# MOBILITY AND BURIAL OF VARIABLE DENSITY MUNITIONS IN THE SURF ZONE

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## MOTIVATION AND INTRODUCTION

Unexploded ordnance (UXO) resulting from past military activity are present in coastal settings. Mobility of UXO, specifically in the surf zone, constitutes a potential risk for the public. Mobility or exposure may increase under energetic events due to enhanced forcing or sediment erosion. Yet, the conditions leading to exposure, burial, or movement of UXO remain poorly understood. An additional aspect of interest is the bulk density of UXO that can alter mobility and burial.

## LAB EXPERIMENT

An overview of a large-scale laboratory wave flume (120 m x 5 m x 5 m) study (Figure 1) at the Institut national de la recherche scientifique (INRS) in Quebec City, Canada carried out from July 7 to September 23, 2022 will be provided. The aim of the study was to quantify the mobility and burial of variable density surrogate munitions at various locations on the beach profile in response to varying forcing conditions. An undistorted, scaled beach profile from Mantoloking, NJ was constructed using 0.28 mm diameter sand. Eighteen stations were established at roughly 5 m intervals to collect hydrodynamic, sediment process and morphology data. Over 150 munitions of varying bulk density were distributed throughout the flume. Seven waves cases were conducted with each case consisting of 5 or 10 trials of waves for roughly 30 minutes. Wave height, water level, and wave period were varied to generate different forcing conditions with the potential to lead to different migration and burial response. The resulting morphology and munitions position and burial characteristics were measured using GPS and sonar where appropriate.

## PRELIMINARY RESULTS

Beach profile data indicated that for low water level conditions the berm generally eroded and deposited sand offshore. High water levels caused the dune toe and berm to erode generating a mild sand bar. Munitions migration and burial data could only be collected when the flume was drained. From a practical standpoint, the flume was drained only after every two trials. Buried munitions were located with metal detectors. Position and orientation were determined by surveying into the local coordinate system the base and tip of cylindrical munitions (only the center of spherical munitions was surveyed). Additionally, the burial depth was quantified using a ruler. Munitions that had a net absolute travel distance after one trial less than 0.5 m were considered “stationary”. Bulk migration data for munitions that had a net absolute travel distance greater than 0.5 m are shown in Figure 2. Onshore migration is positive and offshore migration is negative. A large majority of munitions had small absolute migration distances of less than 5 m.

Figure 1 - Image looking onshore showing a drained flume, sensors the right and proud munitions.

Some munitions migrated over 30 m offshore while others migrated almost 20 m onshore. Munitions bulk density, cross-shore position, and beach slope are likely to be important for munitions migration. During the presentation, more detailed analysis of the munition bulk density and cross-shore position will be used to better categorize migration distance. In addition, hydrodynamics obtained from in situ data will be used to generate common dimensionless parameters such as the Shields number and mobility number to investigate correlative relationships. Finally, munitions burial data will be presented and related to the Keulegan-Carpenter number.

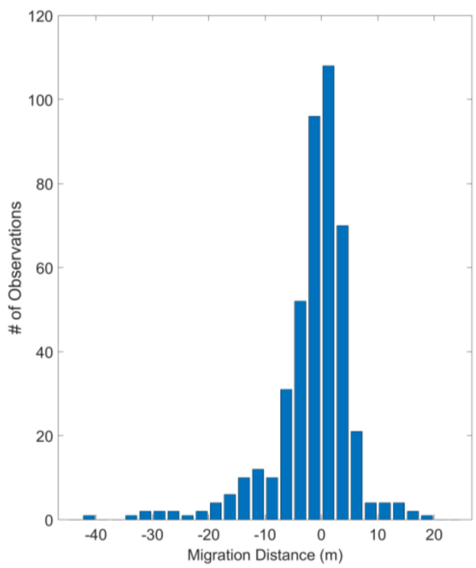


Figure 2 - Histogram of munition migration distance for munitions with a net absolute migration greater than 0.5 m.