The Effect of Marine Traffic on Bottlenose Dolphin (*Tursiops truncatus*) Behavior in the Ría de Arousa in Galicia, Spain

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Background

Due to a large, worldwide distribution, bottlenose dolphins encounter **disturbances due to human activities**, and consequently, face increased threats at both the individual and population levels

General trend toward **urbanization** in coastal regions → Increased levels of **marine vessel traffic**

- Disrupt bottlenose dolphin normal activity due to **noise, speed, and mobility** of vessels

Ría de Arousa

- Resident population (56 – 144 individuals)
- Marine vessel traffic
  - *Mussel Farm Boats*: 2,000 bateas (mussel farm platforms) where mussels grow on long lines below
  - *Fishing Vessels*: Intense upwelling events → Enhanced level of primary production → Supports large populations of fishes
  - *Dolphin Watching Catamarans*: Stimulate local economic development and teach the public about ecosystem conservation

Objectives

- **Behavioral Transitions:** How does marine traffic affect how a group changes behaviors between a specific five-minute behavioral sample and the one that immediately succeeds it?
- **Behavioral Budgets:** How does marine traffic affect the proportion of time a group spends in each behavioral state?
- **Behavioral Bout Durations:** How does marine traffic affect how much time a group spends continuously exhibiting a specific behavior?

Methods

Data Collection

- Land-based observations in O'Grove between April 4, 2018 and May 29, 2018
- Conducted systematic collection sets (surveys) every 20 minutes
  - Collected environmental and anthropogenic data
- Conducted behavioral samples every five minutes upon sighting a group
  - Collected group and vessel data

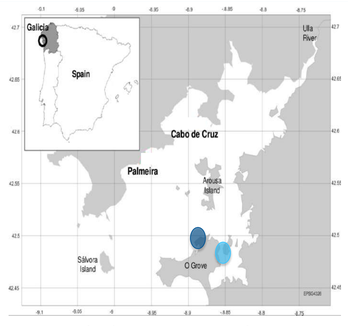

Fig 1. Ría de Arousa in Galicia, Spain. Rons Beach (dark blue) and La Toja Island (light blue).

Group Behavior

- **Traveling**: Persistent and directional movements; Rhythmic surfacings
- **Feeding**: Frequent directional changes; Longer dives; Rapid surfacings
- **Socializing**: Active surface and underwater interactions with group members
- **Resting**: Sluggish movements; Slow surfacings

Types of Marine Vessel Traffic

- Mussel farm boat, large or small fishing vessel, artisanal trawler, seine, outboard, inboard, catamaran

Fig 2. Bottlenose dolphins exhibiting social behavior in front of bateas and a mussel farm boat in the Ría de Arousa.

Analysis

- Statistically compared each control situation (absence of marine vessel traffic) with its corresponding impact situation (presence of marine vessel traffic)
- **Behavioral Transitions:** How a group changes behaviors between successive five-minute behavioral samples
- **Behavioral Budgets:** Proportion of time a group spends in each behavioral state
- **Behavioral Bout Durations:** How much time a group spends continuously exhibiting a specific behavior

Results: Behavioral Transitions

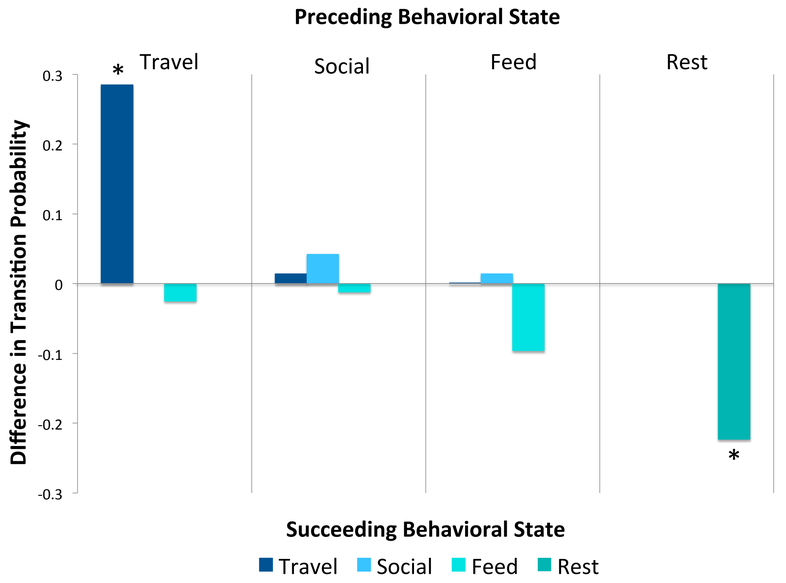

Fig 3. Differences in behavior transition probabilities between control and impact situations. Significant behavioral transitions are indicated (* $p < 0.05$).

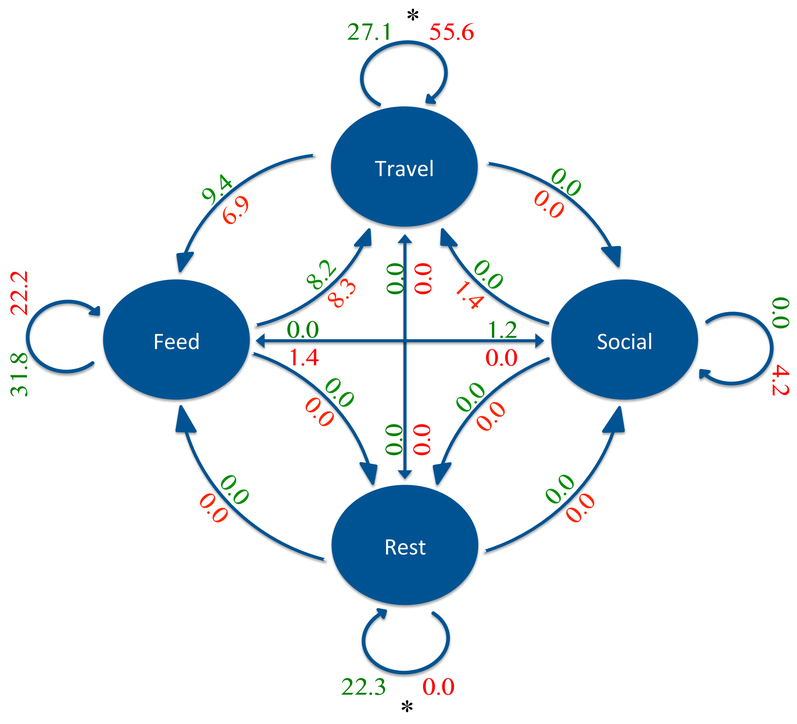

Fig 4. Behavioral transition probabilities for all possible behavioral transitions. Green values show control situations and red values show impact situations. Values are displayed as percentages. Significant behavioral transitions are indicated (* $p < 0.05$).

Results: Behavioral Budgets

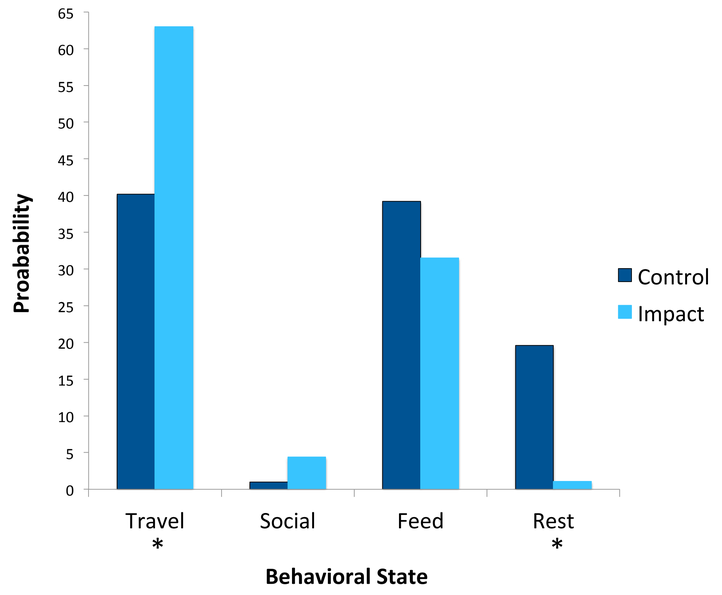

Fig 5. Behavioral budget probability distribution during control and impact situations. Significant behavioral budgets are indicated (* $p < 0.05$).

Results: Behavioral Bout Durations

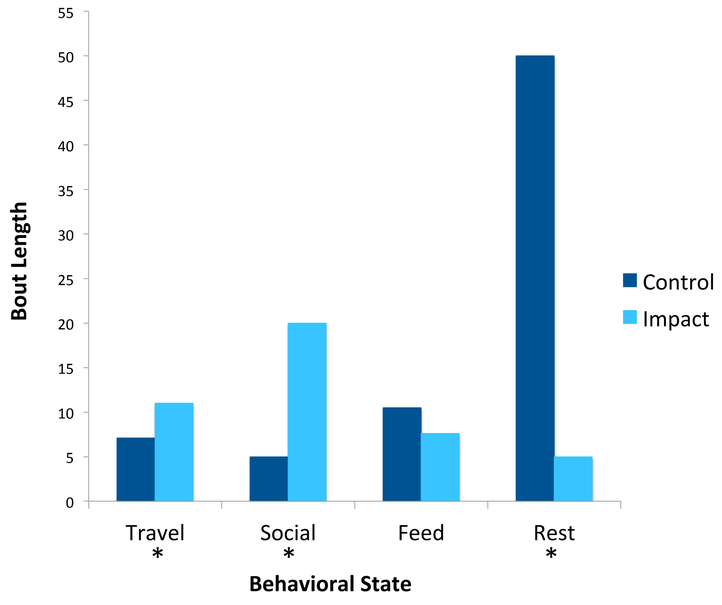

Fig 6. Average bout length of each behavioral state during control and impact situations. Significant behavioral bout lengths are indicated (* $p < 0.05$).

Implications

Short-term, direct consequences observed in this study:

- **Behavioral Transitions**
  - More likely to continue traveling
  - Less likely to remain resting
- **Behavioral Budgets**
  - Evidence of horizontal avoidance
    - More time traveling
    - Less time resting
- **Behavioral Bout Durations**
  - Longer traveling bouts
    - Longer socializing bouts
    - Shorter resting bouts
- May result in long-term decreases in reproductive success and survival at both the individual and population levels

Understanding dynamics between bottlenose dolphin behavior and anthropogenic behavior is essential for the **creation and implementation of effective management and conservation strategies** for this ecosystem

Next Steps

- Improve local legislation and public awareness programs in **collaboration with locals** with the goal of conserving this resident population of bottlenose dolphins and the entire Ría ecosystem
- **Continued regular, systematic monitoring** of the Ría's bottlenose dolphin population and marine traffic

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