

Introduction

Counting the number of sea turtles in a population or area is difficult because they spend most of their time underwater, out of sight. Most counts of turtles are made at nesting beaches which accounts for the number of adult females nesting during a given time period. This has been very useful in determining the status and trends in the reproductive population but does not provide any information about the non-nesting adult females, adult males, juveniles, and subadult turtles. Furthermore, counting the number of sea turtles in the water can be very difficult, time consuming, and expensive. In-water counts have been done using divers towed behind boats, divers swimming over an area, aerial surveys involving manned aircraft and, more recently, unmanned aircraft (UAVs or drones). Surveys can also be done from land. Sea turtles are typically identified using mark-recapture methods that involve capturing a turtle—in-water or on land—and tagging it with a PIT and/or metal tag. However, this method can be time-consuming, expensive, and disturbing to the turtle. Recent studies have shown that the unique patterns in a turtle's facial scute can reliably be used for identification (Calmanovici 2018). This is a less invasive method of identification that requires photos of at least one side of the turtle's face and can be done either in-water or on land.

Hawaiian green turtles have been shown to establish resident foraging pastures in their subadult phase. Surveys of limited areas are possible by walking along the shore and recording the area where sea turtles are observed. This data can produce a sea turtle density distribution map within the area surveyed. By creating a density distribution map, sea turtle population managers, enforcement personnel, and community groups can focus their attention on specific areas where the turtles are most abundant. Repeated counts would be able to show population trends, habitat changes, population size and, given accurate size estimates and behavior records, provide more detailed information about the population.

Puakō is a 1.8 mile long residential community located on the west coast of Hawai'i Island (Figs. 1-3). Listed as a Critical Wastewater Disposal Area, sewage is documented to be entering the water table at Puakō and work is needed to reduce this anthropogenic impact with hopes of this occurring within the next few years (Wiegner 2018). Puakō is primarily made up of wide, shallow reef flats with turf algae that turtles feed on. As previous studies suggest, Puakō is an important juvenile and subadult foraging and resting area (Davis 2000). There are also basking and in-water resting areas (Figs. 16 & 17). The goal of this research was to determine which areas frequently saw high numbers of turtles, the size of a turtle population using this area, how the turtles were using the locations, and the frequency with which turtles use basking or resting areas.

Methods and Materials

Assessing Habitat Use of Puakō Shoreline

Data was collected during day and night surveys by walking segments of the Puakō coastline and recording waypoint number, GPS coordinates, turtle size, and turtle behavior. The Gaia GPS app (www.gaiagps.com) was used to record the data, and each turtle seen was saved as a new waypoint. Gaia GPS was chosen due to its ability to record specific waypoints on a track, attach a photo (or group of photos) to waypoints, and individually export the waypoints into gpx files without cost. Full surveys were typically completed in 2-3 segments that were accomplished within a few days of each other to keep conditions such as tide and wind as similar as possible throughout the survey. Between January and September 2022, 3 full day surveys were completed, which yielded a total of 411 waypoints. 3 full night surveys were also completed, which yielded a total of 344 waypoints.

For each segment, a GPS track was recorded, and each turtle observed was assigned a new waypoint (Fig. 18). When multiple turtles were located close to each other, waypoints were grouped together, but later separated manually for input into the ArcGIS Online map. Waypoints were recorded as near to the turtle as possible without disturbing it. Turtle behavior and size were recorded as a comment for each waypoint. A physical data sheet was also used to record this information. The size classes were based off of the estimated straight carapace length. Behavior was classified as feeding, swimming, basking (out-of-water), or resting (in-water).

After each survey, files were exported from Gaia GPS as gpx files, which were then converted into csv files. Segments were combined so that there was one file for all the daytime surveys and one for all the nighttime surveys. These files were then imported into a map on ArcGIS Online, where layers were created to show turtle distribution in the form of a heat map. Graphs were created to analyze the behavior and size class data.

Assessing habitat use of "hot spots"

Following the shoreline walking surveys, two daytime basking area "hot spots" were identified through the ArcGIS heat maps. These locations will be referred to simply as Basking Location 1 and Basking Location 2. Facial photos were taken of every turtle observed during additional surveys; both right and left side were taken when possible (Figs. 5-7). These images were uploaded to the facial recognition I3S Pattern program. The software serves to quickly find matches within a database allowing for the identification of each turtle (Fig. 4). Once turtles were identified, the date and location the turtle was observed and its behavior were recorded. If the turtle was not previously included in the Turtle Facial Shot database, it was added at this time. Between October 2022 and February 2023, turtles were photographed on 15 separate occasions. Photos were taken from an appropriate distance so the turtles were not disturbed during the process.



Figure 1. Puakō during the day

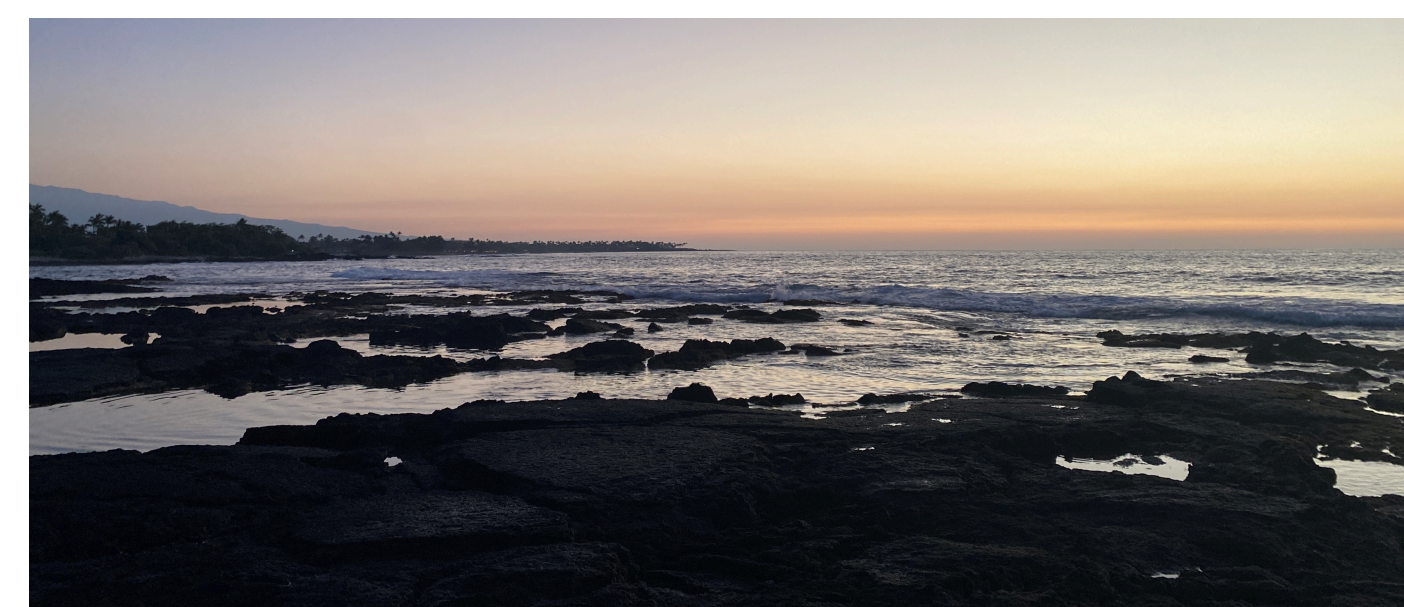


Figure 2. Puakō at sunset



Figures 3a & 3b. Puakō is located on the west side of Hawai'i Island

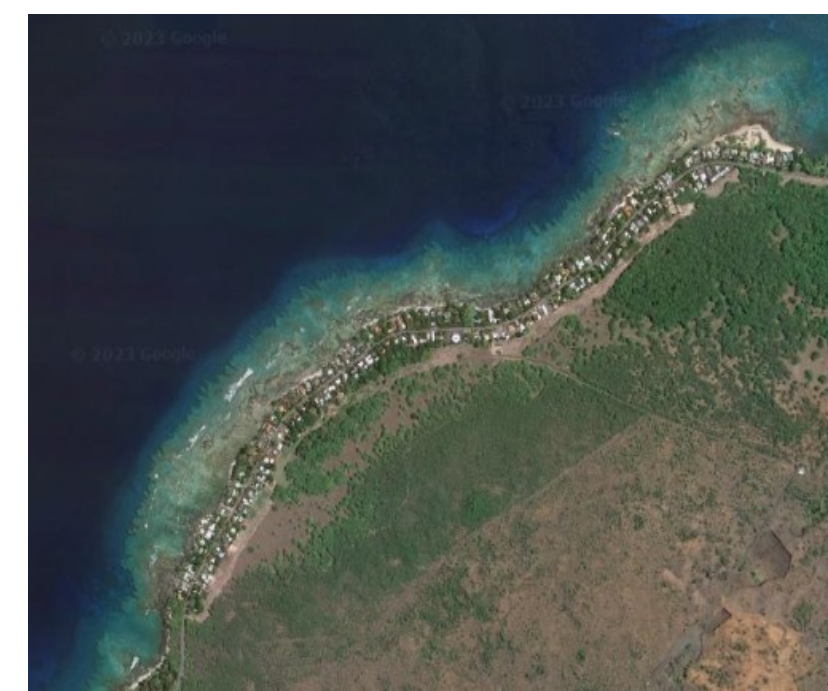


Figure 4. Key points are identified on turtle face by I3S



Figures 5a & 5b. Right (R-TFS) turtle facial photos and left (L-TFS) turtle facial photos of Turtle 120, seen 1 time at Basking Location 1



Figure 6. R-TFS for Turtle 86, seen 7 times at Basking Location 1



Figure 7. R-TFS for Turtle 90, seen 4 times at Basking Location 2

All photos taken by author.

Results

A total of 411 turtles were counted during the day surveys and 344 turtles were counted during the night surveys in a total area of approximately 0.2 km². An average of 137 turtles were seen during each of the 3 day surveys, and an average of 115 turtles were seen during each of the 3 night surveys. This is likely an underestimate of the population size as it only accounts for the turtles observed adjacent to the shore. As is evident through the ArcGIS Online heat maps, there were varying concentrations of turtles within the survey area. The areas with the highest concentrations of turtles (two hot spots) during the first day survey saw 25 and 29 turtles (Fig. 8), while the highest concentration of turtles for the first night survey (one hot spot) was 36 (Fig. 9). All subsequent surveys showed similar numbers. Identified daytime behavior consisted primarily of feeding (75%) and basking (14%) (Fig. 10), while nighttime behavior consisted primarily of in-water resting (60%) and basking (36%) (Fig. 11). Of the 755 turtles classified by size during the day and night, 53% were classified as small and 33% as medium (Fig. 12).

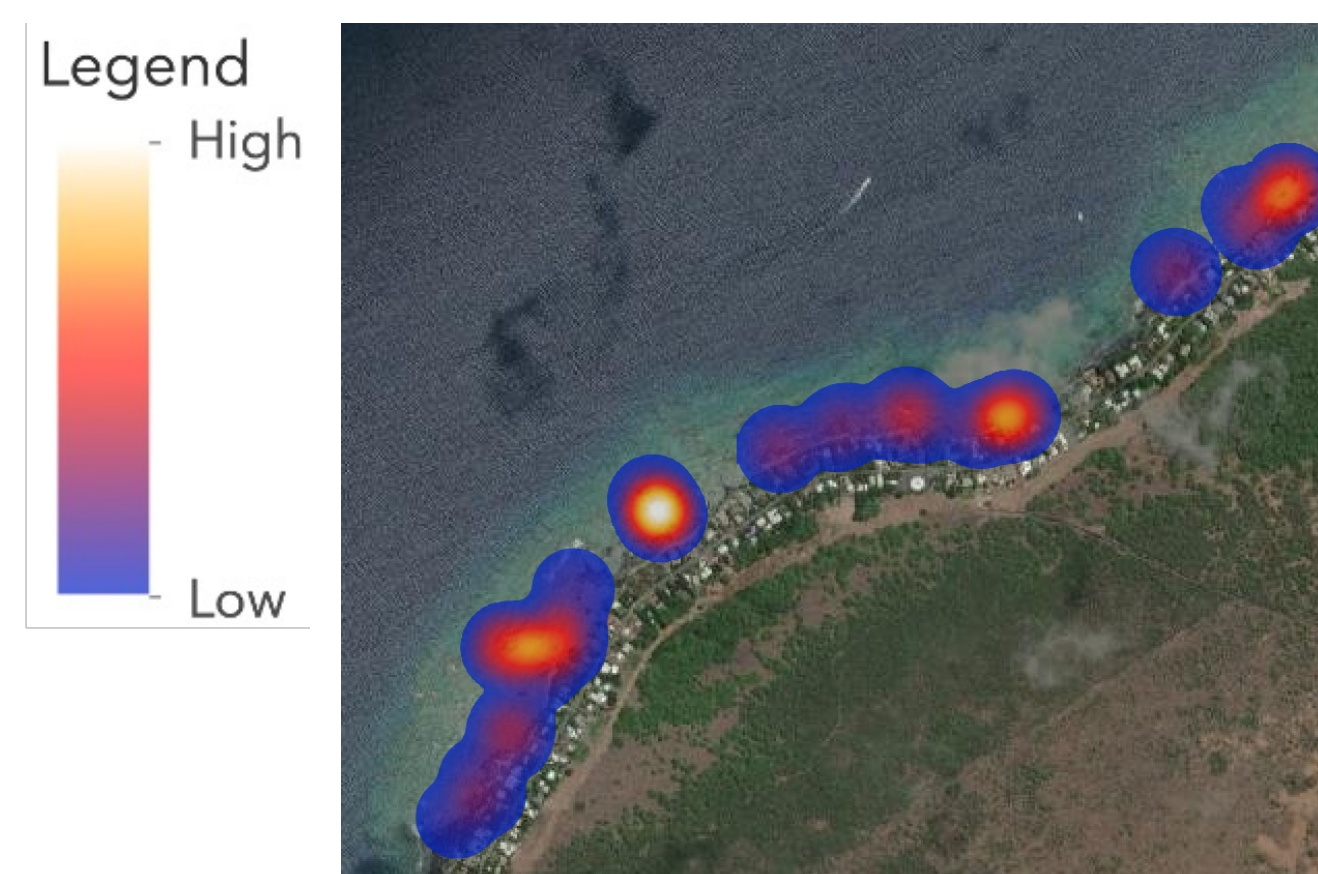


Figure 8. Daytime turtle distribution heat map



Figure 9. Nighttime turtle distribution heat map

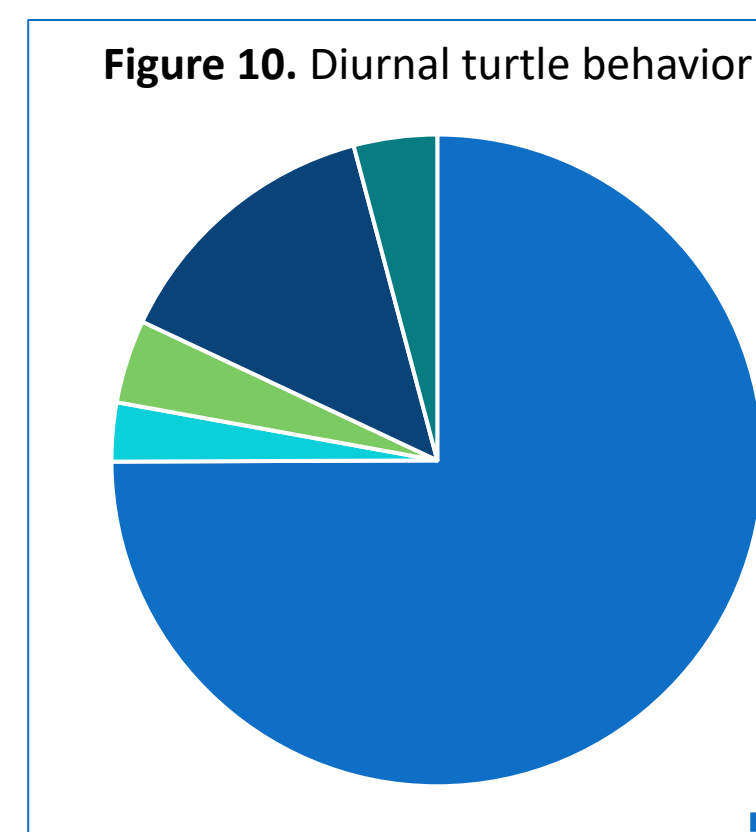


Figure 10. Diurnal turtle behavior

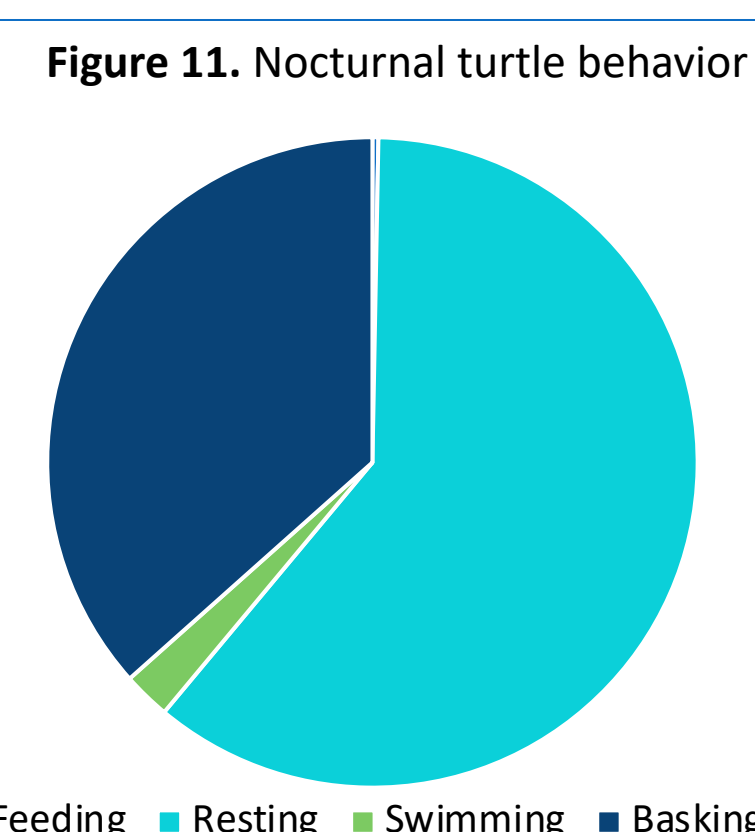


Figure 11. Nocturnal turtle behavior

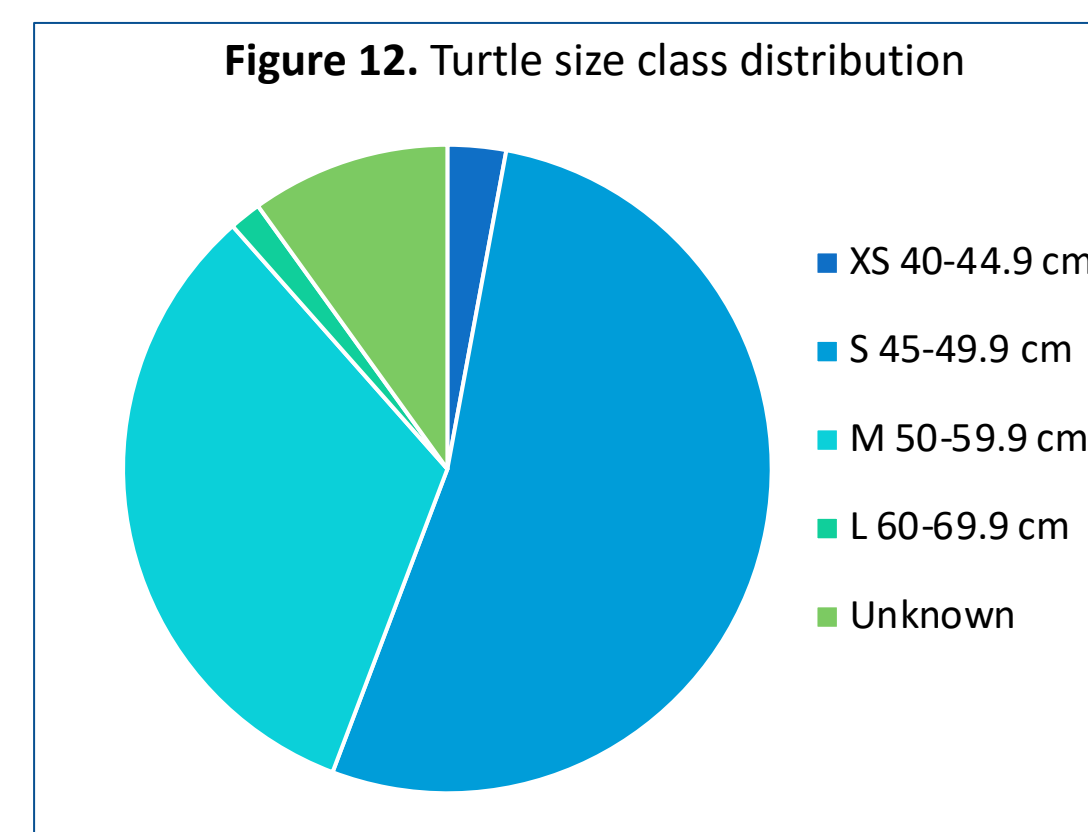


Figure 12. Turtle size class distribution

Results (continued)

A total of 18 individual turtles were observed at Basking Location 1 (Fig. 13). On the days that basking turtles were observed, there were, on average, 2.3 turtles. The maximum number of turtles observed at one time was 8. Of the 18 turtles observed, 11 turtles were observed one time, 5 turtles were observed 2 times, 1 turtle was observed 3 times, and 1 turtle was observed 7 times (Fig. 14).

A total of 19 individual turtles were observed at Basking Location 2 (Fig. 13). On the days that basking turtles were observed, there were, on average, 2.4 turtles. The maximum number of turtles observed at one time was 4. Of the 19 turtles observed, 18 turtles were observed one time and 1 turtle was observed 4 times (Fig. 15).

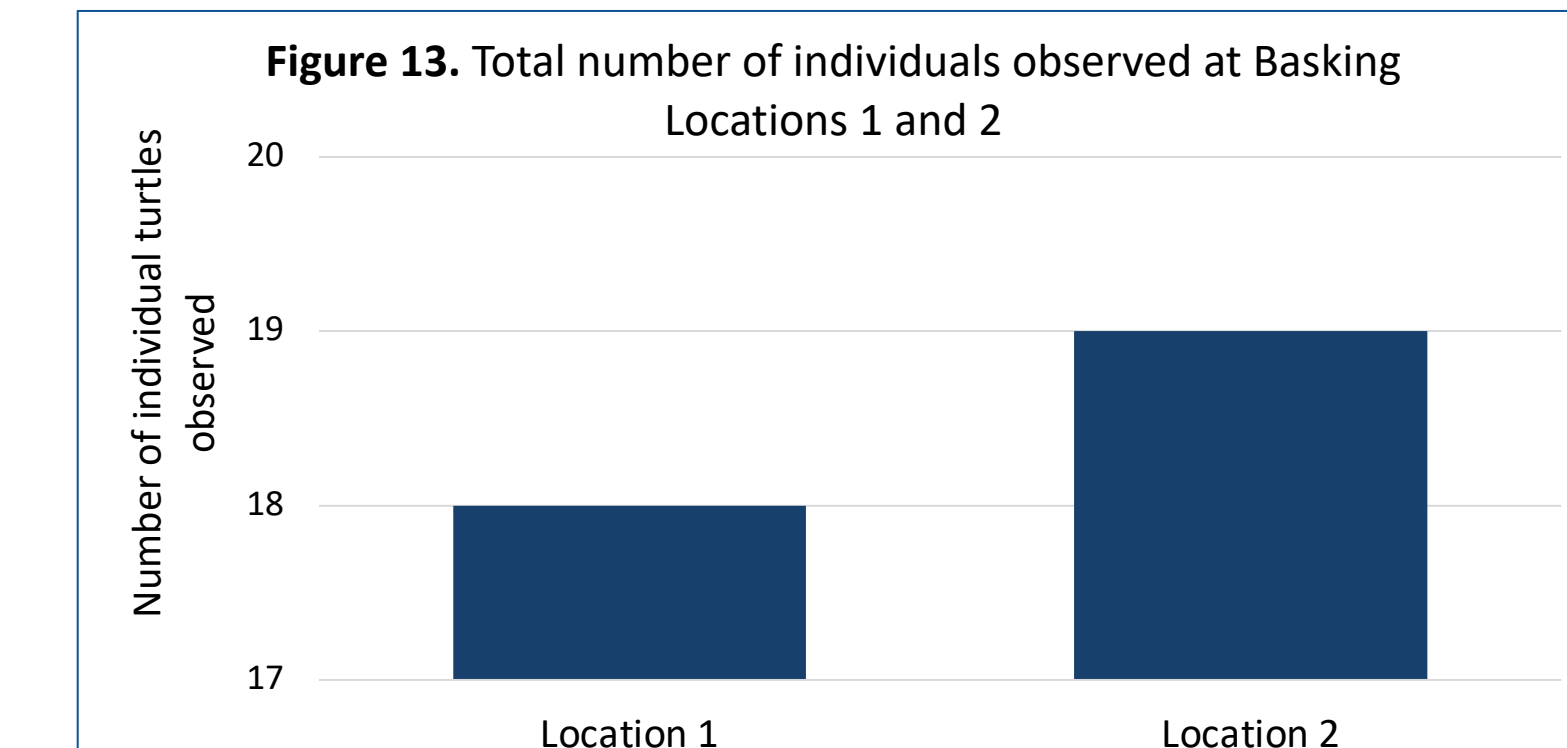


Figure 13. Total number of individuals observed at Basking Locations 1 and 2

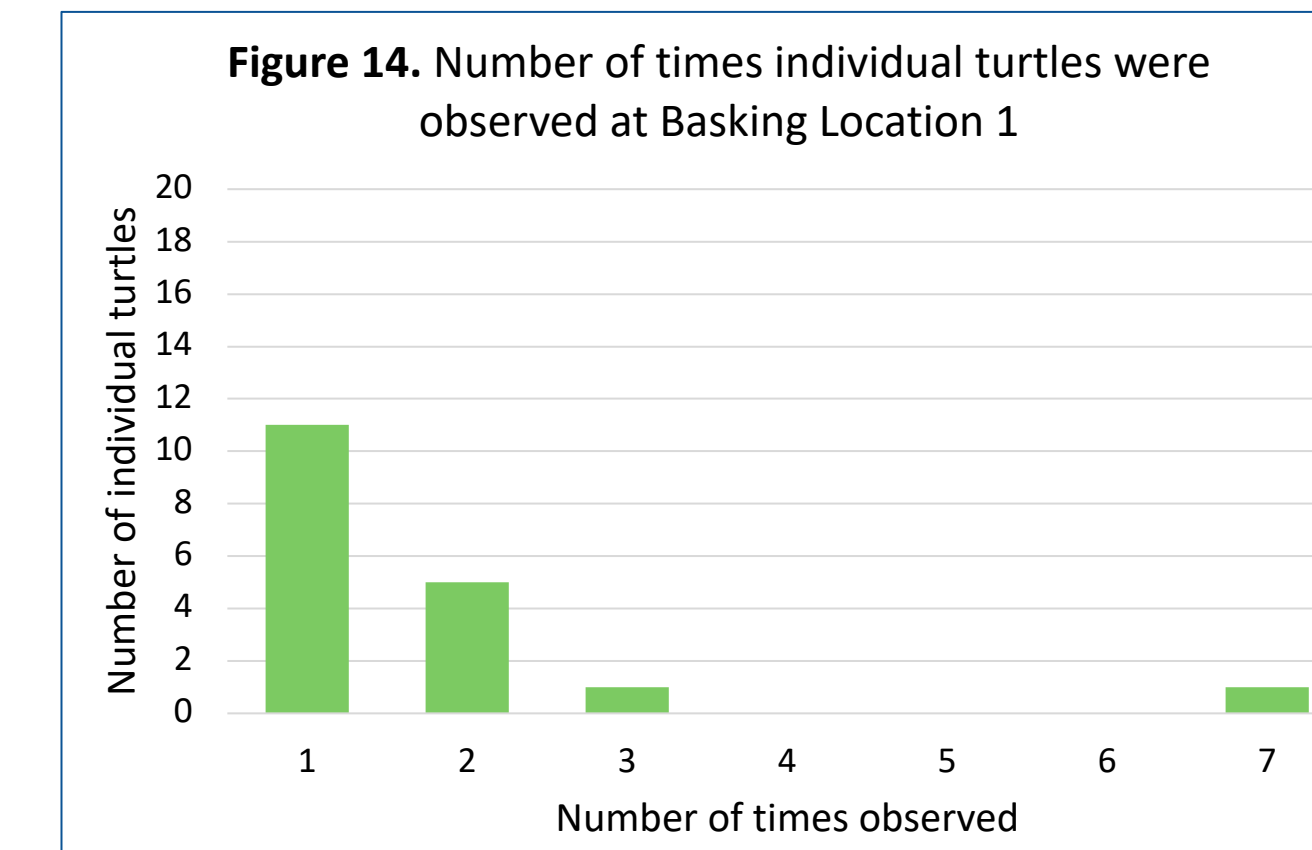


Figure 14. Number of times individual turtles were observed at Basking Location 1

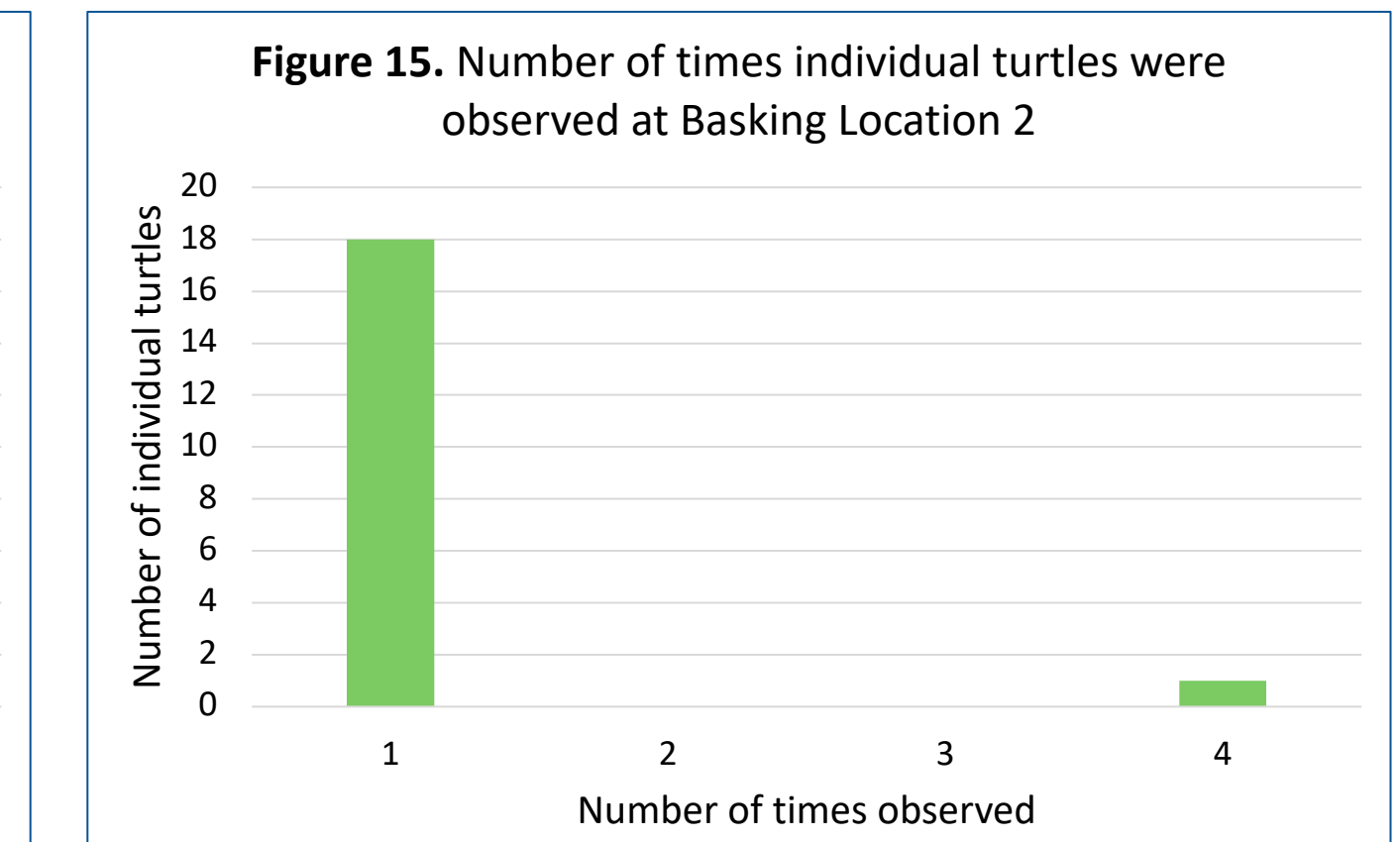


Figure 15. Number of times individual turtles were observed at Basking Location 2

Discussion

The heat maps demonstrate that while sea turtles are common throughout the area surveyed, there are areas with high concentrations of turtles. In the case of Puakō, there are two main hot spots used diurnally and one main hot spot used nocturnally. These areas are important to be aware of and protect. While only a small number of turtles (2.4) are typically observed basking at one time at either location, this data shows that a larger number of turtles (at least 37) use the two basking locations. Thus, any impacts to these locations will affect many turtles. No turtles were observed at both Basking Location 1 and Basking Location 2, suggesting that the turtles have basking site fidelity.

This research has confirmed that Puakō serves as an important juvenile and subadult foraging and resting habitat. Knowing more about the population of turtles at Puakō will help community and management groups to prioritize areas of focus and to use baseline data for reference in advance of environmental changes.



Figure 16. Turtle basking



Figure 17. Turtle resting



Figure 18. Researcher marking waypoint using Gaia GPS app during daytime survey

References

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