

A photograph of three dolphins leaping from the ocean. They are captured mid-air, with their bodies arched and tails still in the water, creating splashes. The background is a clear, bright blue sky. The dolphins are dark grey with lighter underbellies.

# Survival Analysis: Captive Bottlenose Dolphins in the U.S.

LAINE BEATTY

DA 6213

# Data Source

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## Original data set

- Compiled by The Pudding from NOAA Marine Mammal Inventory and crowd-sourced Ceta-Base
- 1946 through May 7, 2017
- 2194 observations from 36 species

## Bottlenose dolphins

- 1668 observations
- 1282 observations with birth and event dates



# Data Preprocessing

- **Age-specific analysis**
  - Time to event calculated from birth rather than entry into captivity
  - Estimated birth year for captured or rescued animals

# Data Preprocessing

- **Categorization of current or last location**
  - Lower accuracy for closed locations
  - 1221 remaining observations
  - 4 Types
    - Travel Destination (e.g., amusement parks, resorts)
    - Aquarium/Zoo
    - Research/Preserve
    - U.S. Navy

# Kaplan-Meier Log Rank Test

SAS: proc lifetest

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Summary of the Number of Censored and Uncensored Values					
Stratum	Location	Total	Failed	Censored	Percent Censored
1	Aquarium/Zoo	319	264	55	17.24
2	Navy	189	109	80	42.33
3	Research/Preserve	115	73	42	36.52
4	Travel Destination	598	359	239	39.97
Total		1221	805	416	34.07

Stratum	Mean Days to Event
1: Aquarium/Zoo	4801.5
2: U.S. Navy	* 9532.8
3: Research/Preserve	* 7689.6
4: Travel Destination	8161.0

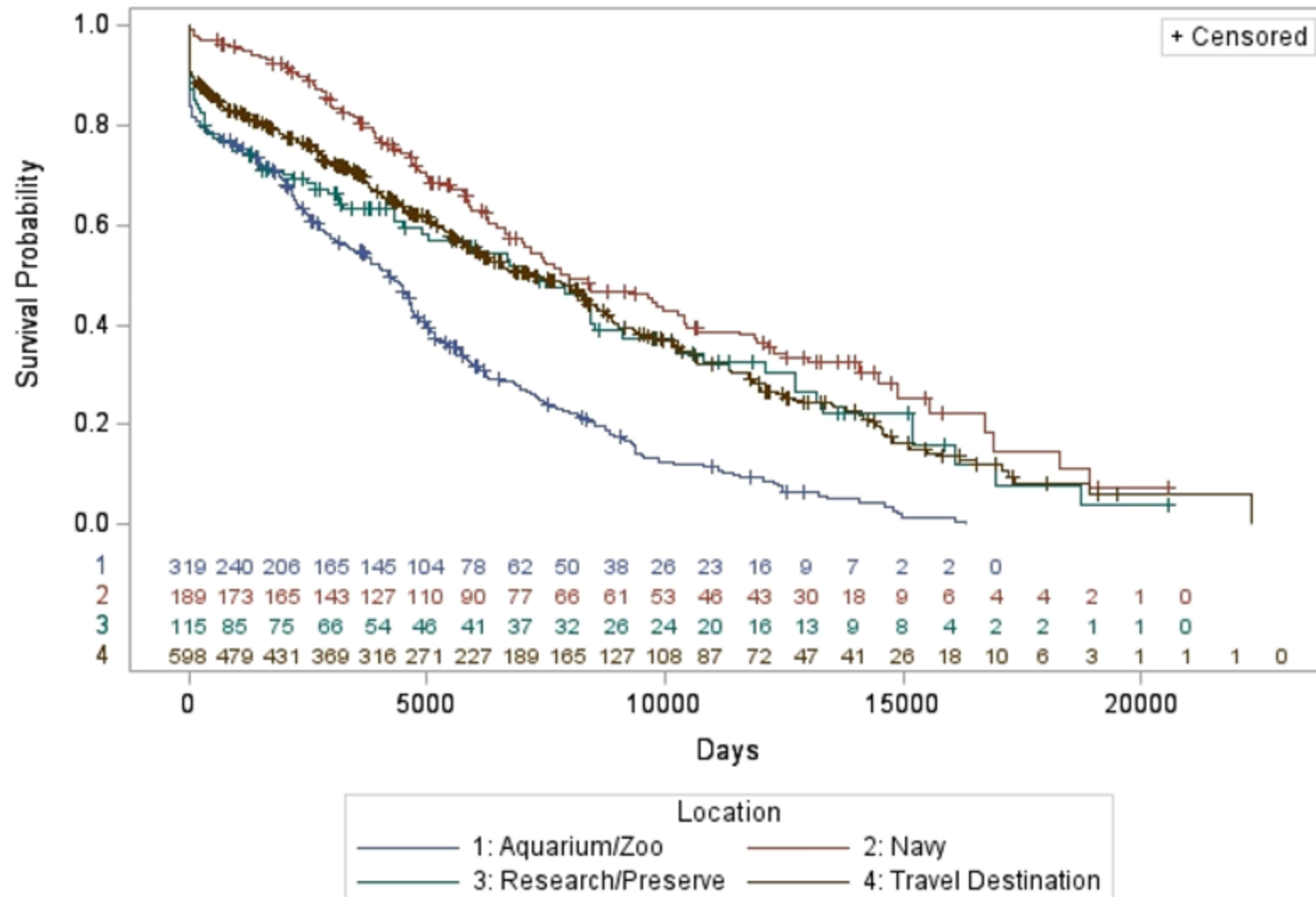
# Log Rank Results

## Significant differences

- Aquariums/Zoos
- Navy vs. Research/Preserve

Test of Equality over Strata			
Test	Chi-Square	DF	Pr > Chi-Square
Log-Rank	92.7731	3	<.0001

Adjustment for Multiple Comparisons for the Logrank Test				
Strata Comparison		Chi-Square	p-Values	
Location	Location		Raw	Sidak
Aquarium/Zoo	Navy	78.5176	<.0001	<.0001
Aquarium/Zoo	Research/Preserve	52.0643	<.0001	<.0001
Aquarium/Zoo	Travel Destination	46.5238	<.0001	<.0001
Navy	Research/Preserve	10.6332	0.0011	0.0066
Navy	Travel Destination	0.1066	0.7441	0.9997
Research/Preserve	Travel Destination	5.1179	0.0237	0.1339



# Survival Plot

- Lowest expected survival:
  - Aquarium/Zoo
- Highest expected survival:
  - U.S. Navy

# Cox Regression

SAS: proc phreg

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- **Origin**

- 1246 observations
- 3 Categories
  - Birth/Pregnancy
  - Capture
  - Rescue (Group 0)

Summary of the Number of Event and Censored Values			
Total	Event	Censored	Percent Censored
1246	828	418	33.55



# Cox Regression Results

- Highest Hazard Ratio
  - Birth/Pregnancy
- Lowest Hazard Ratio
  - Capture

Testing Global Null Hypothesis: BETA=0			
Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	26.3618	2	<.0001
Score	27.0810	2	<.0001
Wald	26.8111	2	<.0001

Analysis of Maximum Likelihood Estimates						
	DF	Parameter Estimate	Standard Error	Chi-Square	Pr > ChiSq	Hazard Ratio
Birth/Pregnancy	1	0.33766	0.24843	1.8473	0.1741	1.402
Capture	1	-0.04475	0.24760	0.0327	0.8566	0.956

# Potential Future Research

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Details of location  
(e.g., available  
space, feeding  
procedures)

Initial condition of  
animals

Number of  
transfers



# Reasonability Checks

# Sources

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Thomas, A. (2017). Free Willy and Flipper by the Numbers. *The Pudding*.  
<https://pudding.cool/2017/07/cetaceans/> Data accessed via:  
<https://data.world/the-pudding/cetaceans/workspace/file?filename=allCetaceanData.csv>  
on April 27, 2022.

Kohler, I. V., Preston, S. H. and Bingaman Lackey, L. (17 November 2006). Comparative mortality levels among selected species of captive animals. *Demographic Research*. Volume 15, Article 14, pp. 413-434, 17 November 2006. <https://www.demographic-research.org/volumes/vol15/14/15-14.pdf>