



# STATE OF ANTARCTIC PENGUINS 2017



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## Abstract

*For the first time in 24 years, this report comprehensively summarizes the status — population size and population trends — of Antarctica's five penguin species, continent-wide and in key regions. These species total at least 5.7 million breeding pairs nesting at 660 or more sites across the entire Antarctic continent. This report uses the most current scientific data, including 3,176 records from 101 sources of on-the-ground colony counts and satellite photo analyses. Key findings include some big changes, such as Adélies and chinstraps declining, and gentoos increasing, in the Antarctic Peninsula. With the exception of the Arctic region, the Antarctic Peninsula has warmed faster than anywhere else in the world. The report also notes key concerns, including ice sheet and glacier collapses both in West Antarctica and East Antarctica, which potentially affect penguin populations. This report represents the first major output from Oceanites' open access MAPPPD tool, which will enable annual updates on Antarctic penguin populations and trends.*

We are pleased to present the inaugural State Of Antarctic Penguins report (SOAP). This is a living document buttressed by ongoing research and the best available scientific data and information. We trust it will assist stakeholders everywhere, particularly the entire community of Antarctic interests — decision-makers and governments, scientists, NGOs, and the private sector, including fishing and tourism operators, as well as concerned citizens throughout the world.

For more than two decades, Oceanites Inc., has championed, and continues to champion, science-based conservation. One of its first programs was the Antarctic Site Inventory (ASI), which began in 1994. The ASI's initial focus was to identify potential penguin population changes caused by human activity. This focus has now shifted to distinguishing the direct and interactive effects of climate change, fishing, tourism and other human activities on the Antarctic Peninsula ecosystem. This past season marked the ASI's 23rd season of field data collection, monitoring the entirety of the warmed Antarctic Peninsula.

In October 2016, the Mapping Application for Penguin Populations and Projected Dynamics (MAPPPD), another major initiative involving Oceanites, went live. MAPPPD is an open

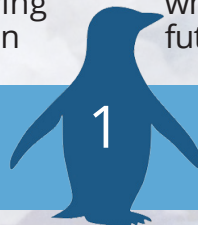
access decision support tool that was designed by The Lynch Lab for Quantitative Ecology at Stony Brook University and Black Bawks Data Science Ltd., with support from the US National Aeronautics and Space Administration (NASA) and Oceanites. MAPPPD will be used to assemble Antarctic penguin population data and to make it publicly available. We intend for MAPPPD to become the 'one-stop shop' for scientific and other information about Antarctic penguin populations, integrating expert biological field surveys, satellite imagery analyses, and citizen science. To date, MAPPPD's database contains 3,176 records of colony counts from 101 sources, involving 660 sites around Antarctica.

Through these annual State Of Antarctic Penguins reports, we will strive to keep interested stakeholders fully apprised of the latest, most accurate population data and trends about Antarctic penguins both continent-wide and regionally. Additionally, we will note key references and report on the latest scientific papers and publications relating to Antarctica's five breeding species of penguins.

With MAPPPD's predictive trend models still being perfected, we focus this first report on summaries of the vast amount of data already compiled in the MAPPPD database. We do this for the entire continent and for three key regions where trends can be identified: the Antarctic Peninsula (CCAMLR Areas 48.1, 48.2 and 48.5), the Ross Sea (CCAMLR Areas 88.1 and 88.2), and East Antarctica (CCAMLR Areas 58.4.1 and 58.4.2). We summarize the data in MAPPPD by aggregating the latest available counts of breeding pairs (i.e. nests) in each Antarctic region. This is reasonably accurate in areas where penguin breeding sites have been recently visited and counted (e.g. the Antarctic Peninsula), but less so in other areas where there are many sites that have not been counted since the 1980s. Specific details can be found at [www.penguinmap.com](http://www.penguinmap.com).

This report also may be accessed via the Oceanites website [www.oceanites.org/penrep](http://www.oceanites.org/penrep), where we'll additionally post maps depicting sites from which MAPPPD would value the submission of more recent, up-to-date data.

Please let us know and suggest what you might want to see in future issues.



# THE ANTARCTIC PENGUINS

There are five penguin species breeding in Antarctica: emperor, Adélie, chinstrap, gentoo, and macaroni. The emperor and Adélie are the only two which breed around the entire continent, while the other three are restricted to the northern sections of the Antarctic Peninsula (in addition to also breeding north of the Antarctic continent).



## Emperor Penguin

(*Aptenodytes forsteri*)

### ANTARCTIC POPULATION SIZE

283,000 breeding pairs per Fretwell et al (2012), data stored and displayed in MAPPPD.

### ACCURACY

Satellite imagery analyses, as utilized in this survey, expand the capacity to discover previously undescribed emperor colonies and enable better estimates of species population size. Estimates are expected to change as analytical techniques for satellite imagery are refined and improved.

### REFERENCE:

Fretwell et al (2012)



## Adélie Penguin

(*Pygoscelis adeliae*)

### ANTARCTIC POPULATION SIZE

3,790,000 breeding pairs per Lynch & LaRue (2014), which is larger than an estimate from more than 20 years ago of 2,465,800 breeding pairs per Woehler (1993). The estimate from the MAPPPD database is 4,125,192 breeding pairs; however, we note that many of these sites have not been counted since the 1980s.

### ACCURACY

There are expected to be revisions using refined satellite imagery analyses and updated ground surveys, augmented by the recent estimate, per Southwell et al (2017), of East Antarctica breeding individuals.

### REFERENCES:

Southwell et al (2017), Casanovas et al (2015), Lynch and LaRue (2014), Lynch et al (2010), Woehler (1993)



## Chinstrap Penguin

(*Pygoscelis antarctica*)

### ANTARCTIC POPULATION SIZE

1,609,393 breeding pairs per the MAPPPD database; however, many sites have not been counted since the 1980s. Existing estimates of the worldwide population range from 4.0-7.5 million breeding pairs.

### ACCURACY

The Antarctic estimate is expected to be revised by: a new survey, presently underway, using satellite imagery analyses; updated colony counts; and MAPPPD predictive trend models, which are still being developed.

### REFERENCES:

Naveen et al (2012), Woehler (1993)



## Gentoo Penguin

(*Pygoscelis papua*)

### ANTARCTIC POPULATION SIZE

115,943 breeding pairs per the MAPPPD database, an increase of 44% from an estimated 80,645 breeding pairs per Naveen (1997). The worldwide population is estimated at 387,000 breeding pairs per Lynch (2013).

### ACCURACY

MAPPPD data are comprised almost entirely of recent ground counts, which are very accurate.

### REFERENCES:

Lynch (2013), Lynch et al (2008, 2009, 2012), Naveen & Lynch (2011), Naveen (1997), Woehler (1996)



## Macaroni Penguin

(*Eudyptes chrysolophus*)

### ANTARCTIC POPULATION SIZE

13,249 breeding pairs estimated in the Antarctic Peninsula per Crossin et al (2013). The worldwide population is believed to have declined 30% to an estimated 6,300,000 breeding pairs.

### ACCURACY

These data come from counts made in the 1980s. There are insufficient, recent surveys enabling an updated assessment of trends.

### REFERENCES:

Convey (1999), Crossin et al (2013), Woehler & Croxall (1996), Woehler (1993)

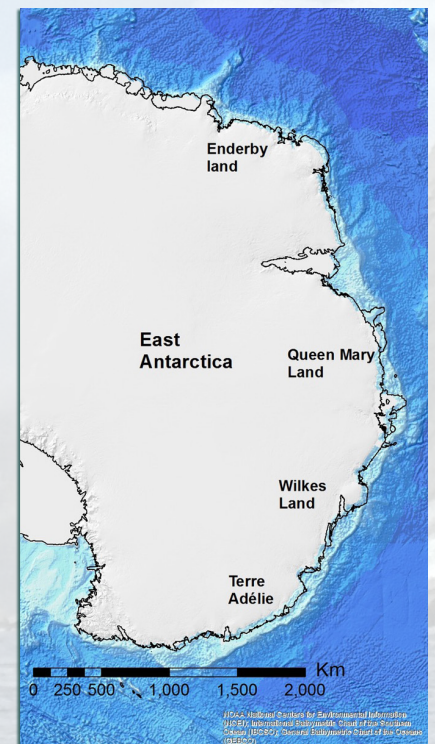
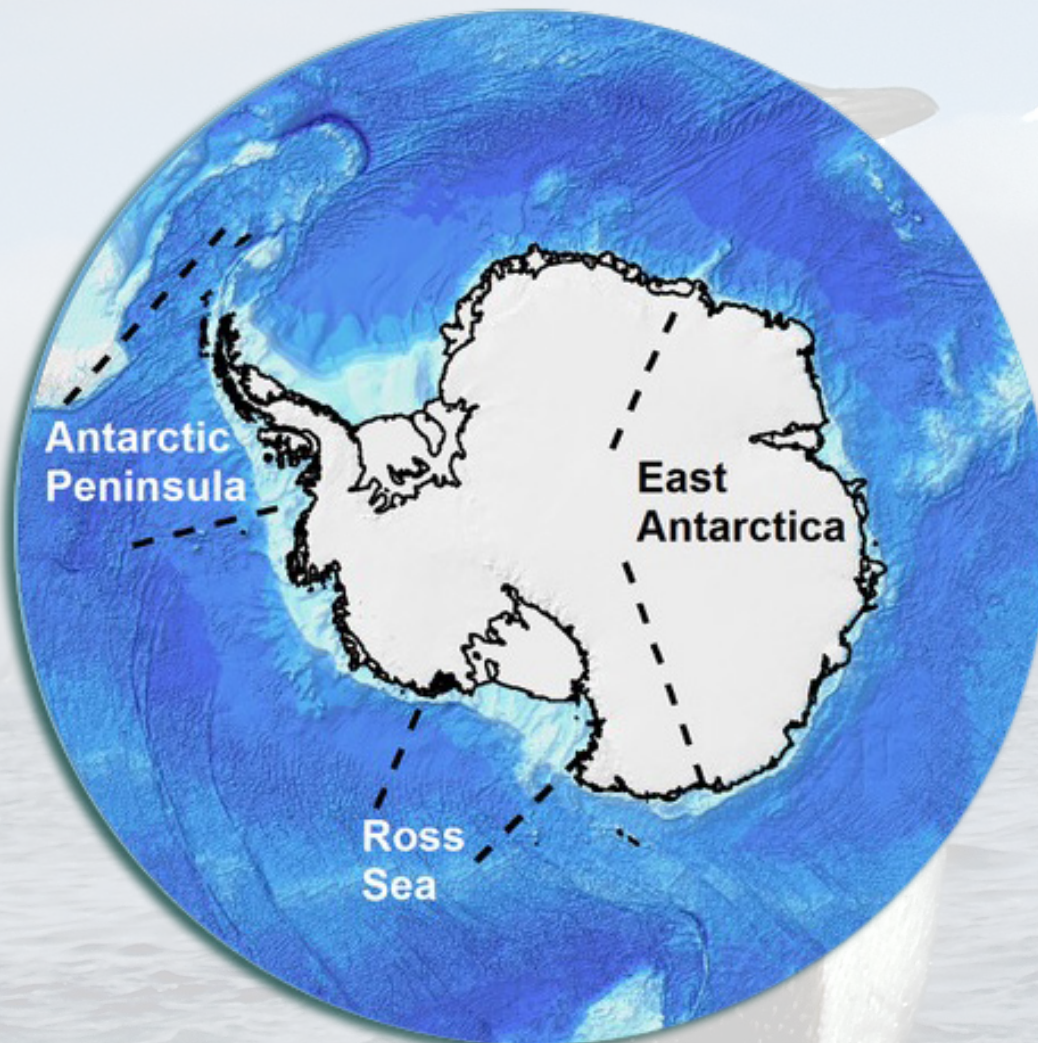


## KEY ANTARCTIC REGIONS

For the inaugural State Of Antarctic Penguins report, we focus on three key regions — **the Antarctic Peninsula**, comprising Areas 48.1, 48.2 and 48.5 demarcated by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR); **Ross Sea**, comprising CCAMLR Areas 88.1 and 88.2; and **East Antarctica**, comprising CCAMLR Areas 58.4.1 and 58.4.2.

The Antarctic Peninsula is where Oceanites' Antarctic Site Inventory concentrates and has collected data from more than 225 sites over 23 field seasons. This region has warmed considerably over more than six decades, year-round by  $2^{\circ}\text{C} / 5^{\circ}\text{F}$ . and in winter by  $5^{\circ}\text{C} / 9^{\circ}\text{F}$ ., but the warming trend appears to have slowed, consistent with natural variability; by contrast, in East Antarctica and the Ross Sea, there has been a cooling trend (Turner et al 2005, 2013, 2016). Paralleling these differences, Antarctic Peninsula Adélie penguin populations have generally been declining, while in East Antarctica and the Ross Sea, they appear to be increasing.

No gentoo or chinstrap penguins appear to be breeding in East Antarctica or the Ross Sea. These two species breed in West Antarctica, but with different responses to the warmed, regional climate: gentoos increasing, while chinstraps appear to be declining, although many sites lack enough data to draw firm conclusions.



Map Sources: NOAA National Centers for Environmental Information (NCEI); International Bathymetric Chart of the Southern Ocean (IBSCO); General Bathymetric Chart of the Oceans (GEBCO)



# ANTARCTIC PENINSULA

(CCAMLR Areas 48.1, 48.2 and 48.5)



## Emperor Penguin

(*Aptenodytes forsteri*)

### REGIONAL POPULATION SIZE

48,343 breeding pairs in the Weddell Sea per Fretwell et al (2012), data stored and displayed in MAPPPD.

### ACCURACY

Counts are from seven sites in 2009, of medium to high accuracy, and are reported in Fretwell et al (2012).

### TREND

Appears to be extirpated from its former breeding site in the Dion Islands. Satellite imagery analyses expand the capacity to discover previously undescribed emperor colonies and enable better estimates of species population size and regional trend. Estimates are expected to change as analytical techniques for satellite imagery are refined and improved.



## Adélie Penguin

(*Pygoscelis adeliae*)

### REGIONAL POPULATION SIZE

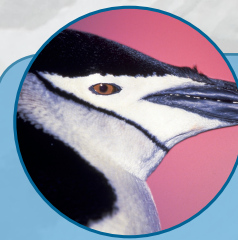
1,369,651 breeding pairs per the MAPPPD database.

### ACCURACY

Counts are from 114 sites, 59 are of high accuracy, 17 of medium accuracy, 38 are estimates from satellite imagery, and most were accomplished in the last decade.

### TREND

In this region, Adélie penguin populations have, in general, declined significantly. However, we note a sharp transition zone at the northern boundary of Marguerite Bay, north of which are widespread declines in Adélie penguin populations, but south of which Adélie penguin populations have remained stable or increased. By contrast, East Antarctica and the Ross Sea have not experienced a regional warming trend and Adélie penguin populations appear to have increased.



## Chinstrap Penguin

(*Pygoscelis antarctica*)

### REGIONAL POPULATION SIZE

1,609,393 breeding pairs per the MAPPPD database.

### ACCURACY

Of 291 sites, mostly counted within the last decade, 97 are of high accuracy ground counts, 167 involve medium accuracy estimates, and 27 involve satellite imagery analyses. Some key, large sites lack updated counts, and many lack complete time series. This estimate is expected to be revised by a new survey, presently underway and using satellite imagery analyses; updated colony counts; and MAPPPD predictive trend models, which are still being developed.

### TREND

At Deception Island, declines have been significant, with populations at neighboring chinstrap penguin breeding sites also declining, though to a lesser degree. The new survey, presently underway and using satellite imagery analyses, will enable the regional trend to be reassessed.



## Gentoo Penguin

(*Pygoscelis papua*)

### REGIONAL POPULATION SIZE

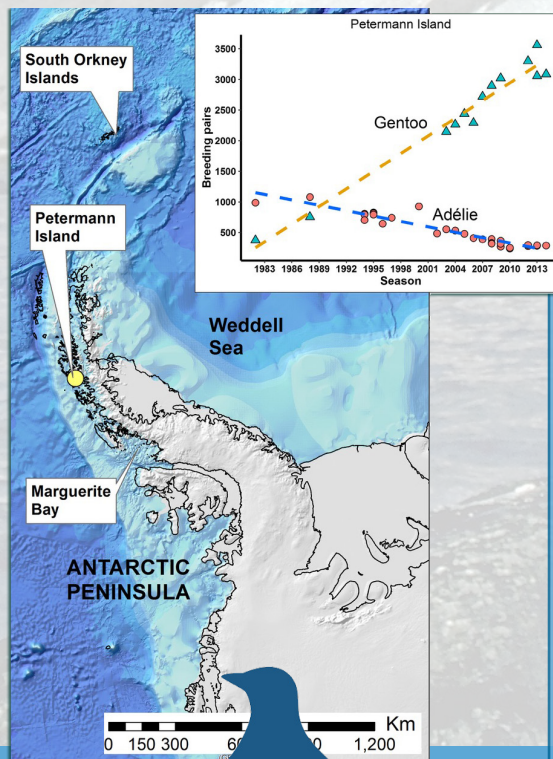
115,943 breeding pairs per the MAPPPD database.

### ACCURACY

Of 107 sites, 79 involved high accuracy ground counts, the rest evenly spread between satellite imagery analyses or medium accuracy ground counts. About 65% of the latest counts were made in the last decade, and 40% within the last two seasons.

### TREND

In this region, the gentoo penguin breeding population has increased significantly.



## Macaroni Penguin

(*Eudyptes chrysolophus*)

### REGIONAL POPULATION SIZE

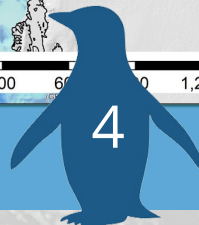
13,249 breeding pairs per Crossin et al (2013). Macaroni penguin data are not available in MAPPPD.

### ACCURACY

These data come from counts made in the 1980s and need to be updated.

### TREND

Worldwide, macaronis appear to be decreasing. In the Antarctic Peninsula, there are insufficient, recent surveys enabling an updated trend assessment.



## ROSS SEA

(CCAMLR Areas 88.1 and 88.2)



### Emperor Penguin

*(Aptenodytes forsteri)*

#### REGIONAL POPULATION SIZE

90,851 breeding pairs per Fretwell et al (2012), data stored and displayed in MAPPPD.

#### ACCURACY

Counts are from 12 sites, were made in 2009, and reported in Fretwell et al (2012). All counts are medium to high accuracy.

#### TREND

Satellite imagery analyses expand the capacity to discover previously undescribed emperor colonies and enable better estimates of species population size and regional trend. Estimates are expected to change as analytical techniques for satellite imagery are refined and improved.



### Adélie Penguin

*(Pygoscelis adeliae)*

#### REGIONAL POPULATION SIZE

1,485,599 breeding pairs per the MAPPPD database.

#### ACCURACY

Estimates from 35 of the 54 sites in this region were high or medium accuracy, with 19 low accuracy estimates.

#### TREND

In the Ross Sea region, which has not experienced a regional warming trend like the Antarctic Peninsula, Adélie penguin populations appear to have increased. Estimates are expected to change as analytical techniques for satellite imagery are refined and improved.

## EAST ANTARCTICA

(CCAMLR Areas 58.4.1 and 58.4.2)



### Emperor Penguin

*(Aptenodytes forsteri)*

#### REGIONAL POPULATION SIZE

58,092 breeding pairs per Fretwell et al (2012), data stored and displayed in MAPPPD.

#### ACCURACY

Counts are from 16 sites and were made in 2009, and reported in Fretwell et al (2012). All counts are medium to high accuracy.

#### TREND

Satellite imagery analyses expand the capacity to discover previously undescribed emperor colonies and enable better estimates of species population size and regional trend. Estimates are expected to change as analytical techniques for satellite imagery are refined and improved.



### Adélie Penguin

*(Pygoscelis adeliae)*

#### REGIONAL POPULATION SIZE

1,093,313 breeding pairs per the MAPPPD database.

#### ACCURACY

These estimates (78 of 88 sites) are made primarily using satellite counts from Lynch and LaRue (2014) for the year 2011. Few ground counts have been made at these sites due to their remoteness. Estimates are expected to be revised using refined satellite imagery analyses and updated ground surveys, augmented by the recent estimate, per Southwell et al (2017), of East Antarctica breeding individuals.

#### TREND

In East Antarctica, which has not experienced a regional warming trend like the Antarctic Peninsula, Adélie penguin populations appear to have increased. Estimates are expected to change as analytical techniques for satellite imagery are refined and improved.



## TRENDS, CONCERNS & FUTURE WORK

As noted, over the past 60+ years in the warmed Antarctic Peninsula, gentoo populations have increased significantly; Adélie penguin populations have, in general, declined significantly; and chinstrap penguin populations have declined and, at some locations, significantly. By contrast, Adélie penguin populations in East Antarctica and the Ross Sea appear to be increasing.

Looking ahead, a number of developments deserve attention, which we'll follow in future State Of Antarctic Penguins reports. Ultimately, all relate to climate. One is that warming in the Antarctic Peninsula appears to have slowed, consistent with natural variability (Turner et al 2005, 2013, 2016).

Another is a sharp transition zone at the northern boundary of Marguerite Bay in the southern Antarctic Peninsula, north of which are widespread declines in Adélie penguin populations and increasing populations of gentoo penguins, but south of which Adélie penguin populations have remained stable or increased (Casanovas, et al 2015). This lends support to the hypothesis that ocean productivity and sea ice dynamics are critical factors regulating Adélie penguin abundance in this location.

A third is concern regarding ice sheet collapse both in West and East Antarctica, which, potentially, affects penguin breeding habitats. Finally, we note that genetic work on all penguin species is ongoing and that, ultimately, censuses and trends will need to be placed in context of population structure and genetic diversity (Clucas et al 2016).

Inevitably, these concerns encourage further work distinguishing climate change impacts from other factors potentially causing Antarctic penguin population changes. Oceanites and colleagues are proceeding with some of this effort (see [www.oceanites.org/soapclimate](http://www.oceanites.org/soapclimate)) while keeping abreast of work by other researchers around Antarctica.

For a complete set of references, please visit: [www.oceanites.org/soaprefs/](http://www.oceanites.org/soaprefs/)

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