Biodiversity

# Atolls are vital for seabirds – and vice-versa

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Predictive modelling based on a global dataset reveals that atolls sustain 31.2 million breeding tropical seabirds. This vast assemblage of birds likely acts as a major nutrient pump, highlighting the need to conserve atoll ecosystems into the future.

Out of sight and far away, each day huge whales travel from the depths of the ocean to the surface and back again, transporting vital nutrients as they move. Although they are perhaps less grand and otherworldly, seabirds also play a role in cross-ecosystem nutrient transfer, and this is increasingly garnering attention[1]. Writing in *Nature Ecology & Evolution*, Steibl and collaborators[2] combine decades of data from multiple seabird surveys to reveal the importance of atolls for tropical nesting seabirds and therefore the utility of these islands in sustaining the cross-ecosystem transfer of nutrients.

Conservation science is often underpinned by surveys and counts of animals[3]. It may sound simple, but the practicalities of obtaining these counts can be challenging. Although breeding on land means that seabirds are relatively accessible compared to other marine animals, they are often be hidden on remote islands or down long twisting burrows. Despite these challenges, scientists continue to try and count animals and Steibl et al were therefore able to collate more than 90 datasets of seabird nesting surveys from atolls around the world. These surveys captured information on the seabird populations that inhabit 199 of the Indo-Pacific's 280 atolls and helped the authors to fill in the gaps and predict seabird population sizes across all the world's atolls. Harnessing a suite of relevant environmental variables within a predictive statistical model, Steibl et al estimated that the Indo-Pacific region's atolls are likely home to 31.2 million seabirds of 37 different species (Fig. 1). By comparing their population estimates to global population assessments, the authors demonstrated that atolls are vital for breeding seabirds. For example, more than 95% of black-footed and Laysan albatross populations nest on atolls, tucking their approximately 2-metre wingspans beneath them as they perch upon grassy nests. Nearing the other end of the seabird size spectrum, more than 50% of Polynesian storm-petrels, a globally endangered species that weighs just more than a packet of crisps, also rely on atolls to burrow, breed, and reproduce.

As well as quantifying the importance of atolls for seabirds, Steibl et al quantify the importance of the birds to their atoll nesting habitats, using their predictions of seabird species richness and abundance to quantify the nutrients that they deliver via their guano.

Humans have long recognised the utility of seabird guano as a fertiliser, the word itself deriving an indigenous Peruvian term for the bird excrement that was scraped from the country's coasts and redistributed to fertilise agricultural fields around the world[4]. It is therefore perhaps unsurprising that islands with seabirds often have enhanced plant biomass and species richness, the high nitrogen and phosphorous content of guano encouraging their growth[5]. Steibl and colleagues estimated that atolls receive an average of 337 kg of nitrogen per hectare per year, more than the European Union's annual legal maximum for farmland fertilization (220 kg per hectare). These high levels of nutrient input are likely to not only impact terrestrial ecosystems, but also adjacent nearshore marine ecosystems. From increased algal species richness[6] to seagrass abundance[7] and enriched mangroves[8], as well as heightened phytoplankton production[9], coral growth rates[10], fish biomasses[1], and manta ray aggregations[11], the presence of seabirds and their nutrient-rich guano have wide-ranging benefits across marine ecosystems in the tropics and beyond. Whilst Steibl et al describe albatrosses and boobies as the greatest nutrient vectors of the seabird assemblages that inhabit atolls, due to their large body sizes and high numbers, seabird diversity also impacts the spatial extent of the influence of these seabird nutrients into the marine realm[12].

Seabirds on atoll islands are subject to threats including invasive species, habitat loss, and human persecution. Historically, prior to the amplification of these threats, seabird numbers were likely much higher than the current estimates that Steibl et al now provide. Fortunately, with effective conservation and management, ghost former seabird colonies could once again be restored, reconnecting frayed pathways of nutrient flows, and yielding benefits that transcend ecosystem boundaries[13].

Steibl and colleagues found that 55% of 74 atolls that qualify as Important Bird Areas are currently recognised in this way. But they also identify 33 other atolls that are unrecognised, despite hosting seabird colonies that are above international thresholds for conservation. Recognising these atolls as globally important and vital to conserve should prompt conservation measures that seek to remove invasive species and restore seabird nesting habitat across them, whilst also upholding the cultural values held by any Indigenous peoples present.

The impacts of atoll conservation and the rebuilding of seabird populations have the potential to be extensive. For example, scientists are only just beginning to uncover the impacts of the ammonia emissions that seabird guano produces, with emissions from Arctic seabirds influencing the properties of clouds near their breeding colonies and having a cooling effect on the atmosphere[14]. What might the influence be of the 2.7 million kg of ammonia emissions from seabirds breeding across the Indo-Pacific, as calculated by Steibl and colleagues?

Returning to the ocean, guano-hastened coral growth can help coral reefs to recover more quickly from bleaching events, in turn protecting coastal areas from increased storms and waves[15]. As atolls themselves face risks from increased frequencies of cyclones, heatwaves and rising sea levels, what other connections between these islands and their seabirds are still to be uncovered? To have hope of answering these questions and the many others that remain regarding the influence of tropical

seabirds on the ecosystems that they walk, fly and swim through, we must continue to count seabirds and advocate for their protection.

**Figure 1 Seabirds in the Chagos Archipelago.** Sooty terns are one of 37 species of seabird identified by Steibl et al. as using atolls as nesting sites.

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