Should I Stay or Should I Go Now:
The effect of breeding success on site fidelity of the Leach's Storm Petrel

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Introduction

Long-lived seabirds frequently exhibit high rates of mate and site fidelity between breeding seasons. For Leach's Storm Petrels (*Hydrobates leucorhous),* which lay a single egg per year, the decision to change partners or burrows between breeding seasons can have important implications for lifetime reproductive success. Because adult survival rates are high, reproductive failure is generally considered the leading reason for divorce[1,2]. We present data from three years (2021–2023) of monitoring on Great Duck Island in the Gulf of Maine. We banded and recaptured breeding Leach's Storm Petrels in a sample of marked burrows to record rates of mate switching and site fidelity. Information on fledging success, though only recorded in 2022, provides additional insight into site and mate fidelity.

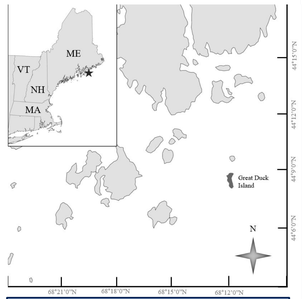

Fig. 1: Great Duck Island's location in the Gulf of Maine

Methods

Fig. 2: Grubbing a burrow

Fig. 3: Banding an adult petrel

This study was conducted on Great Duck Island, Frenchboro, Maine (44.1550° N, 68.2499° W) during June, July, and August of 2021 – 2023. We chose burrows for monitoring based on breeding activity and ease of access. We recorded burrow locations using a Trimble Geo 7X Decimeter with sub-meter accuracy, which allowed for annual relocation and monitoring. Each year, we attempted to band and capture or recapture both members of each burrow's breeding pair. Fledging success was recorded only in 2022; we considered a chick fledged when it reached adequate size to receive a band (approx. 35g), and considered a burrow failed if we found a dead chick, a broken egg, or observed than an egg had been left unattended for more than 7 days[3] Additional burrows were opportunistically added to the monitored sample in both 2022 and 2023, so not all new bands reflect mate switches.

Works Cited

[1]Bried, J., *et al.* 2003. Mate fidelity in monogamous birds: a re-examination of the Procellariiformes. *Animal Behaviour*, *65*(1). [2] Bourgeois, K., *et al.* 2014. Relationships between nest-cavity and mate selection, reproductive performance and fidelity in the Mediterranean endemic Yelkouan Shearwater Puffinus yelkouan. *Acta Ornithologica*, *49*(1). [3]Blackmer *et al.* 2004. Effects of investigator disturbance on hatching success and nest-site fidelity in a long-lived seabird, Leach's storm-petrel. *Biological Conservation*, *116*(1). [4]Morse, D. H., & Buchheister, C. W. (1979). Nesting patterns of Leach's storm-petrels on Matinicus Rock, Maine. *Bird-Banding*, *50*(2). [5]Schreiber, E. A. 2001. Climate and weather effects on seabirds. Chapter in *Biology of marine birds*, 179-207.
All figures made via: R Core Team (2021). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria ; Wickham H, *et al.* 2019. "Welcome to the tidyverse." *Journal of Open Source Software*, **4**(43), 1686

Results

Pair Fidelity and 2022 Breeding Outcomes

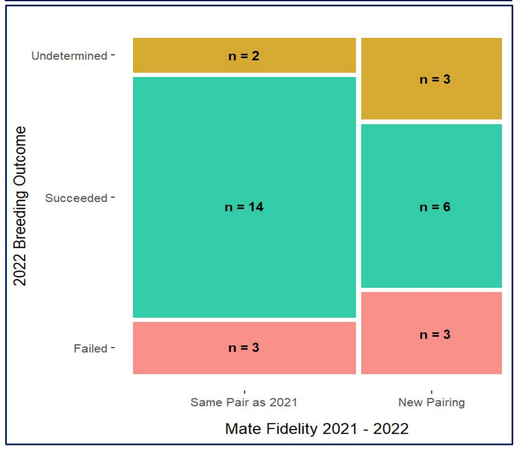

Fig. 4: Mosaic plot showing 2022 breeding outcomes grouped by fidelity to the previous years' pairing.

We examined whether burrows that retained identical pairings between the 2021 – 2022 breeding season were more likely to succeed in 2022 compared to burrows where one bird took a new mate. We captured both birds in 36 burrows, of which 32 contained at least one returning bird from 2021. We were unable to assess fledging success in 5 burrows, which were removed from the sample prior to testing. Burrows containing two new birds were also excluded since we could not know whether those pairs had spent previous years together. We found no difference in 2022 fledging success between burrows retaining their pairings and burrows with one new occupant (Fisher's Exact Test, n = 26, $p = 0.63$).

We examined whether birds who successfully fledged a chick in 2022 were more likely to return to their burrows in 2023 than those who failed to fledge a chick. 41 of the birds for whom fledging success was recorded returned, while 66 did not. Once again, birds for whom fledging success was undetermined in 2022 were excluded from testing. Birds who succeeded in fledging a chick in 2022 were significantly more likely to return in 2023 than those who failed (Chi-squared test, $X^2 = 5.85$, df = 1, $p = 0.015$). 22 returning birds retained the same mate and 5 took a new mate; we were unable to capture the mate of the remaining 14.

2022 Breeding Outcomes and 2023 Return Rates

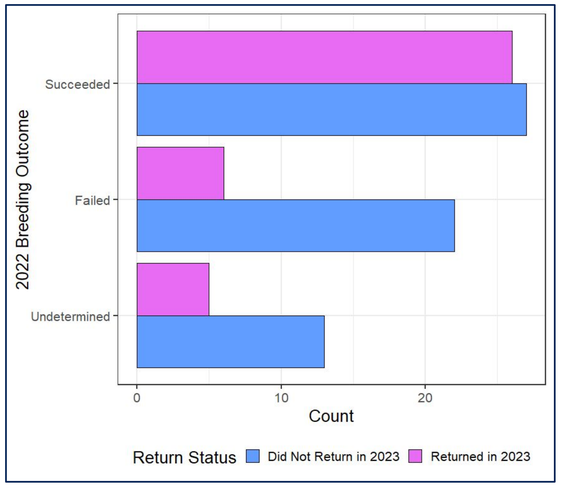

Fig. 5: Barplot showing 2023 return rates based on 2022 breeding outcome.

Overall Mate Switching Rates

Years Present	Potential Mate Switches	Number of Mates	Actual Mate Switches	Count of Occurrence
1	0	1	0	18
2	1	1	0	29
2	1	2	1	26
3	2	1	0	10
3	2	2	1	7
3	2	3	2	3
		Total Potential Switches		95
		Total Actual Switches		39
		Mate Switching Rate		41.05%

Tab. 1: Possible mate switches compared to the number of switches that actually occurred.

We calculated how many opportunities each bird banded in this study prior to 2023 had to switch mates and calculated an overall mate switching rate based on the number of switches that actually occurred. 41.05% of all possible switches over three years occurred. This rate is higher than that found in a similar study is lower than the rates found in a similar study on a nearby colony (Morse & Buchheister 1979)[4], which suggested a mate *retention* rate of 68.42%.

Discussion

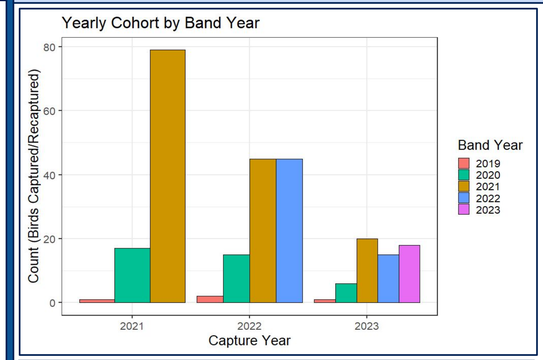

Fig 6: Bar plot of each years' captured/recaptured cohort by original band year. Occasional banding efforts prior to 2021 did not focus on breeding pairs.

Breeding success in 2022 had a significant effect on return rates in 2023 ($p = 0.015$). However, return rates in 2023 were surprisingly low; out of 107 banded birds recorded in 2022, only 42 returned to their burrows in 2023. Though breeding successfully appears to indicate a higher likelihood of return, there are a number of other factors that may have influenced 2023 return rates.

Investigator disturbance has been associated with burrow desertion and decreased return rates in Leach's Storm Petrels[3]. Disturbance very likely plays a role in non-returns between years, and additional monitoring of this colony should attempt to control for disturbance and quantify its impact. If disturbance was the main factor causing non-returns in 2023, however, we might expect to see disproportionate return rates between birds with different initial band years, with more habituated birds being more likely to return (having already been given the chance to desert). In 2023, however, we saw surprisingly few returns among birds of all band years (fig. 7), suggesting additional external factors may have been at play.

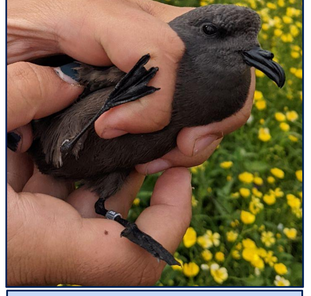

Fig. 8: Handling a Storm-Petrel

The arrival of El Niño was officially reported by NOAA in June of 2023, an event that results in global warmer-than-average sea surface temperatures and irregular weather patterns. The weather on GDI during the 2023 field season was abnormally foggy and rainy. Breeding seabirds are more likely to skip breeding seasons during El Niño years, and are often less likely to breed successfully.[5] Leach's Storm Petrels lay only a single egg per year, but are remarkably long-lived. Because the metabolic costs of incubation and chick-rearing are high, it may be more advantageous to a bird's lifetime reproductive success to desert a breeding attempt early in the season during a bad year, or when disturbed, than it would be to invest in an egg or chick until it fails.[3]

Fig. 9: Fog on Great Duck Island

Future monitoring at this colony has the potential to shed more light on the role that investigator disturbance plays in mate and site fidelity, as well as on the role of external environmental factors.

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