

Nuclear SNPs reveal link between social and genetic structure in Hawaiian short-finned pilot whales

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Introduction

Short-finned pilot whales

- are highly social cetaceans
- form social groups in Hawai'i that are stable across decades (Figure 1)

We hypothesize that

- social groups are comprised of close relatives
- social behavior is a driver of population structure in the Hawaiian Islands

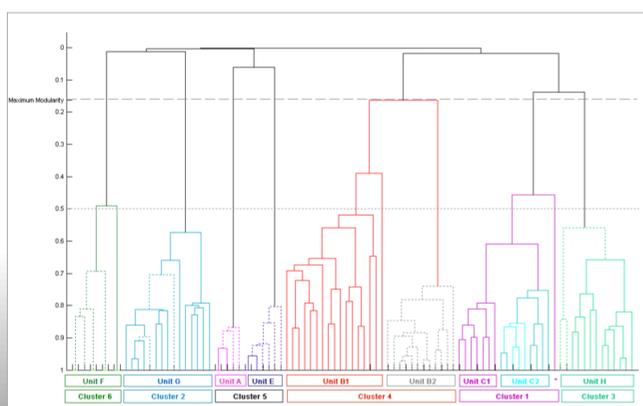


Figure 1. Dendrogram of associations from Mahaffy et al. 2015, showing some of the social units and clusters that exist within the Hawai'i Island population.

Methods

We used capture enrichment and NGS sequencing to genotype 53 nuclear SNPs (nuDNA) from 126 Hawaiian short-finned pilot whales (Figure 3). Sequences were assembled using an assembly pipeline developed at SWFSC, and SNPs were selected manually; only SNPs with coverage for at least 35% of samples were included in the study. Samples with less than 50% SNPs genotyped were removed. Relatedness between social units was analyzed using a maximum likelihood relatedness estimator in the package "Related" for R. Samples were then stratified into clusters of social groups and into island populations, and population structure analyses were performed using the "strataG" package in R. Related individuals were removed from clusters for population structure analysis. Network visualization was completed using the "Network" package in R.

References

Mahaffy, S.D. et al., 2015. High site fidelity, strong associations, and long-term bonds: Short-finned pilot whales off the island of Hawai'i. *Marine Mammal Science*, 31(4), pp.1427-1451.

Wade, P.R., Reeves, R.R. & Mesnick, S.L., 2012. Social and Behavioural Factors in Cetacean Responses to Overexploitation: Are Odontocetes Less "Resilient" Than Mysticetes? *Journal of Marine Biology*, 2012, pp.1-15.

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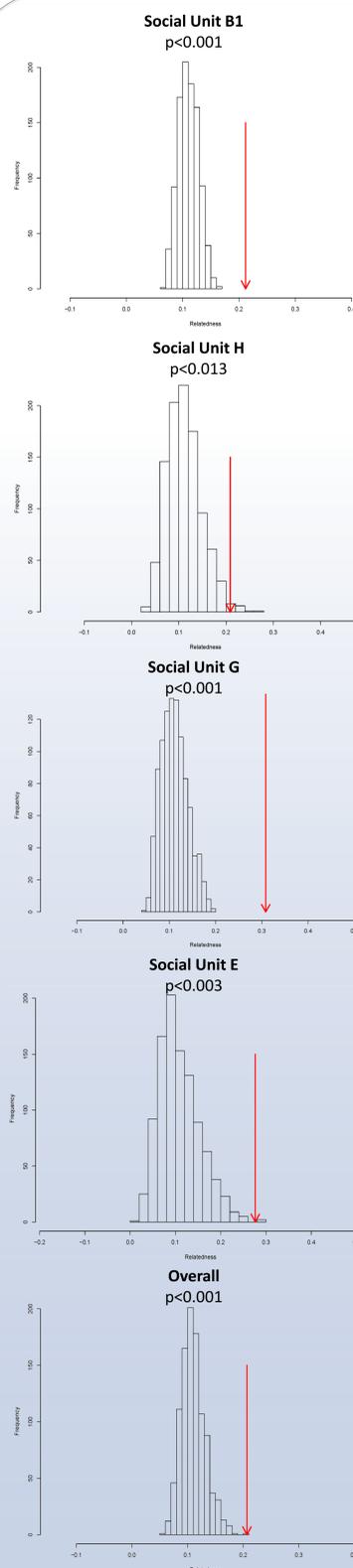


Figure 2. Relatedness estimates (red arrows) for four social units around Hawai'i Island, with estimates of expected relatedness for randomly organized social units.

Results

- Individuals within social groups are more related than expected by chance (Figure 2).
- The Hawai'i Island and O'ahu/Kaua'i populations are significantly different from each other (Figure 3). No other nuclear population differentiation was found among geographic groups, although sample sizes were small in both the NWHI and pelagic groups.
- Among social clusters, 20 of 44 pairwise tests indicated significant differentiation (Figure 4).

Discussion

- Population structure among clusters indicates that the current social structure has been in place for long enough to affect underlying allele frequencies, suggesting a degree of reproductive isolation between clusters.
- Further differentiation may be found among clusters with greater sample sizes or more SNPs.
- Some clusters have not been isolated long enough to exhibit genetic differences.
- Socially-driven population structure in Hawaiian pilot whales could indicate a greater degree of vulnerability to anthropogenic threats (Wade et al. 2012).
- Identifying social structure as a driver of population structure improves our ability to manage interactions with this species on longer timescales.

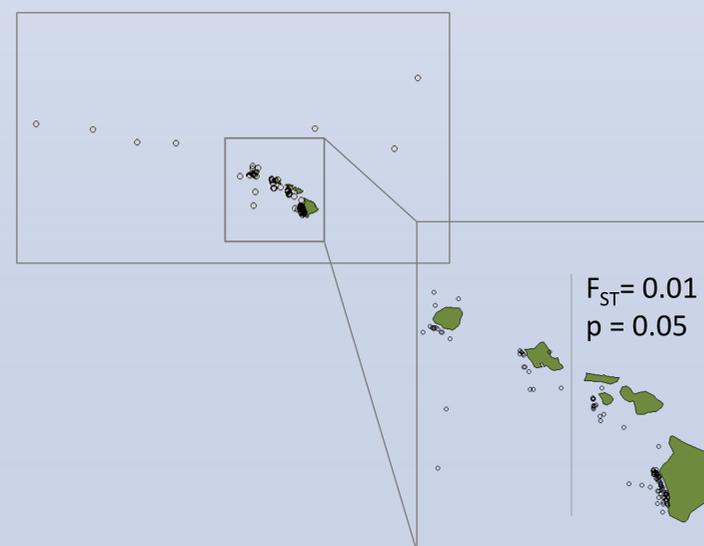
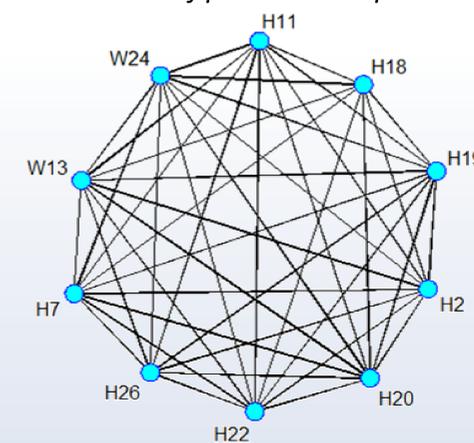


Figure 3. Locations of samples used in this study. Significant differentiation was found only between Hawai'i and O'ahu/Kaua'i. The line in the inset shows the break between the two groups.

Network of pairwise comparisons



Network of gene flow between social groups

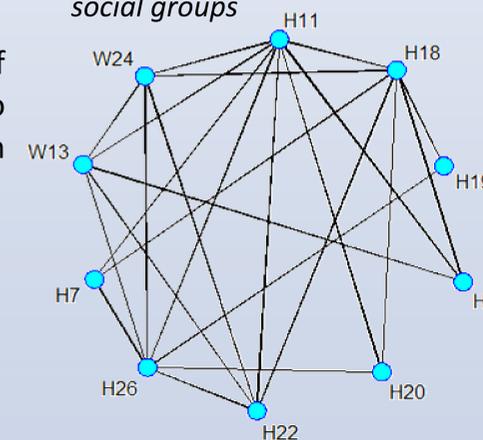


Figure 4. Of 44 pairwise tests between ten social clusters (top), 20 were significantly different and 24 were not (bottom). Social clusters labeled H are from Hawai'i Island; social clusters labeled W are from O'ahu/Kaua'i.

