Report of the Technical Expert Workshop: Developing Recommendations for Field Response, Captive Management, and Rehabilitation of Sea Turtles with Fibropapillomatosis

St. Petersburg, Florida, USA
6 September 2017

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U.S. Department of Commerce
National Oceanic and Atmospheric Administration
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Executive Summary

Fibropapillomatosis (FP) is a disease of sea turtles that primarily manifests as tumors of the skin. Strandings of green turtles with this disease have dramatically increased in the Southeast U.S. over the last decade, necessitating a review of various practices related to the capture, handling, and treatment of afflicted turtles. NOAA and USFWS hosted a workshop in St. Petersburg, Florida on September 6, 2017 to seek input on the development of recommendations to address the following key issues regarding green turtles with FP: 1) disposition when encountered under various circumstances (e.g., strandings, research activities, incidental capture, opportunistic observations); 2) rehabilitation and release; 3) response options if rehabilitation capacity is exceeded; and 4) biosecurity measures to prevent anthropogenic spread of the disease. Federal and state resource agency staff and rehabilitation veterinarians were invited to this workshop to provide input for these recommendations. A review of rehabilitation practices and outcome was shared with participants to inform discussions related to rehabilitation and stranding response. Draft recommendations were prepared for the meeting and participants were asked to share their opinions during moderated discussions and via a written feedback instrument. This input was considered and applied to amend the recommendations, which were also peer-reviewed by six additional veterinarians and a stranding biologist with expertise in sea turtles, rehabilitation medicine, and fibropapillomatosis. The intended use for the completed *Fibropapillomatosis and Sea Turtles: Recommendations for Field Response, Captive Management, and Rehabilitation* is to assist resource agencies with management planning and decisions related to green turtles with FP and to inform relevant aspects of policy, permits, and authorizations under federal and state regulations.

Acknowledgements: We thank all of the participants at the workshop (Appendix A) and peer-reviewers for their valuable contributions to this report and the recommendations. Reviewers included Drs. Tom deMaar, Joseph Flanagan, Craig Harms, Doug Mader, Terry Norton, Annie Page-Karjian, and Ms. Susan Schaf. Data on stranding observations, rehabilitation outcome, and captivity interval reviewed herein were provided to the Florida Fish and Wildlife Commission by participants in the Sea Turtle Stranding and Salvage Network and rehabilitation facilities throughout the state of Florida.

1. Background

1.1. Fibropapillomatosis of sea turtles

Fibropapillomatosis (FP) is a neoplastic (tumor-causing) disease that occurs globally in wild populations of sea turtles (Hargrove et al. 2016). The disease primarily manifests as tumors of the skin and mainly affects green turtles (*Chelonia mydas*). FP rose in prevalence in Florida and Hawaii most noticeably during the 1980s; the first mention of its occurrence in Florida include accounts as early as the late 1800s (Cruz 1985). In Hawaii, prevalence of FP declined over the last couple of decades (Chaloupka et al. 2009); however, there is no evidence that it is abating in the Southeast U.S. or Caribbean. The disease is extremely common in some areas of Florida and Puerto Rico, with over 50% prevalence among green turtles captured during some years (Diez and Patricio 2016, Ehrhart et al. 2016, Foley 2016).

The cause of FP has not been fully elucidated, but the disease has been shown to be transmissible in laboratory studies (Herbst et al. 1995). Outbreaks of fibropapillomatosis among captive green turtles in two documented instances also support that the disease is transmissible (Hoffman and Wells 1991, Herbst 1994). The preponderance of scientific evidence indicates that the agent responsible for FP is a herpesvirus, Chelonid Fibropapilloma-associated Herpesvirus or Chelonid Herpesvirus 5 (CHV5), which has existed in sea turtle populations for millions of years and has evolved into several viral variants (Quackenbush et al. 1998, Herbst 2004, Ene et al. 2005). It is unknown why FP appears to have emerged as a significant disease of green turtles in relatively recent times. Various forms of anthropogenic habitat degradation and pollution may be contributory (Foley et al. 2005, dos Santos et al. 2010, Van Houtan et al. 2010).

The clinical course of FP varies among affected turtles; the disease can be relatively minor (few external tumors) or severely debilitating. In-water studies have documented spontaneous regression of tumors. Of those green turtles observed to have FP and that were subsequently encountered, 32% in Hawaii (Bennett et al. 1999) and 64% in Florida (Ehrhart et al. 2016) exhibited regression. However, some green turtles experience increasingly extensive tumor growth, including tumors involving the eyes and internal organs such as the heart, kidneys, and lungs, leading to impairment of organ function. In Hawaii, tumors also frequently involve the mouth, impeding feeding and respiration. Severely affected green turtles become emaciated, develop severe anemia (low numbers of red blood cells), and are susceptible to opportunistic infections subsequent to immunosuppression (Work and Balazs 1999, Cray et al. 2001, Work et al. 2001, Work et al. 2003, Work et al. 2004). Factors that influence the severity of disease remain unknown.

Fibropapillomatosis is one of the most frequent causes of stranding of green turtles within endemic areas such as Hawaii (Chaloupka et al. 2008b) and Florida (Foley et al. 2005), and is regularly encountered by stranding responders, resource agency staff, in-water researchers, and rehabilitation facility personnel. In the Southeast U.S., the disease may be observed as the primary cause of stranding, as a complicating factor in turtles with other conditions (e.g., cold-stunning, traumatic injuries), and also may develop in previously unaffected turtles while they are in captivity undergoing rehabilitation (Page-Karjian et al. 2014). There are significant regional differences in the care and treatment of turtles with

FP. In Florida, when FP first emerged as a disease of concern in the 1980s, the green turtle nesting population was small and listed as endangered under the Endangered Species Act as amended (16 U.S.C. §1531 et seq.) of 1973. Treatment of green turtles with FP by surgical excision of tumors was pursued as a means of saving individuals and studying the disease. Over time, the number of rehabilitation facilities in Florida that treat sea turtles with FP has grown, and care facilities in other states in the Southeast U.S. have also undertaken treatment of turtles with FP. In contrast, there have been comparatively limited efforts to rehabilitate green turtles with FP in Hawaii and Puerto Rico due to multiple factors, including fewer numbers of strandings, advanced state of the disease (including oral tumors in Hawaii) at the time of stranding, and lack of rehabilitation facilities.

1.2. Current challenges related to FP

Over the last decade, the North Atlantic green turtle population has substantially increased as evidenced by both increased numbers of nesting females and increased catch per unit effort for in-water studies (Chaloupka et al. 2008a, Redfoot et al. 2013, Ehrhart et al. 2016). These conservation gains reflect vital regulatory measures to protect green turtles and their habitat in multiple countries and have occurred despite the continuing presence of FP within populations (Hargrove et al. 2016). Higher numbers of green turtles in coastal areas of the Southeast U.S. have been accompanied by increased strandings. The number and proportion of stranded turtles with FP found in Florida has also notably increased resulting in greater numbers of turtles with tumors being admitted into rehabilitation facilities (Figs. 1 and 2). If this trend continues, the numbers of stranded green turtles with FP could double over the next 5-10 years. In addition, the disease is encountered with increasing frequency in Texas, where numbers of green turtles also are increasing (Tristan et al. 2010, Metz and Landry 2013). FP is sporadically encountered in other areas of the Southeast U.S. and remains common in Hawaii and some localities within the Caribbean.

In Florida, resources are already strained by pulses of debilitated turtles with FP brought ashore by conditions favoring beach-cast stranding, creating animal welfare and quality of care concerns. Substantial resources are expended on FP in the form of stranding response (funded by government and private sector, depending on state) and rehabilitation (funded largely by private sector). A total accounting of the costs of FP has not been compiled but entail a considerable amount of personnel effort, transportation costs, facilities-related expenses (including maintenance of tanks and medical equipment), and direct costs of treatment (thousands of dollars per animal). Realistic expectations of growth for rehabilitation capacity (i.e., creation of new facilities, expansion of existing ones) may be unable to meet demands should numbers of affected turtles continue to increase at the current rate. Although the resources used for rehabilitation and conservation-focused management efforts often come from different sources, these efforts should align in terms of achieving sea turtle recovery goals, maintaining animal welfare standards, and promoting the health of wild sea turtle populations.

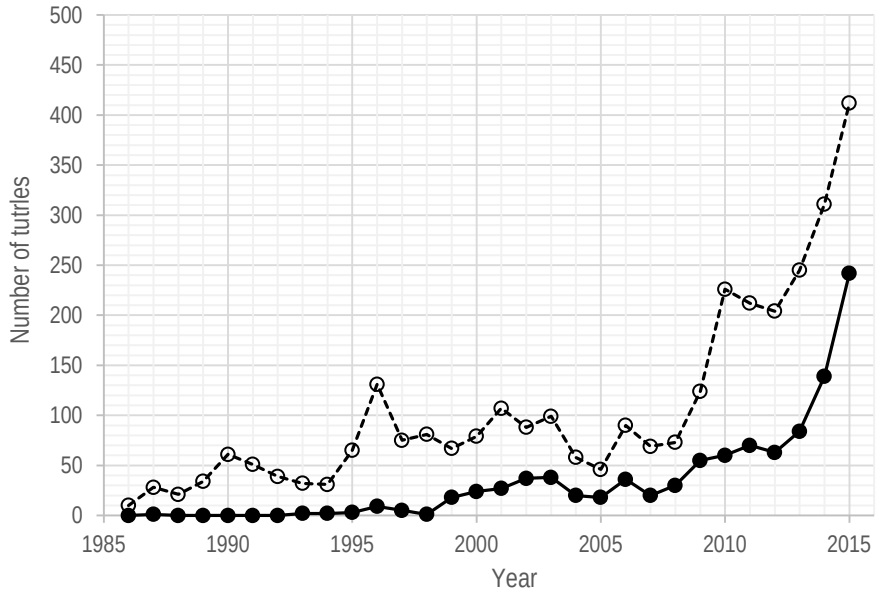


Figure 1. The number of green turtle strandings with FP (dashed line) in Florida and admissions of live green turtles with tumors into rehabilitation facilities (solid line) by year.

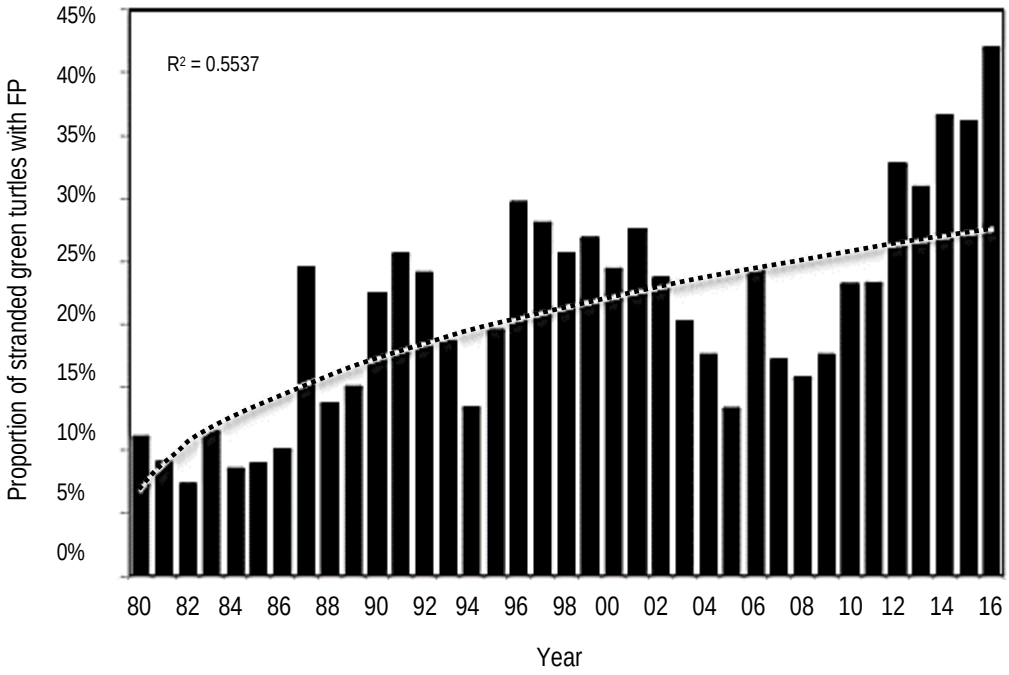


Figure 2. Proportion of green turtle strandings with FP in Florida by year and upward logarithmic trend (dotted line) from 1980-2016 (courtesy of FWC).

1.3. Workshop objectives

If the current pattern of increased strandings of green turtles with FP continues, existing rehabilitation and response efforts could be overwhelmed. In addition to concerns regarding capacity for treatment of individual turtles with FP, other aspects of management related to the disease lack formal guidance that reflects the present status of green turtle populations and our current understanding of FP. Recommendations are needed that address the following: 1) disposition of turtles with FP encountered under various circumstances (e.g., strandings, in-water studies, public encounters, incidental capture); 2) rehabilitation and release; 3) response options for circumstances when rehabilitation capacity is exceeded; and 4) biosecurity measures to prevent anthropogenic spread of the disease. The objective of this workshop was to assemble representatives from resource agencies overseeing sea turtle management within areas where FP is found and veterinarians and scientists engaged in FP research and rehabilitation to assist USFWS and NOAA with development of these recommendations. Although the Southeast U.S. was the focus of this meeting, it is intended that the recommendations will be applicable to other areas of the U.S. as well.

1.4. Participants

Workshop participants included state and federal resource agency staff involved in various aspects of management and conservation and veterinarians from rehabilitation facilities throughout the Southeast U.S. The invited veterinarian participants represented those facilities that regularly treat turtles with FP. In addition, George Balazs (NOAA-retired) and Dr. Thierry Work (USGS) were invited to share their perspectives based on decades of research and management of FP in the Hawaiian Islands. A complete list of participants is provided in Appendix A.

1.5. Workshop organization and materials

The Steering Committee consisted of Dr. Brian Stacy (NMFS-OPR), Barbara Schroeder (NMFS-OPR), Ann Marie Lauritsen (USFWS), and Stacy Hargrove (NOAA-OPR). Drs. Allen Foley (FWC) and Thierry Work (USGS) contributed to the development of key workshop elements. In advance of the meeting, participants were provided with a preparatory document that included key background information on the disease, stranding numbers, admissions to rehabilitation facilities, and survival outcome. This information was also presented at the meeting as a basis for discussions (see subsection 2.1). In addition, Drs. Stacy and Work developed draft recommendations for consideration and discussion by the group that were intended to facilitate participant input on its various elements. This approach was elected in lieu of attempting to synthesize recommendations *de novo* during the course of the meeting.

The discussions were facilitated by Barbara Schroeder following the agenda in Appendix B. At the conclusion of the meeting, non-USFWS/NOAA participants were provided with a take-home feedback instrument that allowed them to express additional input following adjournment. All participant input was expressed as individual opinion. This meeting did not endeavor to seek consensus and is in accordance with the Federal Advisory Committee Act (FACA) of 1972.

2. Workshop Presentations

2.1. Review of rehabilitation effort and outcome in Florida

Since the early 1990s, the FWC has overseen and compiled data on all sea turtle rehabilitation efforts in Florida. Since that time, there have been significant changes in rehabilitation treatment and protocol for FP-afflicted animals. In previous FWC guidelines, rehabilitation centers were asked to hold animals for a full year following tumor excision prior to release in order to monitor turtles through a warm season for tumor recurrence. The rationale was that turtles that remain tumor-free for one year after tumor excision tended to remain so. However, as numbers of FP admissions increased, the prolonged rehabilitation intervals became more burdensome and diminished capacity for treatment of additional stranded turtles requiring care. This issue was especially problematic during periods of increased strandings, such as cold-stunning events. In 2011, recommendations were provided by a group of veterinarians that aimed to allow judicious release of turtles with non-immediately life-threatening tumors, clarify conditions for euthanasia,[1] and eliminate the one-year holding period, which has since been removed from the FWC rules and FWC Marine Turtle Conservation Handbook and is no longer practiced by most facilities.

This review covers data collected in Florida since 2006 because this period most closely reflects current rehabilitation practices. Information reported to FWC and included in this review comprises observations related to cause of stranding (e.g., FP, traumatic injuries, entanglement), duration of rehabilitation, outcome (release, spontaneous death, euthanasia), and the extent of external tumor growth. Note that details of veterinary records, including results of blood analyses and diagnostic imaging are not provided to government agencies and thus are not included in this review. For any statistical comparisons, (e.g., chi-square, Fisher's exact test, Kruskal-Wallis test) p-values <0.05 were considered significant. Data from other states were not included in this review because lower numbers of cases and key differences in rehabilitation practices may influence outcome. In particular, imaging or endoscopy for detection of internal tumors is not routine at some facilities outside of Florida due to resources and availability. This difference is relevant to survival outcome because detection of internal tumors is a significant cause of euthanasia in Florida rehabilitation centers. Also, some facilities outside of Florida use a shorter post-operative holding period, thus opportunity for observing regrowth, a cause of prolonged rehabilitation and euthanasia, may not be comparable to the circumstances from which much of the Florida data were derived.

Two methods were used to characterize the severity of FP. Initially, an FP data sheet completed by the FL Sea Turtle Stranding and Salvage Network (STSSN) participants was used to derive a tumor score (TS) of 1 (least severe), 2 (moderate), or 3 (most severe) based on criteria developed by Work and Balazs (1999). During discussions at the workshop, the issue was raised that this approach may not align well with the visibly apparent tumor severity. In response to these concerns, NOAA and FWC staff undertook a review of photographs taken at the time of stranding for a large subset (>200 cases) of FP-afflicted

[1] All mention of "euthanasia" within this document refer to accepted methods for reptiles approved by the American Association of Zoological Veterinarians (2006) and the American Veterinary Medical Association (2013).

turtles and found that there were many instances in which the tumor scores poorly represented relative severity and that there was significant inconsistency in tumor severity among turtles with the same score. We surmised that the morphology and pattern of tumor growth may be leading to inconsistency in completion of data forms, and hence variability in the resulting score. As an alternative approach, a visual ordinal scoring method was developed based on photographic comparison following the same 1-3 convention (Fig. 3, see Appendix C). A single observer with significant experience with FP (A. Foley) retrospectively scored all turtles from the period of interest for which adequate photographs were available (n=698). The results of this scoring method were used to repeat all analyses related to tumor severity (Tables 1 and 2).[2]

Figure 3. Examples of green turtles with fibropapillomatosis exhibiting the tumor scores (TS) that were used in the analyses. Mild tumor growth (TS1, left); moderate growth (TS2, middle); and severe growth (TS3, right). A complete array of examples used to assign tumor scores by photographic comparison is provided in Appendix C.

Between 2006-2016, there were 995 admissions of live stranded green turtles with FP. The majority (620, 62.3%) presented with FP as the primary problem along with secondary conditions such as emaciation, buoyancy abnormalities, and accumulated epibiota. The remaining cases had other potential primary abnormalities noted in the stranding report that may have led to stranding, including entanglement or other fishing gear interaction (193, 19.4%); other traumatic injuries, especially vessel strikes (157, 15.8%); and miscellaneous other conditions (25, 2.5%). Of the 944 turtles that had concluded their period of care at the time of analysis, 730 (77.3%) were deceased and 214 (22.7%) were

[2] The original presentation given at the workshop reported data and comparisons based on tumor scores derived from Work and Balazs (1999). Only the updated results based on the new photographic scoring method are reported here to avoid any confusion.

released. Thus, an average of 21 sea turtles (with FP) per year were rehabilitated and released in Florida during this 10-year period. The deceased turtles included 370 (39.2%) that died spontaneously and 360 (38.1%) that were euthanized. An additional five turtles (0.5%) were declared permanent captives due to other conditions. The proportion of green turtles with FP that survived and were released (22.7%) was significantly lower than that of green or loggerhead (*Caretta caretta*) turtles without FP (831/1577, 52.7%; 598/1246, 48.0%, respectively).

Probability of successful rehabilitation was inversely related to TS; more severely afflicted animals had a lower probability of release and a higher probability of spontaneous death or euthanasia (Table 1). These proportions were similar when cases with injuries and other abnormalities were excluded. These findings concur with systemic effects of FP where animals with moderate or advanced tumor growth have a poor prognosis for survival because of malnutrition, physiological imbalances, anemia due to chronic disease (Work et al. 1999), weakened immune response (Work et al. 2001), and opportunistic infections (Work et al. 2003). Survival of turtles with the least severe tumor growth (TS1) was not significantly different than for green turtles without tumors. It is likely that mortalities of these less-afflicted turtles in some instances were due to co-morbidities that were not defined in the available data and may not have been attributed to FP. However, we did not have information on the detection of internal tumors, which can occur in turtles with TS1 and may have been the reason for death/euthanasia in some instances.

Table 1. Percent of green turtles that were released, died spontaneously, or were euthanized in Florida from 2006-2016 partitioned by tumor score (1-fewest tumors to 3-most severe) based on visual assessment.

FP tumor score	n	Released	Died	Euthanized	Total deceased[1]
1	139	61 (43.9%)	46 (33.1%)	32 (23.0%)	78 (56.1%)
2	418	86 (20.6%)	177 (42.3%)	155 (37.1%)	332 (79.4%)
3	141	9 (6.4%)	57 (40.4%)	75 (53.2%)	132 (93.6%)
Total	698	156 (22.3%)	280 (40.1%)	262 (37.5%)	542 (77.7%)

[1]Sum of turtles that died or were euthanized.

Following the 2011 recommendation for abrogation of the one-year post-tumor excision holding period, the median duration turtles spent in rehabilitation declined by an average of approximately 33% across all FP admissions (from a median of 377 days to 251 days). Median duration and range for those with an assigned TS are shown in Table 2. Nearly half of turtles that were ultimately released spent greater than 200 days in captivity, whereas death or administration of euthanasia occurred within seven days of admission for the majority of turtles that did not survive. Around 15% of turtles that died spontaneously or were euthanized were in rehabilitation for longer than one month. Although not evident in the FWC data, tumor recurrence is the most common cause of increased duration of rehabilitation for FP cases

admitted to the Turtle Hospital (Marathon, FL) and occurs in over 80% of turtles at this facility (D. Mader and B. Zirkelbach, pers. com).[3]

Table 2. Days (median and range) in rehabilitation for green turtles in Florida from 2006-2016 by tumor score (1-fewest tumors; 3-most severe) for admissions. Admissions during 2011 are excluded as this was the year when changes in holding practices occurred at multiple facilities

FP tumor score		Number of days to release			Number of days to death			Number of days to euthanasia		
	Years	n	Median	Range	n	Median	Range	n	Median	Range
1	2006-10	9	217	114-559	7	1	0-4	9	31	0-543
	2012-16	47	120	2-667	37	4	0-369	19	17	0-894
2	2006-10	12	405	144-735	28	1	0-176	31	8	0-443
	2012-16	69	306	60-689	140	2	0-401	113	9	0-355
3	2006-10	2	420	401-439	7	6	0-181	9	7	0-229
	2012-16	7	265	0-306	48	1	0-183	61	8	0-306

One index of rehabilitation capacity-use is the number of days spent in captivity, during which sea turtles are provided with food, shelter, and medical care (i.e., rehabilitation-days). For example, four turtles each spending 30 days in rehabilitation would equate to 120 rehabilitation-days. Around 67% of total rehabilitation-days resulted in release of live turtles. Of the remaining 33% of days required for turtles that died, 62% were expended on TS2 turtles that died spontaneously or were euthanized, and 34% were expended on TS3 turtles, most of which were euthanized. Although only 15% of turtles that ultimately died spontaneously or were euthanized were in captivity longer that one month, these cases required much of the rehabilitation capacity that did not result in release of live turtles (Fig. 4).

[3] Much lower rates of regrowth have been encountered at the Texas Sealife Center (T. Tristan pers. com), but it is unclear whether this difference may be due, at least in part, to a shorter post-operative holding period practiced at this facility. Potential regional differences in regrowth rates warrant further study.

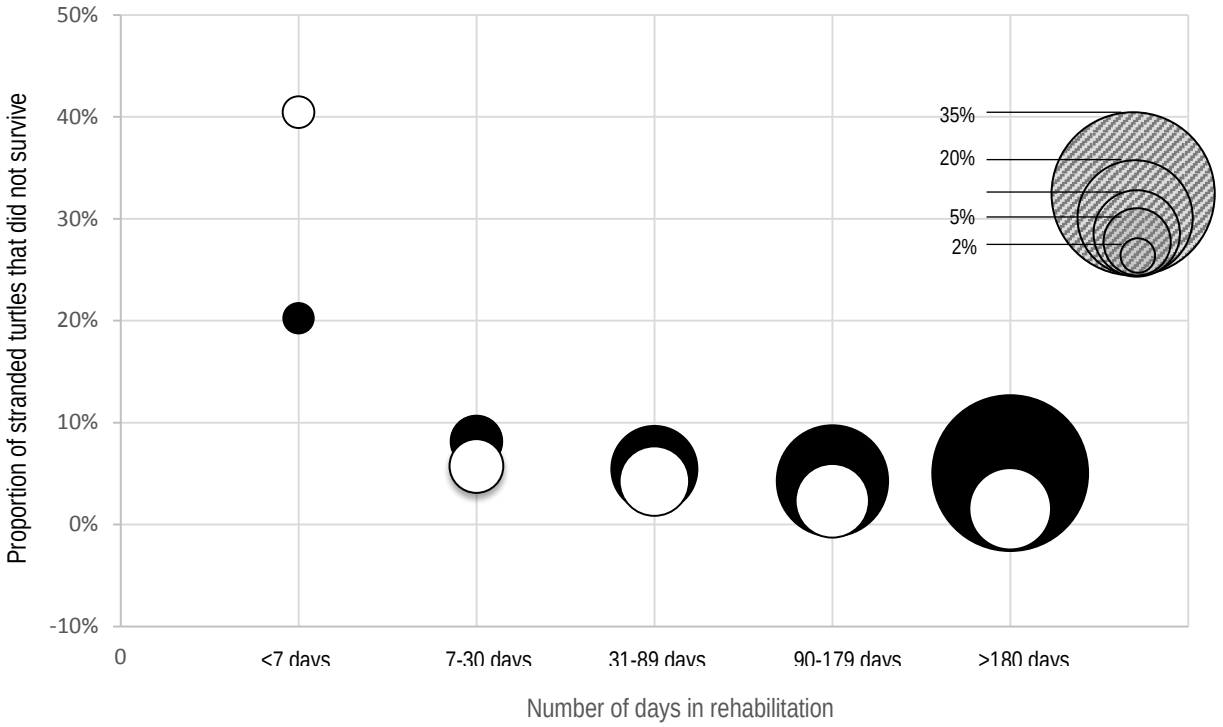


Figure 4. Duration of rehabilitation for green turtles with tumor scores 2 or 3 that did not survive (2012-2016 data). Euthanized animals (n=111) are shown in black; those that died spontaneously (n=146) are shown in white. The size of the circle reflects the proportion of total effort (measured as days spent in captivity) expended on sea turtles that spontaneously died or were euthanized. Most turtles that ultimately did not survive were in captivity for less than one month. The vast majority of rehabilitation capacity was required to accommodate a small number of turtles that died or were euthanized after lengthy periods of captivity.

2.2. Review of FP-related strandings, euthanasia, and rehabilitation practices in Hawaii

An average of 36 sea turtles (~95% green turtles) are admitted for rehabilitation in Hawaii per year; the average number euthanized annually is 24. Fibropapillomatosis is the primary reason for euthanasia in most instances, whereas most turtles that undergo rehabilitation are treated for injuries sustained from human interaction. Most of these turtles originate from Oahu and Maui. Logistics of transport of live turtles between islands is challenging, and there is only one facility that rehabilitates turtles. Research on turtles afflicted with FP in Hawaii shows that immunosuppression occurs by the time they present with a TS2, leading to death from complications such as opportunistic infection. Turtles that are euthanized are in captivity for a mean of 14 days (0-1,895 days). Those that are rehabilitated are held for an average of 10 days (0-259 days). Euthanasia cases have significantly lower body condition index reflecting the fact that most euthanasia cases are FP cases TS2 or TS3. Prevalence of FP at an index study site in Molokai has fallen over the last 20 years; however, the percent occurrence of FP among stranded turtles remains about 30% (Murakawa 2016).

2.3. Introduction of draft recommendations for field response, captive management, and rehabilitation

The draft recommendations consist of three main elements, which were presented and explained in detail:

I. Best practices when green turtles with FP are encountered in the wild, including circumstances when human intervention is or is not indicated;
II. Rehabilitation of green turtles with FP, including response options for rehabilitation efforts when capacity is exceeded;
III. Best practices related to biosecurity for sea turtles in captivity and during field research.

Printed or electronic copies of the draft recommendations were provided to the participants. The amended recommendations based on workshop discussions, participant feedback, and resource agency staff deliberations are presented in Appendix D. A detailed list of changes made to the draft recommendations is provided in Section 5.

3. Facilitated Discussions

The meeting began with introduction of the meeting objectives, agenda, and participants. Each participant was asked to briefly describe their background and experience with FP. Following the presentations outlined in Section 2, the facilitated discussions were structured into two reviews of 1) rehabilitation outcome and stranding trends; and 2) each element of the draft recommendations. When relevant, participants are referred to by their current role as a veterinarian or resource agency representative in the following summary.

3.1. Review presentations

Following the first two presentations, participants were invited to ask any questions. Participants asked about the percent occurrence of internal tumors in stranded green turtles found in Hawaii (response: 30-40%). A brief general discussion followed that considered the pathophysiology of immunosuppression in relation to FP, internal tumor formation in relation to severity of disease (tumor score), and challenges in Hawaii associated with members of the public mistaking basking sea turtles for strandings.

Veterinarian participants were asked: 1) how the presented review aligned with their perceptions of the mortality rate; and 2) whether anyone wanted to add any clarifications or additions regarding rehabilitation practices and FP.

One participant opined that they are encountering turtles with intermediate and high tumor scores and those with large ocular tumors that are not emaciated. This participant also expressed that it is challenging to predict outcome to help guide allocation of resources and that each case requires a different approach rather than attempting to institute a uniform protocol. Other participants affirmed similar observations regarding nutritional condition of turtles with tumors, including an in-water researcher who works in the Indian River Lagoon, FL.

Another participant stated that their facility has never held turtles for a year following excision and usually releases turtles 2 to 3 months after excision if healing well. The broader group was asked about the 1-year holding period and all said this is not part of their standard practice. Two other participants commented that they are releasing turtles after about 1-2 months depending on weight gain and healing, if no other conditions exit. Clarification of the history of the 1-year holding time was provided, specifically that it was intended to allow turtles to be monitored through a warm period, and was based on early clinical and research findings. It was offered that the Turtle Hospital is likely the only facility that still holds turtles for lengthy periods post-excision.

Individual comments were provided related to imaging modalities for the detection of internal tumors and surgical excision. Access to computed tomography is variable among facilities. Some participants favor imaging and surgical approaches that do not require use of general anesthesia. A representative from Texas commented that they do not see such high recurrence rates. It was briefly discussed whether the lengthier holding times or differences in surgery modalities may contribute to differences in regrowth observations or perceptions.

Summary of participant comments:

- The one-year holding time previously used is longer than is typically practiced among facilities represented by attending veterinarians
- Modalities of techniques used to screen sea turtles for internal tumors vary among facilities

Participants were asked to discuss the issue of animal welfare, specifically the negative consequences of treatment undergone by sea turtles with a poor prognosis, and euthanasia as an alternative humane course of action.

Additional context was provided by one of the meeting organizers, explaining that judicious use of euthanasia is an integral part of the issue at hand and relates to both fulfilling animal welfare responsibilities and managing rehabilitation capacity. Additionally, participants were asked to comment about current facility stances regarding reluctance to euthanize turtles due to staff concerns, as expressed at a previous meeting in 2011. The subsequent discussions included comments related to decision-making, staff and public perceptions, and the current status of sea turtle populations.

One participant, a resource manager, expressed that humane euthanasia is a form of treatment to end suffering and should not have a negative connotation. He commented that negative feelings towards euthanasia in his region is fueling interest in creating more rehabilitation capacity.

Veterinary participants were asked whether the decision to euthanize is made by the veterinarian. All that responded indicated that the veterinarian makes the final determination, but one participant added that staff also may weigh in on those decisions. Expanding on this issue, participants were asked how they feel about current rehabilitation efforts considering the low percentage of turtles with severe FP scores that survive. One respondent stated that treatment is attempted regardless of tumor severity, and staff want that effort, but the current discussion is causing this respondent to rethink this approach. Another added that the extent to which treatment is pursued is, to some degree, a matter of available resources. They may expend more effort if they have time, space, and means, adding that it would be helpful to have better prognostic capability. Another veterinary respondent questioned the value of attempting treatment when viral infection is lifelong and asked whether the low numbers of survivors warrant the expended effort. Responding to the initial question, one of the facility veterinarians echoed an earlier comment that euthanasia should be described as a means of ending suffering. Texas representatives discussed euthanasia as possible humane option given the increasing numbers of stranded turtles with FP (increasing from 5% after it was initially encountered to 35% in recent years) and fewer available rehabilitation resources in that state. An additional comment was made on the clinical knowledge gained by treatment of FP cases.

It was stated that an appropriate treatment strategy should consider animal welfare issues; doing everything possible to save every animal can be inhumane rather than beneficial. Another participant referenced improving prognostic capability as part of the solution (further discussion later). Participants from Hawaii discussed their approach in additional detail, citing that a team of 3 resource agency staff (including a veterinarian) make euthanasia decisions. It was responded that a system would have to be simpler in the Southeast U.S. because of the numbers of strandings and large area.

Continuing the discussion of animal welfare, a veterinary participant offered that evaluating whether or not reptiles are suffering pain can be difficult because of their stoic nature. Efforts to control pain are not always effective. Another participant noted the important distinction between short-term, temporary pain and long-term pain and suffering – that releasability and quality of life are key considerations in euthanasia decisions. A third veterinarian then opined on our limited knowledge of pain perception in reptiles and cautioned against relying on this factor excessively to guide determinations. The challenges associated with making euthanasia decisions for larger species, i.e. marine mammals, were acknowledged with one participant noting that logistical constraints usually preclude attempted treatment.

The question was posed to participants as to whether facilities are reluctant to euthanize sea turtles due to anticipated criticism from donors, their administration, or the public, even if animals were brought to facilities solely for the purposes of humane euthanasia. This sentiment had been expressed in the past; thus, the recommendations were developed, in part, to provide a framework for those decisions should resource agencies need to develop capacity for euthanasia outside of rehabilitation facilities. Participants expressed concerns about non-medical personnel administering euthanasia and felt that the recommendations might help them communicate with staff and facilitate cooperation. A resource agency veterinarian responded that, ideally, every turtle would be evaluated and, if indicated, euthanized at experienced rehabilitation facilities. However, it is impossible for agencies to manage state-wide or region-wide capacity among facilities with differing protocols/objectives unless there is a high degree of cooperation. Another agency representative added that the current state in Florida is already challenging; staff frequently have problems placing stranded turtles and accommodating logistics. Another agency veterinarian asked whether these recommendations might actually benefit case success rates and perceptions because it allows facilities to deduct from their efforts for turtles that we now know have a poor prognosis for survival.

The discussion then pivoted to the issue of prognostic capability. One of the Hawaiian representatives asked why these analyses have not yet been done given the number of years turtles have been treated in Florida facilities. Two participants who previously investigated this cited variability in the quality of medical records among facilities, especially in earlier years, as a significant challenge. It was pointed out that the tumor score system developed by Work and Balazs (1999) was tied to hematology and that this score had also been used to categorize turtles in the Indian River Lagoon, FL. One of the organizers pointed out that creating a practical prognostic approach, including blood work would be challenging, if the projected trend of FP cases is realized. It could be helpful for therapy/euthanasia decisions, but parameters like blood work and imaging require time and resources that are not practical if numbers of strandings are overwhelming. One veterinarian participant commented that using virtual consultation might be helpful for seeking additional opinions.

Summary of participant comments:

- Euthanasia is an appropriate, humane means of ending pain and suffering.
- Administration of euthanasia ultimately is decided by the attending veterinarian, but there is individual variability in its use. These differences reflect case load, philosophical perspectives on treatment, and personnel dynamics within facilities.
- When euthanasia is necessary, clear understanding and communication with other facility staff are key and largely are the responsibility of the veterinarian.
- A clearly defined plan would help explain and justify decisions related to euthanasia within facilities.
- Pain endured during attempted treatment is an important consideration, especially if recovery is unlikely.
- Pain is difficult to evaluate in reptiles and is incompletely understood.
- More effort is needed to improve prognostic capabilities.

3.2. Recommendations

Following the presentation of the draft recommendations, each of the three primary elements was discussed. Participants were asked to provide individual comments, noting could also express their opinions via a written feedback instrument if preferred.

I. Best practices for turtles with FP when encountered in wild

Discussions began with review of the criteria used to designate turtles as "debilitated." Concerns were voiced that assessment of body condition is subjective, as is common use of the term "emaciated." Also, there are regional differences in "normal" body condition and severe dehydration can be misinterpreted as weight loss. Photographic examples and written descriptions would be helpful. Additionally, it was pointed out that turtles often exhibit multiple signs of debilitation. Participants opined on various observations and approaches that can be used to determined or guide people in determining whether humane intervention is needed, such as if the turtle does not make a normal attempt to evade capture or is unable to dive.

One participant asked what rehabilitation facilities should do if a member of the public brings them a turtle with FP that is not debilitated, which would constitute capture of a sea turtle that is not authorized under ESA. The need to educate members of the public about the disease was discussed so that people are aware that all turtles with tumors do not require rehabilitation. Various options were discussed, including signage within select areas.

Summary of participant comments:

- Standardized criteria for recognition of debilitated sea turtles should be developed.
- Outreach may be required in areas where turtles with FP are highly visible.

II. Rehabilitation and recommendations for turtles with FP

Prior to beginning discussions of this element, one of the organizers encouraged participants to voice any suggestions that they feel are pertinent. Major restructuring of these recommendations was presented as acceptable if there were better, feasible solutions. The approach described in the draft recommendations was intended as a starting point to facilitate discussions. To aid discussions, response options for use of humane euthanasia and allocation of care were reviewed again for the participants, pointing out that the lowest response level (1) was intended to represent current practices as understood by resource agencies. Other key aspects of the draft recommendations that were reviewed were that the response level would be determined by resource agencies based on rehabilitation capacity by state or region (not the facility) and that criteria beyond the lowest response levels were chosen to include parameters could be ascertained in the field – i.e., determination of whether turtles would be treated or euthanized do not require admission to rehabilitation facilities.

Multiple participants felt that the recommendations needed to clearly demonstrate the tumor scoring system; some had difficulty visualizing the presented classification as it relates to turtles in hand. Some participants also opined about examples of tumor manifestations that do lend to easy classification. It was pointed out that the Work and Balazs (1999) approach was the product of published research and needs to be validated in Florida. One of the in-water research/resource agency representatives pointed out that it had already been used in Florida to study the disease, citing Hirama and Ehrhart (2007 and 2014). To move the discussion forward, one of the organizers suggested that participants consider the 3 tumor scores in relative terms, with 3 representing the most severe cases, also pointing out that the survival data for turtles admitted to Florida facilities correlated with this type of tumor scoring, supporting its value for the purpose at hand.

To calibrate the way the recommendations characterized current practices, participants were asked whether their facilities were consistently euthanizing green turtles with FP meeting the level 1 criteria. Following some brief discussions, it was reiterated and clarified that the response levels are intended as a recommended course of action when rehabilitation capacity is at risk of becoming overwhelmed. Nonetheless, the survival data, animal welfare concerns, and resources should be considered. One participant stated that it seems some facilities are operating at “level 0” – treatment is attempted for all cases.

One facility veterinarian commented that they did not feel like most of their TS3 turtles were dying. A counter-point was made that data collected over the last decade strongly indicated otherwise. A Texas representative also felt like the survival rate of TS3 turtles was higher than indicated in the meeting documents (note: TX data was not included in the initial review) but that this needed to be confirmed. Multiple individuals made comments that we need to ensure that tumor scores are being consistently applied. An FWC representative responded that the scores were given based on a data sheet completed upon stranding, the “pap form.” The topic of tumor scoring came up again later in discussions. One of the organizers assured participants that a photographic review of tumor scores assigned to turtles included in the data compilation would be incorporated into the workshop product.

A veterinary participant asked if data could be mined to understand why some TS3 turtles were treated successfully. It was explained that such an effort would require compilation of medical records, which

are not routinely provided to agencies. A Hawaiian representative stated that all turtles euthanized in that state were necropsied, and it was determined that all likely would have died if released. One agency representative commented that the low survival rate, specifically citing that for TS3, was a little shocking and attempting treatment in these cases seemed counter to how most people approach euthanasia decisions for pets, and that euthanizing turtles with the most severe forms of disease does not diminish the purpose of rehabilitation facilities.

Returning to the discussion of consistency in current treatment practices, participants were asked if they now feel, after seeing the low survival rate of TS3 turtles, that these turtles should be euthanized. All individuals that responded answered affirmatively. Two veterinarians suggested that euthanasia of TS3 turtles should be strongly advised, but ultimately left to the discretion of facilities to allow for medical advancement. In response to the latter, it was noted that TS2 turtles would still provide an opportunity for medical advancement. Another veterinarian felt that euthanizing TS3 turtles should be a requirement, otherwise there would likely be a tendency to continue attempting to rehabilitate these turtles. It was noted that if staff at one facility makes attempts to rehabilitate TS3 turtles, staff at other facilities may feel or be exposed to pressure to do the same. Consistently applied recommendations would help alleviate this issue.

The topic of knowledge gained from FP cases was introduced. Hawaii representatives reviewed the research efforts related to turtles that were euthanized in Hawaii and commented that there does not seem to be much empirical data or studies resulting from clinical rehabilitation efforts of turtles with FP in Florida. One facility representative asked whether there are specific requests for data or sampling of turtles with FP, specifically histopathology, and whether government resources are available for this. This topic was shelved in the interest of time. One agency veterinarian responded that any data collection efforts need to be geared towards specific objectives.

Turning back to the actual response levels criteria [editor's note: the term "triage" was amended to "response level" based on reviewer comments] and potential modifications suggested thus far, opinions regarding euthanasia of TS3 turtles indicated that the criteria of response levels 1 and 2 could be merged. One of the organizers also noted that the current sentiment of veterinarians suggests that facilities may be more willing to euthanize turtles under a defined response system than was originally expressed prior to the workshop. The veterinarians were asked whether they felt euthanasia might be a feasible course of treatment at their rehabilitation facility to aid implementation of this approach. The current circumstance was restated: there is no capacity for euthanasia of sea turtles by resource agencies in Florida – this would have to be created. The most expeditious and preferred solution, if feasible, would be to continue the practice of euthanasia at permitted rehabilitation facilities. Participants felt that this could be feasible, but most that responded indicated that a clear demonstration of capacity issues is required to help communicate the situation to facility staff and volunteers. An updatable graphical presentation of rehabilitation capacity was suggested as an option.

Summary of participant comments:

- A tumor scoring system is needed that can be consistently applied and that clearly corresponds to easily recognizable categories of tumor severity.
- At the time of the meeting, some criteria for euthanizing turtles with FP are variable among the rehabilitation facilities.
- Euthanasia is indicated for TS3 turtles.
- Under conditions where rehabilitation capacity is exceeded, facilities may be able to provide humane euthanasia of turtles under a defined response system.
- Clearly described and reasoned recommendations combined with an explanation of capacity issues are necessary to gain cooperation and understanding from rehabilitation facility staff.

III. Biosecurity

Captive management of sea turtles within FP endemic regions

Starting with recommendations for sea turtles in captivity, the points of the draft recommendations were projected for discussion. The physical separation of species and turtles with FP was anticipated to be the most logistically challenging recommendation and was the focus of initial discussions. Participants considered the relative risks of transmission citing evidence (e.g., Work et al. 2014) that turtles with tumors are logically associated with the greatest risk of transmission to turtles without FP. One of the organizers clarified that separating all green turtles from other species was included because non-FP green turtles (referring to absence of tumors as determined by visual examination) have developed tumors in captivity in Florida and other states (Page-Karjian et al. 2014). Therefore, only isolating turtles with FP creates a somewhat arbitrary biosecurity measure in a rehabilitation situation. Participants from Hawaii commented that they do not see tumor formation in captivity; another participant speculated that water temperature might be a contributing factor in that case.

Although one rehabilitation facility currently isolates turtles with FP and non-FP green turtles, most said this would not be possible with their current set-ups and felt that managing three separate units would be logistically prohibitive. Multiple participants said the isolation of turtles with FP was the priority and that isolation of non-FP green turtles in FP-endemic areas (less critical where FP not found) should be considered when constructing new facilities or remodeling existing ones. An agency veterinarian added that there are additional biosecurity benefits of separating species, citing the recent emergence of *Caryospora* infections in stranded green turtles in the Southeast U.S.

There was additional discussion about biosecurity under mass stranding conditions, such as cold-stunning events. Comments reflected opinions that biosecurity is maintained to the degree conditions allow. An agency representative asked if the requirement to maintain separate systems would mean that facility capacity becomes limited if strandings are predominantly species other than green turtles. It was asserted that facilities can be appropriately disinfected to accommodate such situations.

Summary of participant comments:

- Separation of turtles with FP from turtles without tumors is the top priority for biosecurity.
- Guideline recommendations should be phased-in by incorporating them into the design of new rehabilitation facilities or the remodeling of existing facilities.

Field studies and other activities in FP endemic regions

Participants discussed the challenges with biosecurity in the field, especially involving tangle-net captures when multiple animals may be boarded within a short time.

Tagging practices were also discussed, including the risk of tumor formation at tag locations. In Hawaii, only PIT tags are used; tumors have not been seen at PIT tag locations. In Florida, turtles with FP found during cold-stunning events no longer receive metal flipper tags (only PIT tags). It was suggested that recommendations related to mass events and tagging should be incorporated into the recommendations. As far as ceasing the use of metal flipper tags within FP endemic areas, researchers worry that the detection of tagged turtles would be significantly reduced.

Glove use in the field was discussed. Multiple participants noted that it is difficult to use them in hot, humid or wet conditions. As an alternative, an alcohol-based hand sanitizer was suggested. Glove use should be emphasized when touching tumors, and should be required if collecting biopsies or making excisions.

Virucidal solutions were briefly discussed, noting that alcohol is preferred for many applications because its effect is rapid and it does not corrode metal. A preference of 70% alcohol over 95% alcohol was mentioned, but participants could not recall if this was based on scientific study. The logistics of disinfecting large equipment was also discussed, noting that the rinsing of surfaces with water is all that is feasible in some circumstances. A suggestion endorsed by multiple participants was to focus biosecurity measures on prevention of transmission between different geographic areas.

Summary of participant comments:

- Omission of metal flipper tags to prevent tumor growth is an option under some circumstances but must be balanced with information needs gained from flipper tagging.
- Biosecurity measures should emphasize disinfection between areas.
- Alcohol-based hand sanitizers are an alternative when conditions do not allow use of disposable gloves.
- Address flipper-tagging under circumstances involving large numbers of turtles (e.g., cold-stunning events).

3.3. Prognostic studies

The last topic of discussion was prognostic indicators for treatment outcome, i.e., parameters that aid prediction of whether turtles are likely to complete treatment or to have complications such as aggressive regrowth of tumors or internal tumors. Better ability to evaluate the likelihood of successful treatment could lead to more effective allocation of rehabilitation effort and reduce surgeries and other treatments undergone by animals that ultimately do not survive. Two agency staff shared prior experiences with attempting to obtain data relevant to prognosis for treatment in 2011, specifically the quality of medical records in previous years and the many confounders, such as concurrent conditions and inconsistent availability of some commonly used blood parameters. It was emphasized that such an undertaking would require a concerted, multi-institutional approach and most likely would need to be prospective. One participant opined on the potential challenges of predicting long-term outcome over the course of rehabilitation, i.e., death occurring weeks or months following admission - engagement of someone with epidemiological experience would be valuable. Participants indicated interest in contributing to such an effort. NOAA and USFWS offered to take on or identify a suitable party to pursue development of an initial approach and then to circulate among facilities for input. It was suggested that an MPVM student or equivalent may be a good option for moving the effort forward.

Summary of participant comments:

- A multi-institutional study is necessary to obtain adequate sample size and representation.
- There is broad interest within the rehabilitation community to pursue this effort.

[Editorial note: During peer-review of this report, the authors were made aware that a retrospective review of FP cases from a subset of Florida facilities has been conducted and a forthcoming publication is in development: Page-Karjian et al. Tumor re-growth, case outcome, and tumor scoring systems in rehabilitating sea turtles with fibropapillomatosis.]

4. Feedback Instrument

4.1. Description of instrument

Each participant not affiliated with NOAA or USFWS (n=14) was asked to complete the Feedback Instrument. The form consisted of six question and comment fields:

1. Which of the following best characterize your work with sea turtles and fibropapillomatosis (select all that apply)? Choices: veterinarian (rehabilitation), veterinarian (research), sea turtle biologist, resource agency staff, other.
2. Which of the following best characterizes your opinion of the draft recommendations? Choices: the draft recommendations are acceptable as written; minor revisions are required; or major revisions are required. Space was provided for any comments or to describe the necessary revisions.
3. In your opinion, are the draft recommendations logical, do they reflect current concerns related to fibropapillomatosis, and do they apply best available information? Choices: strongly agree, somewhat agree, or disagree. Again, space was provided for explanation of the chosen response.
4. Are there any major changes or additions not described under Question #2 that you think would benefit any aspect of the draft recommendations?
5. Please use the following space to share any opinion or perspective drawn from your experience with sea turtles and fibropapillomatosis that you feel would be useful to further develop these recommendations.
6. Use the following space to complete any additional comments. We are especially interested in your opinion regarding any challenges that you foresee associated with implementation of these recommendations, as well as possible solutions.

4.2. Summary of results

Responses were received from 12 individuals. Based on the roles indicated on the forms, respondents included six veterinarians, three sea turtle biologists, and three resource agency staff. Unless otherwise indicated, the comments were those of individuals. Two respondents from the same resource agency elected to combine their responses. In the following tables, attendee comments provided in the feedback instrument are presented alongside any indicated response from workshop organizers, including description of any associated modification of the draft recommendations.

Which of the following best characterizes your opinion of the draft recommendations?

Four respondents felt that the recommendations were acceptable as written; eight said that minor revisions were needed; none expressed that major revisions were needed.

The following revisions were suggested (grouped according to section):

Disposition of turtles with FP encountered in the wild

Comment	Response
Add more language regarding the definition of debilitated turtles that may be relevant to turtles encountered in the field (i.e., in-water studies) such as that ocular tumors alone do not necessarily mean that turtle is debilitated.	Additional language has been added regarding the definition of "debilitated" under these recommendations.

Rehabilitation and response for turtles with FP

Comment	Response
An alternative tumor scoring system is needed to ensure accuracy and consistency (multiple respondents).	Yes, as explained elsewhere in this document, the previously applied scoring system was closely examined and found inadequate for the purposes of these recommendations. We incorporated an alternative, more easily applied tumor scoring method that correlates better with survival and is more consistent in application.
Provide photographs to illustrate different degrees of tumor severity.	Photographs have been added to this document.
Incorporate changes discussed during the meeting (e.g., condensation of response levels).	Changes discussed at the meeting (as outlined in Section 5) have been incorporated.
A flow chart or decision tree might assist decision-making in the field.	Although such a tool may be helpful for actual application in the field, the specifics of this approach can only be defined during actual implementation. The specific method(s) in which these recommendations may be implemented will likely vary by region and is thus beyond the scope of this document.
Specify the point of contact for field researchers as related to response and rehabilitation.	This aspect of communication is unchanged from current practices and has now been explained in a footnote.
Discuss contingencies for implementation of response for facilities that are unable or unwilling to comply with the necessary measures.	This issue was already included in the draft recommendations– it primarily is determined by whether or not facilities are willing to euthanize turtles according to the response plan. Implementation will be cooperative; not required. If assistance from rehabilitation facilities is inadequate and capacity for animal care is exceeded, resource agencies must develop the ability to euthanize debilitated sea turtles with FP.

Biosecurity measures for captivity and field research

Comment	Response
Clarify which disinfectants are appropriate for field applications and make consistent with existing requirements.	This aspect of the text has been revised to be consistent with conditions of other permits.
Include the use of hand sanitizer when gloves are not an option.	This suggestion has been incorporated.
Clarify that isolation measures for green turtles in captivity are a goal and directive for new/renovating facilities, but immediate modifications are not required for existing facilities to be in compliance with permit conditions.	The text has been modified to clarify requirements.
Specify who sets the response level. A veterinarian should be involved in the response system. (Similar comment expressed another respondent under another question)	This was included in the draft recommendations. Although it is ideal for a veterinarian that is familiar with FP and the response system to be involved in euthanasia decisions, it is impractical to stipulate this as a requirement for several reasons: 1) qualified veterinarians are not accessible in some regions; 2) the logistics of consulting a veterinarian are not always compatible with effective management of these issues (i.e., cold-stunning events, frequent strandings, remote areas, irregular hours); and 3) the response system is intended to be practical for field application and based on parameters that are easily apparent in the field (i.e., they do not require specific veterinary expertise). Regional differences in the extent of veterinary involvement are anticipated. To a large degree, this may be influenced by cooperation from rehabilitation facilities in implementing the recommended response approach and maintaining the numbers of admissions within capacity. Explanatory language has been added to the response section of the recommendations.

Additional comments:

Comment	Response
The applied Work and Balazs scoring system is not reflective of tumor severity as assessed from a clinical or prognostic perspective.	Network-wide data supported a correlation between outcome and tumor score using this system. However, we found inconsistency in assigning of scores that are attributed to variability in tumor counting and measurement. The new visual-based system addresses this problem.
Stranding report data are inadequate for characterizing the condition of stranded sea turtles and co-morbidities that are relevant to survival. [Note that this respondent also referenced concerns about tumor scores derived from stranding forms.]	Point of clarification: the tumor scores are derived from the fibropapilloma data form, not the STSSN Stranding Report. Nonetheless, tumor scores were applied based on the new visual system. It is unfortunate that no applicable prognostic studies have been undertaken by rehabilitation facilities. This was suggested in a meeting among the facilities in 2011, but was never acted upon. Given the current stranding trend – we may not have the luxury of waiting several more years for such a study – thus, we are using the best available information for which an adequate sample size is available (tumor severity and survival). This approach can be revisited if new information becomes available. Improved prognostic capability certainly may inform decision making related to individual animals under care. Given the low survival rates (20% and 6% for moderately and severely afflicted turtles, respectively), it seems challenging for a more nuanced approach to be fruitful in terms of increasing the success of rehabilitation efforts. Moreover, once animals are admitted to facilities – reluctance to euthanize turtles, even if they are assessed to have a poor prognosis, likely will be a persistent challenge for some facilities. Also, any degree of diagnostic evaluation (e.g., blood analyses, imaging) will cost resources that projections suggest may not be sustainable in the coming years. Therefore, a relatively simple response system is needed in order to address these challenges and meet the needs of different areas of the U.S. and territories.

Comment	Response
Given the numbers of strandings and relatively low survival rates of stranded sea turtles with FP, resources would be better spent on sea turtles without the disease.	No response required.
Solicit feedback from individuals that were invited to attend the meeting but unable to attend.	These individuals were included among the reviewers of the workshop report and recommendations.

In your opinion, are the draft recommendations logical, do they reflect current concerns related to fibropapillomatosis, and do they apply best available information?

Seven respondents strongly agreed; five somewhat agreed; none disagreed.

Comments related to responses for those that "strongly agreed" included (no responses required):

- Resources should be used for treatment of turtles with higher chances of survival.
- Policy related to rehabilitation should be based on animal welfare and management of the species, not emotional responses from facility personnel or donors.
- The data presented by NOAA at the meeting should more fluidly flow from the rehabilitation facilities themselves.
- Data from other Gulf states (Texas) should be included.
- The data speaks for itself.

Comments related to responses for those that "somewhat agreed" included:

Comment	Response
Reference to responses to previous question (the need for an alternative tumor scoring approach, complexity of prognostic evaluation, the need for a veterinarian to be involved in euthanasia decisions).	See previous responses.
Recent discoveries may further inform biosecurity measures (referencing molecular data showing detection of herpesvirus by PCR in 100% of tested green turtles).	Any new information can be incorporated into future revisions of the recommendations, as indicated. Note that very high prevalence of herpesvirus infection among hosts is not uncommon. This aspect of virology and risk of transmission was already considered in the current recommendations (i.e., separation of green turtles from other species).

Comment	Response
Agree that [recommendations] are "clearly" based on best available information, but stakeholder review is required to determine if they are logical and easy to follow.	This question referred to logic in terms of clear, sound reasoning based on available information. Specific aspects of implementation, including ease of following necessary instructions under different circumstances, are outside of the scope of this document.
Resources don't appear to be limited because facilities are using advanced imaging techniques and expensive medications.	Availability of these resources is not universal across areas where FP is found. The characterization of resources as "limited" indicates that they are not "unlimited," which is a true statement. There is only so much space within rehabilitation facilities to hold and treat sea turtles in a manner that is compliant with minimum standards.
Concerns that there is no proof that treated turtles survive; and that treated turtles may pass on heritable disease-related traits or herpesvirus to their offspring.	We have limited ability to detect treated turtles post-release. Tag returns simply are not a sensitive enough measure and probability of re-encountering turtles in this scenario is extremely low. The implication of rehabilitation on health of the free-ranging population is a significant concern. However, an average of only 20 turtles per year were released during the last decade. Given the current numbers of green turtles, the prevalence of FP in the wild, and protocols to ensure turtles are only released in areas where FP is found, this number is very unlikely to have any impact on the course of the disease.
Rehabilitators have operated without strict [recommendations] related to this disease – some don't see a problem with trying to save them all.	There are multiple concerns related to current practices: 1) The trend in strandings of turtles with FP over time indicates that current practices may not be sustainable; There have already been periods where agency staff have had a difficult time finding facilities to accept turtles with FP; 2) There is a credible ethical argument voiced by both veterinarians and biologists that putting animals through attempted treatment is inhumane when mortality rates are this high.
Additional comment from respondent that "strongly agreed."	
They should also include information from other Gulf states that see and treat FP.	Additional explanation of why we focused the review on data from Florida rehabilitation facilities has been added to the text.

Are there any major changes or additions [not included in responses to previous questions] that you think would benefit any aspect of the draft recommendations?

The following revisions were suggested (all pertained to rehabilitation and response):

Comment	Response
Reduce the threshold for anemia to PCV of <10%. (Similar comment voiced by second respondent for an earlier question)	This comment was in regard to criteria listed under complicating conditions in the first iteration of the response system. These criteria, including anemia, have been omitted based on broad agreement that turtles with a tumor score 3 should be euthanized due to low survival rates.
Clarify whether or not turtles already under care would be affected by changes in response level.	Clarification has been added.
Define criteria for changing response levels (also suggested that this may be best handled in an alternative document).	General criteria were already included. More specific information needs to be developed for each state or territory based on specific aspects of the network, capacity, and the agency that authorizes sea turtle rehabilitation.
Define the area of scope for response levels (i.e., statewide, regionwide).	Clarification has been added.
Provide guidance on justifiable and medically-warranted post-operative holding periods to the extent possible.	Language regarding this issue has been added to the recommendations.
Determine whether there will be an expectation that new facilities, or added capacity at existing facilities, will allow treatment of turtles with FP.	This issue is beyond the scope of these recommendations.
I would also like to see other state's numbers on survival rates.	This comment refers to Texas, which is the only state other than FL that regularly treats sea turtles with FP. A sentence has been added to Section 2.1 that explains data from TX may not be comparable to FL due to differences in rehabilitation practices.

Please use the following space to share any opinion or perspective drawn from your experience with sea turtles and fibropapillomatosis that you feel would be useful to further develop these recommendations.

Comment	Response
More research is needed into many aspects of FP, including factors that affect prognosis; more easily accessible funding would be helpful.	No modification of recommendations required.
Improved diagnostics or predictors for more aggressive forms and internal tumors would be ideal.	No modification of recommendations required. See previous comments regarding the practicality of advanced diagnostics given anticipated stranding numbers.
Veterinarians and staff from other facilities may benefit from a broader understanding of rehabilitation practices outside of their specific facility and area.	No modification of recommendations required.
Current rehabilitation practices are not sustainable in Texas based on the current stranding trend.	No modification of recommendations required.
Concur that the more “aggressively-tumored” turtles do not do well.	No modification of recommendations required.
Consider [recommendations] for turtles under treatment, e.g., limiting the numbers of surgical procedures.	Resource agencies generally defer to attending veterinarians because: 1) it is assumed that they are the most qualified to make medical decisions (include those related to welfare) about individual cases; 2) flexibility is needed during the course of treatment (this respondent also noted that a singular approach is not appropriate for all cases); 3) limitations can stymie innovations in care and treatment. A paragraph has been added to these recommendations regarding the need for standardization to the degree possible.
Though this may be out of the scope of this document, standard of care for tumor excision should be considered (i.e., laser, electrocautery, scalpel). A comment such as, " the method of tumor removal should incorporate the most up-to-date veterinary surgical techniques and equipment to expedite the time required to keep a turtle in rehabilitation" which should be determined by the staff veterinarian.	A brief statement to this effect had been added to the “Rehabilitation and release” section of the recommendations.

Use the following space to complete any additional comments. We are especially interested in your opinion regarding any challenges that you foresee associated with implementation of these recommendations, as well as possible solutions.

Comment	Response
Euthanasia decisions should fall in the hands of veterinarians whether at a facility or in the field.	See previous comments regarding feasibility of veterinarian involvement. Wildlife agencies currently use euthanasia administered by non-veterinarians (using defined protocols) under many different circumstances.
Concern that the "save them all" mentality is not practical or humane.	No modification of recommendations required.
Consider incorporating a tumor size score as used in Hirama and Ehrhart 2007, which has been correlated with blood indices.	In evaluating the current Work and Balazs scoring system for use in evaluating data collected by the STSSN, there is evidence that any application that requires stranding responders to count and measure tumors is unlikely to yield reliable results. These approaches work well for research applications, but not under circumstances where quality control and assurance are especially challenging. It is of interest that a recent publication describing a new tumor scoring approach (also based on tumor number and size) used a basic visual assessment as its gold standard (Rossi et al. 2016).
Tumor characteristics are different between Florida and Hawaii; a system for Florida greens is more applicable.	See previous comments related to tumor scoring.
In Texas, there will be a point at which the few available rehabilitation veterinarians are unable to euthanize the most severely afflicted turtles. Capacity will have to be developed outside of rehabilitation facilities, especially during cold-stun events.	See previous comments related to implementation of response measures and euthanasia capacity within resource agencies.
How will the response level be communicated?	The need for this determination has been added to the recommendations, but specific means will be region-by-region.
Important to create a clear distinction between decisions within the response system and the rehabilitation process.	Additional clarifying language has been added to the recommendations.

Comment	Response
Concerns that volunteers and some facility administrators will have a problem with euthanasia; sharing the data and statistics presented at this meeting may assist in helping them understand the situation.	Agreed. This workshop report will be a publicly available document.
Rehabilitation personnel need help understanding the reasoning behind these [recommendations], including the low success rates for moderately and severely afflicted turtles and the rebounding North Atlantic green turtle population.	Agreed. It is intended that review of rehabilitation data used to develop these recommendations (and included in this report) will help people understand why these recommendations are necessary.
Once completed, written assurance as to whether or not facilities will abide by the [recommendations] is important. Otherwise, it is impossible to gauge the anticipated success of implementation.	Additional language to this effect has been added to the recommendations. The need for development of implementation capacity within resource agencies will be determined to a large degree by cooperation from rehabilitation entities. An understanding of whether or not facilities are willing to assist is necessary for planning management needs.
A rollout plan is needed for the [recommendations] that engages all relevant resource agencies in a thoughtful manner, including communication with stakeholders and the public.	Agreed, no modification of actual recommendations required.
Outreach is needed to explain the current situation, including examples of similar approaches in other wildlife, the current understanding of FP, and the status of green turtle populations. These issues are inaccurately presented in many publications.	Comment noted, no modification of recommendations required.
There seems to be general agreement with most aspects of the [recommendations]. They need to be steadfast and everyone needs to comply; it shouldn't be left up to facilities.	This comment primary relates to decisions whether or not to euthanize sea turtles with FP. In general, agencies have preferred to approach such issues cooperatively. The implementation of these recommendations will pursue this approach to the extent possible, but will include contingencies as needed.
Consider dispensations for doing research, e.g., attempting to rehabilitate severely afflicted turtles that would otherwise be euthanized.	Such activities are not covered under authorizations for rehabilitation and would require a separate research permit. This process is not necessarily prohibited by these recommendations, but is beyond the scope of this document.

Comment	Response
Though the [recommendations] are extremely helpful in their overall scope, there are geographical differences that should be mentioned. In Texas, for example, our population of green sea turtles has only recently presented with FP in comparison with FL. As a result, in my opinion, we are seeing the early progression of the disease in the population as seen in the late 90s and early 2000s in FL. Currently we are seeing few internal tumors, similar to 1990-2000s in FL, but now internal FP's appear more prevalent in FL. I suspect with longer duration of disease prevalence in TX, we may also see an increase in internal FP's.	Data to substantiate that there are regional differences within the SE US in manifestation of FP are lacking at this time. Within this document, we have endeavored to focus on empirical data. Compilation of data for rehabilitation of turtles with FP certainly would be a worthwhile endeavor, but we feel that the existing dataset for FL, which is much longer and larger, is adequate for the purposes of these recommendations. As previously stated, differences in rehabilitation practices may explain some of the perceived regional differences in the disease and survival outcome.
Challenges may occur based on severity of tumors and decisions for euthanasia.	No response required.
Options may include minimal tumor removal (ie eyes, larger restricting tumors) as opposed to complete removal. This is raised as an option due to the reference to possible tumor regression in particular areas of the country.	It is now stated in the “Rehabilitation and release” portion of the recommendations that complete excision of tumors is not required for medical clearance and release.
During events such as hurricanes, oil spills, cold stunning events, the need to implement actions such as euthanasia and capacity for care may come in question and should be overseen and reviewed by veterinary staff and officials to insure implementation of these [recommendations].	These implementation considerations will be the responsibility of the permit authorities (FWS or state resource agency).
Maybe something should be added into the [recommendations] about number of surgeries. For example, "if more than 3 surgeries are necessary for FP removal, euthanasia should be considered and discussed with the attending veterinarian"	Such guidance has been discussed, but there is considerable disagreement among veterinarians. The issue is specifically included in Section 6.

5. Workshop Participant Input and Amendment of the Recommendations

Input from participants and seven peer-reviewers were considered in the revision of the recommendations. The amended recommendations are provided in Appendix D. An itemized list of changes to the draft recommendations (beyond minor editorial modifications) are as follows:

General

- An introduction and explanation of the purpose of the recommendations has been added so that it may be used as a standalone document.
- The term "guidelines" has been changed to "recommendations" to maintain consistency in use of terminology within some agencies. To avoid confusion, the term "guidelines" is not used within this document unless in reference to an existing guidelines. Any changes in these terms within quoted responses from individuals are indicated by brackets.
- The term "triage" has been changed to "response level." Some reviewers felt that the term "triage" is likely to be misunderstood by some readers. The introduction and discussion of this section of the guidelines has been revised from the draft language in response to reviewer comments related to implemention, cooperative engagement of rehabilitation facilities, and existing agency practices.

Disposition of sea turtles with FP encountered in the wild

- Additional explanation of "debilitated" has been provided, including suggested side-by-side photographs of robust and emaciated green turtles with FP.

Rehabilitation practices and needs

- This section was added to more clearly demarcate aspects of individual care within rehabilitation facilities from those related to circumstances in which capacity is more limited or exceeded. The text is intended to capture important discussions and differences of opinion related to animal welfare and other critical elements, identify persistent knowledge gaps, and include guidance related to post-operative holding and release.
- Accommodation for various treatment options (including partial excision, excision foregone) was also added.

Response options for sea turtles with FP if rehabilitation capacity is approached or exceeded

- The title of this section was modified to clarify that these measures are only exercised when capacity within rehabilitation facilities will be exceeded, as well as use of alternative language to the term "triage."
- An alternative visual-based tumor scoring approach was developed to address concerns regarding use of the Work and Balazs (1999) methods for Florida data. This method allows more consistent assessment of severity of disease for stranding response and documentation. All analyses shared at the workshop were repeated using this system. These results, which are

presented in subsection 2.1, did not alter the substance of the data presented and discussed during the meeting. Survival of turtles with TS2 remained around 20% and was much lower (6.4%) for those with TS3.

- The text has been reorganized to more clearly explain the approach, basis for the selected criteria, and options for implementation. It is explicitly stated that veterinary involvement in euthanasia services is preferred, but explains why contingencies are required.
- The response levels have been modified based on discussions and opinions from multiple participants that turtles with a TS3 should be euthanized due to extremely low probability of survival. This change effectively merged response levels 1 and 2.
- Response level 4 has been omitted due to concerns that this level is not supported by currently available prognostic data.
- Minor additional clarifications were added.

Biosecurity measures for captivity and field research

- The following changes were included based on workshop discussions:
  <u>Captive management</u>
    - Further explanation that isolation measures are not an immediate requirement for existing facilities.
    - Clarification that designated use of specific systems can be changed following disinfection to allow greater flexibility.
    - Prioritization that turtles with tumors should be maintained in separate systems from those without tumors.
    - Inclusion of biosecurity measures during cold-stunning events.

  <u>Field studies</u>
    - Emphasize importance of field biosecurity measures between different study areas.
    - Improve consistency of disinfection recommendations with existing permit conditions.
    - Inclusion of alcohol-based hand sanitizer if gloves are impractical.
    - Increase practicality of measures for washing surfaces in the field.

6. Rehabilitation and FP: Discussion and Debate

There were many significant issues related to rehabilitation of sea turtles with FP that were discussed during the course of this workshop and development of the recommendations. This section is intended to capture those topics that were the focus of considerable debate and that remain contentious among the diverse community of individuals that work with sea turtles as resource managers, conservationists, biologists, veterinarians, and rehabilitators. These issues are presented as three topical questions:

1. Does treatment of sea turtles with FP influence the wild population?
The issue of whether human intervention benefits or causes harm to free-ranging wildlife populations is an important point of consideration for rehabilitation of any species. There are several factors related to FP that are critical to this question that have been invoked during discussions. Concerns can be generally categorized as potential near-term vs. long-term effects on sea turtle populations.

Near-term concerns include risk of spreading the disease to new areas by enhancing contact between turtles with FP and unaffected turtles through release of rehabilitated animals. Regarding transmission of FP, the associated herpesvirus is the primary agent of concern based on current knowledge. Herpesviral infections generally are considered to be lifelong; viral infection is not cured by treating tumors during the course of rehabilitation. It is now understood that this herpesvirus is relatively widespread within green turtle populations, and it can be detected in many turtles without tumors. Nonetheless, substantial knowledge gaps persist in our understanding of the mechanisms that lead to tumor formation, thus veterinarians and disease experts generally agree that it remains prudent to limit anthropogenic dissemination of FP-afflicted turtles, especially contact between animals from different regions. These precautions include exercising biosecurity measures within rehabilitation facilities (and during field studies) and releasing turtles where they were originally found to the maximum extent possible. Such measures are sound general disease management practices for pathogens other than the FP-associated herpesvirus.

Concerns about the long-term effects of rehabilitation primarily relate to whether release of treated turtles ultimately may influence dynamics of the disease in populations. A goal of sea turtle rehabilitation is to save individuals and release them back into the wild with the hope that they will eventually reproduce and contribute to the population. Regarding FP, it is unknown whether there are heritable factors that may influence disease severity. If there are genetic predispositions related to FP development or severity, saving turtles that otherwise would die from the disease may artificially increase numbers of animals with these traits. Another concern is that the fate of rehabilitated turtles is largely unknown. If severe disease recurs following release, treated turtles might later contribute to transmission rather than having been eliminated from the population. These criticisms that rehabilitation of turtles with FP may be counter to wildlife disease management practices are valid but are not well understood. Current studies are in the early stages of exploring genetic factors related to FP. Recurrence of tumors post-treatment has not been observed in a small number of non-releasable turtles that have remained in captivity for years, but the long-term fate of released turtles is largely

unknowable. Regarding management implications, the scale of rehabilitation must be put into perspective. The number of green turtles treated for FP that are released (just over 200 in the last decade) is miniscule compared to population size and estimates of disease prevalence. The number of turtles released from rehabilitation facilities is simply too small to significantly influence the disease at the population level; thus, compassionate care for individuals has not been seen as a threat to the free-ranging population as long as the aforementioned biosecurity measures are followed. However, these issues should continue to be raised and discussed.

2. Is rehabilitation of sea turtles with FP a good use of resources?

A frequent criticism of rehabilitation of turtles with FP is that the resources could be better used to address priority conservation needs. This discussion requires an understanding of the relevant resources. In most instances, treatment of sea turtles with FP occurs within private rehabilitation facilities that are funded by internal revenue generation and donations with little or no support from funding used for natural resource agencies or other types of sea turtle programs. Although there is inevitably some degree of overlap between people and organizations that may donate to rehabilitation as well as broader conservation initiatives, those drawn by rehabilitation facilities tend to be focused on benefits to individual animals. Thus, there is no indication that resources expended on actual treatment of FP significantly distract from funding that is likely to be used for other population-wide sea turtle needs. However, resource agencies regularly assist with transportation of sea turtles to and between rehabilitation facilities, which could become a concern if FP-related strandings continue to increase.

3. Are treatments humane?

There was considerable discussion during the workshop and its follow-up regarding whether the treatment undergone by some sea turtles with FP is humane. Ten or more surgeries may be required to treat some individuals. These debates included consideration of acute and chronic pain, stress, and differences of opinion regarding treatment that may be considered acceptable or excessive. Those engaged in rehabilitation should be aware that this disagreement exists among people, including veterinarians, that regularly work with and care about sea turtles. Rehabilitators and veterinarians should endeavor to develop standards that address these ethical considerations. Such discussions should consider the specific intended goals of rehabilitating turtles with FP and circumstances in which treatment in the face of poor prognosis may be counter to animal welfare. Thoughtful review of these issues could inform standards and consistency in practices across facilities that benefit both sea turtles and perception of rehabilitation efforts.

The group of turtles afflicted with FP that are at the heart of this issue are those that undergo treatment but do not survive. Almost 60% of green turtles with FP admitted to facilities that survive a week or longer ultimately die or are euthanized, as compared to around 25% of stranded green turtles without FP. Moreover, those that do not survive are treated for an average of 101 days, some for multiple years. Rigorous analysis of medical and survival data collected by facilities is necessary to improve prognostic capability and better inform clinical decisions.

Multiple participants and reviewers felt that the recommendations should include therapeutic standards, particularly a maximum number of surgeries that should be performed on individual turtles. Two veterinarians independently stated that euthanasia should be considered if more than 3 surgeries are required for treatment. Others felt that individual animal care is nuanced and must remain flexible. We elected to leave such decisions to the attending veterinarians for the reasons stated in the response recommendations. However, we encourage clinicians to thoughtfully consider treatment outcomes in their facilities and incorporate these data into their decisions whether to elect treatment or humane euthanasia.

Appendix A – Workshop Participants‡

Name	Affiliation
Barbara Schroeder* *facilitator*	NOAA, Office of Protected Resources
Dr. Brian Stacy*	NOAA, Office of Protected Resources
Ann Marie Lauritsen*	US Fish and Wildlife Service
Stacy Hargrove*	NOAA, Office of Protected Resources
Dr. Donna Shaver	National Park Service
Dr. Allen Foley	Florida Fish and Wildlife Conservation Commission
Dr. Robbin Trindell	Florida Fish and Wildlife Conservation Commission
Meghan Koperski	Florida Fish and Wildlife Conservation Commission
Tomo Hirama	Florida Fish and Wildlife Conservation Commission
Dennis Klemm	NOAA, SE Regional Office
Dr. Thierry Work	US Geological Survey
Dr. Adrienne Atkins	Mote Marine Laboratory and Aquarium
Dr. Shelly Marquardt	Clearwater Marine Aquarium
Dr. Tim Tristan	Texas Sealife Center
Dr. Erin Seney	University of Central Florida
Dr. Trevor Zakariah	Brevard Zoo
Dr. Maria Chadam	Gumbo Limbo Nature Center
Dr. Brook Burkhalter	Whitney Laboratory Sea Turtle Hospital
Dr. Lydia Staggs	Gulf World Marine Park
George Balazs	NOAA, Pacific Islands Fisheries Science Center (ret.)
Jennifer Keene *rapporteur*	NOAA, Office of Protected Resources

*Steering committee

‡Additional invited participants could not attend due to Hurricane Irma, but reviewed the report and recommendations.

Appendix B – Agenda

(Note: The agenda reflects a truncated format due to evacuation for Hurricane Irma. The meeting was convened at 9:00 am and adjourned at 6:00 pm)

Wed. (Sept 6)
Convene meeting and introductory remarks – B. Schroeder/A. Lauritsen
Introductions
Presentation: Rehabilitation data review and projected trends – B. Stacy
Fibropapillomatosis in Hawaii – T. Work
Break
Data review Q&A
Presentation: Introduction of draft recommendations – B. Stacy
Recommendations Q&A
Lunch (extension of discussion of Q&A from morning talks during lunch)
Discussion of recommendations element #1: disposition of sea turtles with FP encountered in the wild
Discussion of recommendations element #2: rehabilitation and response levels
Break
Discussion of recommendations element #3: biosecurity and FP during capture and handling of green turtles
Prognostic studies
Meeting conclusion and next steps

Appendix C - Ordinal Scale for Grading Fibropapillomatosis by Photographic Comparison

Background

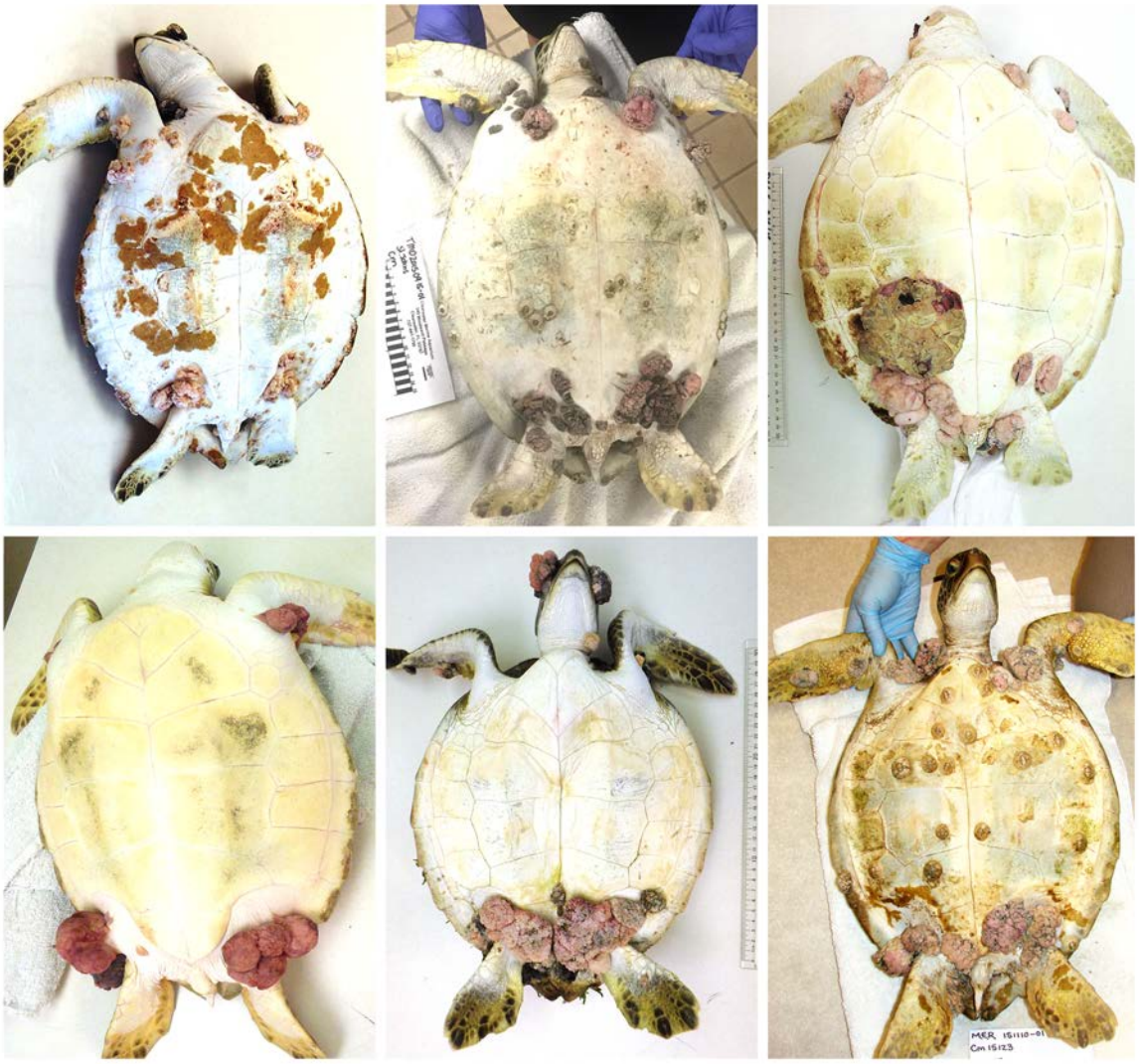
For many years, the Florida Fish and Wildlife Conservation Commission (FWC) used a standardized data collection form to document the extent of tumor formation in sea turtles with fibropapillomatosis (FP). The form was completed by stranding responders participating in the Sea Turtle and Salvage Network. The numbers of tumors within various size ranges were counted. These data were later translated to a tumor score by agency staff using criteria described by Work and Balazs (1999). A review of these assigned scores found both lack of precision and poor correlation with relative tumor burden. It appears that the morphological diversity of fibropapillomas creates challenges for a scoring system based on tumor size and number data collected by numerous individuals. This manner of data collection is inherent to stranding documentation across large geographical areas. A simpler visual system was needed that more accurately categorizes relative severity of disease for the purposes of understanding management-related factors, such as survival outcome/rehabilitation success and general changes in tumor severity and presentation.

Method

We sought to develop a method that could be retrospectively applied by experienced agency staff using photographs of stranded sea turtles. Ultimately, we determined that the most consistent results were obtained by comparing a photograph of the ventral surface of a turtle of interest to an array of similar photographs of the ventral surface of turtles exhibiting each tumor severity score. This method was selected following review of hundreds of cases of FP, consideration of various possible iterations of a scoring system, and examination of results of blinded review of test cases by multiple agency staff. We decided to maintain the use of a 1-3 score - 1 (least affected) to 3 (most affected), as used in other grading schemes because we did not find a strong rationale for additional intermediate categories. The photographic arrays used for comparisons (Figs. 1-3) were specifically selected to show different presentations represented within each category. The observer determines the tumor score for which the examples most closely match the case being evaluating. For cases that appear to fall between two scores, the highest score is selected. The reason for this approach is that 1) these intermediate examples tended to be most like other turtles in the higher tumor score group; and 2) to encourage consistency in tumor grading.

Tumor score 1 (least afflicted)

Tumor score 2 (moderately afflicted)



Tumor score 3 (severely afflicted)

Appendix D - Fibropapillomatosis and Sea Turtles: Recommendations for Field Response, Captive Management, and Rehabilitation

Introduction and purpose of the recommendations

Over the last decade, growth of the North Atlantic green turtle (*Chelonia mydas*) population has resulted in larger numbers of green turtles in coastal areas of the Southeast U.S. This increase in the population has been accompanied by more frequent encounters with turtles visibly afflicted by fibropapillomatosis (FP), a potentially debilitating disease that primarily manifests as skin tumors and is a frequent cause of stranding. If the current trend continues, the number of stranded green turtles with FP could double within the next 5 to 10 years and existing rehabilitation and response capacity could be overwhelmed. Resource agencies and captive facilities dedicated to the care of these animals would then have to make difficult decisions regarding the distribution of care and fate of individual animals. In Florida, resources for managing live stranded turtles with FP are already strained when pulses of debilitated turtles with FP are brought ashore by conditions favoring beach-cast stranding. In addition, the disease is encountered with increasing frequency in Texas, is sporadically encountered in other areas of the Southeast U.S., and is common in Hawaii and some areas of U.S. Caribbean territories (Hargrove et al. 2016).

The purpose of this document is to recommend practices for several key actions and scenarios related to management of sea turtles with FP, including the following: 1) disposition of turtles with FP encountered under various circumstances (e.g., strandings, in-water studies, public encounters, incidental capture); 2) rehabilitation and release; 3) response options when rehabilitation capacity is exceeded; and 4) biosecurity measures to prevent anthropogenic spread of the disease. These recommendations were developed using individual input from resource agency personnel overseeing sea turtle management within areas where FP is found and veterinarians engaged in FP research and rehabilitation.

Although these recommendations were developed primarily to address needs in the Southeast U.S., it is anticipated that much of the content is applicable to other regions of the U.S. as well. Green turtles are the focus of these recommendations as this species is most severely affected by the disease; however, much of the guidance herein applies to other species with FP as well. Additional information regarding the development of these recommendations can be found in *Report of the Technical Expert Workshop: Developing Recommendations for Field Response, Captive Management, and Rehabilitation of Sea Turtles with Fibropapillomatosis* (2018).

Disposition of sea turtles with FP encountered in the wild

Stranded sea turtles with FP found on shore or floating (i.e., unable to return to the water or effectively swim, forage, or dive) are, by definition, impaired to the degree that they require human intervention. Recommendations related to stranded turtles with FP are provided in the next sections. Sea turtles with FP tumors also are encountered swimming in the water and in some areas are frequently observed by the public, researchers, and others. Decisions related to the disposition of turtles with FP that are encountered in the water are primarily based on whether the turtle is exhibiting indications of debilitation. For these recommendations, *debilitation* (Fig.1) is defined as any of the following:

- profound weakness or lethargy
- emaciation
- inability to dive, swim, or forage
- obstruction of the mouth, glottis, or cloaca
- loss of buoyancy control

Note that presentations of FP, including ocular tumors, not accompanied by any of these other abnormalities, i.e., turtles that are active and in good nutritional condition, generally are not considered debilitated as defined in these recommendations. In addition, behavior and activity as related to FP status is not assessed at or below temperatures that are associated with cold-stunning (<55˚F, 12˚C).

Figure 1. Green turtle with few FP tumors in good nutritional condition (left) as compared to an emaciated green turtle with more advanced disease. Signs of emaciation include sunken eyes, gaunt appearance of the neck and flippers, and accentuation of plastron bones.

Any debilitated turtle captured while conducting sea turtle research, incidentally, or as a result of other activities should be transferred to a local authorized stranding network participant or rehabilitation facility when feasible.[4] These debilitated turtles are then treated the same as stranded turtles, as defined in the next sections. Because spontaneous regression of tumors (recovery) without human intervention occurs in a proportion of affected turtles, FP without debilitation (as defined here) does not alone warrant human intervention, particularly for animals with few tumors or that actively evade capture. These animals should be left in the wild. For researchers working in the field, the point of contact for reporting turtles requiring care should be identified prior to conducting field activities and generally is provided by the designated stranding coordinator for a given state or region.

Rehabilitation and release

During the development of these recommendations, there was considerable debate regarding rehabilitation of sea turtles with FP that reflects significant philosophical differences among those that work with sea turtles in various roles. These differences will not be resolved in these recommendations, but are pertinent to future decisions in the fluid context of sea turtle population status, our understanding of FP, allocation of limited resources, and wildlife management. Readers are referred to *Report of the Technical Expert Workshop: Developing Recommendations for Field Response, Captive Management, and Rehabilitation of Sea Turtles with Fibropapillomatosis* (2018) for a discussion of these issues. With regard to treatment of sea turtles with FP within rehabilitation facilities, matters of individual animal care are deferred to the judgment of attending veterinarians because 1) it is assumed that they are the most qualified to make medical decisions (including those related to welfare) about individual cases; and 2) flexibility is needed during the course of treatment to accommodate medical needs of individuals, as well as facility differences in resources available for diagnosis and treatment. Veterinarians should strongly consider prognosis, as well as the stress, pain, and discomfort associated with attempted treatment, when managing individual cases. Therapy should reflect current standards of veterinary practice (e.g., surgical techniques, equipment, supportive care) and aim to achieve medical clearance for return to the wild as expeditiously as possible.

Regarding release, it is recommended that turtles under treatment for FP be released as soon as any surgical sites have healed to the degree that continued unaided resolution is anticipated and all other standard measures of medical clearance have been fulfilled (USFWS 2013). Furthermore, excision of tumors is not required for medical clearance and release. Acceptable alternatives include forgoing excision of any or all tumors that are not immediately life-threatening (e.g., turtles with mild disease or that stranded from other causes); or selective removal of tumors that pose the greatest threat to survival (leaving others to undergo regression). Timely release of rehabilitated sea turtles optimizes the use of current rehabilitation capacity in the face of increasing numbers of sea turtle strandings and

[4] Feasibility includes practical considerations related to interruption of permitted research activities. Intervention is strongly encouraged, but is not required if it will have a significant negative effect on the success of research objectives.

reduces the opportunity for nosocomial transmission or other complications. Turtles should be released as close to their original location of discovery as possible and appropriate. Turtles that have recovered from FP should only be returned to areas where the disease is known to occur.

Response options for sea turtles with FP if rehabilitation capacity is approached or exceeded

Capacity of facilities for rehabilitation of sea turtles is not unlimited, especially for those with FP as only a subset of facilities admit turtles with this disease. Given the current trend of increasing strandings of green turtles with FP, planning is required to achieve these goals should capacity-limited situations arise. Under circumstances where capacity is becoming limited or exceeded and facilities are at risk of being unable to care for incoming stranded turtles, resource agencies and rehabilitation staff must make difficult decisions related to prioritization of resources, which often entails use of humane euthanasia of animals with conditions that are known to have a poor prognosis. Such prioritization should aim to maximize the number of sea turtles returned to the wild and ensure a humane outcome for all turtles that require human intervention. Data on rehabilitation outcome and veterinary opinion can be used to guide effective allocation of resources and identify those conditions with low rates of survival. Decisions to euthanize sea turtles with FP are generally based on advanced features of the disease, such as degree of tumor formation, presence of internal or otherwise inoperable tumors, and severity of concurrent conditions. The number of turtles with FP that are euthanized in current practice is substantial, around 38% of green turtles admitted to Florida facilities within the last decade and most of those encountered in Hawaii. However, there are considerable differences among facilities in use of euthanasia as a humane treatment option. The following recommendations are intended to assist resource agencies and rehabilitation personnel with planning and decisions related to humane treatment of debilitated sea turtles with FP under conditions where capacity is limited.

Explanation of response approach

This response strategy is based on recent data on survival outcomes for sea turtles stranded with external FP tumors and other major abnormalities. The degree of tumor presence is scored using a standardized protocol for visual assessment that is based on a scale of 1 (mildly afflicted) to 3 (severely afflicted) (Fig. 2). Review of rehabilitation outcome for turtles with FP admitted to Florida facilities (2006 through 2016) indicate that only 20.6% of those with tumor score (TS) 2 survive and only 6.4% of those with TS3 survive. Additional detailed clinical information, diagnostic results, and treatments are not currently reported to resource agencies and published studies are unavailable; therefore, recommendations herein are based largely on the correlation between mortality rate and TS, as well as veterinary opinion regarding complicating conditions that logically are associated with greater morbidity and additional required treatment, such as profound weakness/lethargy, emaciation, tumors involving critical anatomy, and major trauma.

In addition, the response recommendations are based on assessments that can be done by non-veterinarians in the field. The reason for this approach is that resource agencies must have the ability to manage rehabilitation capacity and ensure humane treatment of animals under a variety of conditions,

including those in which evaluation of animals by a veterinarian within a rehabilitation facility is impractical. For example, access to veterinarians or rehabilitation facilities is limited in some regions of the U.S. and territories. Furthermore, some clinical diagnostics (e.g., diagnostic imaging) are not universally accessible for routine use and reliance on even basic clinical diagnostic tests (e.g., blood analyses) may not be practicable in resource-limited situations. Nonetheless, the strong preference by resource agencies is that all evaluations and euthanasia decisions be made by experienced veterinarians as is current practice.

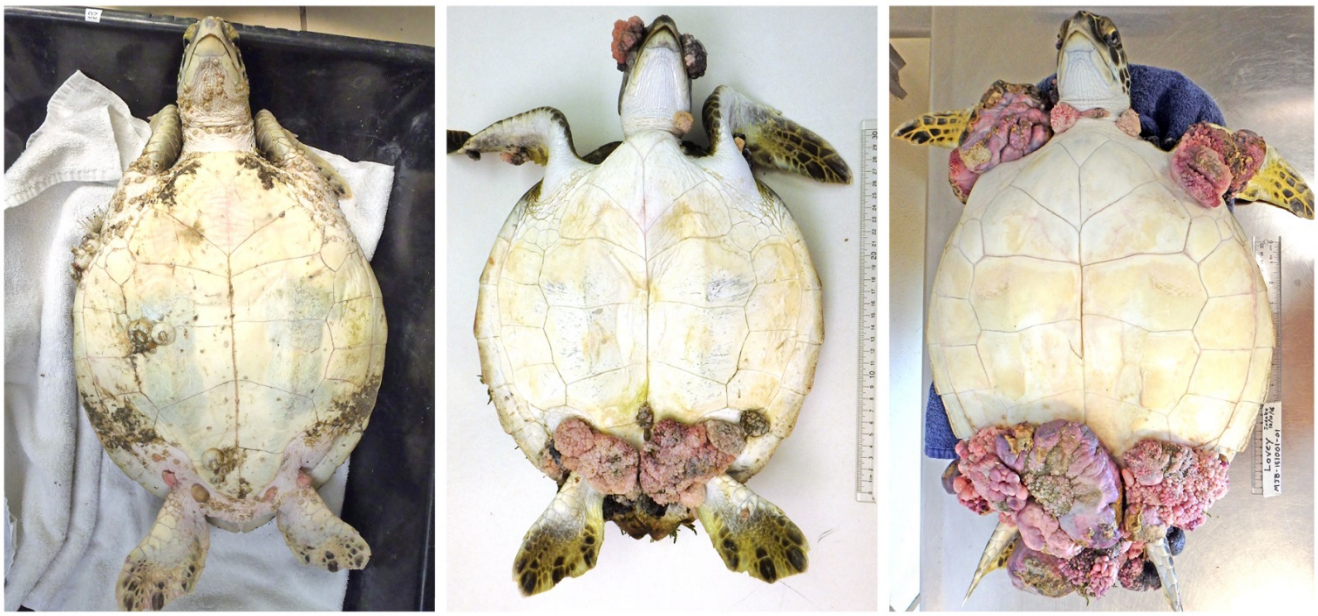


Figure 2. Examples of green turtles with fibropapillomatosis exhibiting the tumor scores (TS) used in response level criteria. Mild tumor growth (TS1, left); moderate growth (TS2, middle); and severe growth (TS3, right). Tumor scores are assessed using the visual comparison protocol provided in Appendix C.

Response plan structure

A response plan to guide decisions related to treatment and humane euthanasia of debilitated green turtles with FP is shown in Table 1. This plan consists of three response levels that include euthanasia[5] of animals with conditions that are documented to have low probability of successful rehabilitation. The levels and criteria are structured such that debilitated turtles with the poorest prognosis for survival are included within the lowest levels, i.e., the first to be implemented once rehabilitation capacity becomes limited. Current practices in the Southeast U.S., including evaluation of all live debilitated turtles with FP

[5] All criteria are compliant with current USFWS guidance on euthanasia. Sea turtles may be euthanized if: "turtle's recuperation is unlikely, if an illness or injury is terminal or untreatable, if an illness is communicable and likely to pose a threat to wild populations or captive turtles, or if a turtle's wounds would preclude survival in the wild."

at rehabilitation facilities, are consistent with response level 1.[6] As capacity becomes limited and the response level is increased, response options expand to include additional turtles with low rates of survival, but a less certain outcome. For instance, debilitated turtles with an intermediate tumor score (TS2) have higher rates of survival than those with high tumor scores (TS3), but still have around 80% mortality. The appropriate response level will be selected based on stranding numbers and availability of rehabilitation space. For example, if the response level is elevated from 1 to 2, but if there is still no capacity for any debilitated sea turtles with TS2 or T3, then the response level would be elevated to 3. Note that sea turtles already under care are not affected by changes in response level, i.e., euthanasia would not be performed on current patients solely due to elevation of response level. As previously explained, response levels 2 and 3 use criteria that can be evaluated in the field (i.e., without admission to a rehabilitation facility) if necessary. It is expected that the required level of response will remain at the lowest level accommodated by rehabilitation capacity.

The federal or state resource agency responsible for coordinating rehabilitation in each state will work with authorized facilities to determine the amount of rehabilitation space available for turtles with FP, assess capacity level, and determine when facilities are nearing their permitted capacity for long-term patients.[7] The geographical scope for considering rehabilitation capacity may be statewide (or inclusive of an entire U.S. territory) or regional depending on the distribution of rehabilitation capacity and availability of resources required for transporting turtles to distant facilities. Because of inherent regional differences, the resource agency that oversees rehabilitation activity in each state/territory should work with facilities on a plan for implementation of the response levels. Implementation within facilities is voluntary; therefore, planning may include capacity for humane euthanasia of debilitated sea turtles with FP outside of rehabilitation facilities[8] if it is deemed necessary to manage capacity in order to maintain ethical standards of care and compliance with USFWS Standard Conditions (2013).

[6] The only exception is that some facilities attempt treatment of severely afflicted turtles. Note that other areas of the U.S. and territories may operate at a higher baseline level of response due to limited or no rehabilitation capacity.

[7] Does not include temporary capacity for emergency situations as provided in the USFWS Standard Conditions (2013).

[8] Such activities will be compliant with all relevant policies, regulations, and state and federal law related to euthanasia and controlled substances, as well as euthanasia guidelines of the American Veterinary Medical Association and American Association of Zoo Veterinarians.

Table 1. Response levels for debilitated[a] green turtles with fibropapillomatosis and under circumstances when rehabilitation capacity is limited. Each level includes criteria for electing humane euthanasia. Turtles are to be treated at an authorized rehabilitation facility if they do not fulfill these criteria or have other conditions associated with a poor prognosis for successful release. As rehabilitation capacity becomes strained, the next higher response level is implemented. Each level also includes all criteria from the preceding levels. Level 1 represents current practice in the Southeast U.S. whereby all turtles are evaluated at rehabilitation facilities using diagnostic imaging and other tools. Levels 2 and higher are based on criteria that can be practically assessed in the field.

Response level 1 criteria for euthanasia

- Any debilitated turtle with any of the following:
  - Internal tumors
  - Tumor invasion of both eyes[b] or bone[c]
  - Inoperable tumors obstructing the mouth, glottis or cloaca
  - Tumor score of 3

Response level 2 criteria for euthanasia

- Any turtle meeting response level 1 criteria;
- Debilitated turtles with a tumor score of 2 and one or more of the following concurrent abnormalities:
  - Ocular tumors obscuring visual field (corneas are not visible)
  - Unresponsive or minimally responsive
  - Emaciation
  - Major non-healed traumatic injury (including entanglement and vessel strike injuries)

Response level 3 criteria for euthanasia

- Any turtle meeting response level 1 or 2 criteria;
- Any debilitated turtle with a tumor score of 2

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[a]*Debilitation* is defined as any of the following abnormalities: profound weakness or lethargy; emaciation; inability to dive, swim, or forage; obstruction of the mouth, glottis, or cloaca by tumors; or loss of buoyancy control.
[b]Specifically refers to tumor invasion of the anterior or posterior chamber of the eye, not just external growth.
[c]Refers to deep penetration of skull, carapace, or plastron tumors (i.e., not easily excised) or any tumor invasion of long bones.

Predicted outcome of implementation

Consistent euthanasia of turtles with TS3 disease, as defined under response level 1 would reduce rehabilitation effort by around 12%; level 3 would reduce it another 60%.

[1] Although these reductions are considerable, they could be outpaced by the increase in stranded turtles if the current trend continues. Moreover, these reductions are substantial overestimates as there will be inevitable logistical challenges that prevent full implementation in some areas. Willingness to follow response level recommendations should be discussed with pertinent facilities during planning so that implementation needs can be identified.

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[1] Note: reduction achieved by implementation of response level 2 cannot be quantified because information on some specific criteria are not consistently available (e.g., nutritional status, responsiveness), thus reductions discussed here are limited to levels 1 and 3.

Response considerations during mass stranding events

Additional considerations related to sea turtles with FP are necessary during mass stranding events. Cold-stunning events have the potential to quickly result in large numbers of stranded turtles with various degrees of tumor formation. During these events, turtles that do not have immediately life-threatening tumors or evidence of debilitation (as defined in these recommendations) associated with tumor formation are managed identically to those without tumors in accordance with the biosecurity measures described in the next section to the maximum extent possible under emergency conditions. This includes releasing animals with tumors (in areas where FP is known to occur) whose condition is otherwise comparable to turtles without FP. Turtles deemed non-releasable in their current condition will be considered for rehabilitation under the appropriate response level dictated by the relevant resource agency during the event.

Biosecurity measures for captivity and field research

Green turtles in captivity

Although outbreaks of FP within captive facilities are uncommon, appropriate biosecurity is warranted to prevent unintended transmission among animals. The FP-associated herpesvirus, ChHV5, likely survives in seawater (Curry et al. 2000) and may also be transmitted by vectors such as marine leeches (Greenblatt et al. 2004). Although the prevalence and distribution of the viral variants have not been extensively studied across sea turtle species, some variants have been documented in multiple turtle species – thus transmission between sea turtle species is presumed possible. Inter-species transmission is known to occur with other chelonian herpesviruses (Origgi 2012). It is also unclear whether severity of disease is influenced by variants of ChHV5.

Tumors are known sites of viral replication and are believed to play a significant role in transmission (Work et al. 2014). Also, green turtles are known to develop tumors while undergoing rehabilitation (Page-Karjian et al. 2014). Therefore, green turtles without tumors and those with FP should be segregated from one another and other species by use of separate water-handling systems, disinfection procedures, and other measures to prevent transmission (Table 2) (Page-Karjian et al. 2014). Another feature of herpesviruses across taxa is that the virus can be present (latent) in asymptomatic hosts, and many more individuals are infected by the virus than manifest tumors. A serological study of green turtles suggested that infection by ChHV5 is widespread among green turtles (Herbst et al. 2008). Furthermore, multiple researchers have detected ChHV5 DNA in turtles without tumors (e.g., Page-Karjian et al. 2012, Alfaro-Núñez and Gilbert 2014). Given the high prevalence of FP in green turtle populations within the U.S. and expectations of even higher rates of ChHV5 infection, *all green turtles should be considered potentially infected* and should be managed to minimize exposure to other species while in captivity. Green turtles have developed FP during rehabilitation at multiple facilities (Page-Karjian et al. 2014, FWC and NCWRC, unpub. data), which further supports these measures as prudent and necessary.

For facilities that receive sea turtles from FP endemic areas and that have multiple tanks or rehabilitation spaces with shared water-handling systems, these systems should be segregated into three groups: green turtles without tumors, other sea turtle species without tumors, and any sea turtle with tumors. Other sea turtle species with FP are managed the same as green turtles with tumors regarding biosecurity. Designation of system use is not necessarily static and can be changed following proper disinfection. These isolation measures should be incorporated into the design of new facilities and those undergoing renovation. Given the associated expense and logistics, these biosecurity measures should be phased into existing facilities as soon as practicable, i.e., immediate modification is not required. In the interim, separation of turtles with and without tumors and rigorous use of disinfection measures are the recommended minimum biosecurity precautions. Notably, capacity for separation and biosecurity has additional disease-control benefits beyond FP.

The recommended measures outlined in Table 2 were developed with an abundance of caution. Very little is known about actual transmission and risk factors in individual turtles. ChHV5 does not pose any health risk to humans or non-chelonian animals.

Table 2. Biosecurity measures for captive management of sea turtles within FP endemic regions.

- Maintain turtles *with tumors* in water handling/filtration systems that are separate from turtles without tumors. Turtles that develop tumors in captivity are immediately placed into designated tumor systems.
- Maintain green turtles *without tumors* using water handling/filtration system separate from those used for other species.
- Use barriers or sufficient distance between tanks to inhibit splashes and aerosol (water droplets) contamination.
- Prevent cross contamination by facility personnel, such as through:
    - dedicated staff assignments for care/husbandry of green turtles and those with tumors; and/or
    - regimented order for operations whereby green turtles are serviced after other species and those with tumors are serviced last.
- Use disposable gloves and foot baths when handling turtles or entering enclosures.
- Use dedicated equipment and/or disinfection using virucidal solutions according to manufacturer recommendations.
- Thoroughly disinfect tanks between patients.
- Remove marine leeches upon admission (i.e., through mechanical removal and/or freshwater baths).

Cold-stunning events present additional challenges because of the numbers of turtles that must be managed. For some regions, these events can include many turtles with FP. Implantation of metal flipper tags in cold-stunned turtles with FP should be forgone during these events because of the risk of tumor development at the tag site, potential impaired immune function in hypothermic turtles, and the added risk of cross-contamination among animals during mass events. PIT tags, which have not been observed to result in tumor formation at the injection site, may still be inserted if standards of cleanliness and disinfection are maintained.

Biosecurity and FP during capture and handling of green turtles

Measures to prevent transmission of FP during field research are also necessary. Potential sources of transmission include contaminated surfaces and equipment (including tag applicators, tags, nets, measuring devices, etc.), as well as hands of researchers and animal handlers. Variability in the circumstances of field operations requires development of effective biosecurity measures and protocol that are specific and practical for a given situation. Recommended elements are provided in Table 3. Thorough disinfection between study areas or use of separate equipment (designated for specific sites) is important, especially when working in areas with differences in FP prevalence or where occurrence of FP is not well characterized. Various options are available to disinfect equipment and surfaces. Herpesviruses are readily killed by many disinfectants, exposure to ultraviolet light, and desiccation. Two inexpensive options are 70% isopropyl alcohol and 10% sodium hypochlorite (bleach solution) (Croughan and Behbehani 1988). Isopropyl alcohol immediately inactivates herpeviruses, does not corrode equipment, dries quickly, and can be applied using squirt or spray bottle, soaked gauze, or other disposable material. Bleach solutions require longer contact times (approximately 10 minutes), are corrosive to some materials with repeated use, but are better options for larger surfaces and some equipment. Other products with virucidal efficacy against herpesviruses may be used. Most solutions require clean surfaces (i.e., washing to remove debris prior to application) to be effective and should be used according to manufacturer recommendations. Although prevention of FP transmission is the focus of these recommendations, these practices are good general biosafety considerations for any wildlife research activities.

Table 3. Biosecurity measures for field studies and other activities in FP endemic regions.

- Have a designated set of equipment that is only used for turtles with tumors, including tagging pliers, PIT tag applicators, vacutainer sleeves, rulers/measuring tapes.
- Disinfect equipment after every use (between each turtle) with solutions that have demonstrated efficacy against herpesviruses and according to efficacy/manufacturer recommendations.
- Use disposable gloves whenever feasible, especially for procedures involving penetration of the skin and for any turtles with tumors. If gloves are impractical, use alcohol-based hand sanitizer between animals.
- Thoroughly clean and rinse surfaces in contact with turtles, e.g., boat decks.
- Rinse equipment such as tangle nets, dip nets, etc., thoroughly and allow to completely dry with exposure to sunlight as frequently as possible.

Appendix E – Literature Cited

Alfaro-Núñez, A., and M.T.P. Gilbert. 2014. Validation of a sensitive PCR assay for the detection of Chelonid fibropapilloma-associated herpesvirus in latent turtle infections. J. Virol. Methods 206: 38-41.

American Association of Zoo Veterinarians (AAZV). 2006. Guidelines for Euthanasia of Nondomestic Animals. 111 p.

American Veterinary Medical Association (AVMA). 2013. Guidelines for Euthanasia of Animals. 102 p.

Bennett, P., U. Keuper-Bennett, and G.H. Balazs. 1999. Photographic evidence for the regression of fibropapillomas afflicting green turtles at Honokowai, Maui, in the Hawaiian Islands. In: Kalb, H., Wibbels, T. (compilers) Proc. Nineteenth Annual Sea Turtle Symposium. 2-6 March 1999, South Padre Island, Texas. U.S. Department of Commerce, National Oceanographic and Atmospheric Association, National Marine Fisheries Service. NOAA-TM-NMFS-SEFSC-443, pp. 37-39.

Chaloupka, M. K.A. Bjorndal, G.H. Balazs, A.B. Bolten, L.M. Ehrhart, C.J. Limpus, H. Suganuma, S. Trong, M. Yamaguchi. 2008a. Encouraging outlook for recovery of a once severely exploited marine megaherbivore. Glob. Ecol. Biogeogr. 217: 297-304.

Chaloupka, M., T.M. Work, G.H. Balazs, S.K.K. Murakawa, R.M. Morris. 2008b. Cause-specific temporal and spatial trends in green sea turtle strandings in the Hawaiian Archipelago (1982-2003). Mar. Biol. 154: 887-898.

Chaloupka, M., G.H. Balazs, and T.M. Work. 2009. Rise and fall over 26 years of a marine epizootic in Hawaiian green sea turtles. J. Wildl. Dis. 45: 1138-1142.

Cray, C., R. Varella, G.D. Bossart, P. Lutz. 2001. Altered in vitro immune responses in green turtles (*Chelonia mydas*) with fibropapillomatosis. J. Zoo. Wildl. Med. 32: 436-440.

Croughan, W.S., and A.M. Behbehani. 1988. Comparative study of inactivation of herpes simplex virus types 1 and 2 by commonly used antiseptic agents. J. Clin. Micro. 26: 213-215.

Cruz, E. 1985. Saga of the Sea Turtle, Turtle Kraals Museum, Key West, 307 p.

Curry, S.S., D.R. Brown, J.M. Gaskin, E.R. Jacobson, L.M. Ehrhart, S. Blahak, L.H. Herbst, P.A. Klein. 2000. Persistent infectivity of a disease-associated herpesvirus in green turtles after exposure to seawater. J. Wildl. Dis. 36: 792-797.

Diez, C.E., and R. Patricio. 2016. Fibropapillomatosis in marine turtles of the Caribbean region: the case study of Puerto Rico. In: Hargrove, S, Work, T., Brunson S., Foley, A.M., and Balazs G. (compilers) Proc. 2015 International Summit on Fibropapillomatosis: Global Status, Trends, and Population Impacts. U.S. Department of Commerce, National Oceanographic and Atmospheric Association, National Marine Fisheries Service. NOAA-TM-NMFS-PIFSC-54, pp. 9-11.

dos Santos, R.G., A.S. Martins, E. Torezani, C. Baptistotte, F.J. da Nóbrega, P.A. Horta, T.M. Work, and G.H. Balazs. 2010. Relationship between fibropapillomatosis and environmental quality: a case study with *Chelonia mydas* off Brazil. Dis. Aquat. Organ. 89: 87-95.

Ehrhart, L., W. Redfoot, K. Mansfield, J. Gorham, S. Weege, and J. Provancha. 2016. Prevalence and trends in fibropapillomatosis in green turtles on Florida's Atlantic coast. In: Hargrove, S, Work, T., Brunson S., Foley, A.M., and Balazs G. (compilers) Proc. 2015 International Summit on Fibropapillomatosis: Global Status, Trends, and Population Impacts. U.S. Department of Commerce, National Oceanographic and Atmospheric Association, National Marine Fisheries Service. NOAA-TM-NMFS-PIFSC-54, pp. 15-21.

Ene, A., M. Su, S. Lemaire, C. Rose, S. Schaff, R. Moretti, J. Lenz, and LH Herbst. 2005. Distribution of chelonid fibropapillomatosis-associated herpesvirus variants in Florida: molecular genetic evidence for infection of turtles following recruitment to neritic developmental habitats. J. Wildl. Dis. 41: 489-97.

Foley, A.M., B.A. Schroeder, A.E. Redlow, K.j. Fick-Child, and W.G. Teas. 2005. Fibropapillomatosis in stranded green turtles (*Chelonia mydas*) from the eastern United States (1980-98): trends and associations with environmental factors. J. Wildl. Dis. 41: 29-41.

Foley, A.M. 2016. Characteristics of green turtle fibropapillomatosis in the Northwest Atlantic as indicated by strandings. In: Hargrove, S, Work, T., Brunson S., Foley, A.M., and Balazs G. (compilers) Proc. 2015 International Summit on Fibropapillomatosis: Global Status, Trends, and Population Impacts. U.S. Department of Commerce, National Oceanographic and Atmospheric Association, National Marine Fisheries Service. NOAA-TM-NMFS-PIFSC-54, pp. 12-14.

Greenblatt, R.J., T.M. Work, G.H. Balazs, C.A. Sutton, R.N. Casey, and J.W. Casey. 2004. The Ozobranchus leech is a candidate mechanical vector for the fibropapilloma-associated turtle herpesvirus found latently infecting skin tumors on Hawaiian green turtles (*Chelonia mydas*). Virology 321: 101-10.

Hargrove, S, Work, T., Brunson S., Foley, A.M., and Balazs G. 2016. Proceedings of the 2015 International Summit on Fibropapillomatosis: Global Status, Trends, and Population Impacts. U.S. Department of Commerce, National Oceanographic and Atmospheric Association, National Marine Fisheries Service. NOAA-TM-NMFS-PIFSC-54, 87 p.

Herbst, L.H. 1994. Fibropapillomatosis of marine turtles. Ann. Rev. Fish Dis. 4: 389-425.

Herbst, L.H., E.R. Jacobson, R. Moretti, T. Brown, J.P. Sundberg, and P.A Klein. 1995. Experimental transmission of green turtle fibropapillomatosis using cell-free tumor extracts. Dis. Aquat. Organ. 22: 1–12.

Herbst, L., A. Ene, M. Su, R. Desalle, and J. Lenze. 2004. Tumor outbreaks in marine turtles are not due to recent herpesvirus mutations. Cur. Biol. 14: R697-R699.

Herbst, L.H., S. Lemaire, A.R. Ene, D.J. Heslin, L.M. Ehrhart, D.A. Bagley, P.A. Klein, and J. Lenz. 2008. Use of baculovirus-expressed glycoprotein H in an enzyme-linked immunosorbent assay developed to assess

exposure to chelonid fibropapillomatosis-associated herpesvirus and its relationship to the prevalence of fibropapillomatosis in sea turtles. Clin. Vaccine Immunol. 15: 843-51.

Hirama, S., and L.M. Ehrhart. 2007. Description, prevalence, and severity of green turtle fibropapillomatosis in three developmental habitats on the east coast of Florida, Florida Sci. 70: 435-448.

Hirama, S., L.M. Ehrhart, L.D. Rea, and R.A. Kiltie. 2014. Relating fibropapilloma tumor severity to blood parameters in green turtles *Chelonia mydas*. Dis. Aquat. Organ. 111: 61-8

Hoffman, W., and P. Wells. 1991. Analysis of a fibropapilloma outbreak in captivity. In: Salmon, M., Wyneken, J. (compilers) Proc. Eleventh Annual Workshop on Sea Turtle Biology and Conservation. 26 February-2 March 1991, Jekyll Island, GA. U.S. Department of Commerce, National Oceanographic and Atmospheric Association, National Marine Fisheries Service. NOAA-TM-NMFS-SEFSC-302, pp. 56-58.

Metz, T.L. and A.M. Landry, Jr. 2013. An assessment of green turtle (*Chelonia mydas*) stocks along the Texas coast, with emphasis on the lower Laguna Madre. Chelonian Conserv. Biol. 12: 293-302.

Murakawa, S.K.K. 2016. Hawaiian Archipelago Fibropapillomatosis Data. In: Hargrove, S, Work, T., Brunson S., Foley, A.M., and Balazs G. (compilers) Proc. 2015 International Summit on Fibropapillomatosis: Global Status, Trends, and Population Impacts. U.S. Department of Commerce, National Oceanographic and Atmospheric Association, National Marine Fisheries Service. NOAA-TM-NMFS-PIFSC-54, pp. 44-56.

Origgi, F.C. 2012. Testudinid Herpesviruses: A Review. J. Herpetol. Med. Surg. 22: 42–54.

Page-Karjian, A., F. Torres, J. Zhang, S. Rivera, C. Diez, P.A. Moore, D. Moore, and C. Brown. 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. SpringerPlus 1: 35.

Page-Karjian, A., T.M. Norton, P. Krimer, M. Groner, S.E. Nelson Jr, and N.L. Gottdenker. 2014. Factors influencing survivorship of rehabilitating green sea turtles (*Chelonia mydas*) with fibropapillomatosis. J Zoo Wildl. Med. 45: 507-19.

Quackenbush, S.L., T.M. Work, G.H. Balazs, R.N. Casey, J. Rovnak, A. Chaves, L. duToit, J.D. Baines, C.R. Parrish, P.R. Bowser, and J.W. Casey. 1998. Three closely related herpesviruses are associated with fibropapillomatosis in marine turtles. Virology 246: 392-9.

Redfoot, W.E. and L.M. Ehrhart. 2013. Trends in size class distribution, recaptures, and abundance of juvenile green turtles (*Chelonia mydas*) utilizing a rock riprap lined embayment at Port Canaveral, Florida, USA, as developmental habitat. Chelonian Conserv. Biol. 12: 252-261.

Rossi, S., A.M. Sánchez-Sarmiento, R.E. Vanstreels, R.G. Dos Santos, F.E. Prioste, M.A. Gattamorta, J.H. Grisi-Filho, and E.R. Matushima. 2016. Challenges in Evaluating the Severity of Fibropapillomatosis: A Proposal for Objective Index and Score System for Green Sea Turtles (*Chelonia mydas*) in Brazil. *PLoS One*. Dec 9;11(12): e0167632.

Tristan, T., Shaver, D.J., Kimbro, J., deMaar, T., Metz, T., George, J., and Amos, A.. 2010. Identification of Fibropapillomatosis in Green Sea Turtles (*Chelonia mydas*) on the Texas Coast. J. Herp. Med. Surg. 20: 109-112.

US Fish and Wildlife Service. 2013. Standard Permit Conditions for Care and Maintenance of Captive Sea Turtles. Accessed on 6/25/2018 at: https://www.fws.gov/northflorida/seaturtles/Captive_Forms/20130213_revised%20_standard_permit_conditions_for_captive_sea_turtles.pdf

Van Houtan, K.S., S.K. Hargrove, and G.H. Balazs. 2010. Land use, macroalgae, and a tumor-forming disease in marine turtles. PLoS One. doi: 10.1371/journal.pone.0012900.

Work, T.M., and G.H. Balazs. 1999. Relating tumor score to hematology in green turtles with fibropapillomatosis in Hawaii. J. Wildl. Dis. 35: 804-7.

Work, T.M., R.A. Rameyer, and G.H. Balazs, C. Cray, and S.P. Chang. 2001. Immune status of free-ranging green turtles with fibropapillomatosis from Hawaii. J. Wildl. Dis. 37: 574-581.

Work, T.M., G.H. Balazs, M. Wolcott, and R. Morris. 2003. Bacteraemia in free-ranging Hawaiian green turtles *Chelonia mydas* with fibropapillomatosis. Dis. Aquat. Organ. 53: 41-6.

Work, T.M., G.H. Balazs, R.A. Rameyer, and R.A. Morris. 2004. Retrospective pathology survey of green turtles *Chelonia mydas* with fibropapillomatosis in the Hawaiian Islands, 1993-2003. Dis. Aquat. Organ. 62: 163-76.

Work, T.M., J. Dagenais, G.H. Balazs, N. Schettle, and M. Ackermann. 2014. Dynamics of virus shedding and in situ confirmation of chelonid herpesvirus 5 in Hawaiian green turtles with fibropapillomatosis. Vet. Path. 52: 1195-1201.