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First report of fibropapillomatosis and critical habitat use in green sea turtles in Curaçao

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ABSTRACT

Fibropapillomatosis, a disease affecting green sea turtles (*Chelonia mydas*), has been documented in many regions of the world, including the Caribbean, but has not been scientifically reported in Curaçao until now. The present study utilized VHF telemetry in Caracas Bay, Curaçao, to track green sea turtles, both healthy and affected by fibropapillomatosis, with the objective of ascertaining their foraging locations. VHF telemetry proved to be a pivotal method for assessing habitat use in areas characterized by limited visibility and high boat traffic, conditions that present significant challenges for divers and snorkellers attempting to access the area. The results demonstrate the significance of the marina in Caracas Bay as a green sea turtle feeding ground and lay the groundwork for future studies and conservation initiatives that are essential to comprehend potential triggers for fibropapillomatosis in this species, particularly in understudied regions like the Leeward Antilles. This initial report of fibropapillomatosis in Curaçao highlights the pressing need for targeted conservation strategies and long-term monitoring to assess environmental stressors, disease dynamics, and their potential associations with anthropogenic impacts in critical sea turtle habitats.

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Fibropapillomatosis; green sea turtles; *Chelonia mydas*; telemetry; Curaçao

Introduction

Green sea turtles, *Chelonia mydas*, play a crucial role in marine ecosystems by promoting the health and preservation of coral reefs, estuaries, rocky coasts, and sandy beaches, and are widely recognized as an indicator of a healthy marine ecosystem (Da Cruz et al. 2024).

Despite being distributed in tropical and subtropical areas worldwide, this species is recognized as endangered by the International Union for Conservation of Nature (Seminoff 2004). In fact, *Chelonia mydas* is subjected to many threats of anthropogenic origin, such as exposure to hazardous marine debris, habitat degradation, nesting site and foraging area disturbances, predation on nests and hatchlings by wild, feral, and domestic animals, boat strikes, traditional hunting, and egg collection, and the impacts of climate change on marine and terrestrial environments (Wallace et al. 2010; Patrício et al. 2012; Jensen et al. 2018). Moreover, a growing threat to sea turtles is represented by fibropapillomatosis (FP), a disease first observed in Florida in the 1930s (Smith & Coates 1938). FP causes tumour-like growths on the skin, eyes, mouth, flippers, and internal organs, impairing vision, mobility, and feeding, resulting in a high mortality rate (Jones et al. 2016; Manes et al. 2022; Whilde et al. 2024). The disease affects marine turtles worldwide, with green sea turtles being particularly vulnerable, with a prevalence of over 50% in juvenile turtles reported in recent years (Foley et al. 2005; Manes et al. 2022). Although this disease has been documented in various Caribbean locations, its presence and implications in Curaçao remain poorly understood despite observations by local conservation organizations. It has been suggested that FP is linked to the herpesvirus *Chelonid Herpesvirus 5* (ChHV5), which can remain latent in the host until triggered (Patrício et al. 2012; Alfaro-Núñez et al. 2016). The DNA of ChHV5 has been isolated from both the tissues of affected and healthy green sea turtles, thus highlighting the latency of the virus (Lackovich et al. 1999; Page-Karjian et al. 2012; Alfaro-Núñez et al. 2014). These investigations emphasize that the precise origin and activation of this disease are intricate and

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believed to be multifactorial. Scientists have excluded that mutations in the virus are the causes for the increased number of cases, as no changes have been detected in ChHV5, shifting the focus to environmental factors as potential drivers of disease outbreaks (Herbst et al. 2004; Nash & Ryan 2023; Van Houtan et al. 2010). FP's aetiology likely involves a complex interplay of various environmental factors, such as sea surface temperature, salinity, water currents, residence time, pollution, and red tide events (Manes et al. 2022, 2023; Vanstreels et al. 2023). Recent studies suggest that disease outbreaks may be linked to a combination of immunogenetic susceptibility and environmental pressures, particularly those arising from human disturbance of coastal habitats (Manes et al. 2023; Da Cruz et al. 2024). As reported by Perrault et al., poorly circulated lagoon systems located near densely populated areas with potential points of agricultural and urban wastewater are typically where high prevalences of FP are recorded (Perrault et al. 2021). Moreover, the potential horizontal transmission of the virus, especially in areas where turtles congregate to forage, raises concerns about how these shared habitats may facilitate the spread of fibropapillomatosis. High turtle densities in nutrient-rich coastal zones can increase the likelihood of contact and viral shedding, further compounding the disease's transmission dynamics (Jones et al. 2020). This highlights the importance of monitoring ecological hotspots where turtle aggregation and environmental stress coexist.

In the Caribbean region, the presence of FP has been documented in several regions, including the Lesser Antilles, specifically Martinique Island and the Gulf of Venezuela, where this pathology primarily affects young turtles (Espinoza-Rodriguez & Barrios-Garrido 2022; Roost et al. 2022; Lelong et al. 2025). While these studies provide valuable insights into FP prevalence and its environmental associations in the broader Caribbean region, comprehensive research on these islands is limited or unpublished, especially in Curaçao.

Notwithstanding the documented threat to green sea turtles and the surveys conducted by Sea Turtle Conservation Curaçao (STCC) that have identified areas of disease occurrence around the island, research on fibropapillomatosis in Curaçao remains limited.

The first aim of this work is to initiate a systematic research plan for green sea turtles in Curaçao, beginning with a population in Caracas Bay. Here, we reported, for the first time, the presence of FP in the island's population. Furthermore, based on previous studies highlighting the importance of the composition of the foraging area and its role as a triggering factor in FP development, we aimed to identify the foraging area of this population. We used radio telemetry to investigate a possible feeding ground in a difficult-to-access area that, due to its characteristics of being enclosed and subjected to human effects, could represent a hotspot for fibropapillomatosis. These findings provide a foundation for identifying critical seagrass habitats and advancing conservation efforts in Curaçao by exploring the potential link between FP prevalence and habitat use.

Materials and methods

Study area

The study was conducted in Caracas Bay, Curaçao (12°04′ N, 68°52′ W) starting at the end of June 2023 (Figure 1).

Caracas Bay is 8 kilometres southeast of Willemstad on Curaçao's south coast. The old oil station at Caracas Bay was demolished in 1996. Large ships and other floating items can be berthed in this vast, deep-water bay, which is conveniently accessible from the open sea. A growing number of ships use Caracas Bay for underwater cleaning, maintenance, and inspections because of the pristine water. The marina opens into the bay, with an opening that is about 50 metres wide (Figure 2). It serves as a launch pad for recreational boats and jet skis and a docking facility for boats connected to the surrounding resort. It is also utilized for in-water cleaning of boats. Because of the marina's extremely murky water, visibility is difficult; additionally, the area is unsafe for divers or snorkellers to patrol due to the substantial safety threats posed by busy boats and jet skis.

Turtle capture and release

The turtles were hand-caught at a spot called "turtle island" (12°04′37″N, 68°51′58″ W) by divers and transported to shore using kayaks and a dinghy boat. Tents were set up on the shore to keep the turtles out of the sun and comfortable. Turtles were caught for three days starting June 28, 2023, either in the

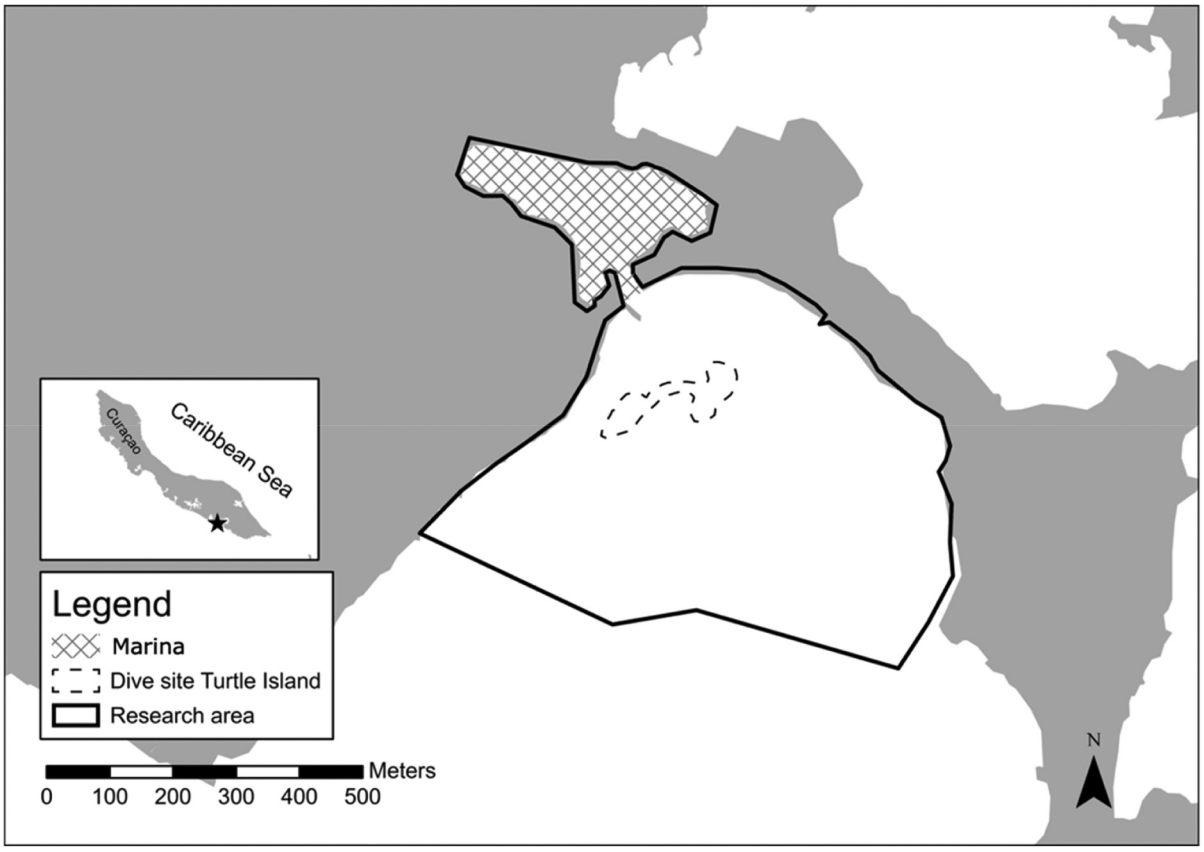

Figure 1. Research area. The research area is outlined in black, with the dashed line indicating the site where divers caught the 8 turtles. The cross-hatched pattern indicates the marina that was monitored during the project.

Figure 2. The marina entrance on Caracas Bay. The entrance is about 50 metres wide.

evening or morning. The turtles were measured, weighed, tagged with Inconel style 681 metal tags on the front flippers and equipped with a radio transmitter. Turtles were measured following standard procedures. Body mass was recorded using a Samsonite mechanical hanging scale (±0.5kg). A Hogetex vernier caliper (±0.1cm) was used to measure straight carapace length (SCL) and straight carapace width (SCW), while a flexible plastic sailor tape (±0.1cm) was used to measure curved carapace length (CCL) and curved carapace width (CCW). Turtles were categorized into life stages based on CCL: juveniles (immature) with CCL < 65cm, sub-adults (immature) with 65cm ≤ CCL < 90cm, and adults (mature) with CCL > 90cm, according to Chaloupka and Limpus (2001).

Turtles were visually inspected for fibropapillomatosis (FP) upon capture. Tumour severity was assessed using the classification system by Work and Balazs (1999), which considers number, size, location, and functional impact of tumours (Work & Balazs 1999). Due to the extent of the FP tumour growth on the flippers, one of the turtles was not tagged to avoid tumour disturbance. The turtles were released on the same day of their capture from shore.

Transmitter attachment

To attach the radio transmitter, we modified the protocol described by Berube et al. 2012. The top centre part of the turtle's carapace was sanded with a sanding block and cleaned with alcohol. A fibreglass net was cut to the shape of the second vertebral scute and was attached to the turtle using Bondo Liquid Resin for Fibreglass, 3 M, to prepare the carapace for the transmitter attachment. Instant Ocean HoldFast epoxy putty was used to set the transmitter on the scute. After 30 minutes, the transmitter and putty were covered with fibreglass and Bondo Liquid Resin for Fibreglass, 3 M.

Transmitters and receiver

Radio transmitters (Model AI-2, 28 g weight, 46 length × 17 mm dia., Holohil Systems Ltd, Carp, ON, Canada) and a TRX-48S receiver w/3-element Yagi antenna (manufactured by AF An-tronics, Champaign, Il), were purchased from Wildlife Materials, Murphysboro, IL. The radio transmitters have an estimated battery lifespan of 12–30 months. The antenna has a detection range of several hundred metres to ~1.5 km in open terrain.

Each transmitter has its own channel to be detected on the antenna.

Tracking

Once tagged, the antenna operator tracked the turtles from a spot inside the marina. Monitoring was performed in July 2023 for 15 days (from July 3 to July 17), twice a day between 10 am and 1 pm and between 4:30 pm and 6:30 pm. The antenna operator would scan all eight channels for an hour and be able to identify if the turtle was inside or outside the marina based on the strength of the signal and the direction of the antenna. The directional nature of the Yagi antenna allowed researchers to infer the direction of the transmitter by slowly rotating the antenna and identifying the orientation that produced the strongest signal. The TRX-48S receiver provided both an audible tone and a visual LED display, with LED intensity increasing as the antenna was aligned more precisely with the direction of the transmitter signal. They also included the recording of visuals, as the operators could spot the turtles coming up for air in the marina.

Data analysis

The transmitters provided general directional data, allowing us to infer the position of the turtles inside or outside the marina, rather than specific spatial parameters or detailed trajectories. However, the key to assessing activity levels was the frequency of resurfacing events, as indicated by the radio signals. Frequent resurfacing suggested active behaviours, while infrequent signals implied reduced activity or resting states. No fine-scale spatial or environmental parameters were evaluated as part of this analysis.

The protocols and procedures of this study were approved by Thomas Jefferson University Institutional Animal Care and Use Committee (Protocol #: 23–10–728).

Results

In total, eight green turtles were caught at Caracas Bay with a straight carapace length (SCL) ranging from 45.3 cm to 66 cm (average: 55.56 ± 3.29 cm (SE)), straight carapace width (SCW) ranging from 34.5 cm to 53.5 cm (average: 42.66 ± 2.71 cm (SE)) (Table 1). The curved carapace length ranged from 49.5 cm to 73,8 cm (average: 59.48 ± 3.49 cm (SE)), and the curved carapace
width (CCW) ranged from 42 cm to 66.2 cm (average: 53.95 ± 3.47 cm (SE)). The weights ranged from 13.5 kg to 50.0 kg, suggesting a mix of juvenile and subadult individuals.

As shown in Table 1, five out of eight turtles exhibited indications of FP. The tumour score was determined in accordance with the guidelines established by Work and Balazs, wherein severity is classified from FP0, indicating the absence of visible tumours, to FP3, signifying a subject severely affected by tumours (see Table 1 and Figure 3) (Work & Balazs 1999). The tumour score is a comprehensive evaluation that considers not only the quantity of tumours but also their dimensions, location, and the potential impact on the turtle's mobility, vision, and feeding ability. Three turtles (IDs 2351, 2352, and 2353) were designated as FP1, as they exhibited tumours of a small or mildly affecting nature. Turtle ID 2354, which exhibited the highest number of tumours (10), was classified as FP2, indicating the presence of small tumours with a moderate impact at this time. Conversely, turtle ID 2349 demonstrated several larger tumours, indicative of a severe case, and was thus classified as FP3 (see Table 1 for details).

In the present study, a range of fibropapillomatosis (FP) manifestations were documented, indicating varying stages of tumour development and anatomical distribution within the study population. Some individuals presented with small, pink to greyish nodules on the soft tissue of the flippers or around the cloaca, consistent with early-stage FP (Figures 3c–f) (Work & Balazs 1999). Additionally, periocular tumours were observed, characterized by raised, irregular lesions that were either near or partially covering the eye. These lesions have the potential to affect vision and the blinking mechanism (see Figures 3b–c).

Of note is turtle ID: 2349, the sole specimen in our population with a tumour score of 3 (Table 1). This individual exhibited a dark, nodular mass along the anterior edge of the flipper. The mass manifested a spherical geometry, with the surface presenting as dry, irregular, and crusted. This observation may suggest underlying trauma, such as abrasions or secondary infection, which is prevalent in untreated or late-stage FP tumours (Figure 3e). Another extensive, rough, lobulated growth is present at the base of the hind limbs and around the cloacal opening. This growth exhibits darker reddish and raw-looking areas, which may be indicative of abrasion, inflammation, or minor infection (Figure 3d).

Understanding how FP cases relate to habitat use is crucial for identifying environmental conditions that may exacerbate disease progression or facilitate transmission; therefore, we combined health assessments with VHF tracking to obtain a more complete picture of this population's movements and habitat use.

During monitoring at Caracas Bay, all turtles were detected both within the marina (inside) and outside the marina using receiver-equipped antennas (Table 2). Visual sightings from the shore further corroborated the presence of turtles and surfacing behaviour (Table 2). These findings demonstrate that turtles frequently visit the marina in Caracas Bay for feeding purposes. This increased activity is associated with a higher oxygen intake, which requires the turtles to resurface more frequently (see Figure 4) (Taquet et al. 2005; Hazel et al. 2013). Conversely, diminished signal detections in areas external to the marina indicate periods of resting behaviour (Hays et al. 2000). The integration of radio telemetry and direct observation methods yielded significant insights into the patterns of habitat utilization exhibited by each individual.

Table 1. Turtle IDs, morphometric measurements, and tumour data of turtles captured during the transmitter attachment. Tumour score based on Work and Balazs (1999).

Turtle ID	Transmitter number	SCL (cm)	SCW (cm)	CCL (cm)	CCW (cm)	Weight (Kg)	Number of tumours	Tumour score
2348	270145	55.8	47.8	64	58	36	0	0
2349	220144	45.7	34.5	50	42	16	7	3
2350	270143	66	53.5	73.8	66.2	50	0	0
2351	270182	47	36.2	51	43	15.5	1	1
2352	270141	55.5	44.6	61	57.7	27.5	2	1
2353	270144	59.2	37.9	54.3	56	16.5	0	0
2354	270147	45.3	35.3	49.5	43.7	13.5	10	2
2355	270148	70	51.5	72.3	65	43	9	1

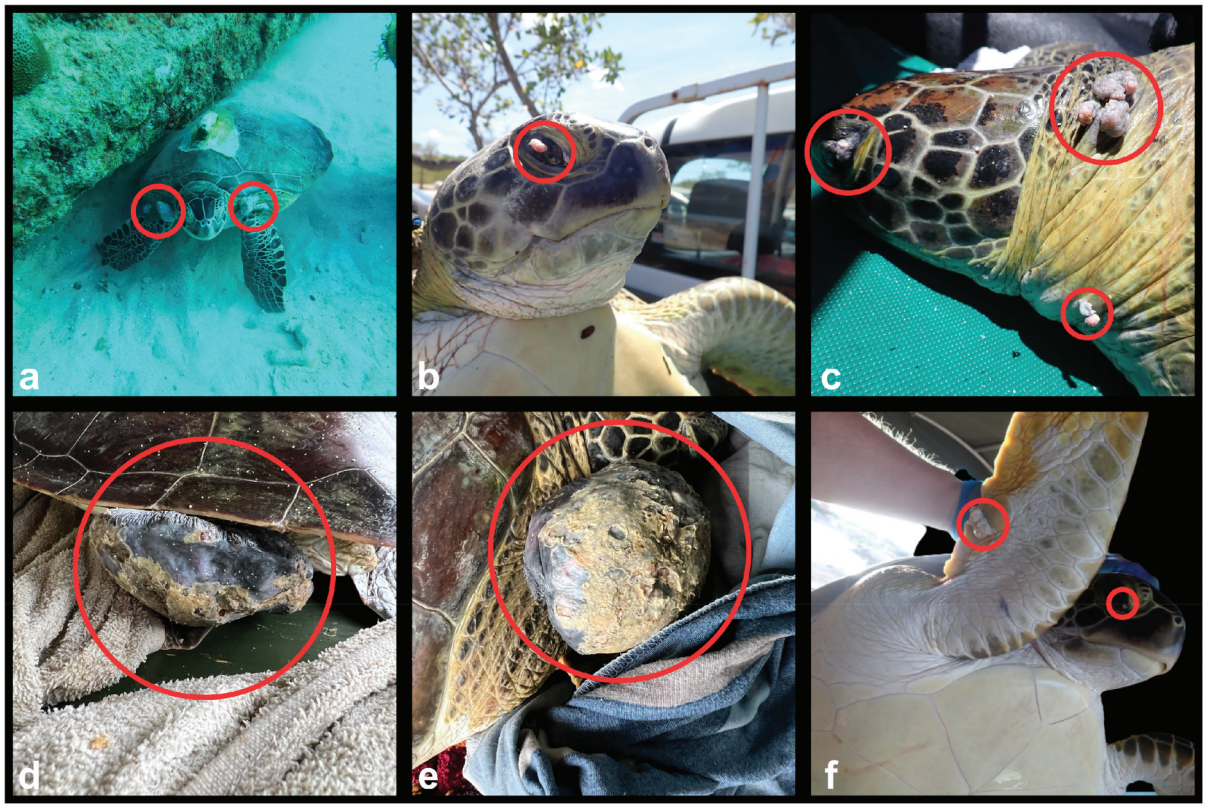

Figure 3. External manifestations of fibropapillomatosis (FP). Examples of tumours observed in the population studied. Tumours, highlighted with red circles, vary in size, location, and morphology. (a) Tumours located on both front shoulders. (b) Periocular tumour on the right eye. (c) Multiple small tumours distributed on the head and neck. (d) Large tumour protruding from the inguinal region. (e) Large tumour on the shoulder region. (f) Tumours located on the right eye and the ventral surface of the right fin. These images illustrate the diverse presentations of FP tumours observed in the subject population.

Table 2. Total number of signals detected and visual sightings inside and outside the marina for each turtle from July 3 to July 17 at Caracas Bay. The antenna operator tracked for 1 hour twice a day, switching channels every 2–3 minutes.

Turtle ID	Total signal detected inside	Total signals detected outside	Total visuals inside the marina
2348	5	7	2
2349	14	2	1
2350	12	2	1
2351	13	4	4
2352	14	3	3
2353	37	5	2
2354	29	7	3
2355	17	2	3

Notably, several turtles, including the one affected by fibropapillomatosis, were repeatedly detected inside the marina, exhibiting a higher signal frequency and increased resurfacing events compared with cases detected in external areas.

The results of this study designate the marina as a pivotal foraging ground and underscore the efficacy of VHF telemetry in circumventing the limitations imposed by poor visibility and safety concerns in intricate environments such as marinas, where conventional visual surveys encounter significant challenges. Furthermore, the observation that both healthy and FP-affected animals often frequent the marina has led to concerns regarding the environmental conditions in this habitat. These conditions may have ramifications for the behaviour, health, and susceptibility to disease of turtles.

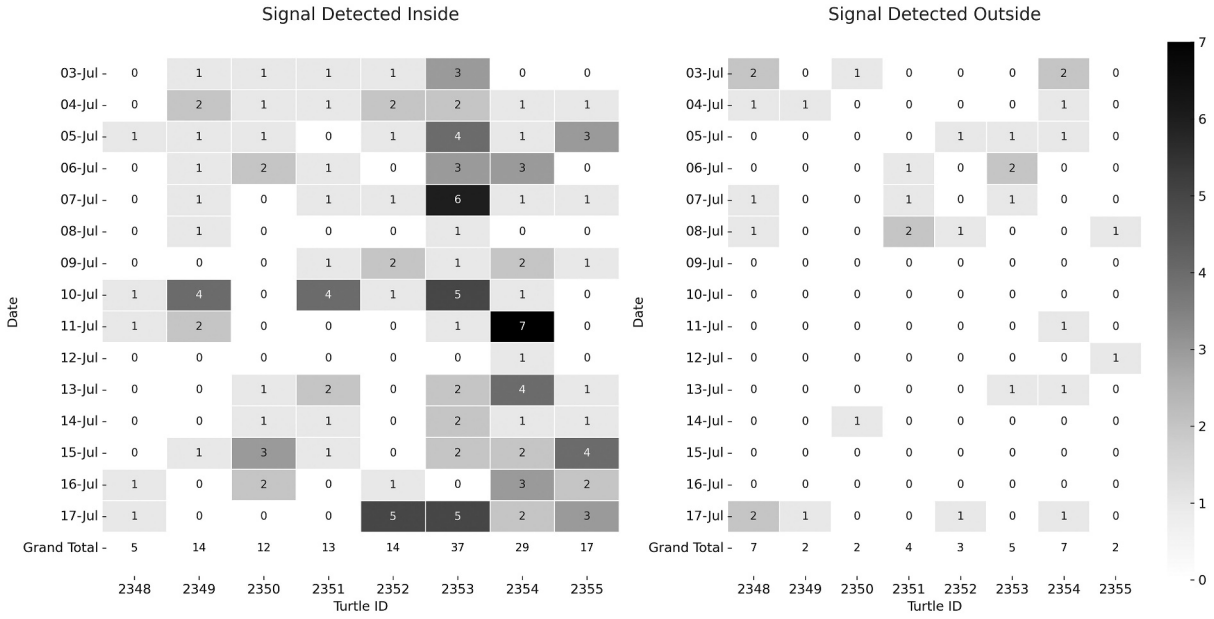

Figure 4. Heat map of signals detected daily from tagged turtles inside and outside the marina during the monitoring (July 3–July 17). Rows represent detection dates, while columns correspond to individual turtle IDs. The intensity of shading reflects the number of detections, with darker shades indicating higher counts. The total indicates the total number of signals detected during the project.

Discussion

This study represents the first scientific report of fibropapillomatosis (FP) in green sea turtles in Curaçao and even in the Leeward Antilles. FP has been documented in multiple locations in the Caribbean, including the Lesser Antilles (James et al. 2021; Roost et al. 2022; Lelong et al. 2025), Puerto Rico (Page-Karjian et al. 2012), and Venezuela (Espinoza-Rodriguez & Barrios-Garrido 2022). However, to date, no literature data are available regarding the presence of FP in Curaçao or its neighbouring islands. This underscores a significant knowledge gap regarding sea turtle health in the region. Our study helps fill that gap by providing clinical observations and behavioural monitoring of affected individuals using VHF telemetry.

Here, we documented for the first time turtles exhibiting signs of FP in the marina of Caracas Bay, a challenging location to monitor through observation alone.

Our study also highlights the value of radio telemetry in detecting turtle behaviour in complex and hard-to-access environments. VHF telemetry allowed us to track individuals in an area with poor water visibility and high boat traffic, conditions that render diver-based surveys unsafe and ineffective. Our data revealed that healthy and FP-affected turtles repeatedly entered the marina, suggesting that this location is an essential foraging site. These results align with previous research, which has documented high site fidelity in green turtles (Taquet et al. 2005; Hazel et al. 2013; Siegwalt et al. 2020).

The use of the marina raises essential conservation concerns. According to the literature, fibropapillomatosis is strongly associated with Chelonid Herpesvirus 5 (ChHV5), which can remain latent in turtles and become active under certain environmental conditions, such as pollution, eutrophication, or algal overgrowth (Van Houtan et al. 2010; Alfaro-Núñez et al. 2014). The Caracas Bay marina is a semi-enclosed space where boats are cleaned in the water and where runoff from adjacent developments may enter the ecosystem.

These environmental conditions have been demonstrated to promote the proliferation of harmful algal blooms, as well as to suppress the immune systems of turtles and to expose them to various chemical pollutants. All of these factors contribute to various degrees to immune system suppression and viral activation (Arthur et al. 2008; Keller et al. 2014; da Silva et al. 2016; Vanstreels et al. 2023). Understanding the environmental background is essential to comprehending the FP emergence and to watch for possible hazards. The results of this study indicate the critical importance of

safeguarding and re-establishing natural foraging habitats, particularly in the presence of FP within the population.

The implications of our results are substantial from the perspective of conservation, considering that green sea turtles are classified as endangered by the IUCN. It is widely acknowledged that FP is able to compromise foraging, locomotion, and vision, thereby reducing individual fitness and survival (Seminoff 2004; Nash & Ryan 2023; Wallace et al. 2010; Jones et al. 2016). Turtles may experience limited access to undisturbed feeding grounds as a result of habitat loss, competition, or changes in food supply, as evidenced in the usage of anthropogenic coastal habitats like marinas (Guiry et al. 2024). The management of existing human-use areas, such as the Caracas Bay marina, should incorporate turtle-sensitive policies. These measures may include the restriction of boat cleaning activities, the monitoring of water quality, the enforcement of no-wake zones to reduce the incidence of vessel strikes, and the designation of conservation areas where turtle foraging is known to occur.

Moreover, our results clearly demonstrated that radio telemetry is a valuable tool for monitoring turtle behaviour in confined or complex habitats where GPS lacks the spatial resolution needed to detect fine-scale habitat use. Their use is particularly advantageous in areas that are difficult to access or pose safety risks for researchers and divers. Visual observations offer another data layer, particularly confirming the presence and behaviour of turtles outfitted with radio transmitters. Long-term monitoring is crucial to ascertain whether the disease spreads throughout the population or whether these cases are isolated occurrences. Future studies will include comprehensive water and seagrass sampling to assess pollutant levels, microbiological profiles, and nutrient concentrations.

Conclusion

This study provides the first scientific report of fibropapillomatosis in green sea turtles in Curaçao, highlighting the ecological significance of the Caracas Bay marina as a turtle foraging site. VHF telemetry allowed us to overcome the observational restrictions in the marina, where boat traffic and poor visibility make it unsafe for divers and snorkellers to access. We confirmed the area's significance as a critical feeding ground for green turtles, including individuals affected by FP.

Our findings emphasize the importance of this habitat and raise concerns regarding the environmental conditions that may contribute to the onset and progression of FP in the population studied. These results represent the first step of a much-needed long-term investigation into FP's prevalence, aetiology, and potential environmental triggers in Curaçao. They also underscore the immediate need for conservation and management strategies to mitigate human-induced stressors and preserve the key marine ecosystems that sustain turtle populations on the island.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

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Institutional review board statement

This study received IACUC protocol approval from Thomas Jefferson University, Philadelphia, PA, USA (Protocol #: 23–10–728).

References

Alfaro-Núñez A, Bojesen AM, Bertelsen MF, Wales N, Balazs GH, Gilbert MTP. 2016. Further evidence of chelonid herpesvirus 5 (ChHV5) latency: High levels of ChHV5 DNA detected in clinically healthy marine turtles. PeerJ 4: e2274. DOI: 10.7717/peerj.2274.

Alfaro-Núñez A, Frost Bertelsen M, Bojesen AM, Rasmussen I, Zepeda-Mendoza L, Tange Olsen M, Gilbert MTP. 2014. Global distribution of chelonid fibropapilloma-associated herpesvirus among clinically healthy sea turtles. BMC Evolutionary Biology 14(1):206. DOI: 10.1186/s12862-014-0206-z.

Arthur K, Limpus C, Balazs G, Capper A, Udy J, Shaw G, Keuper-Bennett U, Bennett P. 2008. The exposure of green turtles (*Chelonia mydas*) to tumour promoting compounds produced by the cyanobacterium *Lyngbya majuscula* and their potential role in the aetiology of fibropapillomatosis. Harmful Algae 7(1):114–125. DOI: 10.1016/j.hal.2007.06.001.

Berube MD, Dunbar SG, Rützler K, Hayes WK. 2012. Home range and foraging ecology of juvenile Hawksbill sea turtles (Eretmochelys imbricata) on inshore reefs of Honduras. Chelonian Conservation and Biology 11(1):33–43. DOI: 10.2744/ccb-0898.1.

Chaloupka M, Limpus C. 2001. Trends in the abundance of sea turtles resident in southern Great Barrier Reef waters. Biological Conservation 102(3):235–249. DOI: 10.1016/S0006-3207(01)00106-9.

Da Cruz KPP, Gattamorta MA, Matushima ER, Salvarani FM. 2024. Fibropapillomatosis: A review of the disease with attention to the situation Northern coast of Brazil. Animals 14(12):1809. DOI: 10.3390/ani14121809.

da Silva CC, Klein RD, Barcarolli IF, Bianchini A. 2016. Metal contamination as a possible etiology of fibropapillomatosis in juvenile female green sea turtles *Chelonia mydas* from the southern Atlantic Ocean. Aquatic Toxicology 170:42–51. DOI: 10.1016/j.aquatox.2015.11.007.

Espinoza-Rodriguez N, Barrios-Garrido H. 2022. Fibropapillomatosis in immature green turtles (Chelonia mydas) from the gulf of Venezuela/Fibropapilomatosis en juveniles de tortuga verde (Chelonia mydas) del golfo de Venezuela. Revista Cientifica 32. DOI: 10.52973/rcfcv-e32086.

Foley AM, Schroeder BA, Redlow AE, Fick-Child KJ, Teas WG. 2005. Fibropapillomatosis in stranded green turtles (Chelonia mydas) from the eastern United States (1980–98): Trends and associations with environmental factors. Journal of Wildlife Diseases 41(1):29–41. DOI: 10.7589/0090-3558-41.1.29.

Guiry E, Kennedy JR, Malcom C, Miller M, Hall O, Buckley M, Szpak P. 2024. Archaeological evidence for long-term human impacts on sea turtle foraging behaviour. Royal Society Open Science 11(7):240120. DOI: 10.1098/rsos.240120.

Hays G, Hochscheid S, Broderick A, Godley B, Metcalfe J. 2000. Diving behaviour of green turtles: Dive depth, dive duration and activity levels. Marine Ecology Progress Series 208:297–298. DOI: 10.3354/meps208297.

Hazel J, Hamann M, Lawler IR. 2013. Home range of immature green turtles tracked at an offshore tropical reef using automated passive acoustic technology. Marine Biology 160(3Article 3):617–627. DOI: 10.1007/s00227-012-2117-0.

Herbst L, Ene A, Su M, Desalle R, Lenz J. 2004. Tumor outbreaks in marine turtles are not due to recent herpesvirus mutations. Current Biology 14(17):R697–R699. DOI: 10.1016/j.cub.2004.08.040.

James A, Page-Karjian A, Charles KE, Edwards J, Gregory CR, Cheetham S, Buter BP, Marancik DP. 2021. Chelonid alphaherpesvirus 5 prevalence and first confirmed case of sea turtle fibropapillomatosis in Grenada, West Indies. Animals: An Open Access Journal from MDPI 11(6):1490. DOI: 10.3390/ani11061490.

Jensen MP, Allen CD, Eguchi T, Bell IP, LaCasella EL, Hilton WA, Hof CAM, Dutton PH. 2018. Environmental warming and feminization of one of the largest sea turtle populations in the world. Current Biology: CB 28(1):154–159.e4. DOI: 10.1016/j.cub.2017.11.057.

Jones K, Ariel E, Burgess G, Read M. 2016. A review of fibropapillomatosis in green turtles (Chelonia mydas). The Veterinary Journal 212:48–57. DOI: 10.1016/j.tvjl.2015.10.041.

Jones K, Burgess G, Budd AM, Huerlimann R, Mashkour N, Ariel E, Devlin JM. 2020. Molecular evidence for horizontal transmission of chelonid alphaherpesvirus 5 at green turtle (Chelonia mydas) foraging grounds in Queensland, Australia. PLOS 15(1):e0227268. DOI: 10.1371/journal.pone.0227268.

Keller JM, Balazs GH, Nilsen F, Rice M, Work TM, Jensen BA. 2014. Investigating the potential role of persistent organic pollutants in Hawaiian green sea turtle fibropapillomatosis. Environmental Science and Technology 48(14):7807–7816. DOI: 10.1021/es5014054.

Lackovich JK, Brown DR, Homer BL, Garber RL, Mader DR, Moretti RH, Patterson AD, Herbst LH, Oros J, Jacobson ER, Curry SS, Klein PA. 1999. Association of herpesvirus with fibropapillomatosis of the green turtle Chelonia mydas and the loggerhead turtle Caretta caretta in Florida. Diseases of Aquatic Organisms 37(2):89–97. DOI: 10.3354/dao037089.

Lelong P, Besnard A, Girondot M, Habold C, Priam F, Giraudeau M, Le Loc'h G, Le Loc'h A, Fournier P, Fournier-Chambrillon C, Fort J, Bustamante P, Dupont SM, Vincze O, Page A, Perrault JR, De Thoisy B, Gros-Desormeaux J-R, Martin J, Bourgeois O, Lepori M, Régis S, Lecerf N, Lefebvre F, Aubert N, Frouin C, Flora F, Pimentel E, Passalboni AS, Jeantet L, Hielard G, Louis-Jean L, Brador A, Giannasi P, Etienne D, Lecerf N, Chevallier P, Chevallier T, Meslier S,

Landreau A, Desnos A, Maceno M, Larcher E, Le Maho Y, Chevallier D. 2025. Fibropapillomatosis dynamics, severity and demographic effect in Caribbean Green turtles. EcoHealth 22(1):108–123. DOI: 10.1007/s10393-025-01701-5.

Manes C, Carthy RR, Hull V. 2023. A coupled human and natural systems framework to characterize emerging infectious Diseases—the case of fibropapillomatosis in Marine turtles. Animals 13(9):1441. DOI: 10.3390/ani13091441.

Manes C, Pinton D, Canestrelli A, Capua I. 2022. Occurrence of fibropapillomatosis in Green turtles (Chelonia mydas) in relation to environmental changes in coastal ecosystems in Texas and Florida: A retrospective study. Animals 12 (10):1236. DOI: 10.3390/ani12101236.

Nash A, Ryan EJ. 2023. Immunity in sea turtles: Review of a host-pathogen arms race millions of years in the running. Animals 13(4):556. DOI: 10.3390/ani13040556.

Page-Karjian A, Torres F, Zhang J, Rivera S, Diez C, Moore PA, Moore D, Brown C. 2012. Presence of chelonid fibropapilloma-associated herpesvirus in tumored and non-tumored green turtles, as detected by polymerase chain reaction, in endemic and non-endemic aggregations, Puerto Rico. Springer Plus 1(1):35. DOI: 10.1186/2193-1801-1-35.

Patrício AR, Herbst LH, Duarte A, Vélez-Zuazo X, Santos Loureiro N, Pereira N, Tavares L, Toranzos GA. 2012. Global phylogeography and evolution of chelonid fibropapilloma-associated herpesvirus. The Journal of General Virology 93 (5):1035–1045. DOI: 10.1099/vir.0.038950-0.

Perrault JR, Levin M, Mott CR, Bovery CM, Bresette MJ, Chabot RM, Gregory CR, Guertin JR, Hirsch SE, Ritchie BW, Weege ST, Welsh RC, Witherington BE, Page-Karjian A. 2021. Insights on immune function in free-ranging Green sea turtles (Chelonia mydas) with and without fibropapillomatosis. Animals 11(3Article 3):861. DOI: 10.3390/ani11030861.

Roost T, Schies J-A, Girondot M, Robin J-P, Lelong P, Martin J, Siegwalt F, Jeantet L, Giraudeau M, Le Loch G, Bejarano M, Bonola M, Benhalilou A, Murgale C, Andreani L, Jacaria F, Campistron G, Lathière A, Martial F, Hielard G, Arqué A, Régis S, Lecerf N, Frouin C, Lefebvre F, Aubert N, Flora F, Pimentel E, Lafolle R, Thobor F, Arthus M, Etienne D, Lecerf N, Allenou JP, Desigaux F, Larcher E, Larcher C, Curto AL, Befort J, Maceno-Panevel M, Lepori M, Chevallier P, Chevallier T, Meslier S, Landreau A, Habold C, Le Maho Y, Chevallier D. 2022. Fibropapillomatosis prevalence and distribution in immature green turtles (Chelonia mydas) in Martinique island (Lesser Antilles). EcoHealth 19(2):190–202. DOI: 10.1007/s10393-022-01601-y.

Seminoff JA (Southwest F. S. C.). 2004. IUCN red list of threatened species: Chelonia mydas. The IUCN. https://www.iucnredlist.org/en.

Siegwalt F, Benhamou S, Girondot M, Jeantet L, Martin J, Bonola M, Lelong P, Grand C, Chambault P, Benhalilou A, Murgale C, Maillet T, Andreani L, Campistron G, Jacaria F, Hielard G, Arqué A, Etienne D, Gresser J, Régis S, Lecerf N, Frouin C, Lefebvre F, Aubert N, Vedie F, Barnerias C, Thieulle L, Guimera C, Bouaziz M, Pinson A, Flora F, George F, Eggenspieler J, Woignier T, Allenou JP, Louis-Jean L, Chanteur B, Béranger C, Crillon J, Brador A, Habold C, Le Maho Y, Robin JP, Chevallier D. 2020. High fidelity of sea turtles to their foraging grounds revealed by satellite tracking and capture-mark-recapture: New insights for the establishment of key marine conservation areas. Biological Conservation 250:108742. DOI: 10.1016/j.biocon.2020.108742.

Smith GM, Coates CW. 1938. Fibro-epithelial growths of the skin in large marine turtles, Chelonia mydas (Linnaeus). Zoologica: Scientific Contributions of the New York Zoological Society 23(4):93–98. DOI: 10.5962/p.203654.

Taquet C, Taquet M, Dempster T, Soria M, Ciccione S, Roos D, Dagorn L, Dempster T, Soria M, Ciccione S, Roos D, Dagorn L. 2005. Foraging of the green sea turtle Chelonia mydas on seagrass beds at Mayotte island (Indian Ocean), determined by acoustic transmitters. Marine Ecology Progress Series 306:295–302. DOI: 10.3354/meps306295.

Van Houtan KS, Hargrove SK, Balazs GH, Thrush S. 2010. Land use, macroalgae, and a tumor-forming disease in marine turtles. Public Library of Science ONE 5(9):e12900. DOI: 10.1371/journal.pone.0012900.

Vanstreels RET, Durant A, Santos AP, Santos RG, Angélica MSS, Rossi S, Setim FE, Gattamorta MA, Matushima ER, Mayorga LFSP, Uhart MM. 2023. Exploring the relationship between environmental drivers and the manifestation of fibropapillomatosis in green turtles (Chelonia mydas) in eastern Brazil. Public Library of Science ONE 18(8):e0290312. DOI: 10.1371/journal.pone.0290312.

Wallace BP, DiMatteo AD, Hurley BJ, Finkbeiner EM, Bolten AB, Chaloupka MY, Hutchinson BJ, Abreu-Grobois FA, Amorocho D, Bjorndal KA, Bourjea J, Bowen BW, Dueñas RB, Casale P, Choudhury BC, Costa A, Dutton PH, Fallabrino A, Girard A, Girondot M, Godfrey MH, Hamann M, López-Mendilaharsu M, Marcovaldi MA, Mortimer JA, Musick JA, Nel R, Pilcher NJ, Seminoff JA, Troëng S, Witherington B, Mast RB. 2010. Regional management units for marine turtles: A novel framework for prioritizing conservation and research across multiple scales. PLOS 5(12):e15465. DOI: 10.1371/journal.pone.0015465.

Whilde J, Mashkour N, Koda SA, Eastman CB, Thompson D, Burkhalter B, Frandsen HR, Page A, Blackburn NB, Jones K, Ariel E, Dupont SM, Wood L, Duffy DJ. 2024. International overview of sea turtle fibropapillomatosis: A survey of expert opinions and trends. Frontiers in Cell and Developmental Biology 12. DOI: 10.3389/fcell.2024.1445438.

Work TM, Balazs GH. 1999. Relating tumor score to hematology in green turtles with fibropapillomatosis in Hawaii. Journal of Wildlife Diseases 35(4):804–807. DOI: 10.7589/0090-3558-35.4.804.