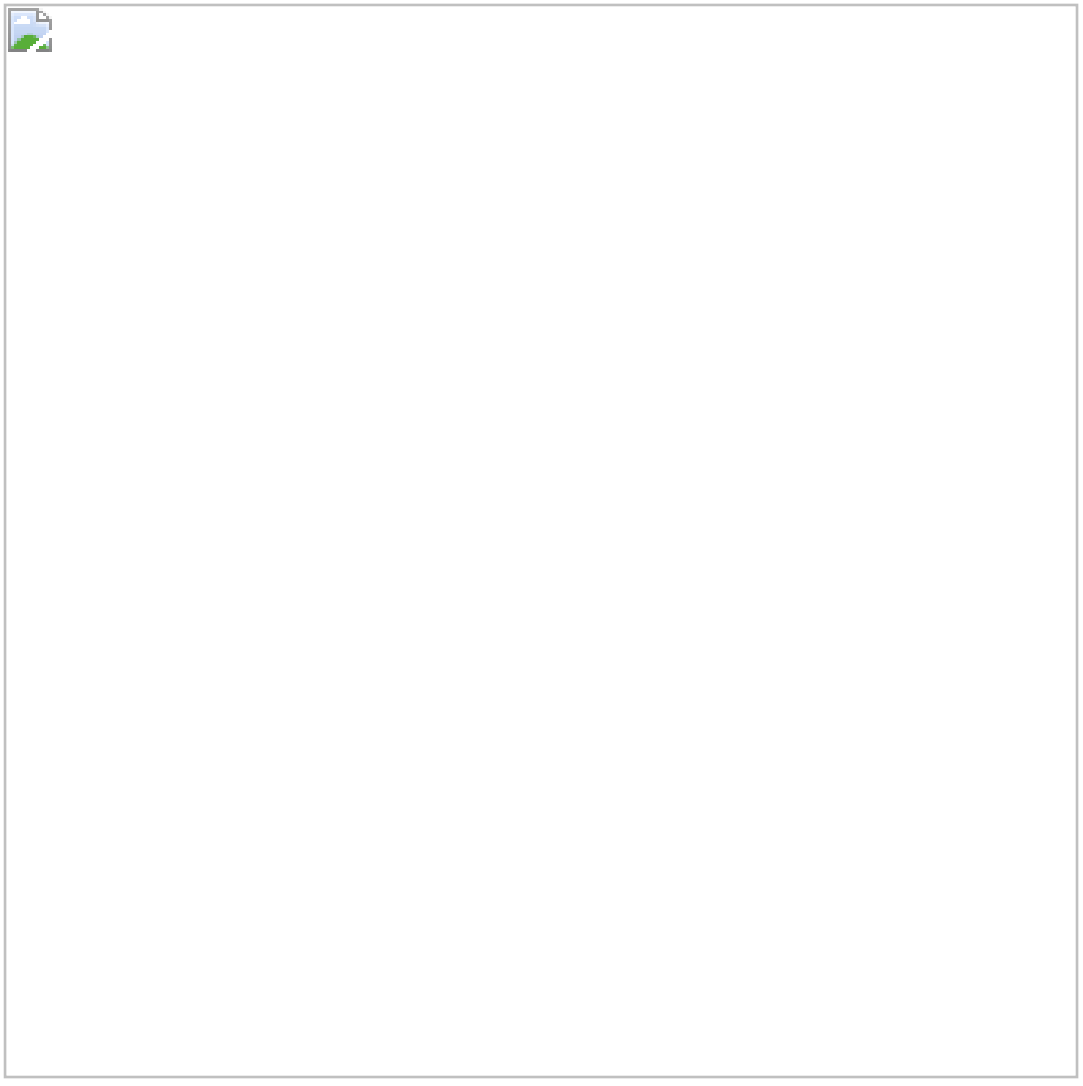

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Opportunistic Development and Environmental Disaster Threat Franciscana Dolphins in the Southeast of Brazil

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Abstract

The Franciscana dolphin (*Pontoporia blainvillei*), a small cetacean endemic to southwestern Atlantic coastal waters, is the most endangered marine mammal species in the south Atlantic. In the Espírito Santo State, in southeastern Brazil, the Franciscana dolphin distribution overlaps regions suppressed and threatened by an intensive industrial and port development in the coastal zone. Moreover, most of Franciscana's home range was recently impacted by the collapse of a dam that released millions of iron mining waste into the Atlantic Ocean. Considering the restricted coastal habitat of the species, these impacts can be considered an immediate threat, increasing the probability of local extinction of the species. This research calls attention to the necessity for improvement in the regional Environmental Impact Assessments, Conservation Action Plans, and to the development of an effective zoning for ports and conservation areas in the region. These actions could increase conservation efforts and mitigate the current and expected impacts on the Franciscana population in the Espírito Santo State.

Keywords

conservation, contamination, environmental impact, Espírito Santo State, harbor, Pontoporia blainvillei, port

Brazil is a country with a long coastline, presenting not only a variety of diverse marine ecosystems and a diverse fauna but also intense human coastal settlement and industrial development (Cagnazzi, Parra, Westley, & Harrison, 2013; Diegues, 1999). Aiming to strength its economy, the Brazilian government has recently changed environmental licensing rules, favoring opportunistic development projects such as ports and mining, which bring high social and environmental pressure (Pinheiro et al., 2019). These large industrial projects exert strong pressure on marine ecosystems, leading to loss of biodiversity (International Panel on Climate Change, 2002). Among all the species affected directly and indirectly, coastal marine mammals are particularly vulnerable due their life history characteristics, which include low natural mortality rates, long lifespan, and low pregnancy rates (Cagnazzi et al., 2013; Perrin & Reilly, 1984).

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The Franciscana dolphin (*Pontoporia blainvillei*) is a small cetacean endemic to southwestern Atlantic coastal waters (Pinedo, Praderi, & Brownell, 1989). It is the most endangered cetacean in the South Atlantic, and its preference for coastal habitats contributes to the threatened status of the species (Pinedo et al., 1989; Rocha-Campos, Danilewicz, & Siciliano, 2010). The accidental capture in fishing nets has been considered the main threat to this small cetacean (Frizzera, Tosi, Pinheiro, & Marcondes, 2012; Netto & Siciliano, 2007; Prado, Secchi, & Kinas, 2013; Secchi, Danilewicz, & Ott, 2003). However, its occurrence overlaps in regions suppressed and threatened by industrial pollution and port development (Torre et al., 2012), a factor that impacts the conservation status of the species.

The distribution of the Franciscana dolphin extends from the Espírito Santo State (ES) (18°25′S), southeastern Brazil (Moreira & Siciliano, 1991), to the Golfo Nuevo (42°35′S), Argentina (Crespo, Harris, & González, 1998). Four Franciscana Management Areas (FMAs) are recognized (Secchi et al., 2003), and recently, Cunha et al. (2014) reassessed the FMAs structure and proposed the division of some areas. The existence of two gaps in Franciscana distribution was recently reinforced: one in the southern ES coast (between 21°18′S and 19°40′S) and another in the southern Rio de Janeiro coast (between 22°44′S and 22°59′S) (Amaral et al., 2018; Danilewicz et al., 2012). In this new approach, the ES coast is site for the occurrence of the main threatened stock (FMA Ia), isolated geographically and genetically (Amaral et al., 2018; Cunha et al., 2014). The Franciscana population in this area was estimated at 653 individuals (Danilewicz, 2018).

In the ES, basic information about the biology, ecology, and distribution of the species is still considered lacking (Frizzera & Siciliano, 2012; Rocha-Campos et al., 2010). At the same time, at least 14 new ports are proposed to be established in the ES (Figure 1), resulting in approximately a different harbor complex for every 20 km of coastline. Considering all established and planned port projects, 16 enterprises overlap the restricted area of occurrence for the Franciscana in this state (Figure 1). Moreover, most of Franciscana's habitat in the ES overlaps the region impacted by the collapse of the Fundão Dam in 2015 (Figure 1). The collapse, also known as the Mariana disaster, released millions of iron mining waste into the Atlantic Ocean (Escobar, 2015; Fernandes et al., 2016).

Environmental Impact Assessments and mitigation plans are part of the national environmental policy of Brazil. Enterprises with significant environmental impact, such as ports, harbors, and mining, are required by regional environmental agencies to conduct studies and elaborate reports to evaluate all possible impacts on the local biodiversity (Leuzinger & Varela, 2014; Santiago, Rezende, Borges, Borges, & Santos, 2015). However, the environmental licensing process in Brazil suffers strong biases, due political and economic influence on the decision-making. In addition, technical assessments are often made on preliminary studies that do not present the real impacts on fauna, flora, soil, air, and water (Oliveira & Cremer, 2018; Santiago et al., 2015). For instance, small cetaceans are rarely considered in environmental impact studies along the Brazilian coast (Domit, Rosa, Sasaki, & Londono, 2009; Silva, 2007). The lack of information exempts the companies from taking concrete steps to mitigate impacts and protects endangered species and their habitats.

Activities related to the establishment and operation of mining and ports pose many threats to the marine biodiversity (Domit et al., 2009; Lamour, Cattani, & Santos Filho, 2009; Valle, Gedanken, & Fischer, 2009), including the Franciscana dolphin (Torre et al., 2012). These industrial endeavors have a high risk of environmental contamination associated with their activities. The Mariana disaster, for instance, resulted in the spillage of 55 to 62 millions of tons of Fe-enriched tailings into the Doce River estuary (Queiroz et al., 2018), and heavy metal rates in shrimp and fishes exceed up to 100-fold the levels tolerated by Brazilian regulations (Bianchini, 2016). As a high-level predator, the Franciscana dolphin is specially affected by the cumulative effects of chemicals in the food web (Torre et al., 2012; Westgate, Muir, Gaskin, & Kingsley, 1997). The long-term exposure to these contaminants may pose a threat to the health and reproductive potential of marine mammals (Bowles, 1999; Kuriyama, Talsness, Grote, & Chahoud, 2005; Marsili et al., 2008). Recent studies have shown high concentrations of bioaccumulative contaminants in Franciscana dolphins along the Brazilian coast (Alonso, 2008; Lailson-Brito et al., 2011; Torre et al., 2012). According to Alonso et al. (2012) and Torre et al. (2012), the accumulation of chemicals in Franciscana dolphins may be related with the increase of industrial development in Brazil.

Moreover, the millions of tons of mud and sediment discharged by the Mariana disaster into the Doce River watershed and the Atlantic Ocean has increased their water turbidity (Hatje et al., 2017). In addition to the disaster, port activities also increase water turbidity and contamination, with sediment suspension caused by regular dredging activities (Kitzmann & Asmus, 2006). This decrease in water quality has the potential to affect the respiration of benthic filtering organisms and fishes (Jefferson, Hung, & Wursig, 2009; Lamour et al., 2009). The increase in sedimentation buries and destroys coastal environments, which changes natural communities and reduces prey availability for Franciscanas and other predators (Jefferson et al., 2009; Valle et al., 2009).

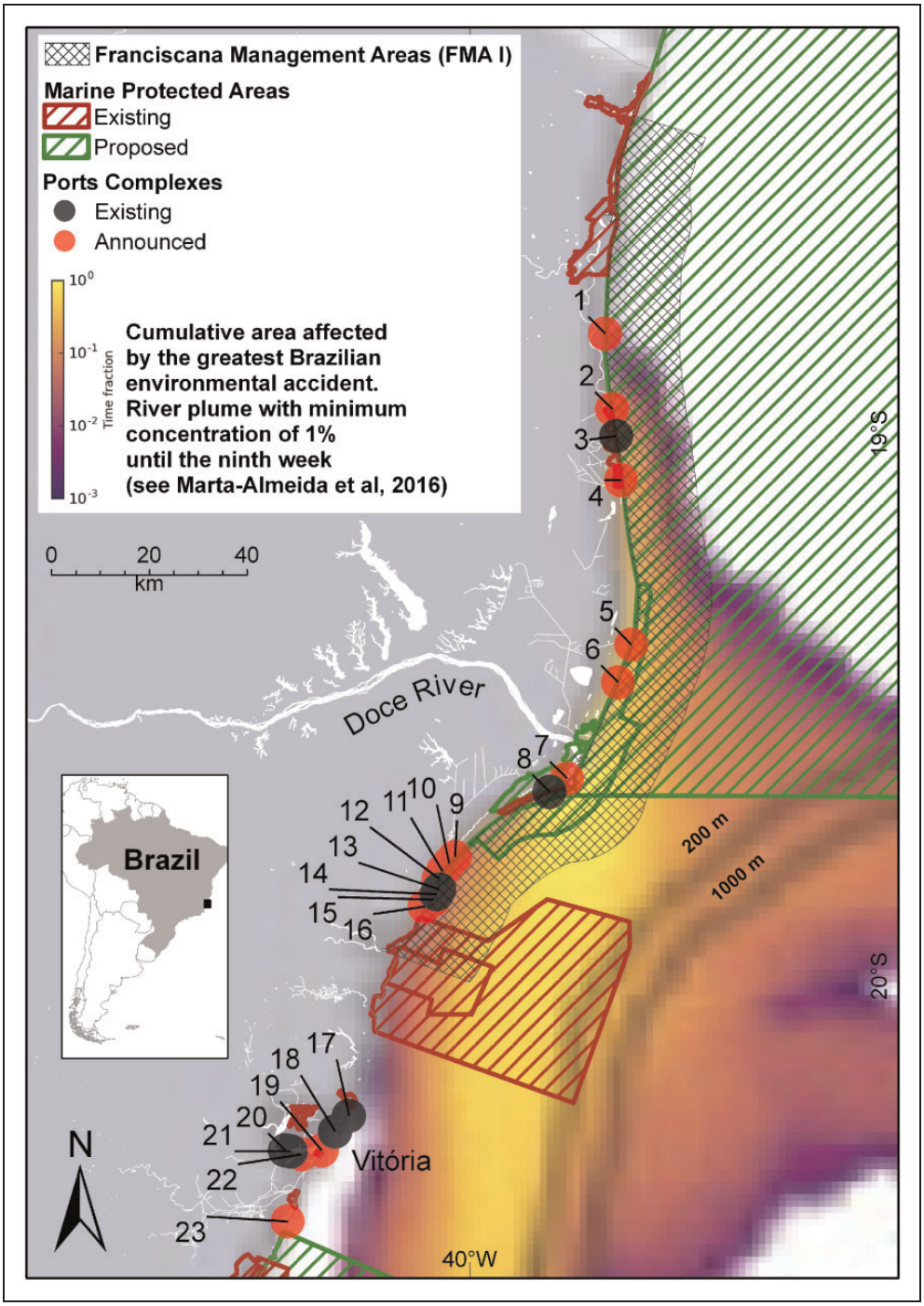

Figure 1. Overlapping of the Franciscana Management Area (FMA I), ports and harbors (existent and announced), oceanic dispersion of River Doce after the greatest Brazilian environmental accident (Mariana disaster), and Marine Protected Areas in the Espírito Santo State. The ports (existent and announced) presented in the map are as follows: 1 = Odebrech; 2 = Superporto Leste; 3 = TNC; 4 = Severin; 5 = MLog; 6 = Manabi; 7 = Porto de Linhares; 8 = TEREG; 9 = Odfjell; 10 = Nutripetro; 11 = Imetame; 12 = BABR; 13 = Portocel; 14 = Jurong; 15 = Terminal GNL; 16 = TABR; 17 = Superporto de Praia Mole; 18 = Porto de Tubarão (Vale); 19 = Nisibra; 20 = Porto de Vitória; 21 = Porto Capuaba; 22 = Porto Marlin; 23 = Superporto de Interlagos.

The maritime traffic is intense around ports and can negatively impact cetaceans due potential collisions (Van Waerebeek et al., 2007) and emission of noise (Bejder & Samuels, 2003; Nowacek, 2007). The port of Barra do Riacho, situated in the southern area of the FMA Ia, by itself, recorded in 2013 a total of 272 vessels loading cellulose and steel products and 517 vessels unloading wood in logs and cellulose (LabTrans, 2015). Some

studies have shown changes in the behavior and physiology of cetaceans as a result of acoustic disturbances (Argüelles et al., 2016; Bejder et al., 2006; Lemon, Lynch, Cato, & Harcourt, 2006). These activities can interfere with the communication of these animals causing changes in vocal behavior (Buckstaff, 2004; Scarpaci, Bigger, CORkERON, & Nugegoda, 2000). The impact of maritime traffic is expected to increase significantly with the establishment of more ports in the FMA Ia (Campana et al., 2015).

The increase in industrial and human activity on the northern coast of the ES can lead increased environmental contamination and reduced habitat quality. In the Tejo estuary, in Portugal, changes in habitat quality caused by port activities and industrial pollution resulted in the abandonment of the area by a population of Bottlenose dolphin *Tursiops truncatus* (Santos & Lacerda, 1987). In the Babitonga bay, Brazil, Cremer, Hardt, Júnior, Simões-Lopes, and Pires (2004) have shown that Guiana dolphin *Sotalia guianensis* have abandoned its core area after the establishment of port infrastructure. Therefore, the proposed industrial development along the ES shore can potentially reduce the ecosystem health of coastal environments considered keystone systems for the conservation of coastal marine mammals (Cremer et al., 2017). In addition to the geographic and genetic isolation of the Franciscana population in the ES (Cunha et al., 2014), the FMA Ia has the smallest Franciscanas' dolphin population (Danilewicz, 2018). This scenario, coupled with the low intrinsic rate of natural population growth (Siciliano et al., 2002; Secchi et al., 2003; Secchi, 2004), and the negative effects caused by pollution and fishing (Alonso et al., 2012; Cremer & Simões-Lopes, 2008; Frizzera et al., 2012; Prado et al., 2013; Secchi, Ott, & Danilewicz, 2006; Torre et al., 2012), is worrisome. The existent and expected impacts in the ES can be considered an immediate threat, increasing the probability of local extinction of the species.

Some premises are essential to evaluate and mitigate the real effects of ports and industrial impacts on the Franciscana population in the ES. In the short term, the monitoring of abundance and stranding is an important strategy for increasing knowledge about the species in this region. Moreover, the management of the established Marine Protected Areas as well as the creation of the proposed ones (such as the one in the region of the Doce River estuary, where Franciscanas are often recorded; Figure 1) are important tools for the maintenance of the species in the FMA Ia. Further studies on the distribution and habitat use of Franciscana dolphins in the FMA Ia could contribute to identifying priority areas for conservation and for the establishment of ports, trying to mediate economic development and environmental conservation.

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