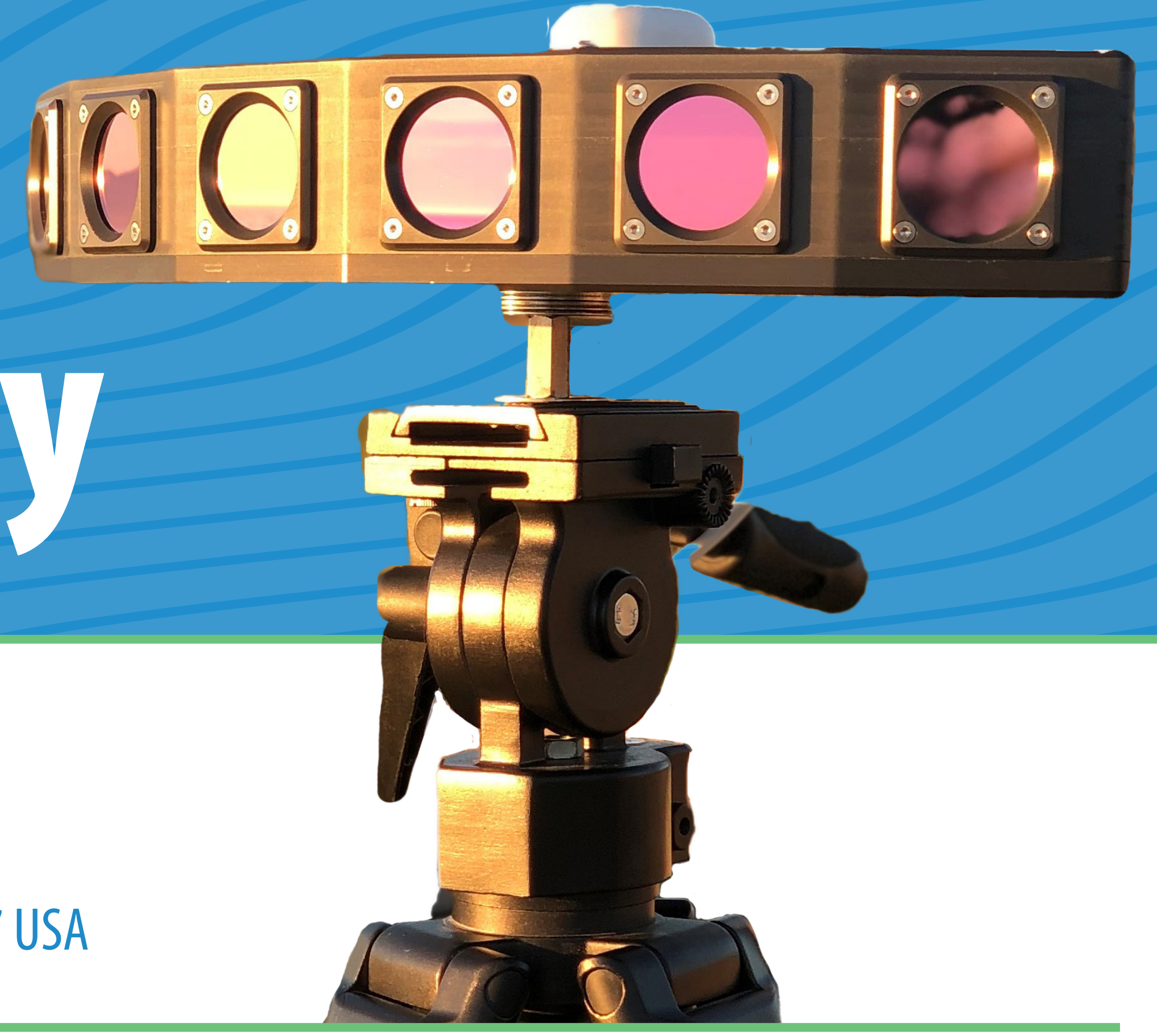


Visual marine mammal detection is improved by using infrared technology



Authors: Sarah Penney-Belbin¹, Christina Tombach Wright², Valerie D. Moulton¹, Meike Holst¹, Kevin Sullivan², Mike Wiatt², Jon Waltman², and Kochise Bennett²

¹LGL Ltd. 1655 Topsail Road, Paradise, NL, A1L 1V1, Canada, ²Toyon Research Corporation: 6800 Cortona Dr. Goleta, CA 93117 USA

Use of an Infrared-Camera System to Detect Marine Mammals from a Seismic Vessel

Introduction

- Toyon developed a long-wave infrared (LWIR) camera to detect blows from large whales.
- Toyon created the Whale Spout Detector software which uses a trained deep neural network (AI) classifier to automatically detect and classify whale blows and other targets.

Methods

- In 2022, the LWIR system was deployed on three vessels – two in North Atlantic and one in North Pacific.
- A total of 1,921 hours of LWIR video were collected over 87 days.
- Independent review of the data was performed by LGL (~63 hours of IR video).
- LGL compared data: auto detections ↔ manual IR video review ↔ marine mammal observers (MMOs).

Results

- LWIR system successfully detected whale blows during:
 - Daylight and darkness.
 - Patchy fog and minor to severe glare.
 - Calm to rough sea states.
- Estimated detection ranges to blows were similar for the LWIR system and MMOs.



Marine Observer infrared autodetection of a humpback whale blow at a range of 60 m from the IR camera mounted on the vessel.

Species/Group	LWIR System	MMO
Fin Whale	3	10
Fin/Sei Whale	1	2
Humpback Whale	17	17
Unidentified Baleen Whale	2	3
Sperm Whale	4	7
Long-finned Pilot Whale		3
Sowerby's Beaked Whale		1
Unidentified Whale	8	1
Unidentified Marine Mammal	23	
Total	58	44

TABLE 1
Whale sightings within LWIR camera's field of view from subset of LWIR video analyzed for all vessels & environmental conditions combined. (Species/Group identified during manual review/MMO watches).

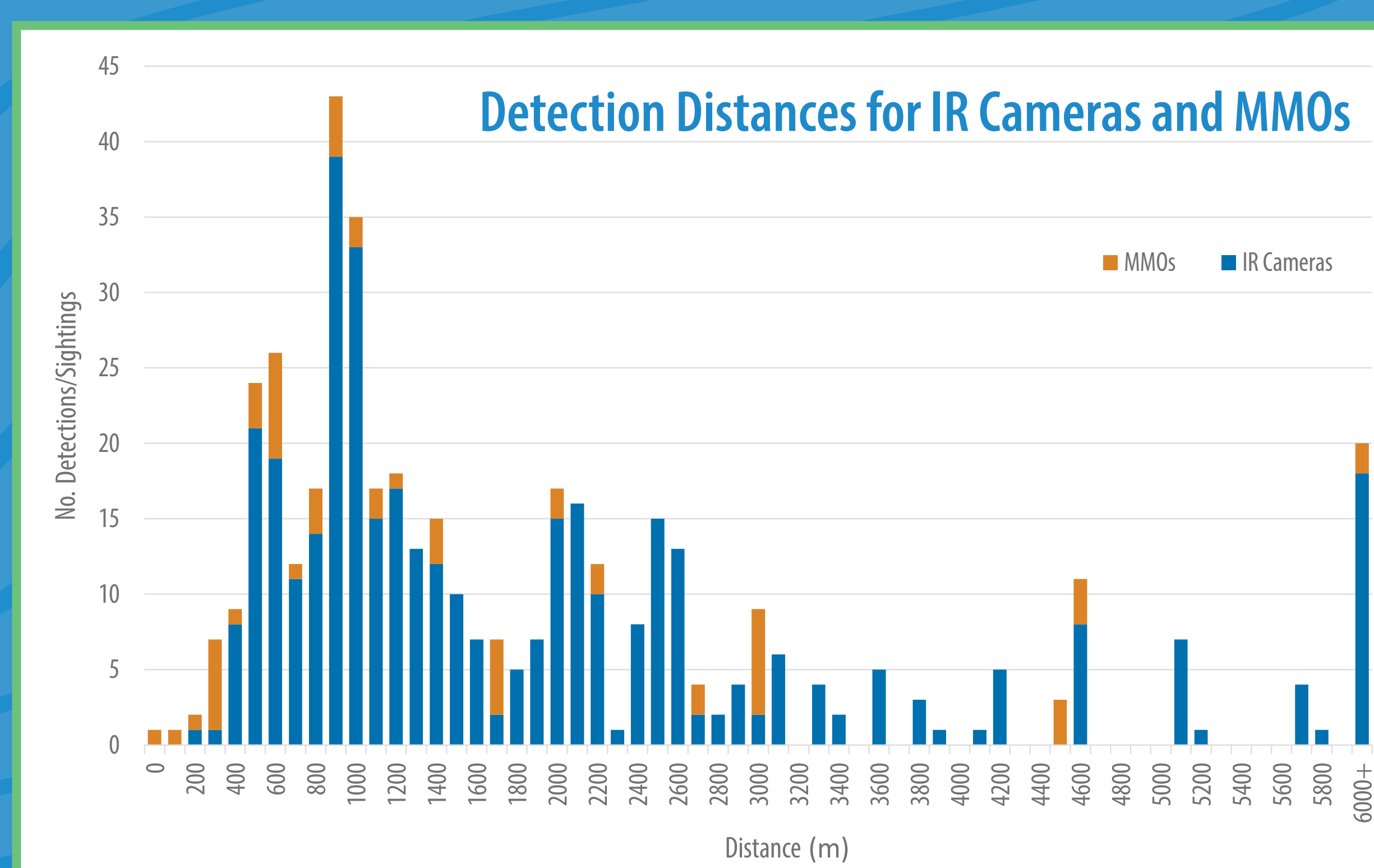
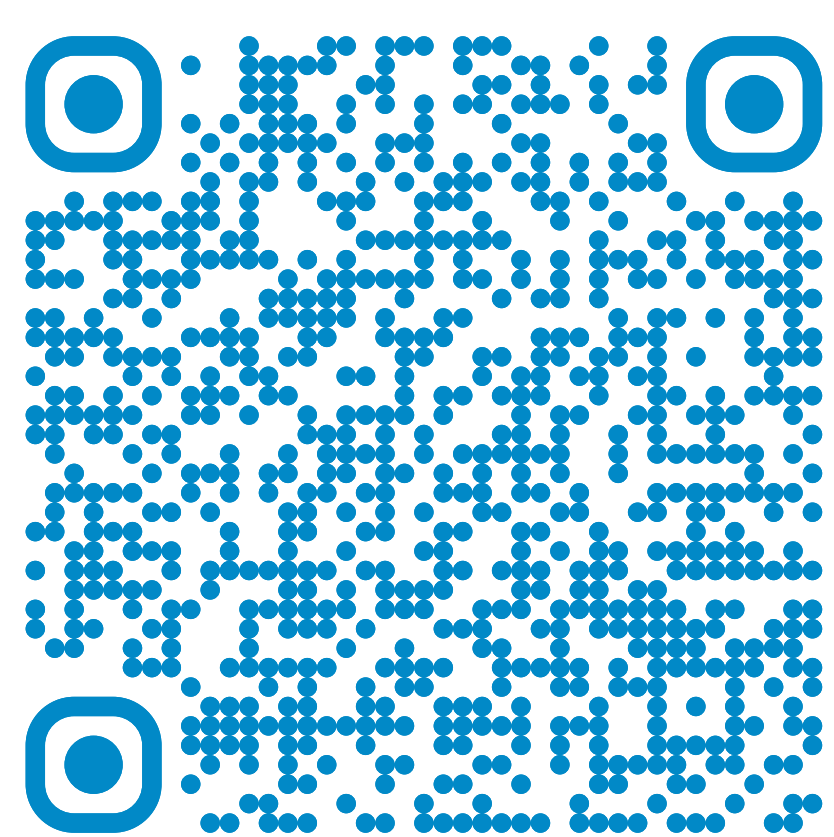


FIGURE 1
Detection distances to marine mammals by the Marine Observer LWIR system and MMOs, all vessel deployments and environmental conditions combined (includes duplicate detections/sightings).

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IR Video Dataset	No. Hours IR Video Analyzed	No. Detections
Groundtruthing (Daytime)	24.8	242
Darkness	21.5	13
Fog (Thick/Variable)	5.0	1
Fog and Rain	1.0	0
Rain	1.5	0
Glare (severe)	8.0	133
BWF Category 1	3.9	42
BWF Category 2	16.6	41
BWF Category 3	10.9	65
Total		537

TABLE 2

True-positive (human confirmed) large whale detections by the LWIR System during different environmental conditions, all vessels and species/groups combined (includes duplicate detections; datasets selected to eliminate/minimize confounding environmental factors; 1 detection occurred during variable fog; BWF = Beaufort Wind Force [Cat.1 = BWF 1-2; Cat. 2 = BWF 3-5; Cat. 3 = BWF 6+]).