

# Occupancy models for characterizing the breeding phenology of Peruvian guano-producing seabirds

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## Abstract:

In marine ecosystems with seasonal dynamics, seabirds are expected to adjust their breeding period to maximal availability of food. However, detailed information on seabird breeding phenology is often scarce and few studies have attempted to link seabird phenology with physical and prey variability on a seasonal basis. For guano-producing seabirds in the Humboldt Current System (Guanay cormorant *Phalacrocorax bougainvillii*, Peruvian booby *Sula variegata* and Peruvian pelican *Pelecanus thagus*) information on the breeding phenology is scarce and contradictory, varying between no breeding phenology to protracted breeding, and no study investigated the synchrony between environmental conditions and breeding dynamics. Our objectives are i) to describe the species-specific seasonal patterns of breeding; and ii) to identify the main environmental drivers of seabird breeding and quantify their relative contribution. We modelled colonization and extinction probabilities of breeding colonies at nesting sites using occupancy models and the PRESENCE software. Observation data of occupancy of nesting sites came from monthly land-based censuses in 28 islands and headlands during the 2000-2012 period. Environmental variables tested were sea surface temperature, chlorophyll, upwelling index, dissolved oxygen, depth of the 2m l<sup>-1</sup> oxygen isoline, abundance, gonadosomatic index, body condition and body fat percentage of anchovy. Results showed that pelicans and boobies had a more marked seasonality of colonization and extinction probabilities than cormorants, with higher colonization probabilities for boobies and pelicans in August-September. For the three species colonization probabilities were best correlated with upwelling index and depth of the 2ml<sup>-1</sup> oxygen isoline with a lag of one month. Colonization of nesting sites by boobies and pelicans was also synchronized with anchovy body condition and gonadosomatic index. Our results show a seasonal pattern in the initiation of breeding of three seabird species, which was highly linked to upwelling activity and prey characteristics suggesting that seabirds adjust their timing of breeding according to prey availability and quality.

## References

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