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A stepwise approach for science-based conservation of Lahille's bottlenose dolphins (*Tursiops gephyreus*) with emphasis on the Patos Lagoon population

Ein schrittweiser, wissenschaftlich fundierter Ansatz zum Schutz des Lahille Großen Tümmlers (*Tursiops gephyreus*) mit besonderem Fokus auf die Population in der Lagune Dos Patos (Brasilien)

Eduardo R. Secchi[1,2], Pedro F. Fruet[1,2,3], Rodrigo C. Genoves[1,2,3], & Lorenzo von Fersen[4]

[1]Laboratório de Ecologia e Conservação da Megafauna Marinha (ECOMEGA), Instituto de Oceanografia, Universidade Federal do Rio Grande - FURG, Avenida Itália km 8, Rio Grande, RS, Brazil.
[2]Museu Oceanográfico "Prof. Eliézer C. Rios", FURG, Brazil.
[3]Kaosa, Rio Grande, RS, Brazil.
[4]Nuremberg Zoo & YAQU PACHA, Am Tiergarten 30, D-90480 Nuernberg, Germany.

Abstract

Here we describe nearly 20 years of research conducted in collaboration with several institutions from Brazil, Uruguay and Argentina that resulted in the formal status assessment of the Lahille's bottlenose dolphin (*Tursiops gephyreus*) and actions for its conservation, with emphasis on the systematic research and conservation process for the Patos Lagoon Estuary (PLE) population. This conservation process can be viewed as a puzzle, for which several pieces of key information were combined, and thus a proper assessment of the conservation status could be made. First, we identified intraspecific structure that can be treated as independent management units (hereafter referred as populations), then population-specific life history parameters, abundance and non-natural removal (in this case bycatch) rates were estimated for the PLE population. Then, these data fed Population Viability Analysis (PVA) models that were developed to

*Corresp. author:
E-Mail: edu.secchi@furg.br (Eduardo R. Secchi)

assess the status of the PLE population and the effects of several scenarios of removal rates. Entanglement in gillnets is possibly the greatest threat to the viability of this population. Although the PLE population seems stable throughout the study period, PVA models suggest that even a low removal rate of adult females may cause a marked population decline in three generations (ca. 60 years). Parameter uncertainty does not change the conclusion that no-fishing zones are needed to reduce the risk of PLE population decline. Scientific-based advice was considered and a no-fishing zone that covers the PLE core area was established. Full compliance of the regulation is expected to increase survival rates and long-term viability of the PLE. Nevertheless, Lahille's bottlenose dolphin is suspected to present a low abundance and some of its population units remain poorly known and not sufficiently protected. We identified main research gaps and provided future directions for the conservation of this species throughout its distribution range.

Keywords: Cetacean, Western South Atlantic, management

Background

Bottlenose dolphins (*Tursiops* spp.) have a widespread distribution throughout the globe and occupy a variety of marine and estuarine habitats from tropical to temperate waters (Wells & Scott, 2009). The genus is globally abundant and is often found in small populations throughout its range, manly in coastal regions associated with rivers, estuaries, bays and fjords (e.g., Sarasota Bay, Florida (Wells et al., 1987); Moray Firth, Scotland (Wilson, 1995); Kvarneri, Croatia (Bearzi et al., 1997); Doubtful Sound, New Zealand (Haase & Schneider, 2001); Patos Lagoon estuary, RS, Brazil (Castello & Pinedo, 1977)), but also in oceanic waters associated with islands or other oceanographic features (e.g., Saint Peter and Saint Paul Archipelago, Brazil (Caon & Ott, 2004); Azores, Portugal (Quérouil et al., 2007); Bermuda, North America (Klatsky et al., 2007); continental shelf-break and slope (Di Tullio et al., 2016)).

While there is presently no evidence to suggest that bottlenose dolphins are threatened globally, many coastal regional populations are at risk of extinction due to human impacts that include bycatch, hunting, pollution, and prey depletion (Gowans et al., 2007; Reeves, 2003; Vermeulen et al., 2019). The viability of these populations depends, in part, on appropriate management based on robust scientific information of their life history, abundance and impact factors. In the western South Atlantic Ocean (wSAO), the genus *Tursiops* is also widely distributed, occurring from the Amazon River mouth, Brazil, to Tierra del Fuego, Argentina, and Malvinas/Falkland Islands (Bastida et al., 2018). However, the occurrence of coastal populations is restricted to a small geographical range between southern Brazil and central Argentina. These coastal populations are small and locally adapted to specific habitats such as estuaries, rivers and bays (Fig. 1; e.g., Baia Norte, SC (Flores & Fontoura, 2006); Imaruí, Mirim and Santo Antônio Lagoon complex, SC (Simões-Lopes & Fabian, 1999); Mampituba river mouth (Laporta et al., 2016); Tramandaí river mouth (Hoffmann, 2004); Patos Lagoon estuary (e.g., Castello & Pinedo, 1977); La Coronilla, Uruguay (Laporta & Dimitriadis, 2004); Bahía San Antonio, Rio Negro Province (Vermeulen & Cammareri, 2009); and Peninsula Valdes, Chubut Province, Argentina (Würsig & Würsig, 1979), though, this later population seems to have disapeared or moved from the Peninsula during the last few decades (e.g., Vermeulen et al., 2017)). These coastal dolphins represent a different lineage of the genus *Tursiops,* and a species level recognition was recently claimed (Lahille's bottlenose dolphin, *Tursiops gephyreus* – Wickert et al., 2016; Hohl et al., 2020), although Marine Mammalogy's Committee on Taxonomy argues that the lineages should be recognized at a subspecies level (Costa et al., 2016, 2019; Marine Mammalogy's Committee on Taxonomy, 2018). Their distribution overlaps with a series of human activities harmful to

Fig. 1: Lahille's bottlenose dolphin (*Tursiops gephyreus*) coastal distribution in the western South Atlantic Ocean, comprising the states of southern Brazil, Santa Catarina (SC) and Rio Grande do Sul (RS), Uruguay (UY) and Bahía San Antonio in Argentina (AR). The Patos Lagoon estuary (PLE) is highlighted in yellow, the site of the largest known resident population of the species.

dolphins and other cetaceans, making them highly vulnerable to human impacts. Due to their vulnerability, the low number of individuals representing the entire lineage and declining sightings in some localities, the Lahille's bottlenose dolphin was recently listed as Vulnerable under criterion D1of the IUCN (Vermeulen et al., 2019).

Until recently, little attention has been given to relevant conservation issues of Lahille's bottlenose dolphins in the Southwest Atlantic Ocean (wSAO), despite their great vulnerability to a series of human activities in coastal areas and the poor health status reported for some local populations due to intense skin diseases and high levels of PCBs and DDTs (e.g., Fruet et al., 2016; Righetti et al., 2019; Van Bressem et al., 2015). Bycatch in gillnets, however, is recognized as the main threat to these coastal dolphins and is known to occur throughout their range (Fruet et al., 2012; Fruet et al., 2021). Relatively high bycatch rates have been documented in the Patos Lagoon Estuary and adjacent marine coast (PLE) in southern Brazil, which is home to the largest population of Lahille's bottlenose dolphins. Although incidental captures of dolphins in gillnets seem to occur only sporadically and were not considered a cause for concern in the past (e.g., Pinedo, 1986), the increased number of observed individuals with evidence of interaction with fisheries (nets attached to the body and rostrum, mutilated appendages) and the significant increase in reported mortality on adjacent coastal beaches since the early 2000s have raised concerns about the viability of this population (Fruet et al., 2012, Prado et al., 2016). To reduce this negative interaction, a resolution was implemented in 2012 through the Ministry of Fisheries and Aquaculture and the Ministry of Environment to regulate gillnet fishing in southern Brazil and establish a fishing exclusion zone in the final portion of the PLE and adjacent shallow coastal waters (Fig. 2) based on a spatial overlap analysis study of the area preferred by dolphins and gillnet fishing (Di Tullio et al., 2015).

Despite increasing evidence that some of the populations could be at risk and that a management plan was necessary to mitigate the sources of impact, the development and implementation of such a plan were hampered by the lack of basic scientific information for a proper assessment of the population's conservation status. Furthermore, although some studies were being conducted with Lahille's bottlenose dolphins throughout the wSAO, they were conducted without institutional cooperation and common goals aimed at species conservation. Information was largely published in grey literature or was not published at all, making assessment of the current conservation status of the species difficult. In the late 2000s, following a successful approach used to increase knowledge on Franciscana dolphins (e.g., Secchi, 2002), South American researchers organized the First Workshop on the Research and Conservation of Tursiops truncatus: Integrating knowledge about species in the Southwest Atlantic Ocean (wSAO), held in Rio Grande, Rio Grande do Sul state (RS), Brazil, in May 2010. Relevant topics such as taxonomy, ecology, and threats were discussed, information was updated, and future action and research recommendations were provided. After this first workshop, the number of publications in peer-reviewed scientific journals and the knowledge on the species' taxonomy, ecology and conservation status increased significantly. A second workshop was held in 2017 to evaluate progress regarding the recommendations made during the first workshop and to further discuss the taxonomy of bottlenose dolphins in the wSAO. Results and recommendations were presented to the Scientific Committee of the International Whaling Commission in 2018 and a series of research and policy recommendations were set and reiterated by the Committee to National Delegates in subsequent years (IWC, 2019, 2021, 2022). An assessment was conducted by the International Union for Conservation of Nature (IUCN) for the first time for Lahille's bottlenose dolphins in 2019, listing it as VULNERABLE under criterion D1 (Vermeulen et al., 2019). A Task Team was formed in 2020 under the auspices of IWC to deal with Lahille's bottlenose dolphin research and conservation in the wSAO (IWC, 2021).

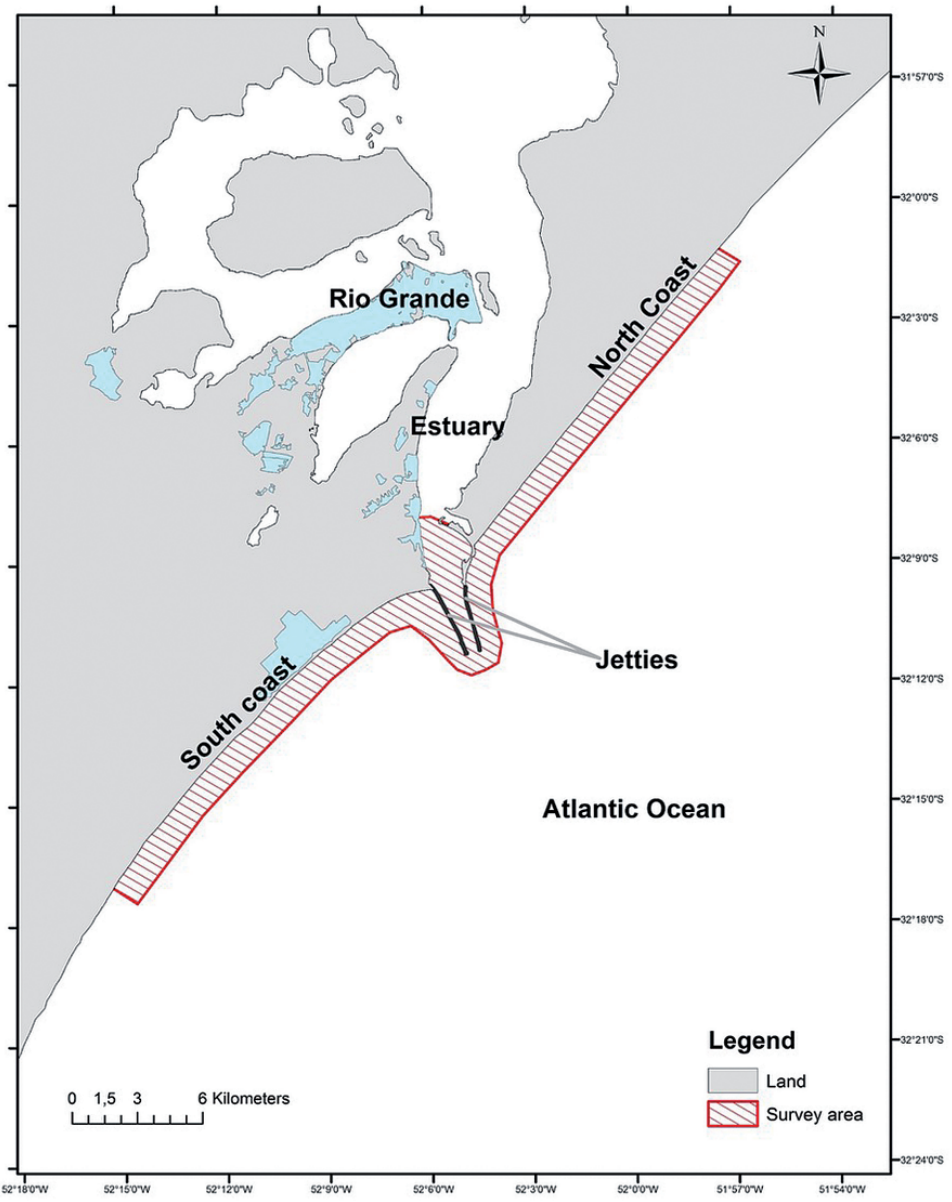

Fig. 3: The fishing exclusion area (red crosshatched) was established in 2012 in the final portion of the Patos Lagoon estuary and its adjacent shallow coastal waters, in Southern Brazil.

In this publication, we present an overview of nearly 20 years of research conducted in collaboration with multiple institutions from Brazil, Uruguay and Argentina. Our research follows a stepwise approach to conduct a formal status assessment of Lahille's bottlenose dolphins (*Tursiops gephyreus*) and provides recommendations for conservation actions. Special emphasis is placed on the systematic research and conservation process for the Patos Lagoon Estuary population (PLE).

Fig. 3: Lahille's bottlenose dolphins, *Tursiops gephyreus*, socializing, feeding and travelling in the Patos Lagoon estuary and its adjacent coastal waters, in Southern Brazil. Photos: Projeto Botos da Lagoa dos Patos

Stepwise approach

The conservation process described in this study can be likened to a puzzle, where various pieces of essential information need to be assembled to conduct a thorough assessment of the population's conservation status. The first step involved identifying distinct intraspecific structures, which were considered independent management units, or populations. Subsequently, population-specific life history traits, including age at first reproduction, fecundity, survival rates and other demographic parameters such as abundance and non-natural removal (specifically, bycatch) rates were estimated for the Patos Lagoon Estuary (PLE) population. These data were then utilized as input parameters in Population Viability Analysis (PVA) models, which were developed to evaluate the status of the PLE population and assess the potential impacts of different removal rate scenarios. The approaches employed to accomplish each of these steps are described further below.

Identification of intraspecific units to conserve

Variations in gene flow can result in the formation of distinct intraspecific units. In the context of conservation, two main types of units are recognized: Evolutionarily Significant Units (ESUs) and Management Units (MUs) (Moritz, 1994). ESUs are concerned with historical population structure, mitochondrial DNA phylogeny and long-term conservation needs. MUs, on the other hand, address current population structure, allele frequencies and short-term management goals. In the Southwest Atlantic Ocean (wSAO), the taxonomy of *Tursiops* dolphins has been a subject of ongoing debate and revision over the past few decades (Costa et al., 2016; Wickert et al., 2016). There is evidence of ecological divergence between an offshore (*T. truncatus*) and a coastal ecotype of common bottlenose dolphins (Committee on Taxonomy, 2019; Costa et al., 2019). Some argue that these two ecotypes exhibit morphological and genetic

characteristics indicative of species-level differences (Hohl et al., 2020; Wickert et al., 2016). Offshore dolphins predominantly inhabit waters beyond the continental shelf break (> 150 m depth), while coastal dolphins are restricted to shallow coastal regions from southeastern Brazil (27°S) to central Argentina (43°S), generally staying within 3 km of the coast in waters less than 20 m deep (Simões-Lopes & Fabian, 1999; Di Tullio et al., 2015; Laporta et al., 2016).

Significant genetic differences have been observed between these ecotypes, with lower diversity observed in coastal dolphins compared to offshore dolphins (Castilho et al., 2015; Costa et al., 2015, 2019; Fruet et al., 2014, 2017; Oliveira et al., 2019). Within each ecotype, genetic differences can also arise due to variations in habitat use and social organization, leading to some degree of reproductive segregation (Fruet et al., 2014; Genoves et al., 2020). Fruet et al. (2014) conducted a study combining analyses of microsatellite loci and mitochondrial DNA control region sequences to investigate the genetic diversity, structure and connectivity of Lahille's bottlenose dolphins in southern Brazil, Uruguay and central Argentina. They found strong and significant genetic differentiation between individuals sampled in southern Brazil – Uruguay and those in Argentinian Patagonia, with limited contemporary gene flow. On a finer scale, moderate differentiation and asymmetric gene flow were detected between five neighboring putative populations in southern Brazil and Uruguay (Fruet et al., 2014). The authors proposed that bottlenose dolphins from Argentina and southern Brazil–Uruguay represent two ESUs, while the latter encompasses five MUs: *i.* Florianópolis (FLN), *ii.* Laguna (LGN), *iii.* Northern Patos Lagoon (NPL), *iv.* Patos Lagoon Estuary (PLE) and *v.* Southern Patos Lagoon/Uruguay (SPL/URU). Further genetic analyses and social network studies of photo-identified individuals inhabiting the PLE and adjacent marine coast confirmed this finer scale structuring, revealing the existence of three distinct social units: estuarine residents, southern coastal residents and northern coastal residents, which displayed low but significant genetic differentiation (Genoves et al., 2018, 2020). Although the objective of this study is to describe the conservation process for Lahille's bottlenose dolphins, particular emphasis will be placed on the PLE social unit (referred to as populations), as it is one of the most extensively studied populations of this species.

Population-specific parameter estimation

Once intraspecific structuring and the presence of independent management units (populations) are identified, the next step is to estimate population-specific abundance, life history parameters and non-natural removal rates (such as bycatch) to assess the conservation status of the population.

Abundance: Studies using mark-recapture methods and photo-identification of individually recognized dolphins in the PLE and its adjacent coastal waters have indicated a relatively large number of Lahille's bottlenose dolphins, with 203 individuals catalogued between 2005 and 2015 (Fruet et al., 2011; Fruet et al., 2015a). However, the PLE population itself is small, with slightly more than 85 individuals. While the population has remained relatively stable, some individuals from this population and the adjacent coastal populations have experienced unnatural mortality due to entanglement in fishing nets over the years (Fruet et al., 2012; Prado et al., 2016; Fruet et al., 2019).

Survival rates: Survival rates for different life stages of the PLE population were obtained through mark-recapture models applied to eight years of photo-identification data from 2005 to 2012 (Fruet et al., 2015a). Using Pollock's robust design model (Pollock, 1982), the authors estimated that the annual apparent survival for adult females was 0.97 (95% CI: 0.91–0.99), which was higher than for adult males (0.88, 95% CI: 0.75–0.94) and juveniles (0.83, 95% CI: 0.64–0.93). This difference in survival rates likely contributes to the observed bias in the sex ratio of known adult dolphins, with approximately one male for every two females. The lower

survival rates of adult males and juveniles compared to adult females suggest that these age-sex classes are more vulnerable to human-induced mortality, particularly in fisheries. This pattern mirrors the higher mortality rates of juvenile males in the area compared to females.

Reproduction and reproductive rates: Reproduction in the Lahille's bottlenose dolphin population is highly seasonal, occurring in spring and summer. Females in the PLE population first reproduce between the ages of 7 and 10, giving birth to calves that are approximately 1 m long at intervals averaging 3.3 yrs (mode = 2 yrs) (Fruet et al., 2015b). The number of female calves born per known mature female was used to estimate a fecundity rate of 0.09. However, since the data on calf presence with their mothers are derived from photo-identified individuals, there is a possibility of undetected births before calf mortality, leading to a downward bias in the estimation. As an alternative approach, fecundity was derived as the reciprocal of the average calving interval (1/3.3 = 0.30). Assuming an even sex ratio at birth, this value is further divided by 2, resulting in a fecundity estimate of 0.15. Limited data from three females with known ages tracked until death suggest evidence of reproductive senescence in this population. These females, aged 40, 44 and at least 40, apparently ceased reproduction 6-8 years before their deaths (Fruet et al., 2015b). They were often observed with other mother-calf pairs, indicating a potential shift in their role from "breeding" to "nursing" individuals at older ages (Wells, 2000), which might be a strategy to increase calf survival and offset the effects of senescence, thus contributing to the long-term viability of the species.

Assessment of conservation status

While recognizing that multiple stressors, such as pollutants and pathogens, can impact Lahille's bottlenose dolphins, the specific population parameters estimated for the PLE were used to conduct a Population Viability Analysis (PVA) to predict population trajectories under the effects of bycatch removal, considering stochasticity and uncertainty in parameter estimates. Among the various stressors, entanglement in gillnets appears to be the greatest threat to the viability of the PLE population. However, the PVA model results suggest that current bycatch rates have a low effect on the population's viability. The model predicts that in the absence of bycatch, the PLE population would grow at a rate of approximately 3% per year over the next three generations (around 60 years) (Fruet et al., 2021). This optimistic projection is mainly due to the high survival of adult females, as juvenile males are the most affected by bycatch. Nevertheless, the PVA models indicate that even the removal of very few mature females (one every year or two) would significantly increase the likelihood of population decline from its current abundance within three generations. To improve the population's viability, it is crucial to focus on increasing the survival of juveniles and sub-adults, as they are the age group most affected by incidental kills in artisanal gillnet fisheries. It is important to note that while the PVA models provide insights into the potential impacts of bycatch on the population, the interaction and synergistic effects of other stressors, such as pollutants and pathogens, have received limited attention and require further investigation to fully understand their effects on Lahille's bottlenose dolphin populations.

Conservation strategies and other future direction

To effectively conserve Lahille's bottlenose dolphins in the PLE, a comprehensive conservation plan is needed. This plan should address and monitor various factors including chemical, physical and acoustic pollution, maritime traffic, fishing activities, as well as the dolphins' ecology and dynamics. The influence of environmental, spatial and temporal variables on dolphin distribution and artisanal fishing patterns should be considered.

Research has shown that dolphin distribution in the PLE is likely influenced by the presence of preferred prey or the avoidance of human-related disturbances (Di Tullio et al., 2015). These patterns often coincide with fishing areas. Seasonal variation in fishing effort and distribution influences the risk of dolphin entanglement, which increases during the warm months (November–April). Based on these findings, a fishing exclusion zone was proposed in the lower estuary and along the adjacent marine coast to mitigate entanglement risks. Implementation of such a no-fishing zone, which covers the core area of the PLE, has been established by the Brazilian Environmental Agency, and full compliance is expected to increase survival rates and the long-term viability of the population. Setting conservation goals is crucial for the recovery of the PLE population. If the fishing exclusion zone effectively reduces entanglement rates, there is a substantial chance for the population to increase above 20% of its current size, which has been proposed as a conservation goal. Achieving this goal has the potential to improve habitat quality, increase genetic diversity, enhance connectivity with adjacent populations and improve the population's resilience to environmental changes and potential disease outbreaks.

While progress has been made in regulating gillnet fishing in the PLE, other fishing gear, such as beach seining and beach stake netting, have been used without proper regulation. Incidents of Lahille's bottlenose dolphin mortality and entanglement have been reported in these unregulated fishing activities (Fruet et al., 2019). Enforcement of the fishing exclusion zone and a ban on unregulated fishing gear are necessary to prevent further harm to the population (e.g., Fruet et al., 2021). Additionally, in 2022, a significant strategy for the conservation of Lahille's bottlenose dolphins in the PLE involved declaring them as Natural Heritage by Rio Grande City. This symbolic gesture plays an important role in raising awareness among the local community and fostering a sense of ownership and responsibility. It serves as a foundation for the development of public policies and effective inspection measures.

Overall, a comprehensive conservation plan should incorporate strict enforcement of fishing regulations, monitoring of various threats, public awareness campaigns and the involvement of local communities to ensure the long-term viability and conservation of Lahille's bottlenose dolphins in the PLE.

Integrated conservation approach for the Lahille's Bottlenose dolphin

Given their poor conservation status and the fact that existing threats cannot be immediately addressed, the Lahille's bottlenose dolphin has been selected by the IUCN Species Survival Commission as a priority species for its new Integrated Conservation Planning for Cetaceans initiative. This initiative is actively promoted by IUCN, which recently adopted Motion 079 which "1. URGES the Secretariat and professional societies to promote integration of *in situ* and *ex situ* conservation interventions by applying the One Plan approach, to ensure effective use of all available conservation tools." And "3. ALSO CALLS ON all Members to ensure that 11th hour, last ditch *ex situ* conservation efforts are prevented by proactive and timely application of planning methods, such as the One Plan Approach, and informed by the Guidelines on the Use of *Ex situ* Management for Species Conservation."

The One Plan approach (OPA) to species conservation is the elaboration of management and conservation strategies by all responsible parties and all available resources for all populations of a species, whether inside (*in situ*) or outside (*ex situ*) their natural range. OPA can be seen as a proper response to the conservation challenges of our current times. The experience has shown that it is no longer sufficient to combat the primary threats to save species from extinction. Often species/populations will go extinct before these threats have been eliminated. Therefore, it is inevitable to consider other tools when it comes to species conservation and OPA is certainly the most effective and has been applied successfully in the conservation of many species. It is important to note that

OPA ensures that all *in situ* protection measures are implemented. It also ensures and evaluates the potential benefits, costs, risks and implementation feasibility of all available *ex situ* measures to see how they contribute to the conservation of the species/population (Traylor-Holzer et al., 2018).

In the case of *Tursiops gephyreus*, several basic requirements for protecting this species within the framework of integrated conservation are met. The first and most important component is *in situ* conservation research. There is a considerable number of studies and publications on the species throughout its distribution range, some of which are reviewed in this article, demonstrating that science-based data are available to provide an accurate understanding of the species' threat status (e.g., Fruet et al., 2021). On the other hand, there are various *ex situ* measures that could be considered. Bottlenose dolphins are particularly suitable for integrated species conservation due to the extensive experience gained from managing this species intensively (von Fersen & Miller, in this issue). Captive breeding plays a significant role in this regard. The EAZA Ex-Situ Program (EEP) for the Bottlenose Dolphin (*Tursiops truncatus*), as one example of a coordinated breeding program, has demonstrated successful reproduction of this species in zoo habitats. As of 2021, the EEP comprises 228 individuals housed in 23 different institutions, with approximately 98% of the pedigree known and third-generation animals already born. With a genetic variability of 98.9%, the population is in good health, and it can be assumed that it has achieved self-sustainability. Comparable breeding successes have also been observed with *T. gephyreus*, although these are limited to one institution, the *ex-situ* population at Mundo Marino Zoo in Argentina. A recent publication (Loureiro, 2021) shows that out of 12 calves born in the park, 11 have survived into adulthood, and many are still alive today. This survival rate exceeds that of the wild population. Furthermore, this small population has provided valuable data on the reproductive biology of the species and has laid the foundation for artificial insemination. The breeding success in intensively managed populations of both species underscores the important role of *ex situ* populations as insurance populations and highlights their contribution to research. Much of our knowledge about the sensory, behavioral and veterinary aspects of this species comes from research conducted with animals in human care. The findings from these studies can greatly benefit animals in the wild. Zoos and aquariums that house these animals and run educational programs to raise awareness about species conservation also fulfill an important *ex situ* role. Additionally, these programs in zoos provide excellent opportunities to raise funds for *in situ* species conservation.

Other relevant initiatives may include gene/cell preservation to conserve genetic variation for potential *in vitro* reproduction, followed by reintroduction into the wild in areas with very low abundance or depleted genetic variability. In such cases, it is recommended to obtain ultra-high-quality DNA and RNA for DNA sequencing, genome mapping, assembly and gene annotation.

Estimating range-wide abundance and reproductive rates are among the highest *in situ* research priorities for this subspecies. Assessing the synergistic effects of multiple stressors on vital rate parameters and population viability is strongly recommended. To achieve these goals, the following objectives should be prioritized, especially for populations in proximity to extensive human activities or showing indications of significant inbreeding (e.g., PLE and Laguna populations, respectively):

Identifying the profile of stress-related and reproductive hormones in the dolphins' blubber.

Investigating levels of DNA damage, immune imparity and endocrine disruption through biomarker analysis.

Characterizing the variability of bacterial and fungal composition in the environment, which can aid in assessing the health of bottlenose dolphins.

Identifying and isolating potential bacterial and fungal pathogens specific to Lahille's bottlenose dolphins from water samples and dolphins' skin lesions and determining their antimicrobial susceptibility profile.

Considering a detailed health assessment in specific populations, the capture of a few individuals from the wild should also be considered. The population inhabiting the northern coastal areas of the Buenos Aires Province, Argentina, is suspected to be shrinking and disappearing from some sites (Vermeulen et al., 2017). Therefore, systematic aerial or boat-based surveys are strongly recommended to be conducted in this area throughout all seasons.

Conclusion

The conservation of Lahille's bottlenose dolphin is of paramount importance due to its low abundance and the presence of human-related threats. The article emphasizes the need to address research gaps and outlines future directions for conservation efforts throughout the species' distribution range. With only approximately 600 individuals remaining, the species is highly vulnerable, and habitat degradation poses a significant risk to its survival. To mitigate these threats and ensure the species' persistence, it is crucial to employ comprehensive conservation strategies. The One Plan Approach framework is highlighted as a promising concept for the conservation of Lahille's bottlenose dolphin. The One Plan Approach emphasizes the integration of *in situ* conservation measures (protecting the species within its natural habitat) and *ex situ* measures (conservation actions outside the natural habitat, such as captive breeding programs or reintroduction efforts). By combining these approaches, the conservation of Lahille's bottlenose dolphin can be strengthened and enhanced. Two articles in this Special Issue authored by von Fersen and Miller, and Taylor et al., discuss the One Plan Approach in more detail. These articles likely provide insights into the practical implementation and effectiveness of this approach for the conservation of Lahille's bottlenose dolphin.

In summary, given the critical status of Lahille's bottlenose dolphin, a comprehensive approach that integrates *in situ* and *ex situ* conservation measures, such as the One Plan Approach, is essential for its survival. Ongoing research and collaborative efforts are crucial to fill knowledge gaps, address human-related threats and ensure the long-term persistence of this species throughout its distribution range.

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Zusammenfassung

In diesem Artikel wird fast 20 Jahre Forschung beschrieben, die in Zusammenarbeit mit mehreren Institutionen aus Brasilien, Uruguay und Argentinien durchgeführt wurde. Die Ergebnisse führen zu einer detaillierten Bewertung des Status des Lahille Großen Tümmlers (*Tursiops gephyreus*) und zu Maßnahmen zu seiner Erhaltung, wobei der Schwerpunkt auf dem systematischen Forschungs- und Erhaltungsprozess für die Population in der Lagune dos Patos (PLE) liegt. Dieser Artenschutzprozess kann als ein Puzzle betrachtet werden, für das mehrere wichtige Informationen zusammengefügt wurden, um eine angemessene Bewertung des Erhaltungszustands vornehmen zu können. Zunächst wurden intraspezifische Strukturen ermittelt, die als unabhängige Management-Areale betrachtet werden können (im Folgenden als Populationen bezeichnet). Für die PLE wurden dann populationsspezifische Parameter zur Lebensgeschichte, zur Abundanz und zu nicht natürlichen Entnahmeraten (in diesem Fall Beifang) geschätzt. Diese Daten wurden dann in Modelle zur Analyse der Lebensfähigkeit der Populationen (PVA) eingespeist, die entwickelt wurden, um den Status der PLE und die Auswirkungen verschiedener Szenarien für Entnahmeraten zu bewerten. Das Verfangen in Kiemennetzen scheint die größte Bedrohung für dieser Population zu sein. Obwohl die PLE während des gesamten Untersuchungszeitraums stabil zu sein scheint, deuten die PVA-Modelle darauf hin, dass selbst eine geringe Entnahmerate erwachsener Weibchen innerhalb von drei Generationen (etwa 60 Jahren) zu einem erheblichen Rückgang der Population führen kann. Die Unsicherheit der Parameter ändert nichts an der Schlussfolgerung, dass Fischereiverbotszonen erforderlich sind, um das Risiko eines Rückgangs der PLE zu verringern. Wissenschaftliche Gutachten wurden berücksichtigt und es wurde eine Fischereiverbotszone eingerichtet, die das PLE-Kerngebiet abdeckt. Es wird erwartet, dass die vollständige Einhaltung der Verordnung die Überlebensraten und die langfristige Lebensfähigkeit der PLE erhöhen wird. Dennoch wird davon ausgegangen, dass der Lahille Große Tümmler nur in geringem Populationszahlen vorkommt, und einige seiner Populationseinheiten sind nach wie vor kaum bekannt und nicht ausreichend geschützt. Wir haben wichtige Forschungslücken identifiziert und zukünftige Richtungen für die Erhaltung dieser Delfinart in ihrem gesamten Verbreitungsgebiet aufgezeigt.

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