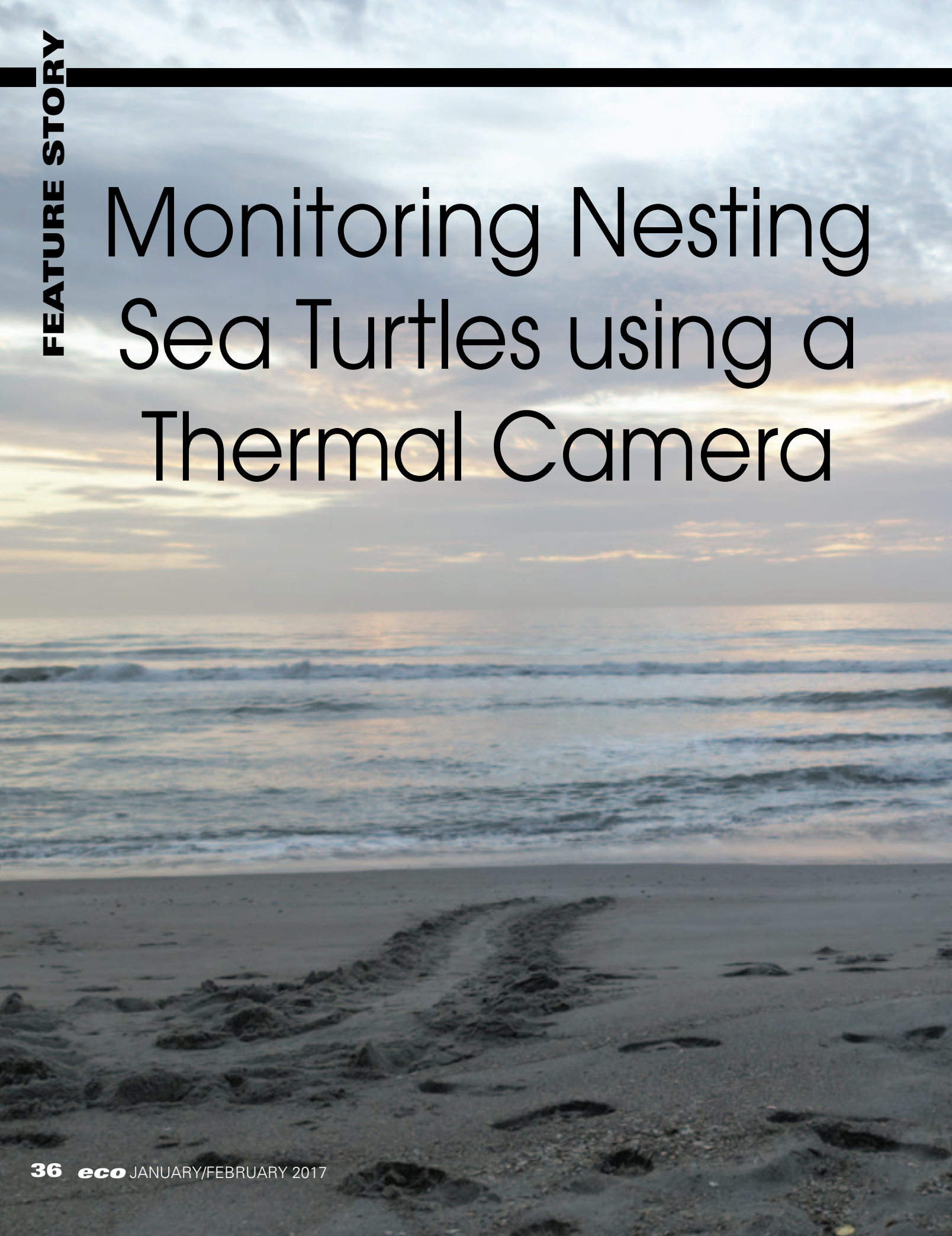
Monitoring Nesting Sea Turtles using a Thermal Camera



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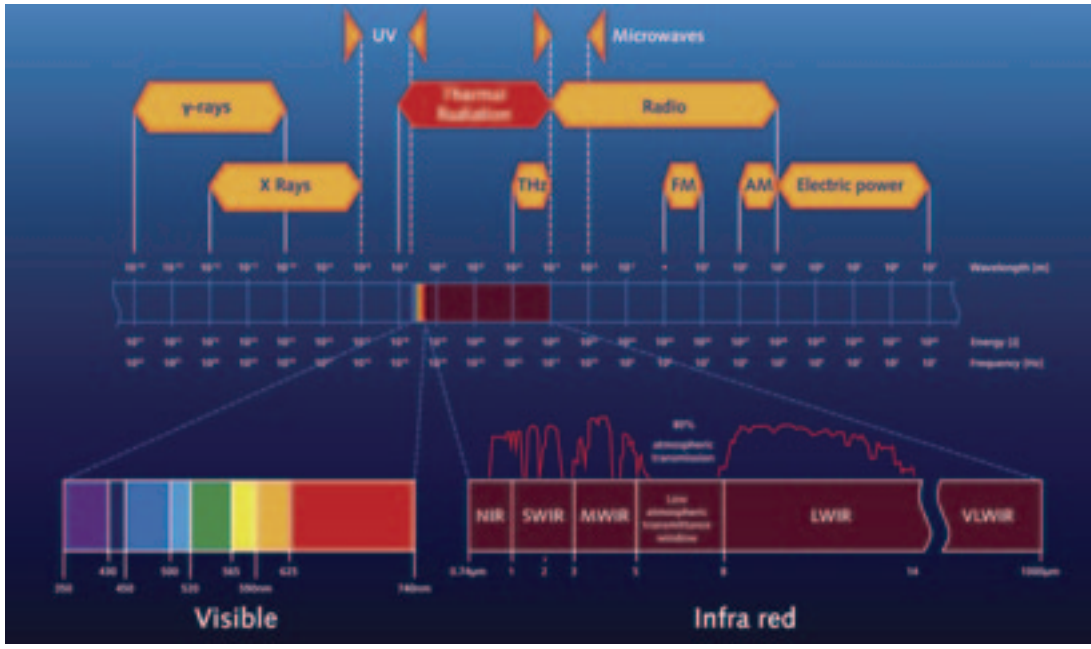
Every year, female sea turtles come ashore to nest on tropical and subtropical beaches around the world. The nesting period is an important time for sea turtle researchers because it represents one of the only opportunities to obtain the counts used to estimate sea turtle populations, many of which are endangered or threatened. Existing monitoring methods include nightly patrols of nesting beaches, however these patrols can be difficult to complete in remote locations and may require several individuals if nesting takes place along long stretches of beach. Additionally, beach patrols have the potential to unintentionally disturb turtles, causing them to return to sea without nesting, producing a false crawl, abandoning the nest, and, in some cases, leading to the release of eggs while at sea rendering them unviable.

An alternative to beach patrols may come in the form of enhanced monitoring technologies such as thermal cameras.

Sea turtles are ectothermic reptiles (their body temperature depends on the external environment), and the use of thermal imaging may seem counterintuitive. However, studies have demonstrated that sea turtles have some capacity to retain heat and, therefore, maintain body temperatures a few degrees above that of the surrounding environment (Standora et al., 1982; Sato, 2014). Leatherback sea turtles may have body-environment temperature gradients as high as 18°C (Bostrom and Jones, 2007). Body temperatures are also elevated when female sea turtles emerge from the sea and journey up the beach to nest (Sapsford and Hughes, 1978; Sato, 2014).

A loggerhead sea turtle emerges from the ocean and onto the beach before nesting. The image was captured during a July 2016 field study by Seiche Limited that tested thermal cameras for this application.

Unlike low-visibility cameras and night-vision devices, which operate in the near infrared (NIR) portion of the spectrum, long wavelength infrared (LWIR), also known as thermal infrared) devices do not require light and can operate in complete darkness. Thermal cameras (cameras operating in the LWIR) produce images based on temperature differences between objects. Therefore, thermal cameras positioned on nesting beaches should be able to detect sea turtles by sensing the small temperature differences in their body temperature compared to that of the surrounding environment, whether that be air, water, or sand.

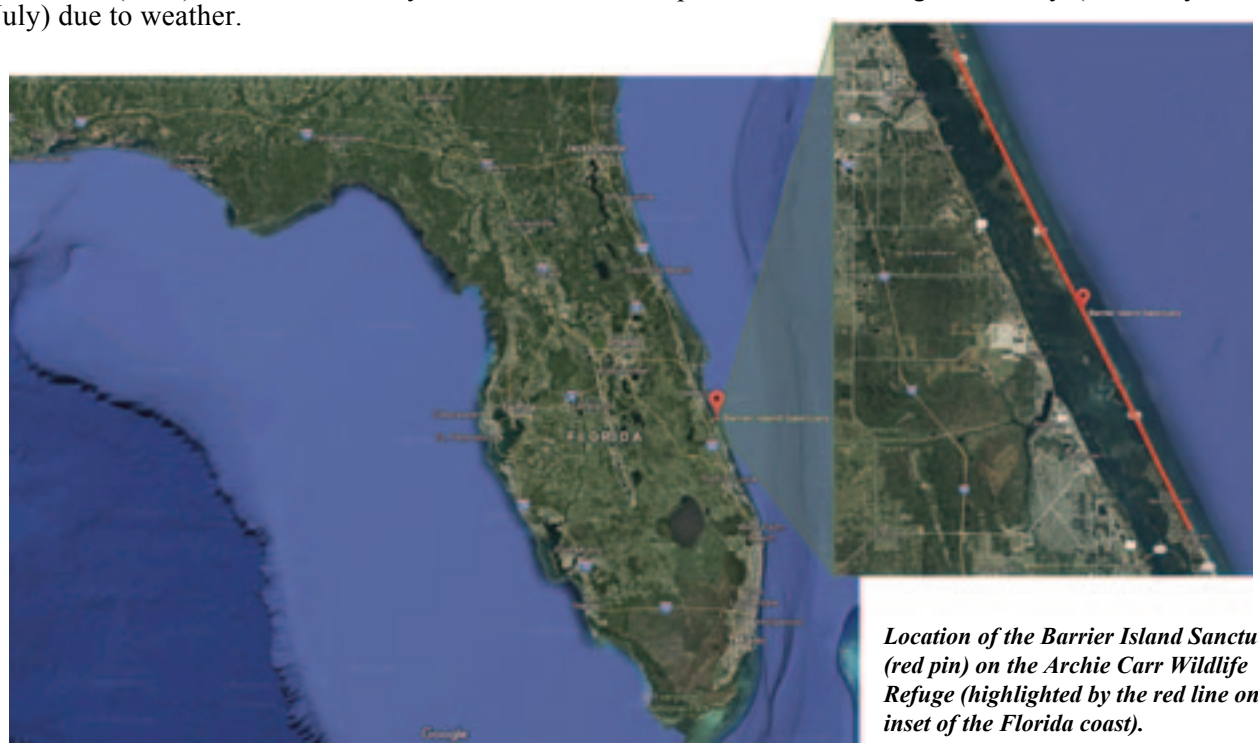


Electromagnetic spectrum.

Low-light technologies have been used to monitor sea turtles and hatchlings; however, little research has been conducted on the use of thermal cameras. To evaluate the efficacy of thermal camera technology to detect and monitor sea turtles, Seiche Limited conducted a field trial during the 2016 sea turtle nesting season in Florida under the permission of the Brevard County Environmentally Endangered Lands (EEL) program.

Methods

The field trial was conducted at the Barrier Island Sanctuary in Melbourne Beach, Florida. The Barrier Island Sanctuary is located near the center of the 20.5-mi Archie Carr National Wildlife Refuge, an important nesting site for loggerhead, green, and leatherback sea turtles. Monitoring was conducted between the hours of 2030 and 0200 (EDT) from 5 to 20 July 2016, with the exception of the evening of 11 July (and early hours of 12 July) due to weather.



Location of the Barrier Island Sanctuary (red pin) on the Archie Carr Wildlife Refuge (highlighted by the red line on the inset of the Florida coast).

The camera system, which consisted of a thermal camera (uncooled, 640 x 480 resolution), tripod, battery pack, laptop, and associated cables, was installed on the observation deck of the Barrier Island Sanctuary. The observation deck sat just above the dunes, providing a clear view of beach for approximately 1 mile to the north and south of the sanctuary.

The thermal camera was positioned to view down the beach at the start of each monitoring session and was repositioned as needed when sea turtles were observed on the beach. Real-time monitoring of the video feed was accomplished using a laptop computer. The brightness of the laptop display was reduced to its lowest setting, the display covered with a red cellophane sheet, and the laptop placed inside a hood to ensure light emissions were minimised (high levels of light can prevent nesting by females and disorient hatchlings). The camera software was programmed to record and save video files continuously while the camera was in operation.

Results

Approximately 51 hours of thermal camera data were collected over the study period. Sea turtles were recorded each day, with a total of 74 turtles observed. Turtles in the surf, emerging from the sea, excavating the nest (both body cavity and egg chamber), covering and camouflaging the nest, returning to the sea, and in the water were all captured on the thermal camera. Hatchlings crawling down the beach for the ocean were observed on one occasion.

The turtle crawl or track produced as the turtle completed the journey from ocean to nesting site and back again was clearly visible on the thermal camera. When viewed at close range, a high level of detail was observed for the crawls.

Discussion

The results of the field study are promising and provide valuable insight on potential applications of thermal imaging for the monitoring of sea turtles.

The instantaneous spatial coverage of a single thermal camera is greater than what a turtle observer would see with the naked eye during a beach patrol at night. Therefore, strategic positioning of multiple cameras at a nesting site would significantly reduce the field effort required to record nightly numbers of nesting turtles over the same area when compared to nightly beach patrols. In addition, fewer individuals on the beach conducting nightly patrols would likely result in less disturbance to nesting turtles. When used in combination with beach patrols, thermal cameras could provide details on the level of disturbance nightly patrols (those conducted on foot and/or with all-terrain vehicles) may have on the behaviors of nesting turtles, which could then be used to inform future survey protocols to minimize impacts.

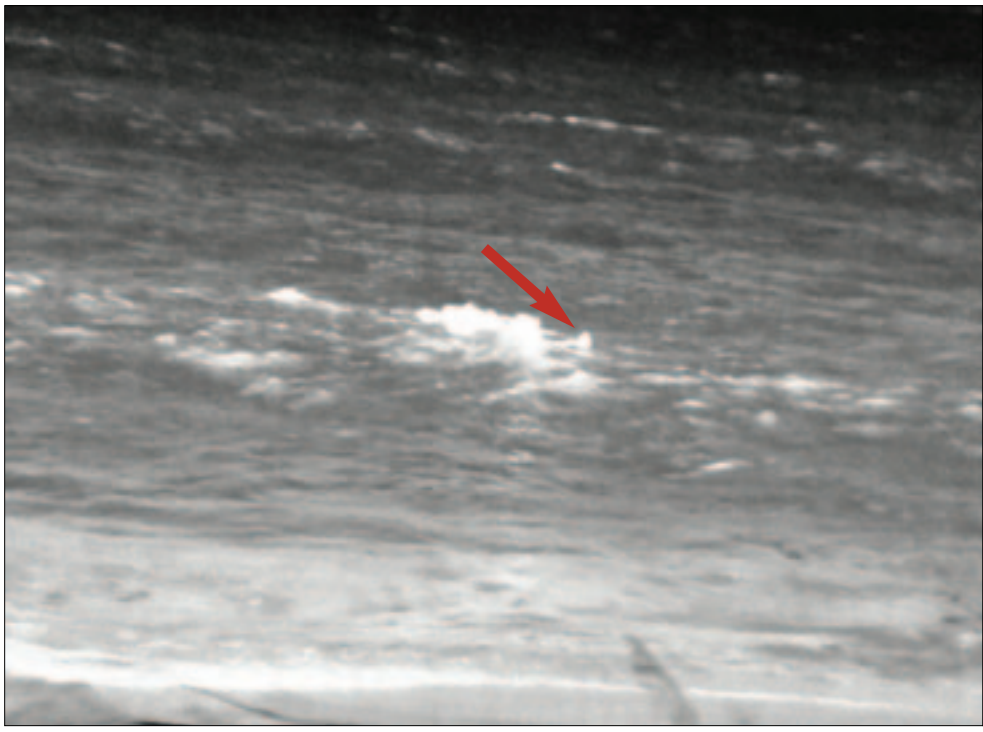
The camera system used for the field study is representative of a temporary set up. A semi-permanent installation would incorporate a high capacity computer to run the camera software and store data files, as well as a telemetry link that would enable data transmission to a central location for real-time monitoring and system checks.

Thermal camera with laptop (in thinkTANK hood) set up on the Barrier Island Sanctuary's observation deck.

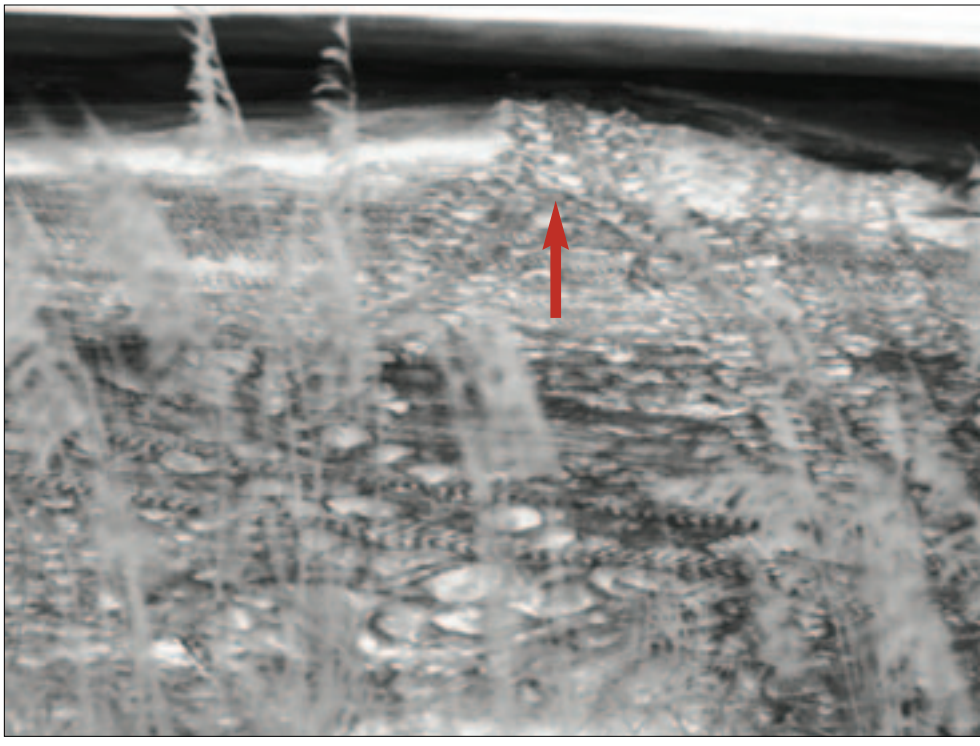
Auto-detection algorithms could facilitate detection and reduce the time needed to produce counts. The level of detail displayed from the crawls is quite high and may be sufficient to support species identification. Crawls are unique to species and are often used to identify and connect nests to species when the turtle itself is not observed. Additional algorithms could be used to identify turtles to species based on the turtle crawls.

The use of thermal cameras may be particularly beneficial for monitoring nesting turtles on remote and difficult to access nesting sites where daily beach surveys are not possible. These sites are often in areas where data for population estimates are deficient and the information obtained could inform conservation and management plans as well as provide insight on population status. Only occasional site visits would be required for system maintenance, such as battery replacement and hard drive exchange; however, these visits may be further minimized by using a renewable power source such as solar.

Thermal imaging cameras on nesting beaches would also provide greater details on the predation of eggs and hatchlings, poaching activities, and interactions between casual beach walkers and turtles. If the cameras are monitored remotely in real-time, environmental enforcement officers could be promptly alerted of poaching or other instances of turtle harassment. The cameras could also serve as a security measure for researchers and enforcement officers patrolling beaches with high levels of poaching.

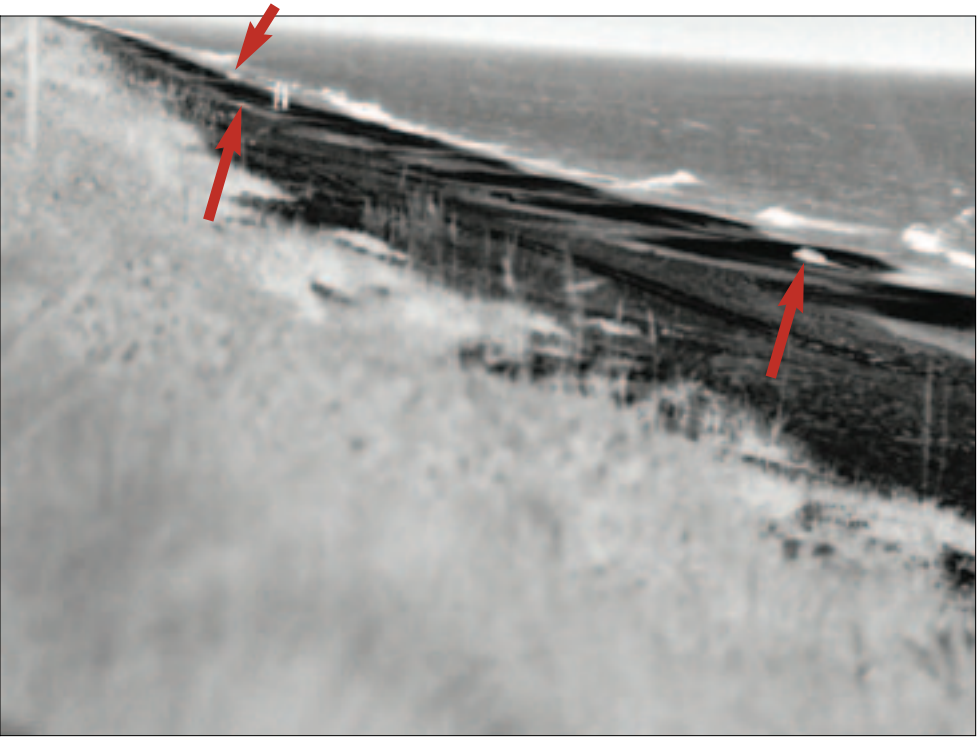


A turtle pops its head out of the water as it swims away from shore.

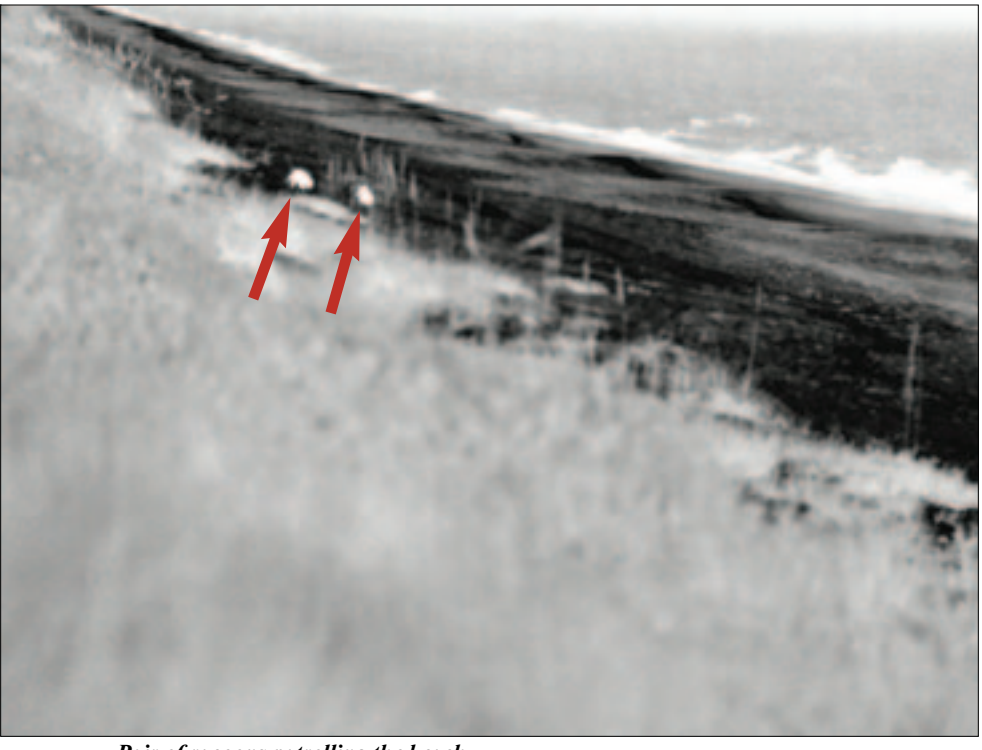


Loggerhead turtle crawl (red arrow) showing the alternating flipper pattern characteristic of the species.

In addition to the shore-based applications, thermal cameras may be used as a night-time detection tool for sea turtles on shipboard surveys. Currently, offshore surveys for sea turtles are limited to visual observations during daylight hours. Mitigation and monitoring programs for industrial activities (dredging, coastal construction, and activities emitting sound into the ocean) often include measures for sea turtles. The inclusion of thermal cameras may make mitigation programs more efficient for sea turtle detection. Detection of sea turtles at sea should be further evaluated, however, due to the low number of turtle detections in the water during this study.



Three turtles are visible in the image: one emerging in the foreground, one returning to the sea near the two people, and one emerging to the left of the people.



Pair of racoons patrolling the beach.

Shipboard surveys for marine mammals often incorporate passive acoustic monitoring for the detection of marine mammal vocalizations, however there is potential for missed acoustic observations during periods of reduced visibility due to variability of call rates between species and potential masking of vocalizations by vessel noise. Incorporating thermal imaging may improve the detection marine mammals as well as sea turtles. Seiche has conducted several at-sea trials for marine mammal detection and the results have been positive.

A key advantage of the use of thermal cameras for monitoring nesting sea turtles is a low level of disturbance. In addition to light emissions, sea turtles have demonstrated sensitivities to the presence of people while emerging from the ocean and excavating the nest, both of which often lead to nest abandonment. Thermal imaging is one technology among several innovative methods for studying marine wildlife and, especially for turtles, may prove to be a less intrusive method and enable the monitoring of sea turtles in locations previously too difficult to access—a positive solution for understanding sea turtle populations across the globe.

Acknowledgements

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