

# Persistent Foraging Segregation Between Closely-Spaced Seabird Populations: A Stable Isotope Perspective From the Last Millennium

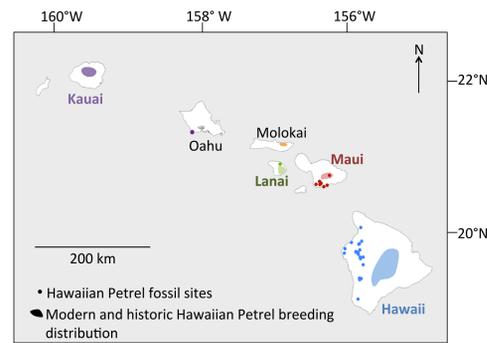
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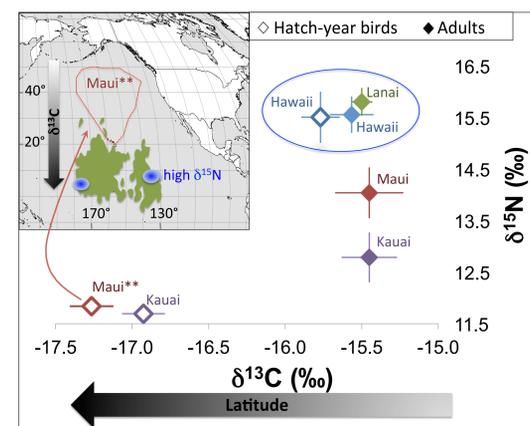


**Study Species:**  
the endangered  
Hawaiian Petrel  
(*Pterodroma  
sandwichensis*)

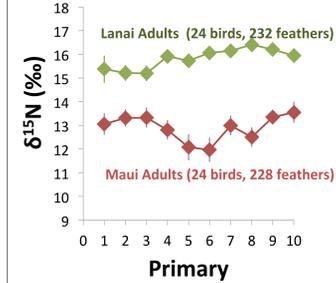
## Exploring Foraging Diversity among Genetically- Distinct Breeding Colonies



## Feather Isotope Data Reveal Differences in Spatial Use & Niche Width

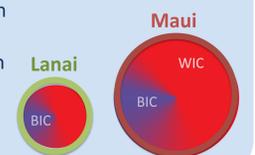


### Foraging Segregation Throughout Primary Molt (Non-Breeding) (ave $\pm$ std error)



**Niche Width & Specialization with regard to  $\delta^{15}\text{N}$**   
(foraging location & trophic level) during adult primary molt:

Between Individual Component (BIC) + Within Individual Component (WIC) = Total Niche Width (TNW: size of circles)



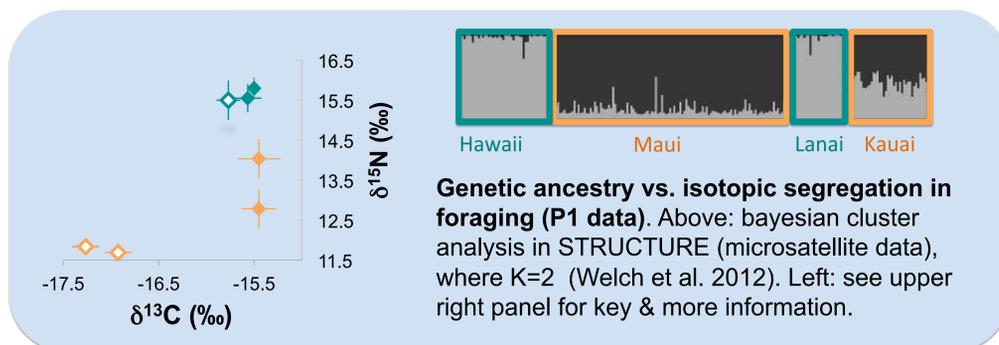
### Why Foraging Segregation Matters:

- Foraging segregation among populations can promote their coexistence.
- Preserving foraging diversity might be critical to the long-term persistence of a species, especially in the face of changing food availability.
- In the absence of physical barriers to dispersal, Friesen et al. 2007 proposed that foraging segregation may lead to genetic divergence in wide-ranging seabirds.

**Foraging Segregation During the Breeding & Non-Breeding Seasons. Stable Isotope Data from Primary 1** (colony ave  $\pm$  std error) & **Map of Major Hawaiian Petrel Foraging Areas** (Wiley et al. 2013) N=75

Maui foraging trip: Chick-rearing period (Adams & Flora 2010)  
Lanai Kernel Density Plot (90%): Non-breeding season (Van Zandt 2012)

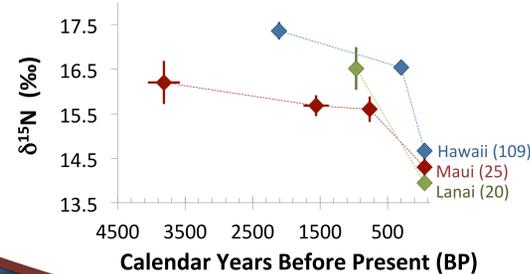
## A Millennial-scale Perspective on Foraging Segregation & its Relationship with Genetic Divergence



**Genetic ancestry vs. isotopic segregation in foraging (P1 data).** Above: bayesian cluster analysis in STRUCTURE (microsatellite data), where K=2 (Welch et al. 2012). Left: see upper right panel for key & more information.

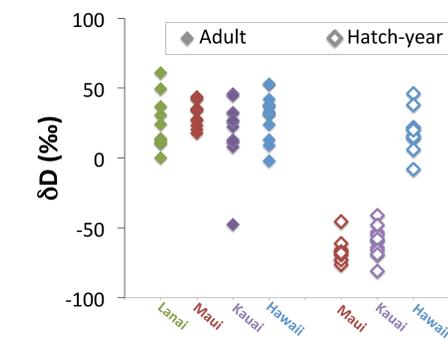
- **Ancient:** Hawaii & Lanai significantly differentiated from Maui (Tukey HSD)
- **Modern:** No significant differences between populations

### Bone Collagen: Foraging Segregation through Time (Wiley et al. 2013)

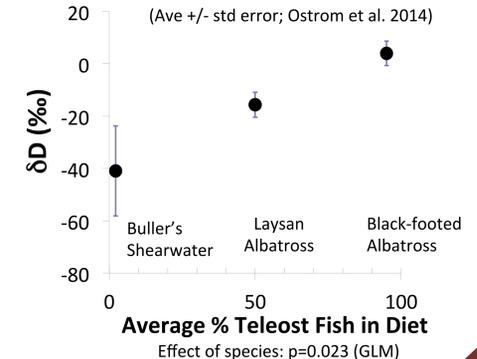


## Dietary & Salt Load Differences Inferred from Stable Hydrogen Isotope Analysis

### H Isotope Values in Hawaiian Petrel Feathers (Ostrom et al. 2014)



### H Isotope Values Correlate with Fish vs. Invertebrate Consumption (Ave $\pm$ std error; Ostrom et al. 2014)



**Dietary Salt Load:** (Green & Gales 1990)  
Fish: 12.8 mmol Na/MJ  
Squid: 26.5 mmol Na/MJ

Hatch-year petrels from the islands of Maui and Kauai have lower H isotope values than their counterparts from Hawaii and all adults (Bonferroni pair-wise comparison,  $p < 0.0001$ ). This divergence may reflect relatively high consumption of fish by Maui and Kauai nestlings.

## Conclusions

We find evidence that inter-colony foraging differences are:

- strong during the non-breeding season
- at least partially spatial
- persistent through many generations
- similar to observed patterns of genetic divergence

... all observations consistent with the hypothesis of genetic divergence mediated by foraging segregation.

## Citations

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- Friesen, V., T. Burg, and K. McCoy. "Mechanisms of population differentiation in seabirds." *Molecular Ecology* 16, no. 9 (2007): 1765-1785.
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