

# SEASONAL OCCURRENCE OF BLUE WHALE (*BALAENOPTERA MUSCULUS*) VOCALIZATIONS IN THE GULLY MARINE PROTECTED AREA

Emmaline Marotte<sup>1,2</sup>, Hilary Moors-Murphy<sup>1</sup>

<sup>1</sup>Fisheries and Oceans Canada, Bedford Institute of Oceanography, 1 Challenger Drive, Dartmouth, Nova Scotia, Canada, B2Y 4A2

<sup>2</sup>Dalhousie University School of Resource and Environmental Studies, 6100 University Avenue, Halifax, Nova Scotia, Canada, B3H 4R2

## 1 Introduction

The North Atlantic blue whale (*Balaenoptera musculus*) is known to frequent waters off eastern Canada during summer months. Many sightings have occurred in the Gully, a large submarine canyon located approximately 200 km off the coast of Nova Scotia, designated a Marine Protected Area (MPA) in 2004 because of its ecological significance [1]. During summer field studies, sightings of blue whales mostly occurred in the Gully in August while few were seen during limited survey efforts in other nearby areas [2]. Their winter occurrence in the area remains poorly understood. Blue whales have been listed as endangered since 2002 and information on their distribution throughout the year is key to establishing effective conservation strategies for the species. The purpose of this study was to examine acoustic recordings obtained from the Gully MPA for the presence of blue whale calls during both summer and winter months.

## 2 Method

### 2.1 Acoustic dataset

Acoustic data for this project were collected from bottom-moored hydrophones called Marine Autonomous Recording Units (MARU; © Cornell Lab of Ornithology) deployed by Dr. Hal Whitehead's lab at Dalhousie University as part of a larger cetacean monitoring project along the Scotian Slope [3]. For the present analysis, recordings from the head (GULH) and the mouth (GULM) of the canyon (Figure 1) collected during the summer (June-Sept 2006 at both locations) and winter (Dec 2006-Jan 2007 at GULM and Dec 2007-Feb 2008 at GULH) were examined.

Data were collected at a sampling rate of 50 kHz, thus frequencies up to 25 kHz were recoverable. Recordings were duty-cycled and a single seven or ten minute recording was collected every hour.

### 2.2 Analysis of call presence/absence

The dataset consisted of > 853 hours of recording and was too large to fully analyze manually, so an automated blue whale call detector developed by JASCO Applied Sciences was used to detect possible blue whale calls on the recordings. Each recording that contained at least one blue whale detection was aurally and visually inspected using spectrographic analysis software Raven Pro 1.4 (© Cornell Lab of Ornithology). When a detection was verified to be a

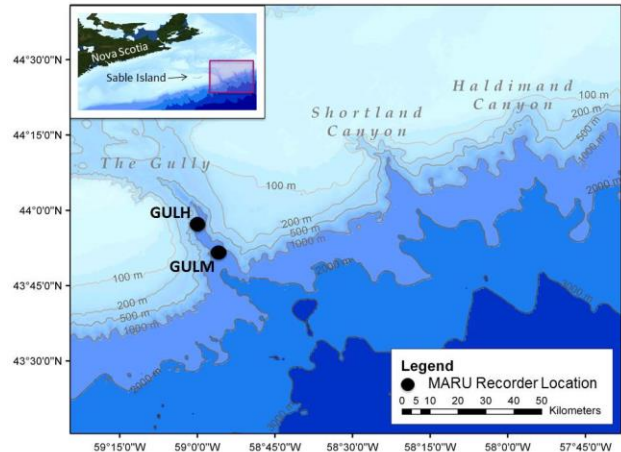


Figure 1: Location of the MARUs within the Gully.

blue whale call, it was deemed a true positive. The minimum proportion of recordings with blue whale calls present on them ( $P_{min}$ ) was calculated as the number of true positives divided by the number of recordings in the dataset.

When using automated detectors, two types of detection error need to be considered: the proportion of false positives (no blue whale call is heard or visually observed on the recording despite there being a detection, i.e., a false alarm) and the proportion of false negatives (no detection despite there being a verified blue whale call on the recording, i.e., a missed call). To determine the proportion of false negatives, 100 recordings with no detections on them were randomly selected from each deployment and inspected for the presence of blue whale calls.

## 3 Results

### 3.1 Call presence/absence

A total of 5695 recordings from the two locations were obtained. Of those, 787 had detections on them. Manual analysis revealed that 432 (55%) of those recordings contained blue whale calls (Table 1) resulting in an overall false positive rate of 45%.

Of the 400 analyzed recordings with no detections, 41 (10%) contained blue whale calls (Table 2). The proportion of false negatives was higher in summer than in winter; however, the false negative rate was relatively low overall for all four locations.

\* emma.marotte@dal.ca

† hilary.moors-murphy@dfp-mpo.gc.ca

**Table 1:** Blue whale call presence at all four locations. S = summer and W = winter.  $P_{min}$  is the minimum proportion of files within a dataset with blue whale calls present on them.

Deployment	Number of recordings with detections	Number of true positives	Proportion of false positives	$P_{min}$
GULM S	267	214	0.199	0.169
GULM W	162	44	0.728	0.035
GULH S	215	94	0.563	0.074
GULH W	143	80	0.441	0.042
TOTAL	787	432	0.451	0.549

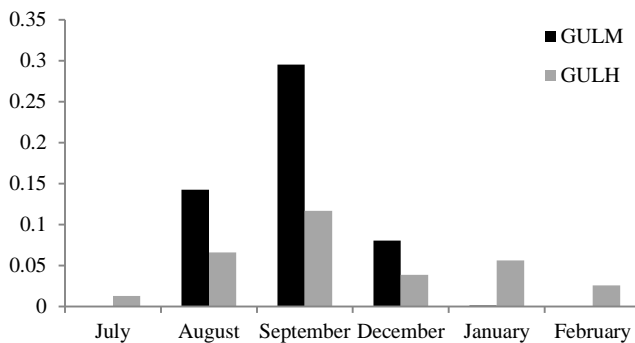
**Table 2:** Blue whale call absence analysis at all four locations. S = summer and W = winter.

Deployment	Number of recordings with no detections	Recordings with no detections examined	Number of true negatives	Proportion of false negatives
GULM S	1000	100	77	0.230
GULM W	1086	100	98	0.020
GULH S	1051	100	90	0.100
GULH W	1771	100	94	0.060
TOTAL	4908	400	359	0.103

### 3.2 Temporal and spatial variation

$P_{min}$  was higher overall in summer than in winter (Table 1) but varied between months (Figure 2). The highest proportion of calls occurred in September, followed by August and only a small number of calls occurred in July. Call presence diminished but continued into the winter months, with the highest proportion occurring in January.

$P_{min}$  was higher at GULM than at GULH in late summer and early winter. However, throughout January and February,  $P_{min}$  was higher at GULH (Figure 2). No recordings were obtained from GULM in February.



**Figure 2:** The mean minimum proportion of recordings with blue whale calls present on them ( $P_{min}$ ) for each month in which blue whale calls were identified.

## 4 Discussion

Because the detector missed some calls, the results presented here are likely to be underestimates of blue whale presence, especially for the summer months. The percentage of calls missed by the detector is generally low but does vary with deployment. This is likely a reflection of varying levels of system self-noise present on the recordings and

differences in background ambient noise levels between seasons.

Many studies suggest that North Atlantic blue whales migrate to southern breeding areas during the winter [4]. Due to limited survey effort, blue whale occurrence in the Gully in winter has not been previously assessed. Results from this study present the first evidence that at least some blue whales remain in the Gully during winter months. Increased calling rates in summer may indicate a higher number of individuals in the area, or that individuals are simply more vocal during that time of year. Reasons for why blue whales call remain debated but it is believed that calling may be related to food availability or to mate selection [5].

## 5 Conclusions

That blue whales continue to use the Gully in the winter months suggests that the area may be an important winter habitat for individuals. Knowledge of blue whale seasonal occurrence is important for understanding their distribution, which in turn has implications for effective management and protection of this endangered species. Further studies are needed to better describe the how blue whales use the area throughout the year relative to other nearby areas.

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