
## Area Size

27,799 km²

## Qualifying Species and Criteria

Dugong – *Dugong dugon*

Criteria A, B1, B2, C1, C2, D1

Humpback whale – *Megaptera novaeangliae*

Criteria A, B2, C1, D1

Indo-Pacific bottlenose dolphin – *Tursiops aduncus*

Criteria B1, C1, D1

## Marine Mammal Diversity (D2)

*Stenella longirostris, Balaenoptera acutorostrata, Balaenoptera omurai, Dugong dugon, Megaptera novaeangliae, Tursiops aduncus*

## Summary

The lagoons and associated seagrass and mangrove ecosystems surrounding the main island of New Caledonia, Grande Terre, support six of the 30 species of marine mammals identified in New Caledonia. These lagoons support a globally significant dugong population, an important breeding area for humpback whales and small isolated populations of Indo-Pacific bottlenose dolphins of extremely low genetic diversity.

# New Caledonian Lagoons and Shelf Waters IMMA

## Description

The New Caledonian Lagoons and Shelf Waters IMMA encompasses all the lagoons bordering Grande Terre, the main island of New Caledonia out to 1 nm outside of the barrier reef, to a depth of 500 m. Grande Terre stretches for 400 km from the south-east to the north-west. The IMMA region is extended by the Isle of Pines in the south and the Belep islands in the north lagoon. A barrier reef of more than 1,600 km surrounds this complex. It delimits a lagoon space of more than 23,400 km² (Testau and Conand 1983). In the south of the mainland, the coastal waters of the southern lagoon encompass a great variety of coral reef structures (Andréfouët et al., 2008) that are relatively exposed to the open ocean, resulting in an area of mixing between the lagoon and the pelagic environments. Due to the diverse and rich marine ecosystems in this region, part of these lagoons have been listed on the UNESCO Worldwide Heritage List in 2008. (http://whc.unesco.org/en/list/1115/).

## Criterion A: Species or Population Vulnerability

A globally significant population of dugong is present in New Caledonia. The IUCN lists the species as Vulnerable at the global level, and it is believed to have declined throughout most of its range (Marsh et al., 2011). The group of humpback whales migrating to New Caledonia belongs to the Oceania subpopulation which is classified as endangered by IUCN (Childerhouse et al., 2009).

## Criterion B: Distribution and Abundance Sub-criterion B1: Small and Resident Populations

A single baseline aerial survey of dugongs in New Caledonia in 2003 estimated a population of 2026 (± SE = 553) individuals (Garrigue et al., 2008). A second similar survey in 2008 produced a lower estimate of 606 (± SE = 200) individuals, leading to concerns that

the dugong population was experiencing a decline (Garrigue et al., 2009). Four additional surveys were conducted in 2011 and 2012, generating abundance estimates that ranged from 649 (± SE = 195) to 1227 (± SE = 296) dugongs (Cleguer 2015; Cleguer et al., 2017). This data was recently re-analysed using improved methods, with depth and location specific correction factors to account for availability bias, leading to a new range of abundance estimates (426 ± 134 to 1,588 ± 407) (Hagihara et al., 2018).

The Southern Lagoon (located off the southern main island) is intensively used by a small number of humpback whales (Fig. 3) (Garrigue et al., 2004; Constantine et al., 2012; Madon et al., 2012; Orgeret et al., 2013; Derville et al., 2019). The size of the humpback population using the southern lagoon has been estimated at a maximum of 692 (95% CI: 591-806) in 2011 (Orgeret 2013).

Photo-ID data collected for *Tursiops aduncus* between 1996 and 2009 revealed high levels of re-sightings within the same areas of the lagoons (Bonneville et al., 2021), and lack of matches between neighbouring areas suggest at least five demographically independent populations (Oremus et al., 2009). Local abundance estimates of these populations are in the low hundreds at most. Genetic analysis revealed an extremely low diversity both at mitochondrial (only 2 haplotypes detected) and nuclear (Allelic Richness = 1 to 8.0) levels, suggesting that *T. aduncus* has a shallow genealogical evolutionary history in New Caledonia. Strong population differentiation was detected at the mtDNA ($F_{ST}$ = 0.912***) and nuclear ($F_{ST}$ = 0.105***) levels. Unexpectedly, high differentiation between two demographic units separated only by a 15 km long shallow plateau was found.

## Criterion B: Distribution and Abundance Sub-criterion B2: Aggregations

Dugong aggregations (i.e., group of ≥ 10 animals) were observed inside the lagoon of Cap Goulvain during the warm season and outside the lagoon during the cool season between April and September (Fig. 1). In 2011-2014 the dugongs in the aggregations were resting and no social behaviour, other than calves feeding, was observed. The most likely cause of the aggregations are access to: (1) warm water, and possibly reduced predation risk outside the lagoons in the cool season and (2) seagrass resources inside the lagoon (Cleguer, 2015).

The area supports several humpback whale aggregation spots. Social behaviour and group composition of humpback whale aggregations overwintering in the Southern lagoon have been presented in Garrigue et al. (2001) and Derville et al. (2018).

## Criterion C: Key Life Cycle Activities Sub-criterion C1: Reproductive Areas

Use of the lagoons of New Caledonia by dugong for reproduction have been reported (Garrigue et al., 2008; Cleguer, 2015). Calves have been observed

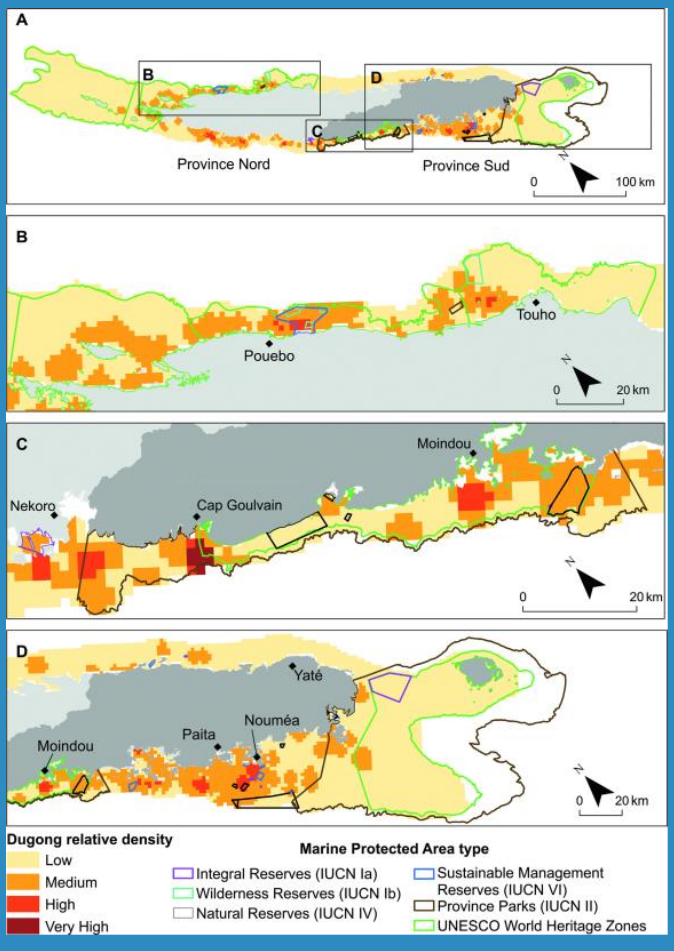


Figure 1: Model of dugong distribution and relative density in New Caledonia (a) and NE-coast (b), W coast (c), S coast (d). From Cleguer et al., 2015

during aerial surveys in the same location as adults. Cleguer (2015) found that the proportion of dugong calves increased from June 2003 (7.4%) to June 2011 (18.0%) and then decreased to reach its lowest value in November 2012 (4.7%) but these variations were not significant.

The South Lagoon of New Caledonia has been identified as a reproductive area for humpback whales based on field-based observations. This area is used for mating and nursing, and also likely for calving, and it constitutes one of the major breeding grounds for this whale sub-stock (Garrigue et al., 2001; Derville et al., 2018).

## Criterion C: Key Life Cycle Activities
## Sub-criterion C2: Feeding Areas

Dugong are known to feed on seagrass in the New Caledonian lagoons (Cleguer et al., 2020). Stable isotope analysis has been undertaken to provide further information on food selection (Cogrel, 2017). Diet was investigated through analysis of soft and hard tissue (teeth) to provide information on ontogenetic dietary changes (Cogrel 2017).

## Criterion D: Special Attributes
## Sub-criterion D1: Distinctiveness

The genetic diversity of dugongs in New Caledonia is low, and there is strong population differentiation indicating low, or no, gene flow between New Caledonia and Australia (Oremus et al., 2011; 2015). Oremus et al., (2011; 2015) analysed sequences of the mitochondrial DNA control regions and genotypes from 10 microsatellite loci from 22 New Caledonia dugongs and compared to sequences from Australia and elsewhere (n = 177+13). Genetic diversity in New Caledonia (mtDNA: h = 0.260, π = 0.12%; microsatellites: A = 3.16) was low in comparison with Australia (h = 0.841 to 0.972 and π = 1.26% to 2.47%, microsatellites: A = 4.82 to 5.80). Six haplotypes were identified in New Caledonia; none of these were found among Australian samples. However, the main haplotype occurring in New Caledonia has been found in Vanuatu (n = 1 sample) and the Solomon Islands (n = 1 sample) suggesting a recent connection within the Melanesian region. Genetic differentiation was also confirmed by AMOVA and Bayesian analyses on microsatellite data. Patterns of mtDNA

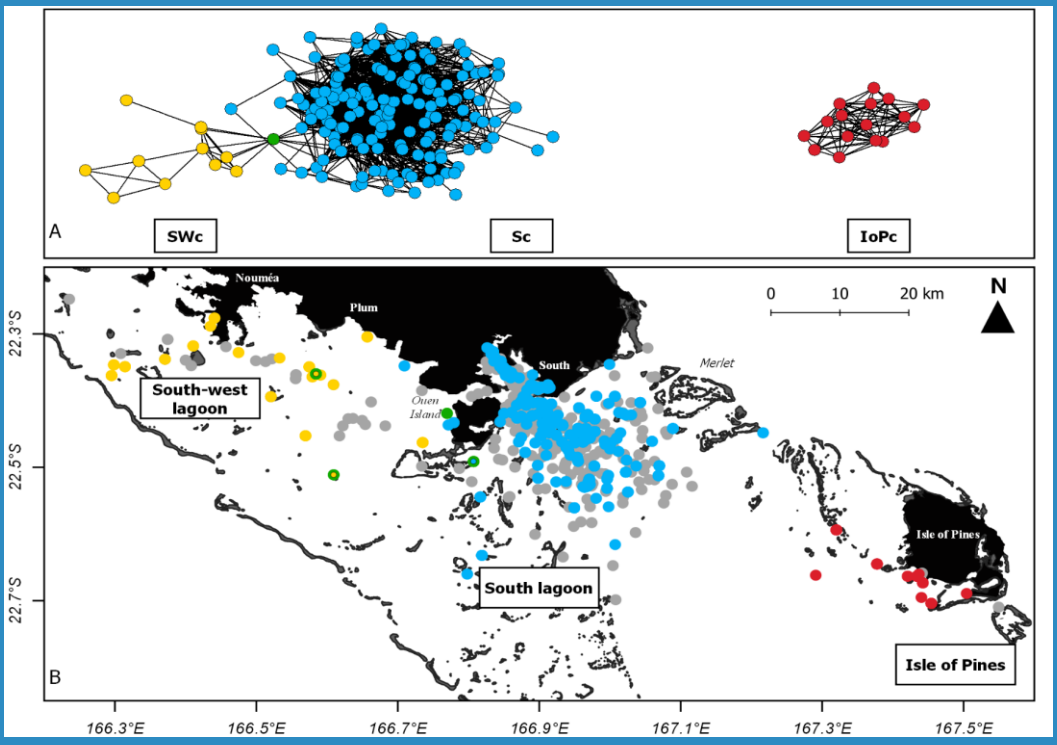


Figure 2: Population structure of Indo-Pacific bottlenose dolphins photo-identified in the southern range of New Caledonia between 1997 and 2019 (winter seasons mostly). (A) Social network of interactions among individuals between three communities: the south-west community (SWc in yellow), the south community (Sc in blue) and the Isle of Pines community (IoPc in red). The green point represents an individual interacting with other dolphins from two different communities (SWc and Sc). (B) Group positions where individuals were observed. Three out of four positions of the green point represents interactions with SWc (yellow center) and Sc (blue center). Gray points represent groups recorded that have not been studied or those containing individuals observed only once. From Bonneville et al, 2020

diversity and neutrality tests support a recent history of population expansion in New Caledonia that could be related to the last glacial period during which the lagoon was re-submerged offering opportunity for seagrass development.

New Caledonian humpback whales constitute the reproductive sub-stock E2 as named by IWC which is genetically different from the other sub-stocks identified in the South Pacific Ocean (Olavarria et al., 2007). The mtDNA of 1,112 samples collected over the South Pacific (New Caledonia, Tonga, Cook Islands, French Polynesia, Colombia) and Western Australia revealed 115 unique haplotypes. Significant differentiation, at both the haplotype and nucleotide level (FST = 0.033; ΦST = 0.022), were found among the 6 breeding grounds and for most pair-wise comparisons (Olavarria et al., 2007). More recent analyses using 962 samples collected in New Caledonia between 1996 and 2012 reveal a high haplotype diversity (hd=0.9731) and a significant differentiation between the migratory corridors of New Zealand, and North and South Australia (FST=0.00577 p<0.005) (Bonneville et al., 2017).

The low level of mtDNA diversity in *T. aduncus* of New Caledonia suggests a recent population bottleneck or founder effect and isolation

## Supporting Information

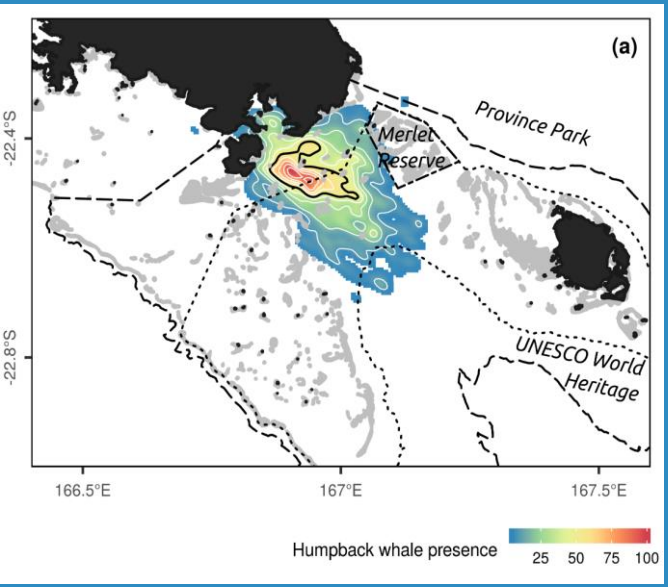


Figure 3: Figure 3. Kernel density estimates of humpback whales distribution in the South Lagoon, New Caledonia, 1995 -2017, based on unique observations at sea and from land over the whole study period (n = 2,651). Values below 5% are not shown. White lines delineate 10% contours from 10 to 100%. The 50% contour, or core area of use, is represented with black line. From Derville et al 2019


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