJI_0086.MP4 / 2020_01_15_09_52DJI_01     | 15/01/2020 | 618 | 5       | DOCE     | NORTE     | JOAO     | BARBARA  | AMANDA    |

LEIA-ME PARAMETRO DE VOO OBSERVACAO MEGAFAUNA DESCRIÇÃO ESPECIES DESCRIÇÃO ESPECIES2 FICHA DE CAMPO FICHA DE ANALISE +

| A   | B            | C                 | D  | E          | F   | G       | H        |           |
|-----|--------------|-------------------|--|------------|-----|---------|----------|-----------|
| 1   | ID_TRANSEC   | ID_VOO            | ID_VIDEO_COMPLETO                              | DATA       | VOO | REPLICA | LOCAL    | TRANSECTO |
| 159 | DO_2019_02_1 | 2019_02_15_149_01 | DJI_0368 / 2019_02_15_08_14_DJI_0369 / 2019_02 | 15/02/2019 | 149 | 1       | DOCE     | NORTE     |
| 160 | DO_2019_02_1 | 2019_02_15_150_01 | DJI_0603 / 2019_02_15_08_37_DJI_0604 / 2019_02 | 15/02/2019 | 150 | 1       | DOCE     | SUL       |
| 161 | DO_2019_02_2 | 2019_02_15_151_02 | VOO CANCELADO / SEM VIDEO                      | 15/02/2019 | 151 | 2       | DOCE     | NORTE     |
| 162 | DO_2019_02_2 | 2019_02_15_152_02 | _02_15_09_23_DJI_0607 / 2019_02_15_09_28_DJI_  | 15/02/2019 | 152 | 2       | DOCE     | SUL       |
| 163 | DO_2019_02_3 | 2019_02_15_153_02 | DJI_0372 / 2019_02_15_09_49_DJI_0373 / 2019_02 | 15/02/2019 | 153 | 3       | DOCE     | NORTE     |
| 164 | DO_2019_02_3 | 2019_02_15_154_03 | DJI_0612 / 2019_02_15_10_32_DJI_0613 / 2019_02 | 15/02/2019 | 154 | 3       | DOCE     | SUL       |
| 165 | DO_2019_02_4 | 2019_02_15_155_03 | DJI_0376 / 2019_02_15_10_56_DJI_0377 / 2019_02 | 15/02/2019 | 155 | 4       | DOCE     | NORTE     |
| 166 | DO_2019_02_4 | 2019_02_15_156_04 | DJI_0615 / 2019_02_15_11_22_DJI_0616 / 2019_02 | 15/02/2019 | 156 | 4       | DOCE     | SUL       |
| 167 | DO_2019_02_5 | 2019_02_15_157_04 | _02_15_11_41_DJI_0620 / 2019_02_15_11_46_DJI_  | 15/02/2019 | 157 | 5       | DOCE     | NORTE     |
| 168 | DO_2019_02_5 | 2019_02_15_158_05 | _02_15_12_12_DJI_0381 / 2019_02_15_12_18_DJI_  | 15/02/2019 | 158 | 5       | DOCE     | SUL       |
| 169 | DO_2019_02_6 | 2019_02_15_159_05 | DJI_0623 / 2019_02_15_12_42_DJI_0624 / 2019_02 | 15/02/2019 | 159 | 6       | DOCE     | NORTE     |
| 170 | DO_2019_02_6 | 2019_02_15_160_06 | _02_15_13_04_DJI_0385 / 2019_02_15_13_09_DJI_  | 15/02/2019 | 160 | 6       | DOCE     | SUL       |
| 171 | CO_2019_02_1 | 2019_02_16_161_01 | _02_16_07_39_DJI_0626 / 2019_02_16_07_49_DJI_0 | 16/02/2019 | 161 | 1       | COMBOIOS | SUL       |
| 172 | CO_2019_02_1 | 2019_02_16_162_01 | 2019_02_16_07_50_DJI_0629                      | 16/02/2019 | 162 | 1       | COMBOIOS | NORTE     |
| 173 | CO_2019_02_2 | 2019_02_16_163_02 | _02_16_08_25_DJI_0630 / 2019_02_16_08_30_DJI_0 | 16/02/2019 | 163 | 2       | COMBOIOS | SUL       |
| 174 | CO_2019_02_2 | 2019_02_16_164_02 | _02_16_08_44_DJI_0627 / 2019_02_16_08_49_DJI_0 | 16/02/2019 | 164 | 2       | COMBOIOS | NORTE     |
| 175 | CO_2019_02_3 | 2019_02_18_165_03 | DJI_0395 / 2019_02_18_07_20_DJI_0396 / 2019_02 | 18/02/2019 | 165 | 3       | COMBOIOS | NORTE     |
| 176 | CO_2019_02_3 | 2019_02_18_166_03 | DJI_0635 / 2019_02_18_12_08_DJI_0636 / 2019_02 | 18/02/2019 | 166 | 3       | COMBOIOS | SUL       |
| 177 | CO_2019_02_4 | 2019_02_19_167_04 | DJI_0638 / 2019_02_19_06_28_DJI_0639 / 2019_02 | 19/02/2019 | 167 | 4       | COMBOIOS | SUL       |
| 178 | CO_2019_02_4 | 2019_02_19_168_04 | _02_19_06_52_DJI_0641 / 2019_02_19_06_53_DJI_  | 19/02/2019 | 168 | 4       | COMBOIOS | NORTE     |
| 179 | CO_2019_02_5 | 2019_02_19_169_05 | DJI_0643 / 2019_02_19_07_11_DJI_0644 / 2019_02 | 19/02/2019 | 169 | 5       | COMBOIOS | SUL       |
| 180 | CO_2019_02_5 | 2019_02_19_170_05 | DJI_0646 / 2019_02_19_07_32_DJI_0647 / 2019_02 | 19/02/2019 | 170 | 5       | COMBOIOS | NORTE     |
| 181 | CO_2019_02_6 | 2019_02_19_171_06 | _02_19_07_55_DJI_0651 / 2019_02_19_07_58_DJI_  | 19/02/2019 | 171 | 6       | COMBOIOS | SUL       |
| 182 | CO_2019_02_6 | 2019_02_19_172_06 | _02_19_08_52_DJI_0400 / 2019_02_19_08_57_DJI_  | 19/02/2019 | 172 | 6       | COMBOIOS | NORTE     |
| 183 | CO_2019_02_0 | 2019_02_19_173_00 | _02_19_09_34_DJI_0404 / 2019_02_19_09_39_DJI_  | 19/02/2019 | 173 | 0       | COMBOIOS | BEHAVIOR  |
| 184 | CO_2019_02_0 | 2019_02_19_174_00 | _02_19_10_00_DJI_0408 / 2019_02_19_10_05_DJI_  | 19/02/2019 | 174 | 0       | COMBOIOS | BEHAVIOR  |

| PILOTO  | OBS_DRONE | OBS_FAUNA | ANOTADOR | OP_LOGISTIC | HORA_INICI | HORA_FIM | TEMPO_VO | N_DRONE | N_BATERIA | N_CARTAO | N_MASCAR | ALTITUDE_VO | VELOCIDADE_V |
|---------|-----------|-----------|----------|-------------|------------|----------|----------|---------|-----------|----------|----------|-------------|--------------|
| LUCIANO | LORENA    | JONATHAS  | BARBARA  | NELSON      | 8:40       | 8:56     | 00:16    | C       | B3        | 7        | B        | 50          | 40           |
| LUCIANO | NELSON    | JONATHAS  | BARBARA  | LORENA      | 9:01       | 9:16     | 00:15    | C       | C3        | 7        | B        | 50          | 40           |
| LUCIANO | IZABELLA  | JONATHAS  | LORENA   | NELSON      | 9:33       | 9:49     | 00:16    | C       | B2        | 7        | B        | 50          | 40           |
| LORENA  | BARBARA   | IZABELLA  | LUCIANO  | NELSON      | 9:58       | 10:13    | 00:15    | C       | A1        | 7        | B        | 50          | 40           |
| NELSON  | LORENA    | BARBARA   | IZABELLA | JONATHAS    | 10:36      | 10:54    | 00:18    | C       | A3        | 7        | B        | 50          | 40           |
| BARBARA | JONATHAS  | LORENA    | NELSON   | LUCIANO     | 11:11      | 11:32    | 00:21    | C       | C2        | 7        | B        | 50          | 40           |
| LUCIANO | NELSON    | AMANDA    | BARBARA  | JOAO        | 8:02       | 8:18     | 00:16    | B       | C1        | 2        | A        | 50          | 40           |
| LUCIANO | NELSON    | AMANDA    | BARBARA  | JOAO        | 8:28       | 8:42     | 00:14    | C       | C2        | 1        | B        | 50          | 40           |
| LUCIANO | JOAO      | AMANDA    | BARBARA  | NELSON      | 8:50       | 9:08     | 00:18    | B       | B3        | 2        | A        | 50          | 40           |
| LUCIANO | JOAO      | AMANDA    | BARBARA  | NELSON      | 9:13       | 9:28     | 00:15    | C       | A1        | 1        | B        | 50          | 40           |
| LUCIANO | NELSON    | AMANDA    | BARBARA  | JOAO        | 9:39       | 9:53     | 00:14    | B       | A2        | 2        | A        | 50          | 40           |
| LUCIANO | BARBARA   | AMANDA    | NELSON   | JOAO        | 10:24      | 10:37    | 00:13    | C       | C3        | 1        | B        | 50          | 40           |
| LUCIANO | BARBARA   | AMANDA    | NELSON   | JOAO        | 10:41      | 11:03    | 00:22    | B       | A2        | 2        | A        | 50          | 40           |
| JOAO    | LUCIANO   | AMANDA    | BARBARA  | NELSON      | 11:13      | 11:27    | 00:14    | C       | A2        | 1        | B        | 50          | 40           |
| JOAO    | LUCIANO   | AMANDA    | BARBARA  | NELSON      | 11:32      | 11:50    | 00:18    | C       | A3        | 1        | B        | 50          | 40           |
| JOAO    | BARBARA   | AMANDA    | LUCIANO  | NELSON      | 12:04      | 12:19    | 00:15    | B       | A1        | 2        | A        | 50          | 40           |
| LUCIANO | BARBARA   | AMANDA    | NELSON   | JOAO        | 12:33      | 12:47    | 00:14    | C       | B3        | 2        | B        | 50          | 40           |
| LUCIANO | JOAO      | AMANDA    | NELSON   | BARBARA     | 12:54      | 13:13    | 00:19    | B       | C1        | 2        | A        | 50          | 40           |
| LUCIANO | JOAO      | AMANDA    | BARBARA  | NELSON      | 7:34       | 7:49     | 00:15    | C       | A2        | 3        | A        | 50          | 40           |
| LUCIANO | JOAO      | AMANDA    | BARBARA  | NELSON      | 7:56       | 8:14     | 00:18    | B       | C2        | 4        | A        | 50          | 40           |
| LUCIANO | BARBARA   | AMANDA    | JOAO     | NELSON      | 8:20       | 8:35     | 00:15    | C       | A3        | 3        | B        | 50          | 40           |

| BEAUFORT | TEMPERATURA | MEDIA_VENT | RAJADA_MA | DIRECAO_VEN | NEBULOSIDA | MARE     | LUA       | TURBIDEZ | IDENCIA_DE_P |
|----------|-------------|------------|-----------|-------------|------------|----------|-----------|----------|--------------|
| 2        | 30          | 7          | 17        | NW          | 25         | BAIXANDO | CHEIA     | CLARA    | 0            |
| 2        | 31          | 7          | 17        | W           | 50         | BAIXANDO | CHEIA     | CLARA    | 0            |
| 2        | 31          | 8          | 14        | W           | 50         | BAIXANDO | CHEIA     | CLARA    | 0            |
| 2        | 32          | 7          | 16        | NE          | 50         | BAIXANDO | CHEIA     | CLARA    | 0            |
| 2        | 33          | 8          | 17        | E           | 50         | BAIXANDO | CHEIA     | CLARA    | 0            |
| 2        | 30          | 10         | 19        | NEW         | 50         | BAIXA    | CHEIA     | CLARA    | 0            |
| 3        | 23          | 5          | 5         | W           | 0          | BAIXA    | CRESCENTE | MEDIA    | 1            |
| 3        | 27          | 5          | 5         | W           | 0          | BAIXA    | CRESCENTE | CLARA    | 1            |
| 3        | 27          | 11         | 11        | SSW         | 0          | SUBINDO  | CRESCENTE | CLARA    | 1            |
| 3        | 28          | 8          | 12        | SSW         | 0          | SUBINDO  | CRESCENTE | CLARA    | 1            |
| 3        | 29          | 10         | 12        | SSW         | 0          | SUBINDO  | CRESCENTE | CLARA    | 1            |
| 3        | 30          | 8          | 12        | S           | 25         | SUBINDO  | CRESCENTE | MEDIA    | 1            |
| 3        | 29          | 9          | 12        | S           | 25         | SUBINDO  | CRESCENTE | MEDIA    | 1            |
| 3        | 29          | 10         | 12        | S           | 25         | SUBINDO  | CRESCENTE | CLARA    | 1            |
| 3        | 28          | 9          | 12        | SSE         | 25         | SUBINDO  | CRESCENTE | CLARA    | 1            |
| 3        | 30          | 10         | 12        | SSE         | 50         | CHEIA    | CRESCENTE | MEDIA    | 1            |
| 3        | 32          | 12         | 13        | SE          | 25         | CHEIA    | CRESCENTE | MEDIA    | 1            |
| 3        | 32          | 12         | 13        | SE          | 25         | CHEIA    | CRESCENTE | MEDIA    | 1            |
| 2        | 26          | 13         | 18        | NNE         | 75         | BAIXA    | CHEIA     | CLARA    | 0            |
| 3        | 28          | 15         | 19        | NNE         | 75         | BAIXA    | CHEIA     | CLARA    | 0            |
| 2        | 29          | 14         | 21        | NE          | 75         | BAIXA    | CHEIA     | CLARA    | 0            |
| 3        | 29          | 21         | 23        | NE          | 75         | BAIXA    | CHEIA     | CLARA    | 0            |



WORKSHOP  
**OCEAN DATA BOOTCAMP**

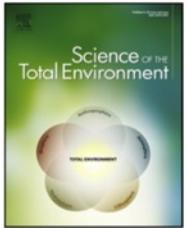
GESTÃO DE DADOS DE  
MONITORAMENTO COSTEIRO

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## Using drones and ROV to assess the vulnerability of marine megafauna to the Fundão tailings dam collapse



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### HIGHLIGHTS

- With Drone-monitoring it was possible to assess the density of cetaceans that use the Rio Doce mouth.
- Marine megafauna uses the area closest to the mouth of the estuaries in the summer.
- Highest density of marine megafauna occurred in areas where the seafloor was muddy.
- Marine megafauna species using the area impacted, in the Rio Doce, for foraging.

### GRAPHICAL ABSTRACT

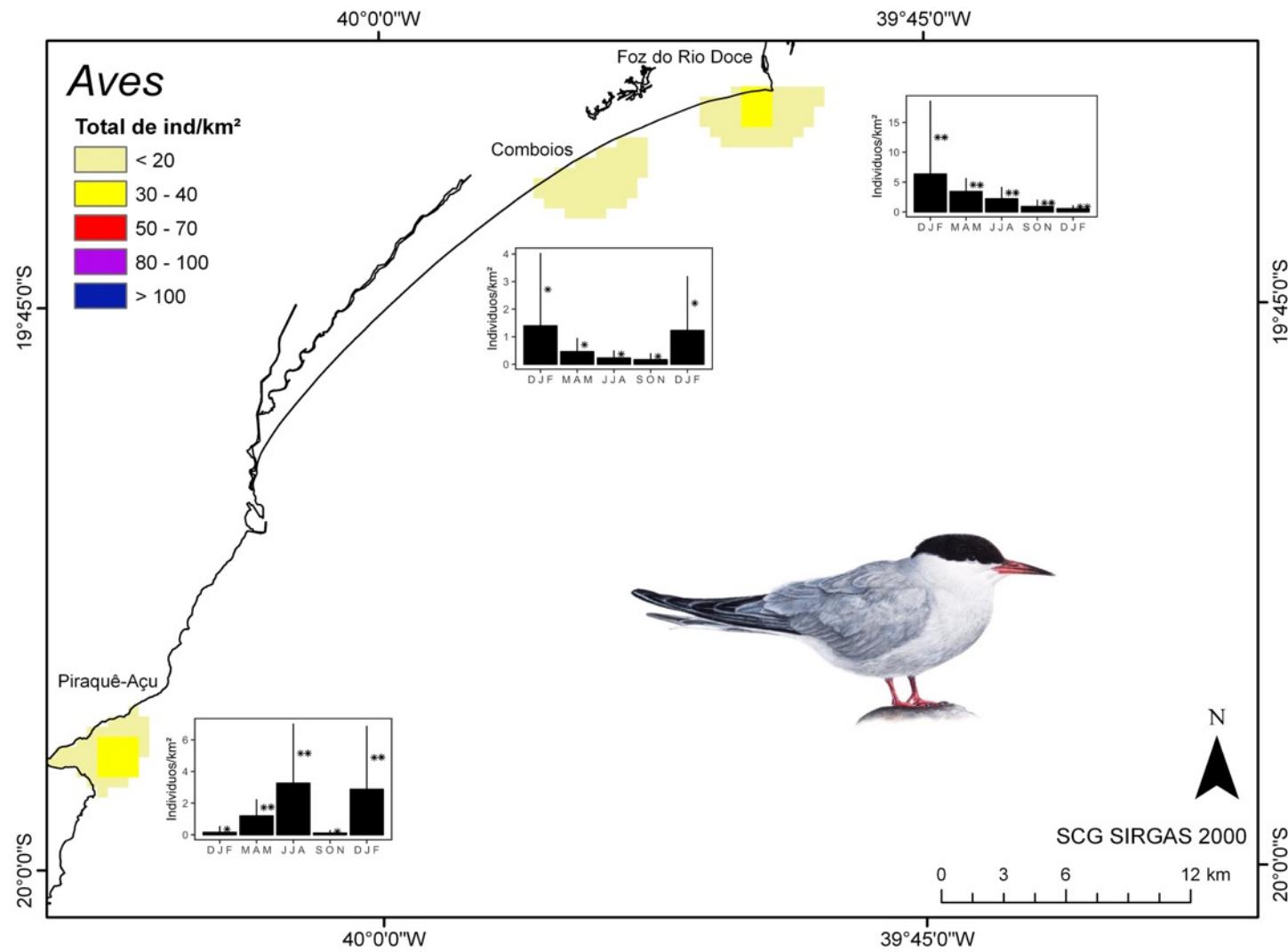


# WORKSHOP OCEAN DATA BOOTCAMP

GESTÃO DE DADOS DE  
MONITORAMENTO COSTEIRO



LABNECTON

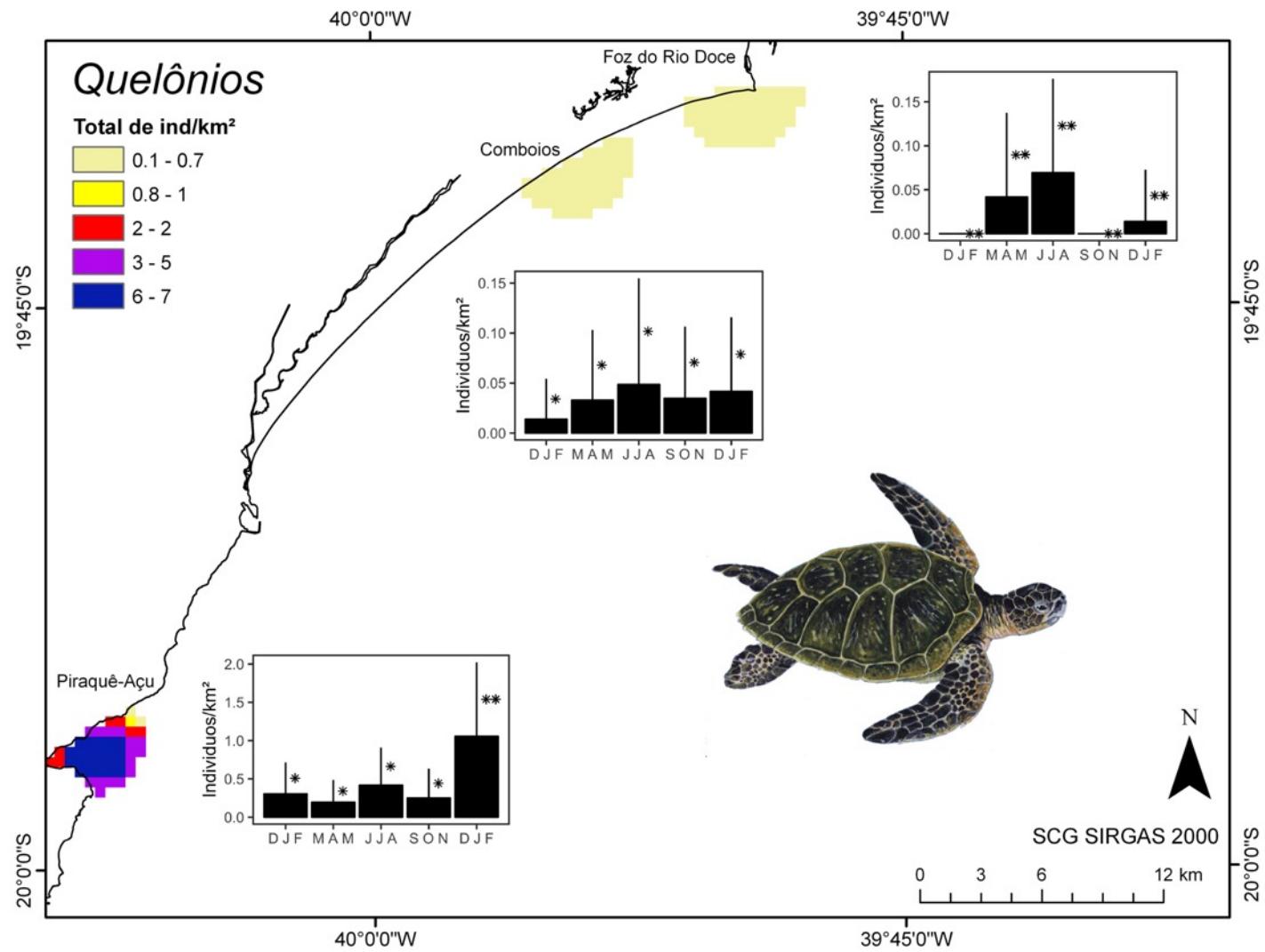


# WORKSHOP OCEAN DATA BOOTCAMP

GESTÃO DE DADOS DE  
MONITORAMENTO COSTEIRO



LABNECTON

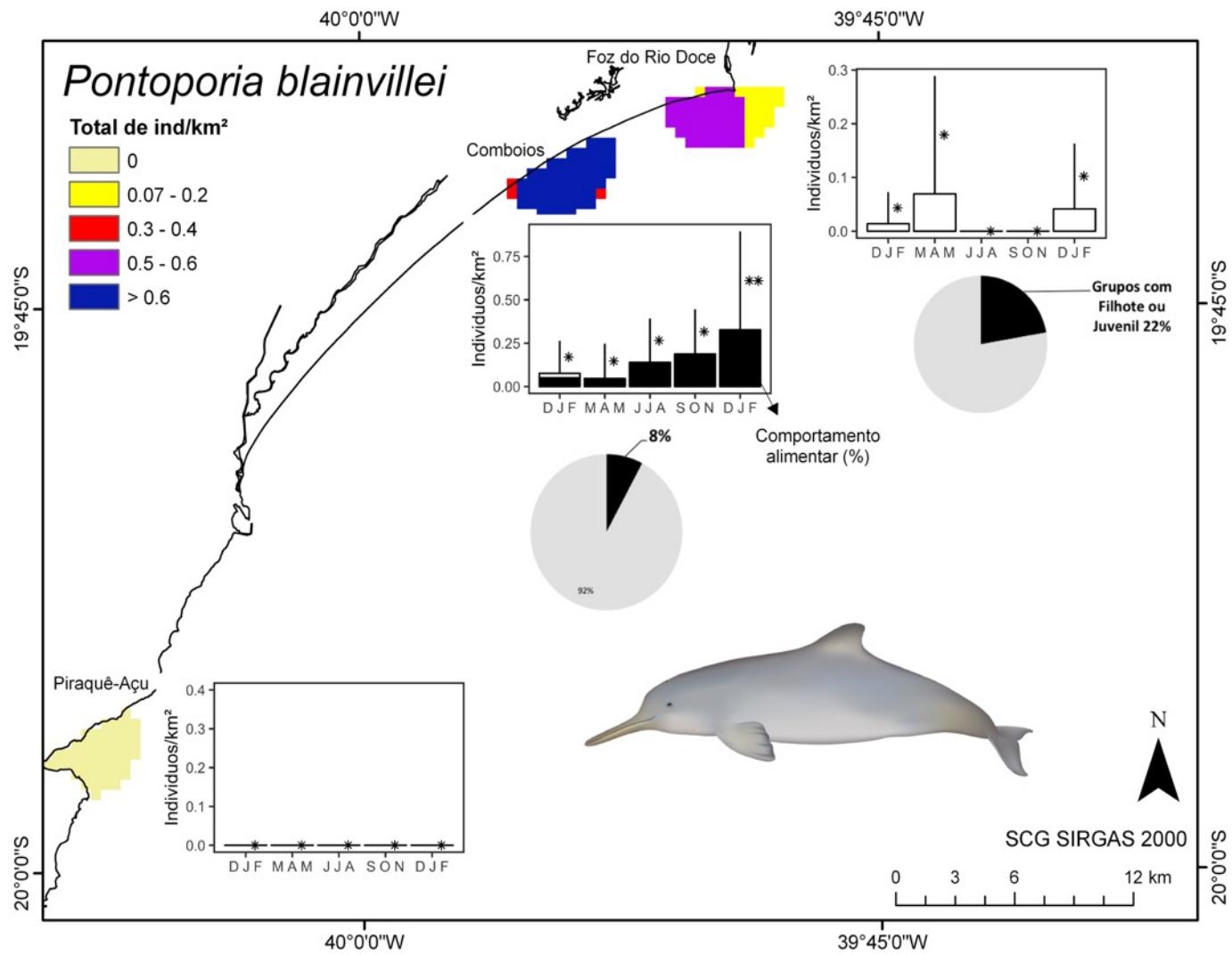


# WORKSHOP OCEAN DATA BOOTCAMP

GESTÃO DE DADOS DE  
MONITORAMENTO COSTEIRO



LABNECTON





# Desafios?





# Desafios? Muitos!



# Integração com outros parâmetros

| ID_VOO           | ID_VIDEO_EDITADO            | CLASSE   | ORDEM           | FAMILIA       | GENERO_ESPECI        | REGISTRO_CAM | INICIO_HORA_RELÓGI | INICIO_OBS_VID | FINAL_OBS_VID | TEMPO_OBS | LATITUDE   | LONGITUDE  |
|------------------|-----------------------------|----------|-----------------|---------------|----------------------|--------------|--------------------|----------------|---------------|-----------|------------|------------|
| 2018_10_17_02_02 | 2018_10_17_09_18_02_24_0005 | AVE      |                 |               |                      | 1            | 09:18              | 02:24          | 02:33         | 00:09     | -19,654869 | -39,822372 |
| 2018_10_17_03_04 | 2018_10_17_09_53_13_48_0006 | AVE      | PELECANIFORMES  | ARDEIDAE      |                      | 1            | 09:54              | 13:48          | 13:50         | 00:02     | -19,658696 | -39,824583 |
| 2018_10_17_05_07 | 2018_10_17_10_57_01_45_0012 | AVE      |                 |               |                      | 0            | 10:57              | 01:45          | 01:54         | 00:09     | -19,654784 | -39,823331 |
| 2018_10_17_07_11 | 2018_10_17_11_43_02_50_0018 | AVE      |                 |               |                      | 0            | 11:41              | 02:50          | 02:55         | 00:05     | -19,655633 | -39,825229 |
| 2018_10_18_08_01 | 2018_10_18_09_13_02_20_0039 | REPTILIA | TESTUDINATA     | DERMOCHELYDAE | Dermochelys_coriacea | 0            | 09:12              | 02:20          | 02:23         | 00:03     | -19,673948 | -39,880639 |
| 2018_10_18_08_01 | 2018_10_18_09_13_03_34_0039 | AVE      |                 |               |                      | 0            | 09:13              | 03:34          | 03:37         | 00:03     | -19,673513 | -39,87987  |
| 2018_10_18_11_04 | 2018_10_18_09_52_03_13_0044 | AVE      |                 |               |                      | 1            | 12:23              | 03:15          | 03:17         | 00:02     | -19,676273 | -39,877888 |
| 2018_10_18_11_04 | 2018_10_18_09_52_03_48_0044 | AVE      |                 |               |                      | 1            | 12:24              | 03:48          | 03:55         | 00:07     | -19,673928 | -39,878529 |
| 2018_10_18_11_04 | 2018_10_18_09_52_04_25_0044 | AVE      |                 |               |                      | 0            | 12:25              | 04:25          | 04:35         | 00:10     | -19,673883 | -39,877223 |
| 2018_10_19_12_05 | 2018_10_19_07_08_01_54_0007 | MAMMALIA | CETARTIODACTYLA | DELPHINIDAE   | Sotalia_guianensis   | 1            | 07:08              | 01:54          | 02:25         | 00:31     | -19,673854 | -39,881946 |
| 2018_10_19_12_05 | 2018_10_19_07_06_02_29_0006 | AVE      |                 |               |                      | 1            | 07:05              | 02:29          | 03:10         | 00:41     | -19,675068 | -39,879081 |
| 2018_10_19_12_05 | 2018_10_19_07_06_03_40_0006 | AVE      |                 |               |                      | 0            | 07:06              | 03:43          | 03:47         | 00:04     | -19,673265 | -39,88097  |
| 2018_10_19_13_06 | 2018_10_19_07_28_01_09_0013 | AVE      | SULIFORMES      | FREGATIDAE    | Fregata_magnificens  | 1            | 07:27              | 01:09          | 01:11         | 00:02     | -19,673142 | -39,876773 |
| 2018_10_19_13_06 | 2018_10_19_07_26_04_00_0011 | AVE      | CHARADRIIFORMES | STERNIDAE     |                      | 1            | 07:22              | 04:00          | 04:06         | 00:06     | -19,677109 | -39,87939  |
| 2018_10_19_13_06 | 2018_10_19_07_26_00_00_0012 | AVE      | CHARADRIIFORMES | STERNIDAE     |                      | 1            | 07:23              | 00:00          | 00:04         | 00:04     | -19,677087 | -39,879401 |
| 2018_10_19_13_06 | 2018_10_19_07_26_01_54_0011 | AVE      | CHARADRIIFORMES | STERNIDAE     |                      | 1            | 07:19              | 01:54          | 02:25         | 00:31     | -19,676039 | -39,884732 |
| 2018_10_19_13_06 | 2018_10_19_07_26_00_33_0012 | AVE      | CHARADRIIFORMES | STERNIDAE     |                      | 0            | 07:24              | 00:33          | 00:38         | 00:05     | -19,67515  | -39,877017 |
| 2018_10_19_13_06 | 2018_10_19_07_26_01_56_0012 | AVE      | CHARADRIIFORMES | STERNIDAE     |                      | 1            | 07:25              | 01:56          | 02:00         | 00:04     | -19,674431 | -39,877981 |
| 2018_10_19_14_07 | 2018_10_19_07_39_03_25_0016 | AVE      |                 |               |                      | 0            | 07:39              | 03:25          | 03:27         | 00:02     | -19,675245 | -39,879961 |
| 2018_10_19_14_07 | 2018_10_19_07_44_01_58_0017 | AVE      |                 |               |                      | 0            | 07:42              | 01:58          | 02:01         | 00:03     | -19,673303 | -39,881555 |
| 2018_10_19_14_08 | 2018_10_19_07_49_01_38_0019 | AVE      |                 |               |                      | 0            | 07:46              | 01:38          | 01:40         | 00:02     | -19,678008 | -39,881571 |
| 2018_10_19_14_08 | 2018_10_19_07_49_00_53_0019 | AVE      |                 |               |                      | 0            | 07:45              | 00:53          | 00:57         | 00:04     | -19,677711 | -39,883086 |
| 2018_10_19_14_08 | 2018_10_19_07_49_03_25_0019 | AVE      |                 |               |                      | 1            | 07:48              | 03:25          | 03:27         | 00:02     | -19,677484 | -39,881059 |
| 2018_10_19_14_08 | 2018_10_19_07_49_04_33_0019 | AVE      |                 |               |                      | 1            | 07:50              | 04:33          | 04:43         | 00:10     | -19,677122 | -39,887938 |
| 2018_10_19_14_08 | 2018_10_19_07_49_04_00_0019 | AVE      |                 |               |                      | 1            | 07:49              | 04:00          | 04:03         | 00:03     | -19,674444 | -39,877892 |
| 2018_10_19_15_09 | 2018_10_19_08_29_02_44_0022 | AVE      | CHARADRIIFORMES | STERNIDAE     |                      | 1            | 08:22              | 02:44          | 03:10         | 00:26     | -19,67643  | -39,883183 |
| 2018_10_19_15_09 | 2018_10_19_08_29_04_44_0022 | AVE      |                 |               |                      | 1            | 08:24              | 04:44          | 04:49         | 00:05     | -19,675978 | -39,88019  |
| 2018_10_19_15_09 | 2018_10_19_08_29_05_15_0022 | AVE      |                 |               |                      | 0            | 08:25              | 05:15          | 05:17         | 00:02     | -19,675711 | -39,879998 |
| 2018_10_19_16_11 | 2018_10_19_08_50_01_55_0024 | AVE      | CHARADRIIFORMES | STERNIDAE     |                      | 1            | 08:46              | 01:55          | 03:09         | 01:14     | -19,677772 | -39,881086 |
| 2018_10_22_18_02 | 2018_10_22_10_38_05_10_0029 | REPTILIA | TESTUDINATA     | DERMOCHELYDAE | Dermochelys_coriacea | 1            | 10:38              | 05:10          | 06:25         | 01:15     | -19,685674 | -39,908208 |
| 2018_10_22_19_03 | 2018_10_22_11_25_07_25_0048 | AVE      | CHARADRIIFORMES | STERNIDAE     | Phaetusa_simplex     | 0            | 11:20              | 07:25          | 07:46         | 00:21     | -19,682281 | -39,899059 |
| 2018_10_22_19_03 | 2018_10_22_11_25_00_40_0048 | MAMMALIA | CETARTIODACTYLA | DELPHINIDAE   | Sotalia_guianensis   | 1            | 11:09              | 00:40          | 02:38         | 01:58     | -19,684169 | -39,905406 |
| 2018_10_22_20_04 | 2018_10_22_12_54_03_25_0054 | REPTILIA | TESTUDINATA     | DERMOCHELYDAE | Dermochelys_coriacea | 0            | 12:48              | 03:25          | 03:52         | 00:27     | -19,684066 | -39,904183 |
| 2018_10_22_21_05 | 2018_10_22_13_30_00_52_0061 | AVE      | CHARADRIIFORMES | STERNIDAE     |                      | 0            | 13:17              | 00:52          | 01:10         | 00:18     | -19,683669 | -39,905523 |
| 2018_10_22_22_06 | 2018_10_22_14_08_04_49_0067 | AVE      | CHARADRIIFORMES | STERNIDAE     |                      | 0            | 14:13              | 04:49          | 04:51         | 00:02     | -19,683678 | -39,905505 |



# Integração com outros parâmetros

| BEAUFORT | TEMPERATURA_AR | MEDIA_VENTO | RAJADA_MAX | DIRECAO_VENTO | NEBULOSIDADE | MARE     | LUA       | TURBIDEZ | CIDENCIA_DE_PLUM |
|----------|----------------|-------------|------------|---------------|--------------|----------|-----------|----------|------------------|
| 4        | 24             | 19          | 21         | SSE           | 100          | BAIXA    | MINGUANTE | MEDIA    | 1                |
| 4        | 25             | 17          | 21         | SSE           | 100          | BAIXA    | MINGUANTE | MEDIA    | 1                |
| 3        | 25             | 14          | 17         | S             | 100          | ALTA     | MINGUANTE | MEDIA    | 0                |
| 3        | 25             | 15          | 17         | SSW           | 100          | ALTA     | MINGUANTE | MEDIA    | 1                |
| 3        | 26             | 13          | 17         | SSE           | 75           | ALTA     | MINGUANTE | MEDIA    | 1                |
| 3        | 26             | 15          | 17         | SSE           | 75           | ALTA     | MINGUANTE | MEDIA    | 1                |
| 2        | 25             | 15          | 18         | SSE           | 75           | BAIXANDO | MINGUANTE | MEDIA    | 0                |
| 2        | 25             | 15          | 18         | SSE           | 75           | BAIXANDO | MINGUANTE | MEDIA    | 1                |
| 3        | 25             | 14          | 18         | SES           | 100          | BAIXANDO | MINGUANTE | MEDIA    | 0                |
| 3        | 25             | 14          | 17         | SSW           | 100          | BAIXANDO | MINGUANTE | MEDIA    | 0                |
| 2        | 23             | 5           | 7          | SSW           | 100          | BAIXA    | MINGUANTE | CLARA    | 0                |
| 2        | 25             | 9           | 10         | SSW           | 75           | BAIXA    | MINGUANTE | CLARA    | 0                |
| 2        | 25             | 8           | 11         | SWS           | 50           | BAIXA    | MINGUANTE | CLARA    | 1                |
| 2        | 25             | 10          | 11         | SWS           | 50           | BAIXA    | MINGUANTE | CLARA    | 0                |
| 2        | 26             | 9           | 12         | S             | 75           | BAIXA    | MINGUANTE | CLARA    | 1                |
| 2        | 26             | 10          | 12         | S             | 100          | BAIXA    | MINGUANTE | CLARA    | 1                |
| 2        | 27             | 9           | 12         | S             | 100          | BAIXA    | MINGUANTE | CLARA    | 1                |
| 2        | 27             | 11          | 12         | S             | 75           | SUBINDO  | MINGUANTE | CLARA    | 1                |
| 2        | 27             | 9           | 12         | S             | 50           | SUBINDO  | MINGUANTE | CLARA    | 1                |
| 2        | 27             | 13          | 13         | SSE           | 50           | SUBINDO  | MINGUANTE | CLARA    | 0                |
| 2        | 27             | 13          | 14         | SSE           | 50           | SUBINDO  | MINGUANTE | CLARA    | 1                |
| 3        | 27             | 14          | 16         | SSE           | 50           | SUBINDO  | MINGUANTE | MEDIA    | 1                |
| 3        | 27             | 14          | 16         | SSE           | 50           | SUBINDO  | MINGUANTE | CLARA    | 1                |
| 1        | 27             | 6           | 8          | SSE           | 100          | BAIXANDO | MINGUANTE | CLARA    | 0                |



# WORKSHOP OCEAN DATA BOOTCAMP

GESTÃO DE DADOS DE  
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# Integração com outros estudos



Contents lists available at ScienceDirect

## Marine Environmental Research

journal homepage: [www.elsevier.com/locate/marenvrev](http://www.elsevier.com/locate/marenvrev)



### Variability in nearshore fish biodiversity indicators after a mining disaster in eastern Brazil

Ciro Colodetti Vilar <sup>a,\*</sup>, Ryan Andrade <sup>a,1</sup>, Flávio Toscano Szablak <sup>a</sup>, Helder Coelho Guabiroba <sup>a</sup>, Helen Audrey Pichler <sup>b</sup>, Kathiani Victor Bastos <sup>a</sup>, Layza Roxanne Santana de Lima <sup>a</sup>, Pedro Garcia Pereira Bastos <sup>a</sup>, Rebeka Ferreira Martins <sup>a</sup>, Vitor Leonardo Amaral Rodrigues <sup>a</sup>, Mauricio Hostim-Silva <sup>b,c</sup>, Jean-Christophe Joyeux <sup>a</sup>

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#### ARTICLE INFO

**Keywords:**  
Biodiversity indicators  
Coastal fishes  
Doce river  
Estuarine fishes  
Mariana disaster  
Mine tailing impacts

#### ABSTRACT

The rupture of the Fundão mining dam (Doce river basin, Brazil) caused a wide range of negative impacts. Yet, assemblage-level implications to estuarine and coastal fishes remain unclear, partly due to the lack of pre-disaster information. Based on monthly otter trawl surveys, we analyzed spatial and seasonal variability in univariate (total biomass, biomass of species vulnerable to exploitation, rarefied richness and evenness) and multivariate (species composition and trophic composition) indicators of fish biodiversity in the Doce river delta, eastern Brazil. We determined the independent and interactive effects of environmental, seasonal and spatial variables on species composition to test whether environmental alterations provoked by mine tailings could affect assemblage's organization. Most indicators present idiosyncratic spatiotemporal patterns, suggesting they have complementary roles in revealing changes in fish biodiversity. Environmental variables, including those affected by the Fundão dam collapse such as turbidity, dissolved oxygen and pH, were much more important than seasonal and spatial predictors in explaining the variation in fish species composition. These findings highlight the potential from mine tailings to disrupt local ichthyofauna and indicate a preponderant role of environmental conditions in assemblage structuring. Given the lack of data prior to rupture, our results may be used as a baseline against which to assess temporal trends in fish biodiversity relative to changes detected in less disturbed estuarine and coastal assemblages.



#OceanDataBootcamp



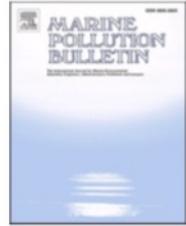
# Integração com outros estudos



Contents lists available at ScienceDirect

## Marine Pollution Bulletin

journal homepage: [www.elsevier.com/locate/marpolbul](http://www.elsevier.com/locate/marpolbul)



Baseline

### Iron ore tailings as a source of nutrients to the coastal zone



Eduardo Schettini Costa <sup>a,\*</sup>, Renata Caiado Cagnin <sup>a</sup>, Cesar Alexandre da Silva <sup>a</sup>, Cybelle Menolli Longhini <sup>a</sup>, Fabian Sá <sup>a</sup>, Ana Teresa Lima <sup>a,c</sup>, Luiz Eduardo de Oliveira Gomes <sup>b</sup>, Angelo Fraga Bernardino <sup>b</sup>, Renato Rodrigues Neto <sup>a</sup>

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<sup>c</sup> Department of Civil Engineering, Technical University of Denmark, Lyngby, Denmark

#### ARTICLE INFO

##### Keywords:

Ore tailings

Dissolved nutrients

Environmental disaster

Coastal zone

#### ABSTRACT

The Fundão dam rupture was one of the largest environmental disasters worldwide and released millions of m<sup>3</sup> of iron ore tailings into the Doce River basin in southeastern Brazil. Here we assessed the supply of dissolved nutrients associated to tailings in the Doce River estuary and its adjacent coastal zone. First, we observed an acute increase in dissolved silicates (From 16.26 µM to 175.47 µM) and nitrate (From 5.56 µM to 50.69 µM) in the estuary when compared to days prior to the event. Coastal marine ecosystems showed significant concentrations of nitrite (From 0.72 µM to 2.99 µM) and phosphate (From 0.09 µM to 2.30 µM) one year after the disaster, which we attribute mainly to nutrient recycling. The chronic effects include an increase in nutrient load to the coastal zone with a predominance of nitrogenous species, which may increase the limitation of phosphorus and silica to marine primary production.



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## Science of the Total Environment

journal homepage: [www.elsevier.com/locate/scitotenv](http://www.elsevier.com/locate/scitotenv)



### Temporal trends of trace elements bioaccumulation by a vulnerable cetacean (*Pontoporia blainvillei*) before and after one of the largest mining disasters worldwide



B.M.R. Manhães <sup>a,b,\*</sup>, M. Vannuci-Silva <sup>a,b</sup>, J.A. Brião <sup>a</sup>, E.B. Guari <sup>a</sup>, S. Botta <sup>c</sup>, A.C. Colosio <sup>d</sup>, H.G.C. Ramos <sup>d</sup>, L.A. Barbosa <sup>e</sup>, I.A.G. Cunha <sup>e</sup>, A.F. Azevedo <sup>a,b</sup>, H.A. Cunha <sup>a,b</sup>, T.L. Bisi <sup>a,b</sup>, J. Lailson-Brito <sup>a,b</sup>

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<sup>c</sup> Laboratório de Ecologia e Conservação da Megafauna Marinha (ECOMEGA), Instituto de Oceanografia, Universidade Federal do Rio Grande (FURG), Brazil

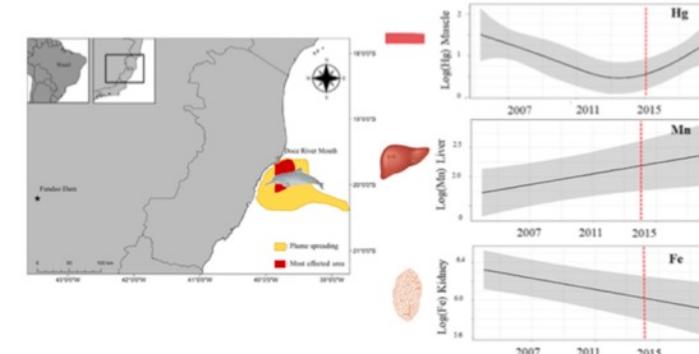
<sup>d</sup> Instituto Baleia Jubarte, Caravelas, Bahia, Brazil

<sup>e</sup> Instituto ORCA, Vila Velha, Espírito Santo, Brazil

#### HIGHLIGHTS

- Trace elements in franciscana dolphins from FMA Ia are reported for the first time.
- Increasing temporal trends of Hg and Zn were found due to higher bioavailability.
- Declining trends of As, Cu and Fe were mainly related to tailing mud association.
- Elements remobilization in the environment can threat franciscana dolphins.

#### GRAPHICAL ABSTRACT





# WORKSHOP OCEAN DATA BOOTCAMP

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# Imagens no banco de dados

| FILHO TE | JUV ENIL | ADUL TO | INDETER MINADO | DESLOCA MENTO | ALIMENTACAO | INTERACAO | COMPORTAMENTO_ INDETERMINADO | INCIDENCIA_DE PLUMA | OBSERVAÇÕES   | LINK_VIDEO_EDITADO1   | LINK_V... |
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# WORKSHOP OCEAN DATA BOOTCAMP

GESTÃO DE DADOS DE  
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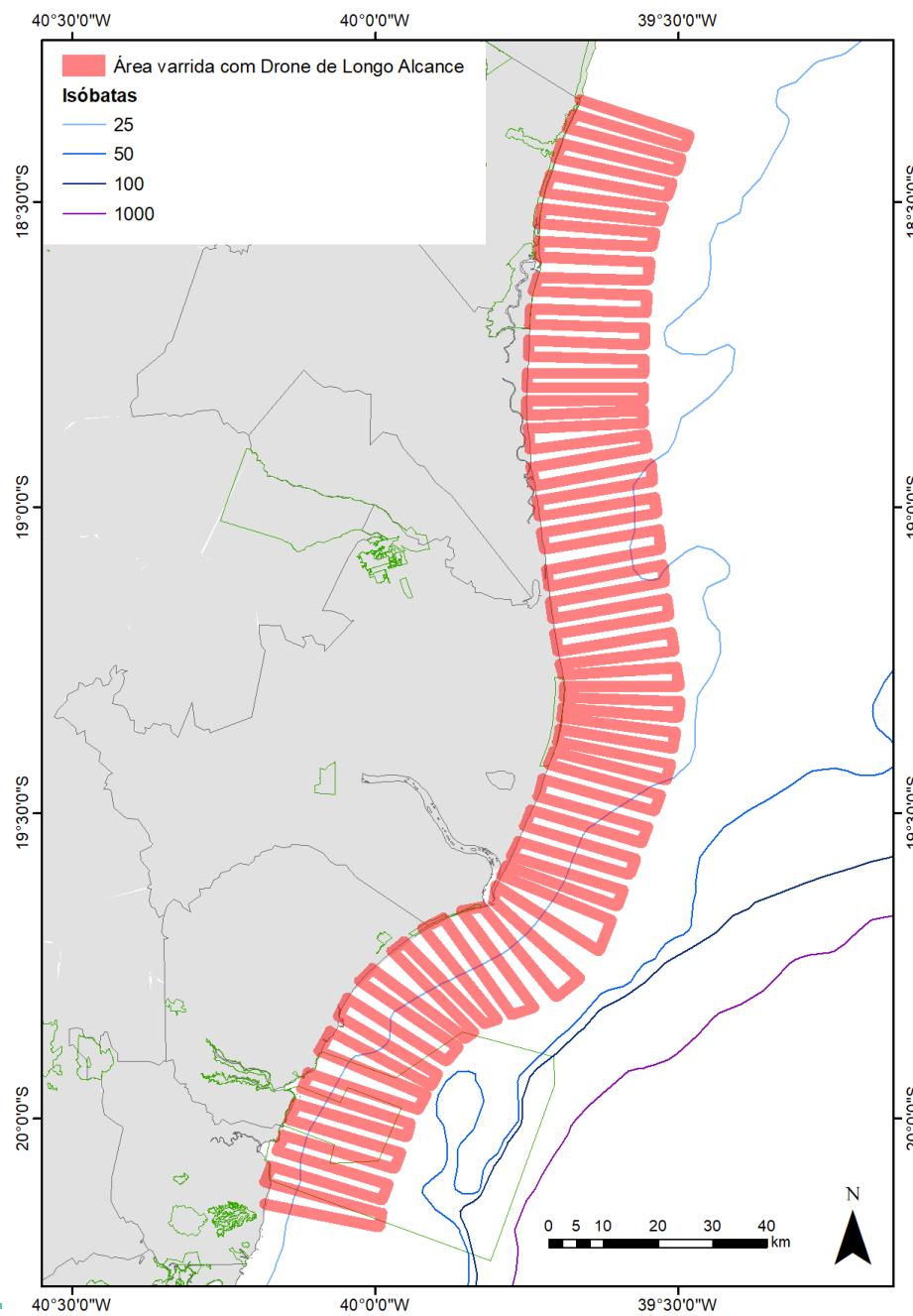
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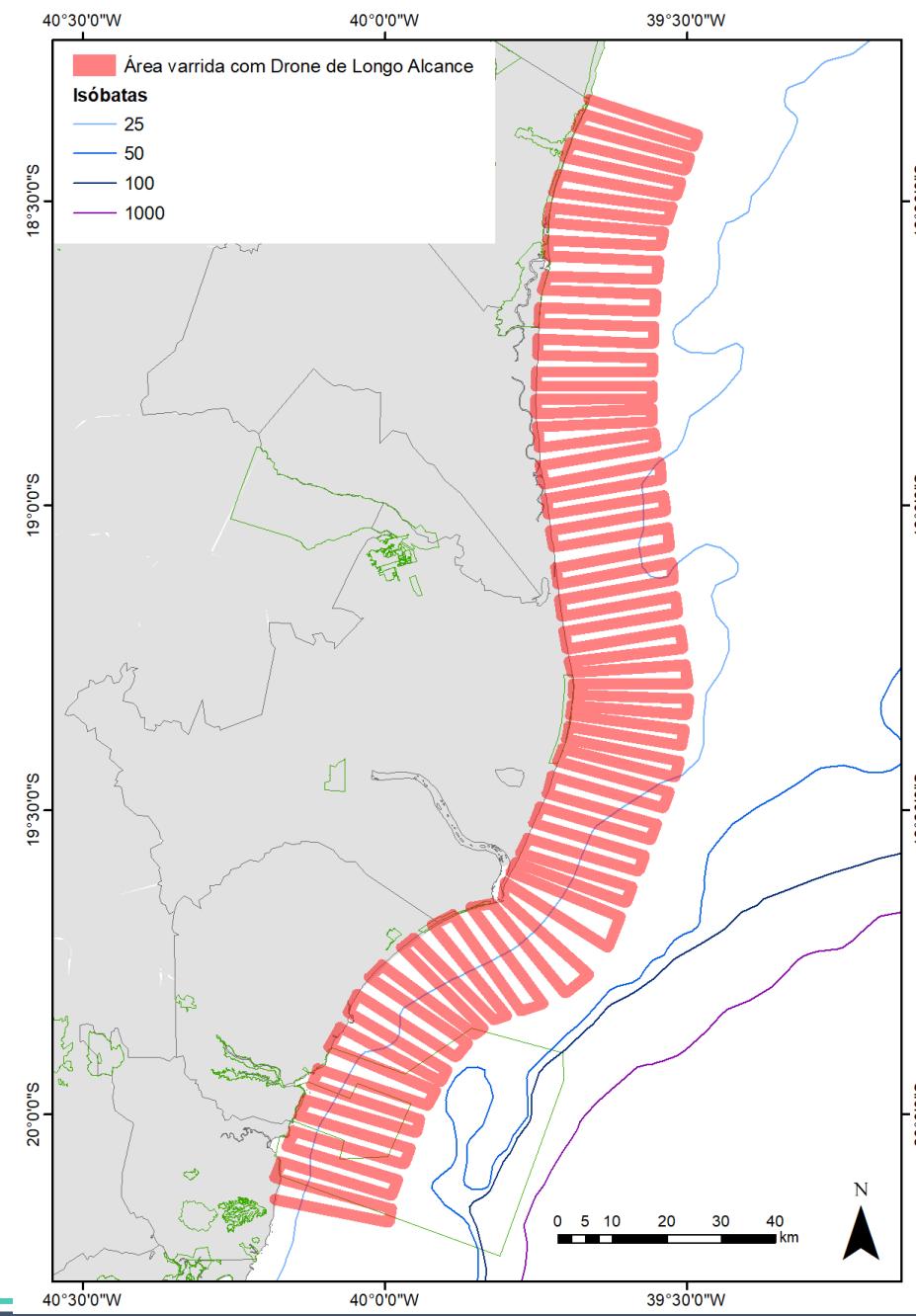


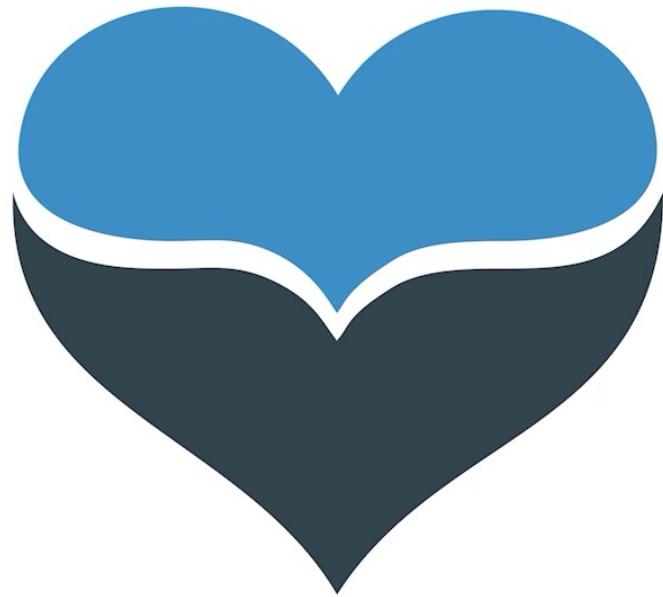


# Próximos voos...











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