

# Impact of climate changes on an Antarctic seabird: linking foraging behaviors to demography.

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# 1 Context and major goals

This project aims to study the effects of extreme sea ice conditions on the foraging behavior, body condition, vital rates and population growth of Southern Fulmar (*Fulmarus glacialisoides* [Smith, 1840])<sup>1</sup>.

Southern fulmars breed in the Southern Hemisphere on islands or along the coast of Antarctica. Southern fulmar's vital rates<sup>2</sup> and population size are impacted by climate variations, especially by sea ice concentration and sea surface temperature (1). However, the processes underlying these indirect relationships remains unknown. Here we combine a two year study of foraging trips and behavior to a long-term demographic study (ca. 50 years) to link climate → foraging behavior → body condition → vital rates → population. Interestingly, we find that the two year study corresponds to extreme sea ice conditions. Extreme Climatic Events (ECEs), such as extreme sea ice conditions, impact ecological processes at multiple levels, from individuals to ecosystems (2, 3). Although, there is increasing evidence of the impact of climate change and ECEs on populations and life history traits (e.g. (4)), comprehensive studies of the processes by which ECEs affect populations are lacking. For the first time to our knowledge, we study the effect of ECEs on the foraging behavior, body condition, vital rates and population growth of a species.

## 2 Accomplishments

### 2.1 Significant Results

We show that extreme sea ice conditions affect the foraging behavior, body condition, vital rates and population growth of Southern Fulmars. During extreme low sea ice conditions, Fulmars forage near the sea ice edge further from the colony, resulting in longer foraging trips

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<sup>1</sup>See description of the project at [www.who.edu/science/B/people/sjenouvrier/JENOUVRIER\\_LAB/project1.html](http://www.who.edu/science/B/people/sjenouvrier/JENOUVRIER_LAB/project1.html)

<sup>2</sup>Vital rates are life history traits, such as survival, maturation, or breeding, that can affect the size and composition of a population.

and higher foraging effort. Such longer foraging trips impact the food load delivered to offspring as well as fledging body condition. As a result breeding success and population growth are lower. Interestingly, responses to extreme events vary between individuals: successful breeders cope better with extreme climatic events and therefore contribute the most to the long term population growth. IPCC models project that extreme low sea ice conditions will increase, and for fulmars, this will result in population decline.

## **2.2 Opportunities for training and professional development provided by the project**

OLI funding supported the mentorship of two international guests students (one undergraduate and one graduate students) and a new collaboration with a postdoctorate Clara Peron. A guest undergraduate student, Julien Collet, conducted preliminary foraging analyses supervised by PIs J. Kellner and S. Jenouvrier. A guest graduate student Lorelei Guery supervised by S. Jenouvrier, studied the effect of distance to the sea ice edge on demographic parameters of adults. Clara Peron (CEFE CNRS) analyzed foraging tracks and foraging behavior using novel Bayesian state-space models approach (5). In addition the methods developed as part of this OLI project enabled us to secure funding for two new related projects that were successfully funded by NSF.

## **3 Impacts**

### **3.1 Dissemination of the results to the scientific community**

They are two major results significant for the field of ecological responses to climate change: 1. the effect of climate on population through its effects on foraging behaviors, and 2. the effect of extreme climate events on foraging behavior, vital rates and population growth. In addition, the contrasted responses to climate change among individuals raised key questions in ecology on the role of life history, individual heterogeneity, adaptation and evolution. To address these questions, the methods developed as part of this OLI project

can be applied to any species and ecosystems.

Results were disseminated to the scientific community at two talks at the the 97th Annual Meeting of the Ecological Society of America in 2012; as well as to the public in the OLI annual report and an article in *Oceanus* (<http://eco.confex.com/eco/2012/webprogrampreliminary/Paper37448.html>). In addition, one paper reviewing the effect of climate change and extreme climate events on birds is already published (Jenouvrier 2013), and one paper is in preparation.

### 3.2 Significance of this research for society

There is a pressing need from society to better understand and predict the ecological responses of present and future climate changes (6). This project improves our understanding of population responses to climate change and our forecasting ability by integrating foraging behaviors into predictive population models. Using seabirds as an early warning species of climate change, we hope to enhance awareness of the impact of climate change and their extreme events.

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