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Introduction

A multi-year satellite tagging effort was conducted on humpback whales off the island of Kauai from 2017-2019. Nineteen whales were successfully tagged, with tag durations lasting 1.6 – 12.3 days. Most tagged whales transited west from Kauai to Niihau, but three animals remained at Kauai and three animals transited east to Oahu. During this field effort, the location, group size, and group behavior were recorded for all encountered humpback whales. A modeling effort was conducted on all encountered groups to determine if **different social groups/behaviors occurred in specific habitats** or if they were randomly encountered in a variety of habitats. In addition, the social role and behavior of the tagged animals were examined to determine if the **habitat or social role in which the tagged whales were encountered was related to where the animals traveled after being tagged**.

Methods

- 23 days of survey effort in Feb 2017, Mar 2018, and Feb 2019 off Kauai (Fig. 1)
 - All encountered groups recorded: location, group size, group behavior, presence of other groups (Fig. 2)
 - Satellite tagged using Wildlife Computers SPLASH10 tags
- Model development
 - Generalized Additive Models (GAM) of behavioral states tested predictor variables including: Julian date, latitude and longitude, water depth, distance from shore, slope, number of other animals in area, group size, average dive interval
 - Multinomial logistic regression model of destination for tagged animals tested inclusion of behavioral state, role in group, group size, water depth/slope/distance from shore (highly correlated)

Effort

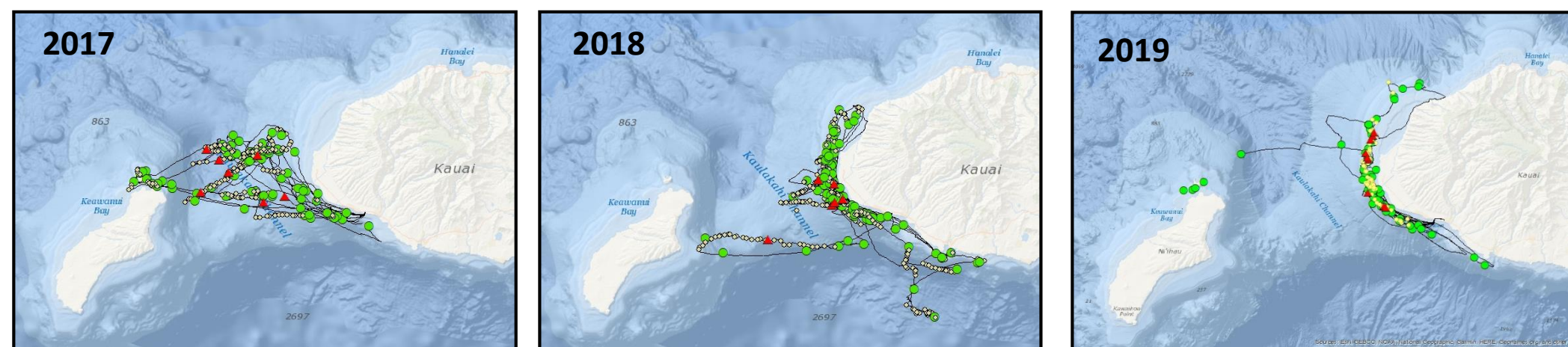


Figure 1 – Survey effort across all years

Encounter Data

- 2017 – 8 days effort
 - 57 groups, 105 individuals, avg grp size = 2.3
 - 85 unique dorsal fins, 58 individual flukes
- 2018 – 9 days effort
 - 92 groups, 166 individuals, avg grp size = 1.8
 - 105 unique dorsal fins, 78 individual flukes
- 2019 – 6 days effort
 - 60 groups, 118 individuals, avg grp size = 2
 - 69 unique dorsal fins, 52 individual flukes

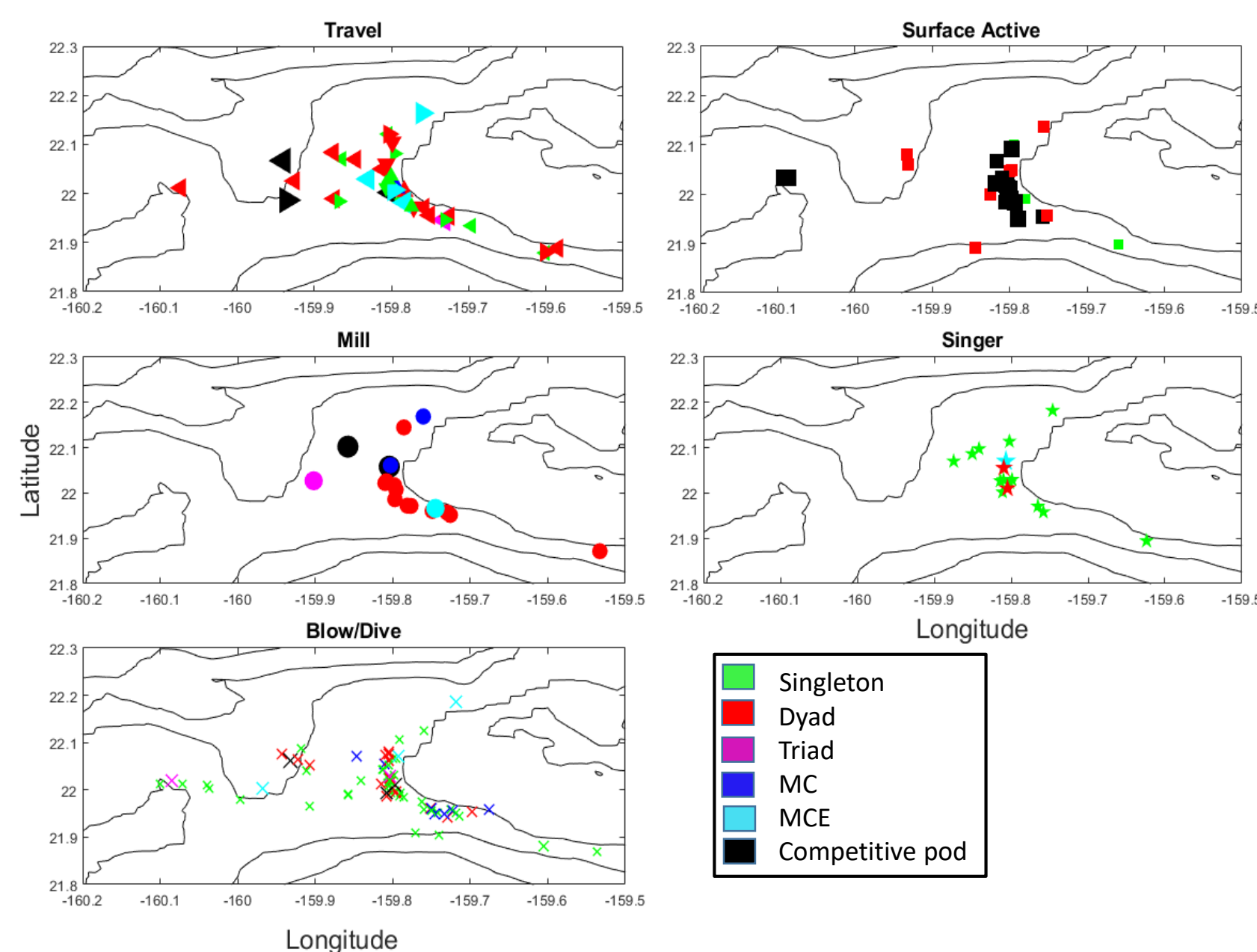


Figure 2 – Behavior of all groups encountered, color coded by group composition

- Travel** ~ Travel Direction + Group Composition + Dive Interval
 - Adj. $R^2 = 0.29$, Dev Expl = 48.2%, REML = -3.44 (Fig. 4)
 - occurred with **shorter dive intervals**, most often in **Dyads** and **MCE** groups, and variability in the direction of travel
- Singing** ~ Year + Group Size
 - Adj. $R^2 = 0.08$, Dev Expl = 22.0%, REML = -15.23 (Fig. 5)
 - most often occurred in small groups (**singletons**), and encountered the **most in 2019 and least in 2018**
- Surface Active** ~ Julian Date + Group Size
 - Adj. $R^2 = 0.16$, Dev. Expl = 15.5%, REML = 42.79 (Fig. 6)
 - occurred **earlier in the year** (Feb), more often in **larger groups**
- Milling** ~ Water Depth + Dive Interval
 - Adj. $R^2 = 0.38$, Dev Expl = 43.7%, REML = -2.16 (Fig. 7)
 - occurred more often **nearshore**, and had **longer dive intervals**

Satellite-Derived Tracks

- 19 whales tagged (Fig. 3)
 - Most probable males, 1 confirmed female
 - 16 adults, 3 sub-adults
 - Encountered in competitive pods, dyads, and solitary
- 13 traveled west to Niihau
- 3 traveled east to Oahu
- 3 remained at Kauai (short tag durations)

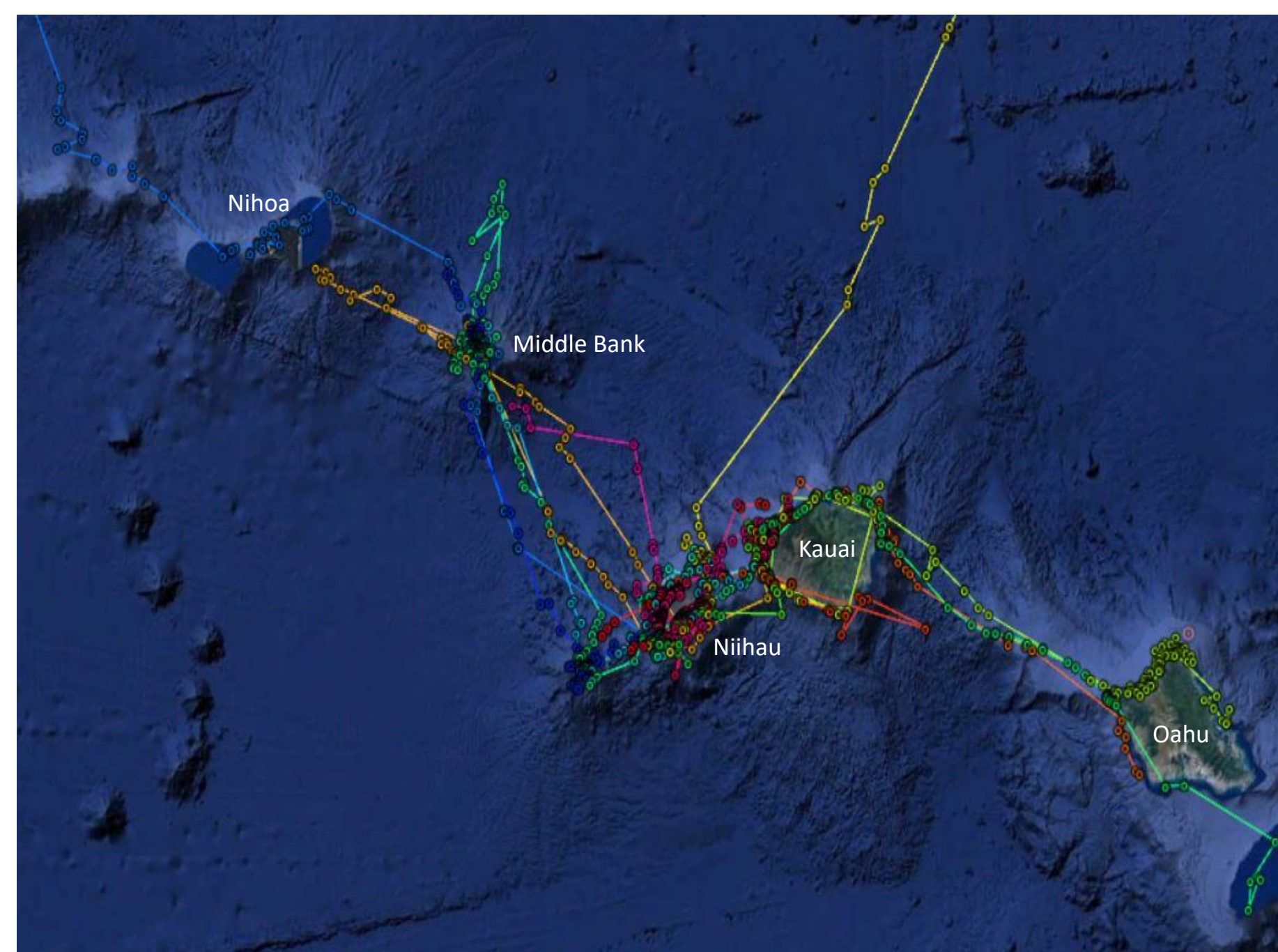


Figure 3 – Argos satellite location tracks of all nineteen tagged humpback whales

Destination Model

Behavior, Role, Group Size, and Slope gradient retained in **multinomial logistic regression** model of tagged animal destination (Fig. 8 and 9)

- Animals encountered in **smaller groups** are more likely to go to **Niihau**
 - Animals that go to **Oahu** more likely to be **Milling** when encountered
 - Animals that go to **Niihau** more likely to be **Traveling or Surface Active** when encountered
 - The only confirmed **Female** went to **Oahu**
 - Animals tagged as **Primary Escorts** more likely to go to **Oahu**
 - Animals tagged as **Secondary Escorts** more likely to go to **Niihau**
 - The only tagged **Singleton** went to **Niihau**
 - Animals tagged in **Dyads** go to **all locations**
 - Traveling Dyads** are the most likely to go to **Niihau**
 - Animals tagged over **steeper slopes** more likely to go to **Niihau**
- HOWEVER:
- Dataset too small for meaningful model results (N=19)
 - Single Comp group had 4 animals tagged, included only female
 - Female and Primary Escort went to Oahu together

Results

Behavioral Models

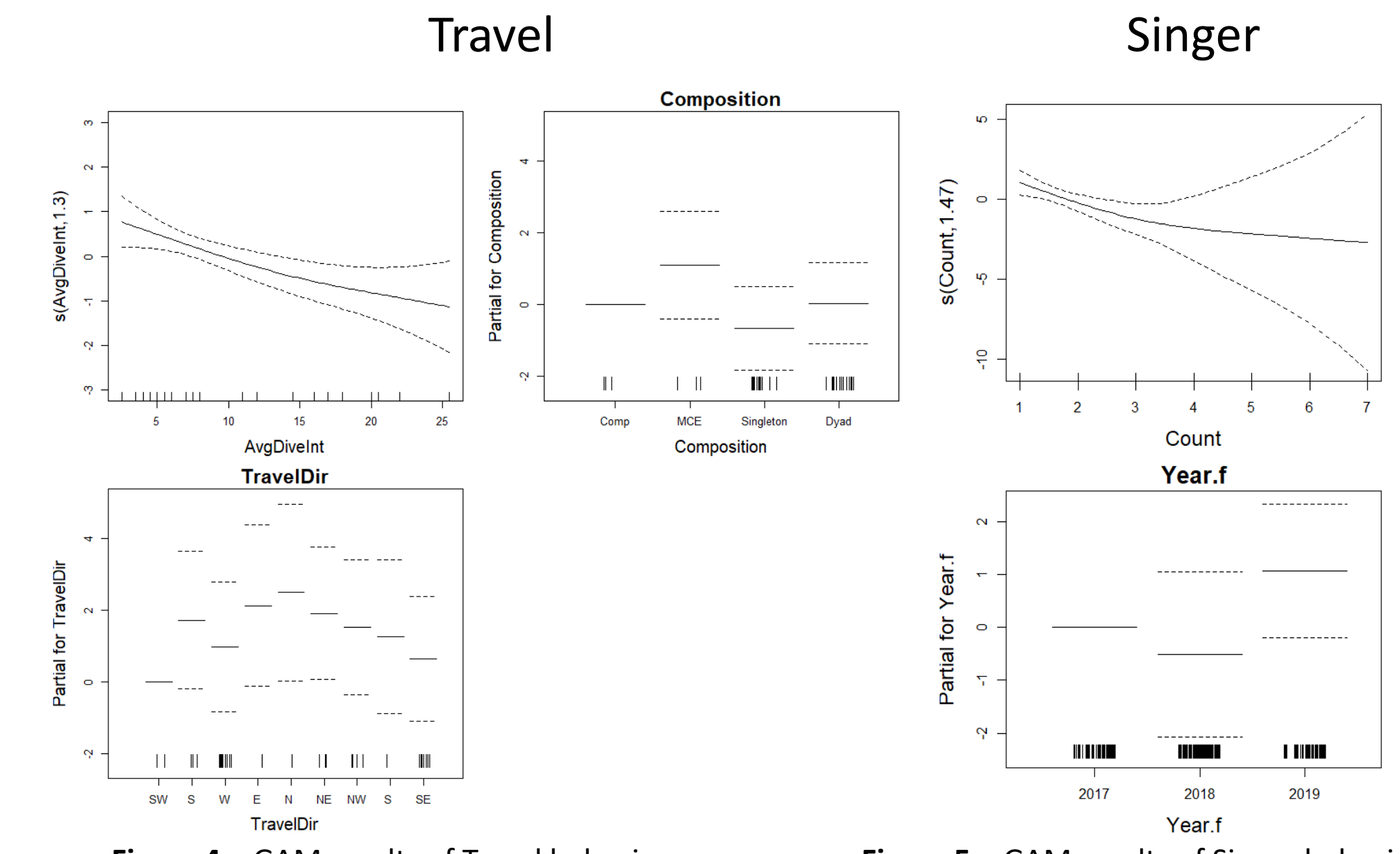


Figure 4 – GAM results of Travel behavior

Figure 5 – GAM results of Singer behavior

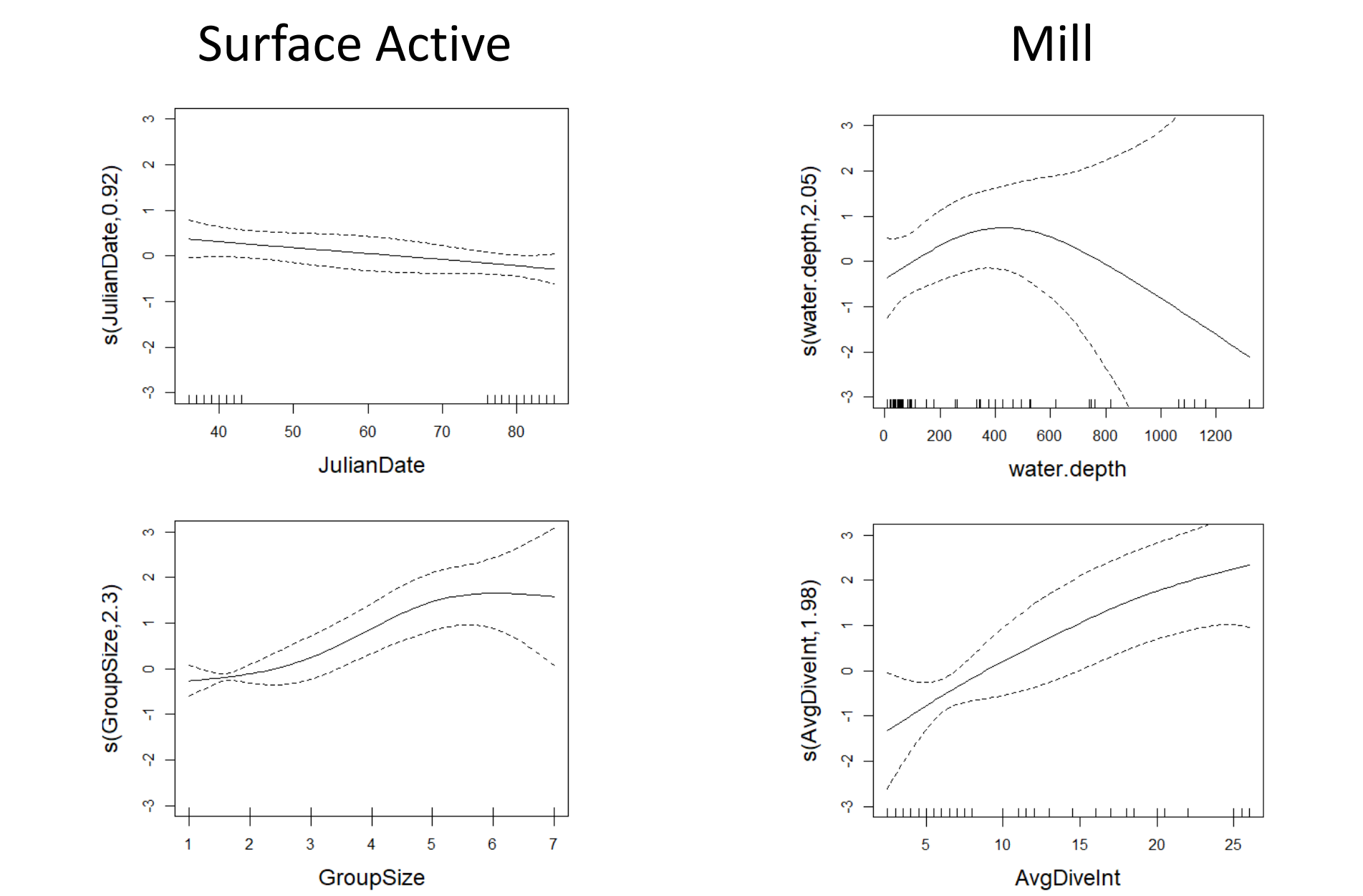


Figure 6 – GAM results of Surface Active behavior

Figure 7 – GAM results of Mill behavior

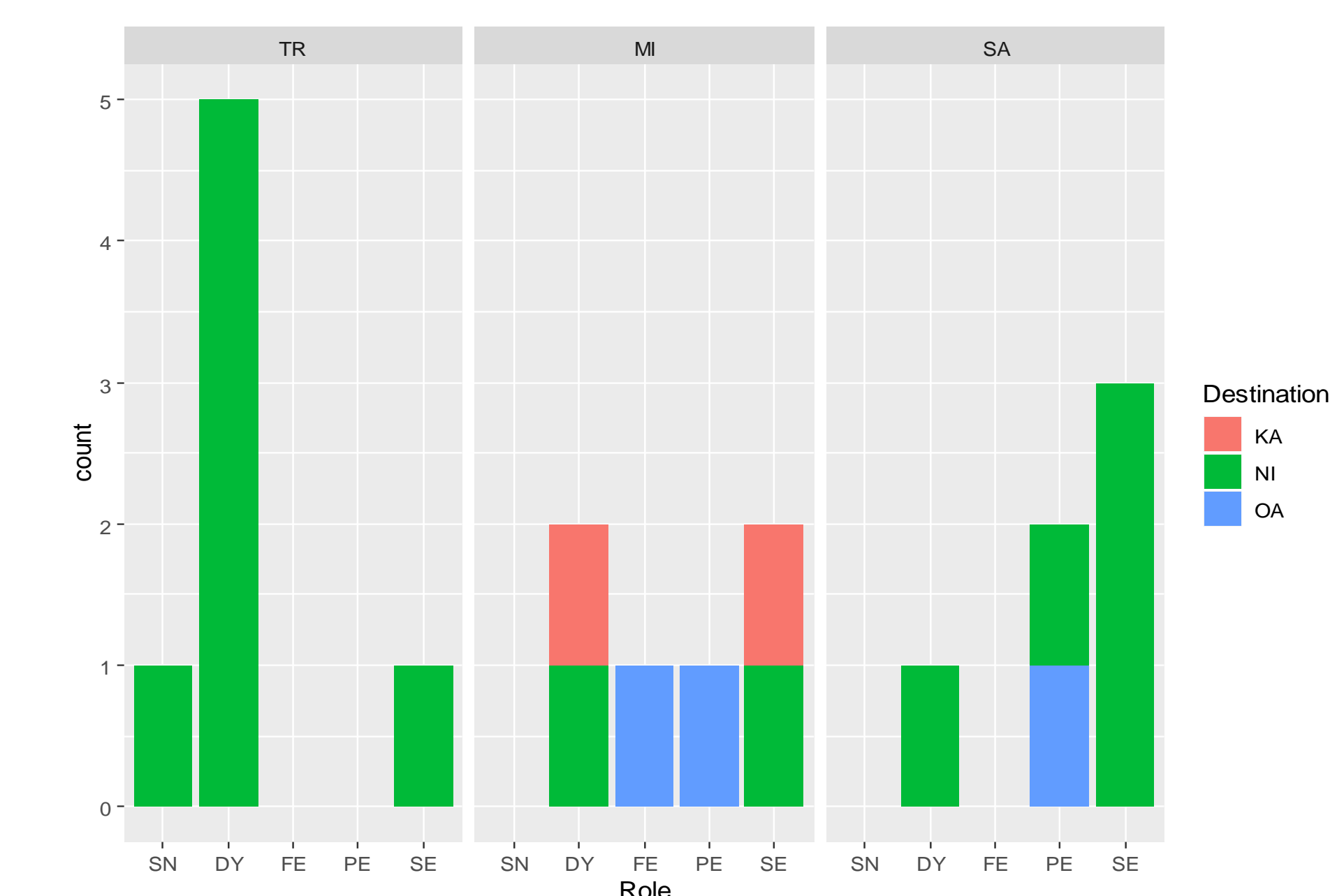


Figure 8 – Bar plots of Destination of tagged humpback whales by behavior and role

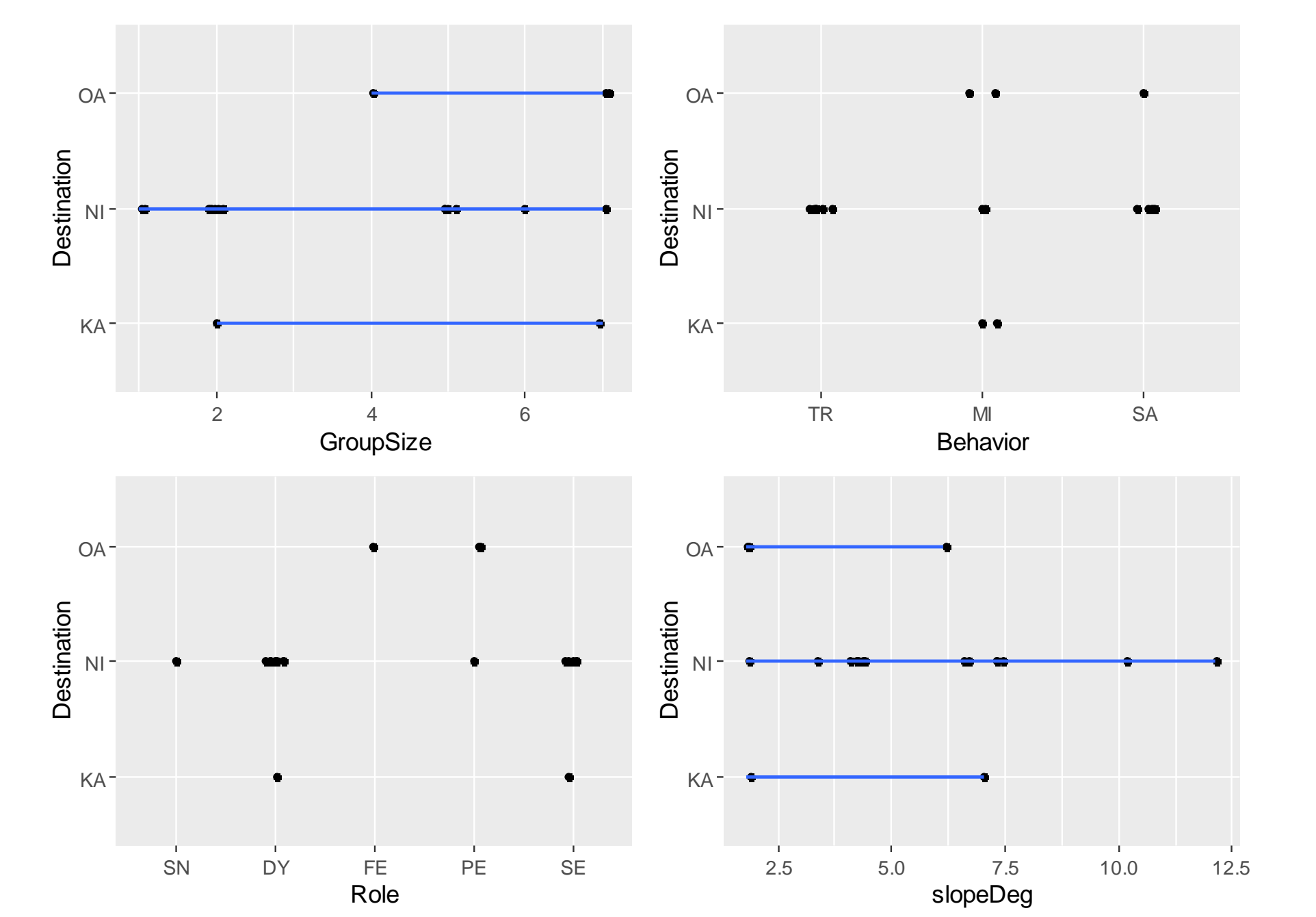


Figure 9 – Plots of multinomial model variables for each Destination of tagged whales