

Using photo-ID to monitor the status of fibropapillomatosis in green turtles at

Maho Bay, St. John, United States Virgin Islands

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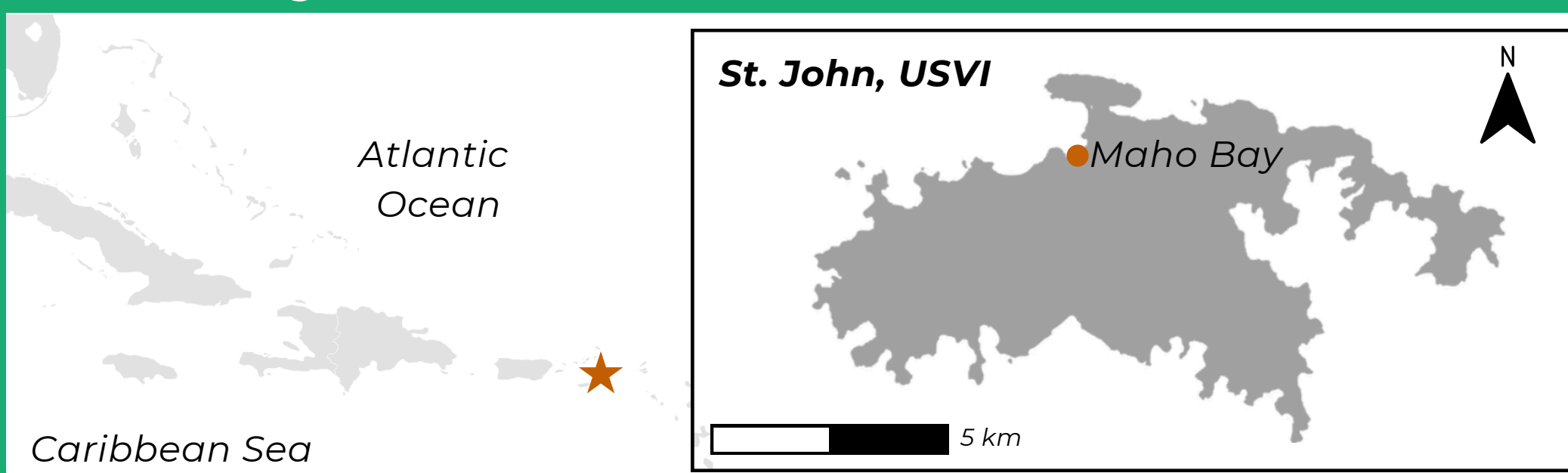
Introduction

- Fibropapillomatosis (FP) is a panzootic disease affecting sea turtles worldwide, primarily green turtles (*Chelonia mydas*). This neoplastic disease presents as both external and internal tumors that can interfere with an individual's sight, ability to swim, reproduce, forage, and evade predators.
- Due to the presence of FP at Maho Bay, St. John, USVI, the Virgin Islands National Park Sea Turtle Program has been cataloging underwater photographs of green turtles dating back to 2012 using photo-ID as a means of mark-recapture.

Objectives

- Evaluate the efficacy of using photo-ID to monitor FP status
- Determine the prevalence of FP in the foraging population
- Assess the severity of FP
- Monitor tumor growth and remission over time
- Provide a baseline and recommendations for future studies

Study site



Methods

- Standardized photographs capturing dorsal, ventral, lateral, posterior and anterior angles were taken and cataloged upon opportunistic encounters. Additional photographs were contributed by citizen scientists, extending the range of the study.
- Each individual was visually identified using their unique scale pattern and subsequently confirmed using the Internet of Turtles (IOT).
- For the purposes of this study, FP tumors were not histologically confirmed and all growths were assumed to be FP.
- The status of FP severity was assessed by assigning a tumor score to individuals with encounters capturing all or the majority of camera angles from 2020-2024 (Table 1).
- Visual inspections of tumors upon recapture events with sufficient photographs were compared to previous encounters and assigned a status of "Growth", "Remission", or "No obvious change".
- Individuals lacking ample photographs were only evaluated for detection or non-detection of tumors.

TABLE 1. Attributes used to assign tumor scores to individuals. Additional attributes assigned by Page-Karjian et al. (2014) were also considered for scoring.

Attributes	TUMOR SCORE				
	0 - Not Afflicted	S - Suspected FP	1 - Least Afflicted	2 - Moderately Afflicted	3 - Severely Afflicted
Hancock et al. (2023)	No obvious tumors	-	Mild - small corneal tumors	Evident tumors in eyes and/or body	Vision or movement impaired
Tumor size Work & Balazs (1999)	Number of tumors				
(A) <1 cm	0	-	1-5	>5	>5
(B) 1-4 cm	0	-	1-5	>5	>5
(C) >4-10 cm	0	-	0	1-3	>4
(D) >10 cm	0	-	0	0	>1
Current study		Multiple tiny warty growths on soft tissues			

Results

- Between February 2012 and July 2024:
 - 472 total encounters;
 - 456 recaptures
 - 95 individuals
- The majority of the population was detected or suspected to have FP.
- The most frequently observed tumor score was 1, while the least common was 3 (Figure 3).
- A variety of growth and remission trends were observed (Table 2).

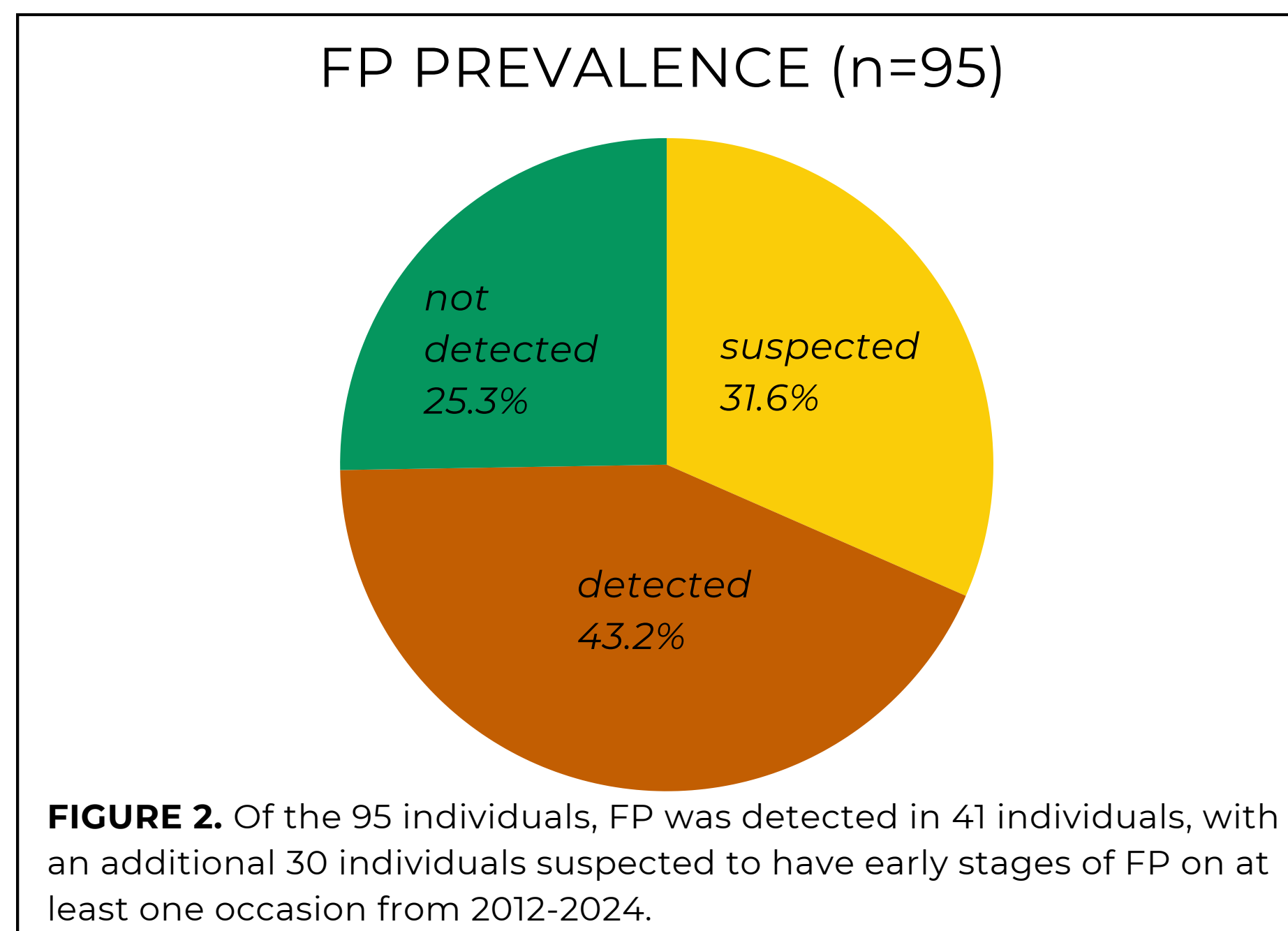


FIGURE 2. Of the 95 individuals, FP was detected in 41 individuals, with an additional 30 individuals suspected to have early stages of FP on at least one occasion from 2012-2024.

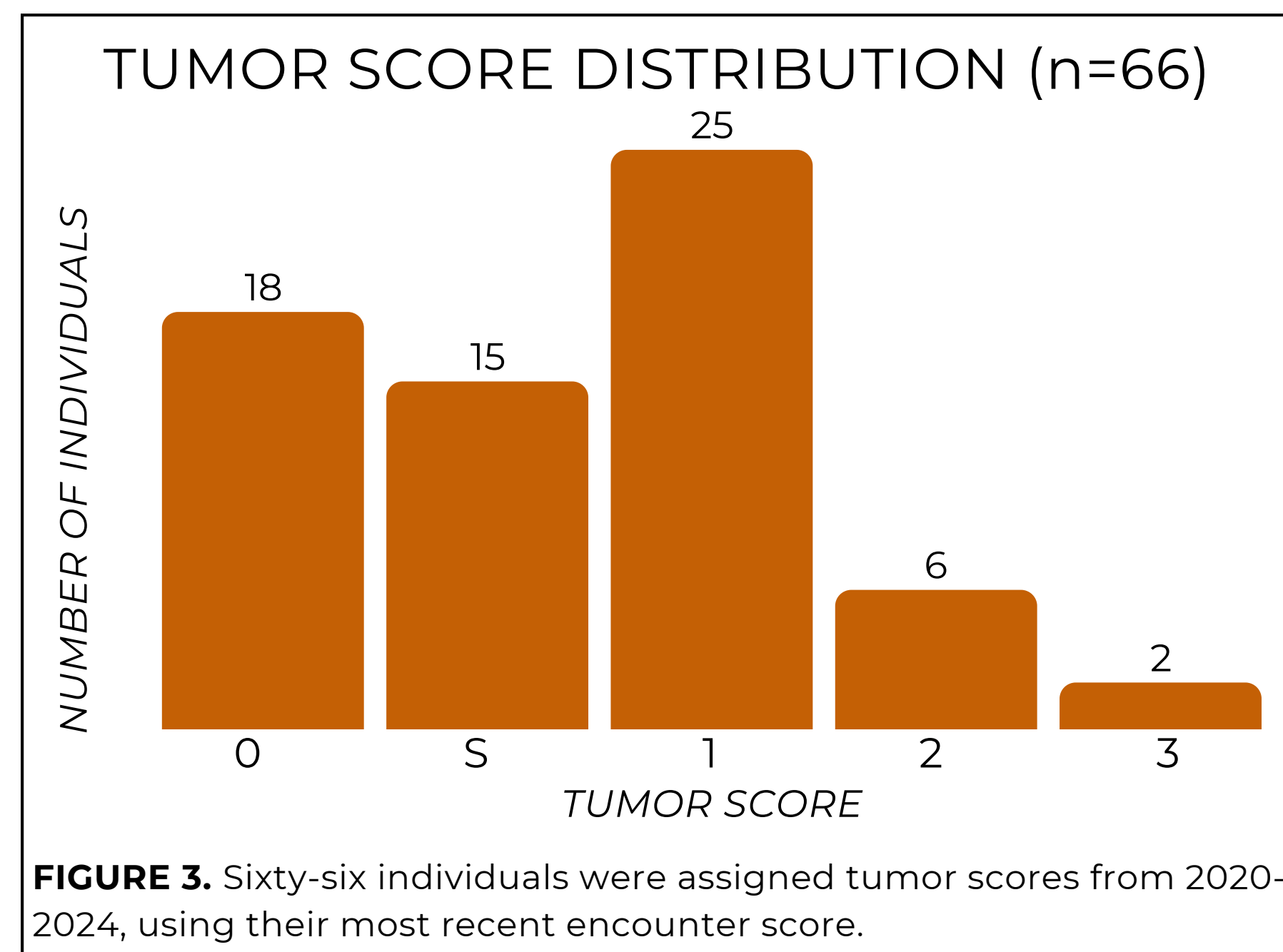


FIGURE 3. Sixty-six individuals were assigned tumor scores from 2020-2024, using their most recent encounter score.

TABLE 2. Number of individuals presenting tumor stability, growth, remission, growth with subsequent remission and growth, and growth with subsequent remission, where 'score' is the tumor score and 'n' is the number of individuals. Data presented represents 51 individuals from 2013-2024.

STABLE		GROWTH		REMISSION		GROWTH → REMISSION → GROWTH		GROWTH → REMISSION	
score	n	score	n	score	n	score	n	score	n
0	4	0 → S	3	S → 0	2	S → 2 → 0 → S	1	0 → S → 1 → 2 → 1	1
S	6*	0 → 1	2	1 → 0	3			0 → 1 → 0	1
1	8*	0 → 2	1	2 → 1	4			S → 1 → S	1
		0 → S → 1	1	2 → S	1			S → 1 → 2 → 1	1
		S → 1	2	3 → 1	1			1 → 2 → 1	1
		0 → 1 → 2	1					S → 2 → 1	2
		S → 2	3					1 → 2 → 3 → 1	1
18		13		11		1		8	

*some individuals were observed with growth and remission within the specified score, but were marked as stable as they did not transition to a new tumor score.

Case Studies



FIGURE 4. Duane, USV0026, exhibits the growth and subsequent remission of an ocular tumor from 2021 to 2024.

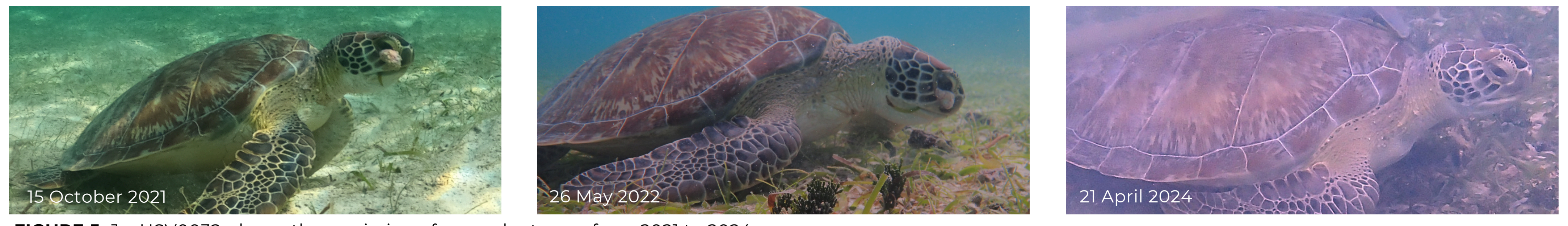


FIGURE 5. Jo, USV0032, shows the remission of an ocular tumor from 2021 to 2024.



FIGURE 6. Woody, USV0046, displays the growth of tumors on epidermal tissues of neck, shoulders and inguinal areas from 2023 to 2024.

Discussion

- The majority of the population was found to have a score of 1 or less, showing that **although FP prevalence is high within this population, only a very small portion has moderate to severe afflictions.**
 - Consistent with other studies showing predominance in tumor scores of least affliction.
- While research suggests that individuals with severe tumor scores have increased immunosuppression and lower chances of survival, **we have observed remission from severe and moderate scores and hope the continuation of our study may reveal insights in wild populations** and support newer models suggesting that almost all new recruits develop and recover from FP before emigrating (Kelley et al. 2022).
- Limitations of using photo-ID to evaluate status of FP:**
 - Factors such as visibility, site conditions, and animal behavior frequently limited the angles available for comparisons and reduced the number of suitable encounters for evaluation.
 - Relying on photographs with no scale or physical measurements could have led to subjectivity in assigning tumor scores and tracking fluctuations in tumor development.
 - Although the 'S' score was created to minimize observer bias, scoring these individuals as 'S' versus early stage FP could have potentially led to an underrepresentation of the proportion of the population detected with FP.
 - Relying solely on visual inspections could have also underestimated tumor prevalence in the population due to the inability to detect internal tumors.
 - The assumption that all tumors were FP without laboratory confirmation could have led to potential misclassification of tumors.
- The high prevalence of FP in this population raises **questions for further investigation:**
 - Water quality parameters
 - Anthropogenic factors and linkages
 - Remora as a potential vector
- Recommendations for improvements to study:**
 - Histological confirmation of tumors
 - Physical measurements and/or photogrammetry software used alongside photo-ID would enhance this study by providing a scale for future comparison
- The use of photo-ID proves to be a cost-effective and minimally invasive technique to monitor the status of FP in a foraging population and establish a baseline to aid in future research and management decisions.**

Acknowledgements

The Virgin Islands National Park Sea Turtle Program is a partnership between the Virgin Islands National Park (VIIS) and the Friends of Virgin Islands National Park (FVINP), with the latter providing the funding. Thank you to all of the donors of the FVINP, who make studies like this possible. The study design was developed by the authors with insights provided by Rafe Boulon and Paul Jobsis. Thank you Willow Melamet, Stephen Connett, Kianna Pattengale, Caroline Rogers, Kaitlyn Cummings, Cali O'Connor, Steve and Janet Simonsen, Max Koestenblatt, Fernando Ramos, and other citizen scientists for their photographic contributions.

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 This research has made use of data and software tools provided by Internet of Turtles, an online mark-recapture database operated by the non-profit scientific organization Wild Me.