

## INTRODUCTION

- The Gulf of Maine is one of the most biologically dynamic and productive ecosystems on Earth (Townsend 1991).
- Its unique topography in addition to cold water temperatures aid in the abundance of surface nutrients, permitting marine life, including humpback whales, to be found in the Gulf of Maine throughout the year (Fautin et al. 2010).
- One location in particular, Jeffreys Ledge, is a humpback whale hotspot.
- The annual return of humpback whales to Jeffreys Ledge makes it possible to identify and track, as well as attribute demographic parameters such as sex, age class, and for females in particular, reproductive status, to individuals over time.
- Humpback whale gestation and lactation typically last 11-12 and 8-10 months respectively, while average calving intervals last approximately 2-3 years (Chittleborough 1958).
- Presently, there is no technique to determine female reproductive status solely on visual cues with the exception of the presence of a calf.

## OBJECTIVE

- The objective of this study was to determine the behavior of female humpback whales in the Western Gulf of Maine under different reproductive states in order to predict reproductive state based on visual cues.

## STUDY SITE

- Data utilized in this study was collected from Jeffreys Ledge in the Western Gulf of Maine located off the coasts of Massachusetts, New Hampshire, and Maine, as shown below.



Figure 1. Gulf of Maine.

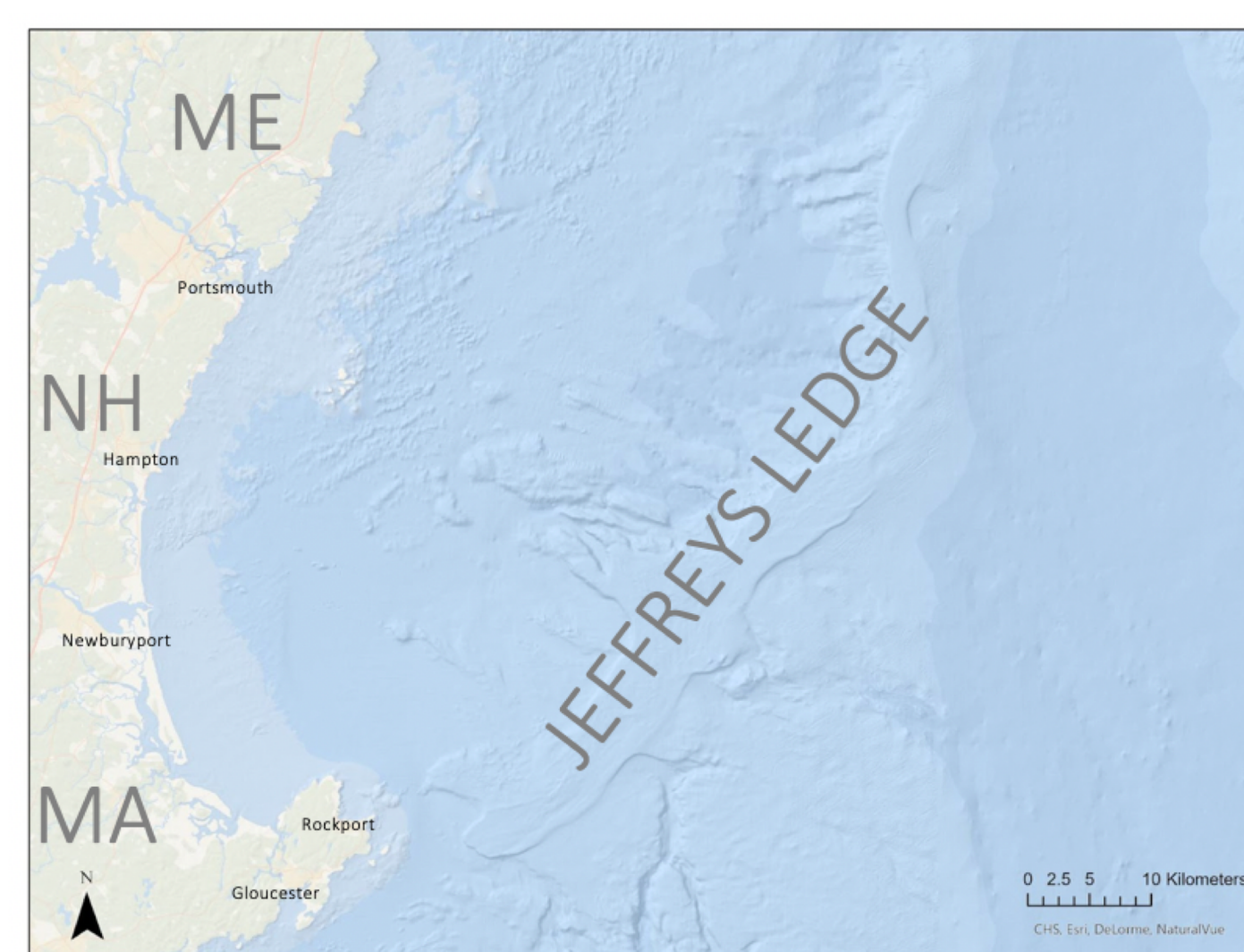


Figure 2. Jeffreys Ledge.

## METHODS

- Data was collected by naturalists and interns on and around Jeffreys Ledge between 2014 and 2019 on the *M/V Granite State* in conjunction with Granite State Whale Watch using handheld GPS units and paper data sheets.
- Data recorded included sighting metrics (time, location), species metrics (ID(s), number present, behavior), and anthropogenic metrics (buoys, boats present).
- Data was stored in Microsoft Excel and all analyses were conducted using the R programming language in conjunction with Rstudio version 1.4.1717.
- During analysis, demographic information regarding sex, age class, and reproductive state were added to each individual sighting.
- Reproductive states included pregnant (P), lactating (L), recovering (prior year lactation, R), no evidence (N), lactating/pregnant (LP), lactating/recovering (LR), recovering/pregnant (RP), and recovering/lactating/pregnant (RLP).

## RESULTS

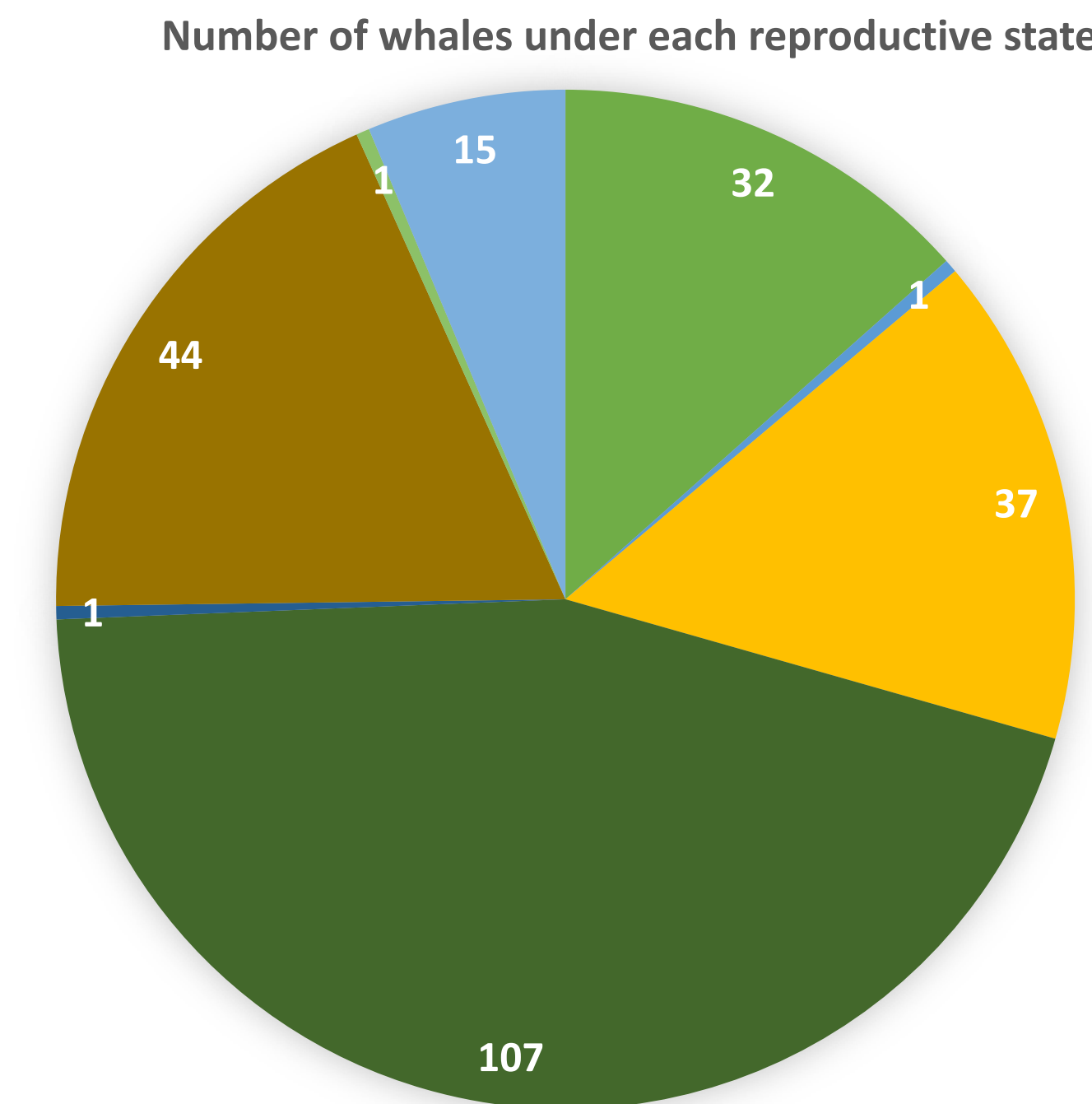


Figure 3. Number of female humpback whales recorded under each reproductive state. Numbers include whales with occurrences in different years of study period.

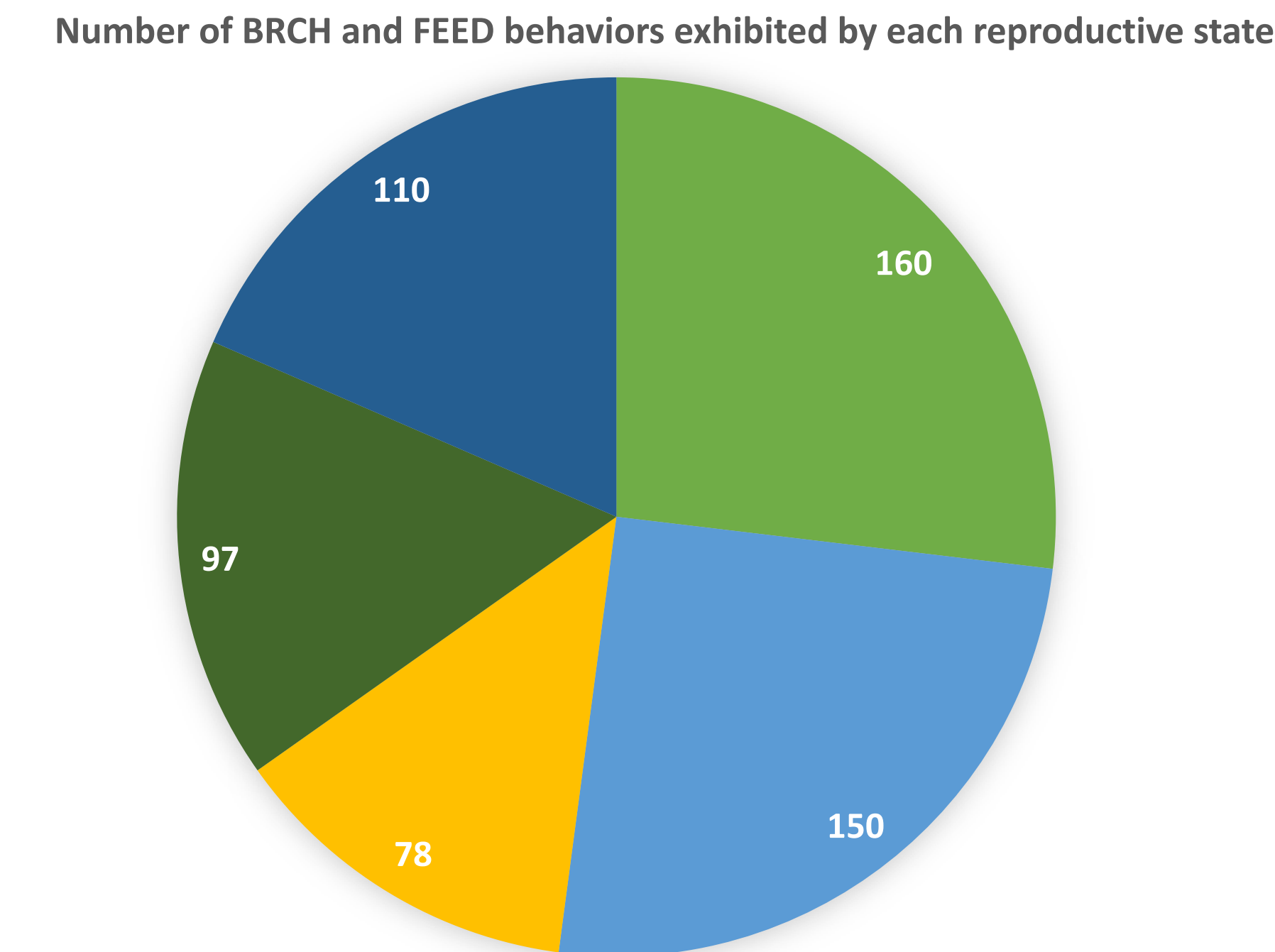


Figure 4. Proportion of BRCH and FEED behaviors exhibited female humpback whales under each reproductive state.

Table 1. Number of BRCH and FEED behaviors observed by female humpback whales under different reproductive states. Behaviors BRB through BRT are BRCH behaviors. Behaviors BLC through VBRL are FEED behaviors.

PLRNV	BRB	BRFL	BRH	BRS	BRSH	BRT	BLC	BLCD	CLD	DEF	FIL	FILD	FILPL	FLU/L	FLU/L	HTA	NET	NETD	SBRL	VBRL
L	5	3	7	0	13	15	11	0	51	20	17	0	7	2	2	0	0	0	0	7
N	0	3	3	0	10	8	25	0	48	8	4	1	1	4	3	2	3	3	3	24
P	0	0	0	0	5	4	9	0	26	15	6	0	3	3	2	2	0	0	0	3
R	0	2	0	0	3	16	11	0	38	10	6	0	2	0	0	0	0	0	0	9
RP	0	0	2	1	1	2	1	1	44	26	22	1	1	4	0	1	3	0	0	0



Figure 5. Lactating female humpback whale Jabiru (back) and her 2021 calf (front) preparing to go on a dive.

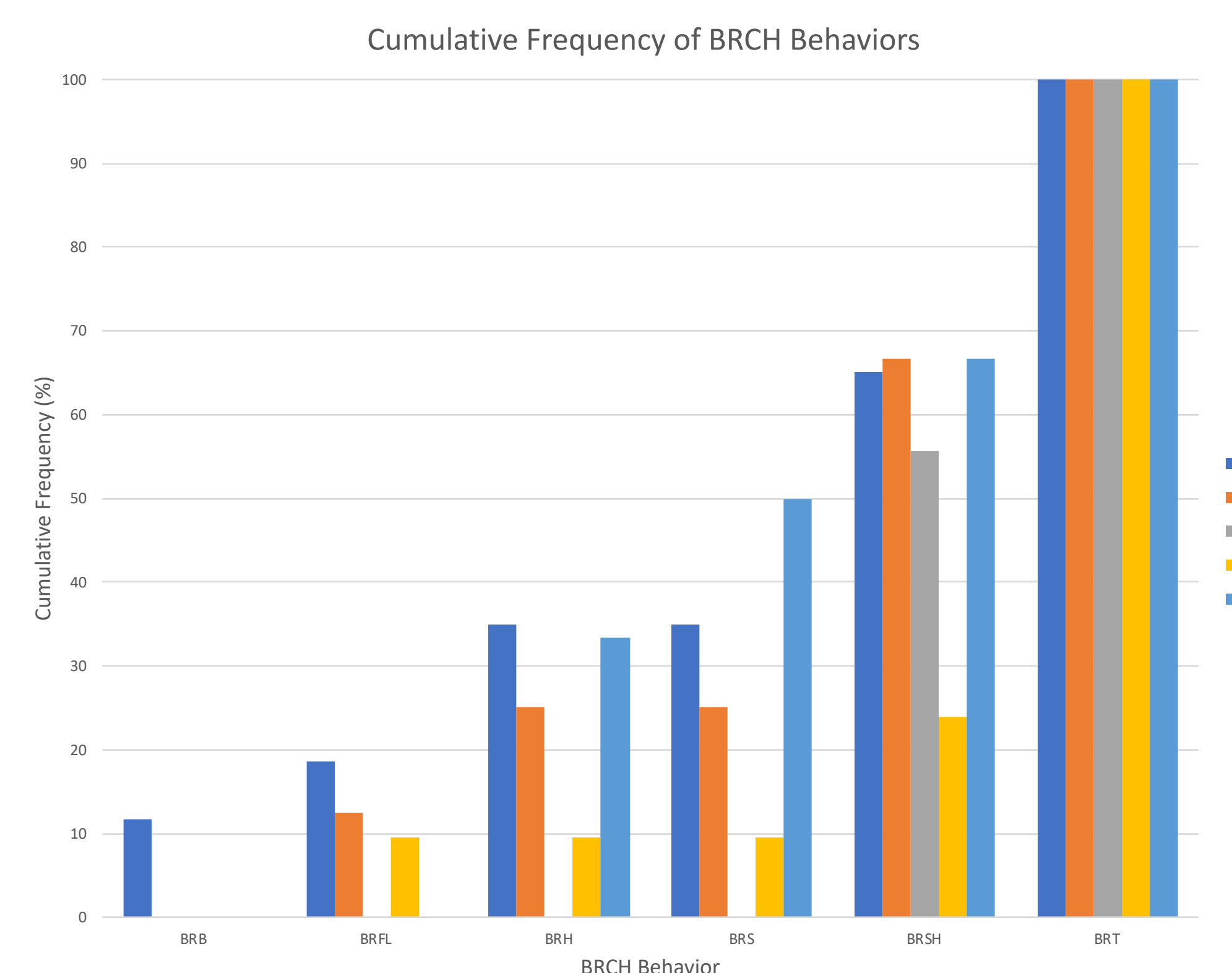


Figure 6. Cumulative frequency of BRCH behaviors in female humpback whales.

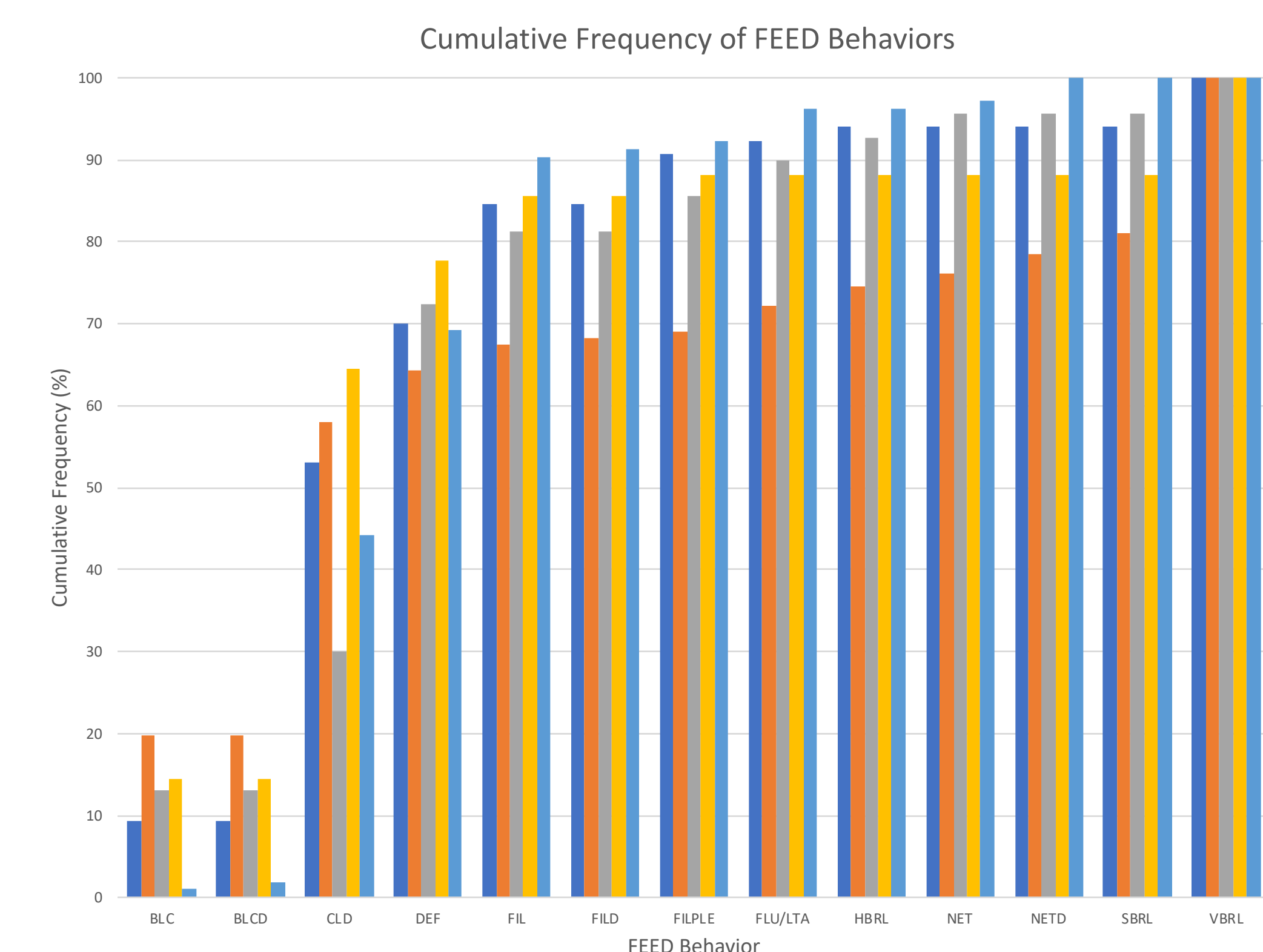


Figure 7. Cumulative frequency of FEED behaviors in female humpback whales.

## CONCLUSIONS

- Results **demonstrate differentiated behavior** between female humpback whales under different reproductive states.
- Lactating females exhibited more BRCH behaviors than any other reproductive state.
- Lactating (L) and Recovering/Pregnant (RP) females displayed BRT, FIL, and DEF behaviors at much higher frequencies than other reproductive states.
- Females with no evidence of reproductive state (N) completed more BLC and VBRL behaviors than any other reproductive state.
- This **suggests behavior could be used as a visual cue** for determining female humpback whale reproductive state.

## FUTURE RESEARCH

- Future work could expand:
  - number of boats used to collect data
  - number of years of sightings data
  - number of distinct behaviors analyzed

## Significance

- Visual determinations of female humpback whale reproductive state can be used to infer habitat usage, which can be used to create appropriate protections for vulnerable populations from anthropogenic threats such as entanglements and ship strikes (Hill et al. 2017; Johnson et al. 2005).

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