MEETING AGENDA - FIBROPAPILLOMATOSIS AND SEA TURTLES: GUIDELINES FOR FIELD RESPONSE, CAPTIVE MANAGEMENT, AND REHABILITATION (SEPTEMBER 6-8, 2017)

Day 3 (Sept 8)	
State/Federal agency staff discussions	9:00-11:30*

*Will conclude earlier if completed.

Meeting location:

Fish and Wildlife Research Institute
100 8th Ave SE, Room 3AB
St. Petersburg, FL 33701

Participants list:

Name	Affiliation
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Dr. Robbin Trindell	Florida Fish and Wildlife Conservation Commission
Meghan Koperski	Florida Fish and Wildlife Conservation Commission
Susan Schaf	Florida Fish and Wildlife Conservation Commission
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Dr. Maria Chadam	Gumbo Limbo Nature Center
Dr. Brook Burkhalter	Whitney Laboratory Sea Turtle Hospital
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MEETING AGENDA - FIBROPAPILLOMATOSIS AND SEA TURTLES: GUIDELINES FOR FIELD RESPONSE, CAPTIVE MANAGEMENT, AND REHABILITATION (SEPTEMBER 6-8, 2017)

Day 1 (Sept 6)	
Convene meeting and introductory remarks – B Schroeder/A Lauritsen	9:00-9:15
Introductions – Participants	9:15-9:35
Presentation: Rehabilitation data review and projected trends – B Stacy	9:35-10:30
Break	10:30-10:45
Data review Q&A	10:45-12:00
Lunch	12:00-1:15
Presentation: Introduction of draft Guidelines – B Stacy	1:15-2:00
Guidelines Q&A	1:30-2:00
Discussion of Guidelines Element #1: Disposition of sea turtles with FP encountered in the wild	2:00-3:00
Break	3:00-3:15
Discussion of Guidelines Element #2: Rehabilitation	3:15-5:00

Day 2 (Sept 7)	
Recap of previous day – Schroeder/Stacy	9:00-9:15
Discussion of Guidelines Element #2: Rehabilitation (continued)	9:15-10:30
Break	10:30-10:45
Discussion of Guidelines Element #2 (continued)	10:45-12:00
Lunch	12:00-1:30
Guidelines Element #3: Biosecurity measures for green turtles in captivity	1:30-2:30
Break	2:30-2:45
Discussion of Guidelines Element #4: Biosecurity and FP during capture and handling of green turtles	2:45-3:45
Comment period for previous topics / final thoughts – Participants	3:45-4:45
Meeting conclusion and next steps	4:45-5:00

Fibropapillomatosis and Sea Turtles: Draft Guidelines for Field Response, Captive Management, and Rehabilitation

Best Practices for Sea Turtles with FP

Disposition of sea turtles with FP encountered in the wild

Stranded sea turtles with FP found on shore are, by definition, impaired to the degree that they require human intervention. These animals are managed according to the rehabilitation and triage guidelines provided in the next section. 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 guidelines, debilitation is defined as any of the following:

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

Any debilitated turtle captured during the course of sea turtle research, incidentally, or as a result of other activities should be transferred to a local permitted stranding network participant or rehabilitation facility when feasible[1]. These debilitated turtles are then treated the same as stranded turtles, as defined in the next section. 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 are able to evade capture actively.

Rehabilitation and triage of sea turtles with FP

Guidelines related to rehabilitation of green turtles with FP are based on data that is currently available to resource agencies, which includes major stranding observations, survival outcome, and the extent of tumor formation. Tumor formation is scored on a scale of 1 (mild) to 3 (severe), hereafter indicated as tumor score (TS), based on criteria described by Work and Balazs (1999). Detailed clinical information, diagnostic results, and treatments are not currently reported to resource agencies; therefore, recommendations herein are based largely on tumor score and complicating conditions that logically are associated with greater morbidity and additional required treatment, such as profound weakness/lethargy, emaciation, and ocular tumors.

[1] 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.

Triage is the allocation of humane treatment to patients using criteria intended to maximize the number of survivors based on available resources. Due to the number of green turtles with debilitating FP and limited capacity for rehabilitation, a system of triage is needed to ensure that resources are applied to those that will most likely benefit from medical intervention while also ensuring that all turtles receive humane treatment. In order to balance rehabilitation capacity with needs, any triage approach inevitably will entail euthanasia of affected turtles that have disease features known to have a high rate of mortality. Stranding responders and rehabilitation facilities already triage cases based on advanced features of the disease associated with a poor prognosis, such as internal tumors. 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. Rehabilitation veterinarians practicing in the Southeast U.S. have expressed a strong preference that capacity for euthanasia be developed at the resource agency level, as done in Hawaii, in order to minimize emotional costs to facility staff and volunteers. Therefore, criteria for triage must include assessments that can be done by non-veterinarians in the field. This precludes most diagnostic tools, such as imaging, endoscopy, and blood analyses. In addition, the system must be adaptable so that resources can be allocated as dictated by current circumstances, i.e., as many sea turtles as possible receive thorough medical evaluation at rehabilitation facilities and field triage is only implemented when necessary. Regardless of the triage approach, attending veterinarians should strongly consider prognosis, as well as the stress, pain, and discomfort associated with attempted treatment, when managing cases.

The triage system for debilitated green turtles with FP is shown in Table 1. This plan consists of five triage levels that define the criteria[2] for euthanasia depending on the current numbers of sea turtles requiring care and the capacity of rehabilitation facilities. 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. preceding these guidelines, including evaluation of all live debilitated turtles with FP at rehabilitation facilities, are consistent with level 1 triage. As capacity becomes limited and the triage level is increased, criteria expand to include additional turtles with low rates of survival, but a less certain outcome. For example, debilitated turtles with an intermediate tumor score (TS2) have higher rates of survival than those with high tumor scores (TS3), but still have around 75% mortality. Also, triage levels 2 through 5 utilize criteria that can be evaluated in the field, thus afflicted turtles can be humanely euthanized without necessarily being admitted to a rehabilitation facility. This triage approach will decrease facility admissions of turtles that are likely to die and will minimize procedures and stress experienced by turtles with the poorest chances of survival, thus allowing resources to be focused on turtles with the greatest chances of return to the wild.

The federal or state resource agency responsible for coordinating rehabilitation in a given state will dictate the level of triage based on their ability to find rehabilitation space efficiently for turtles with FP or when facilities that admit FP turtles are nearing their permitted capacity for long-term patients[3]. Although it is intended that the required level of triage will remain at the lowest level, the increased

[2] 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."
[3] Does not include temporary capacity for emergency situations as provided in the USFWS Standard Conditions.

numbers of FP-related strandings encountered in recent years in the Southeast U.S. necessitates the contingencies afforded by this system to avoid overwhelming rehabilitation facilities and jeopardizing animal welfare.

Based on current durations and outcome of rehabilitation in Florida facilities (since the 2011 memo), absolute implementation of level 2 triage would reduce rehabilitation effort by around 26%; level 4 would reduce it another 60%. Although these reductions may seem considerable, these gains 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. Foremost, implementation relies on euthanasia administered by resource agencies and facilities willing to follow triage planning. Many stranded turtles are not received by resource agency staff, but instead are recovered by or are directly taken to rehabilitation facilities, which may not be willing to follow the current triage directive.[4]

There is no doubt that demands on rehabilitation facilities will remain substantial despite the measures defined in these guidelines. Better prognostic evaluation of patients at facilities and judicious use of euthanasia of patients that are unlikely to survive are needed. Almost 60% of turtles admitted to facilities that survive a week or longer ultimately die or are euthanized, more than twice the number of stranded green turtles without tumors. 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. Such a study would require a relatively large study population due to many potential confounders. Consistent collection of important information and meticulous documentation at all facilities treating turtles with FP is critical.

Triage considerations and mass stranding events

Unusual circumstances require additional considerations related to triage and turtles with FP. In particular, cold-stunning events have the potential to result in 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 associated with tumor formation are managed identically to those without tumors, accommodating biosecurity measures described in the next section to the maximum extent possible under any 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 unreleasable in their current condition will be triaged for rehabilitation under the appropriate level dictated by the event.

[4] Currently, federal and state permitting agencies do not compel rehabilitation facilities to euthanize specific cases.

Table 1. Euthanasia criteria for different levels of triage for debilitated[1] green turtles with fibropapillomatosis. As rehabilitation capacity becomes limited, the next higher triage level is activated. Each level also includes all criteria from the preceding levels. Level 1 represents current practice 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. Tumor scores (1-fewest tumors to 3-most severe) are based on Work and Balazs (1999).

Triage level 1 criteria for euthanasia

- Any debilitated turtle with any of the following:
  - Internal tumors
  - Tumor invasion of one or both eyes[2] or bone
  - Tumors obstructing the mouth, glottis or cloaca
- Debilitated turtles with a tumor score of 3 and one or more of the following concurrent abnormalities:
  - Unresponsive or minimally responsive
  - Anemia (PCV <20%)
  - Emaciation
  - Major non-healed traumatic injury (including entanglement and vessel strike injuries)

Triage level 2 criteria for euthanasia

- Any turtle meeting triage level 1 criteria;
- Any debilitated turtle with a tumor score of 3

Triage level 3 criteria for euthanasia

- Any turtle meeting triage level 1 & 2 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)

Triage level 4 criteria for euthanasia

- Any turtle meeting triage level 1, 2, and 3 criteria;
- Any debilitated turtle with a tumor score of 2

Triage level 5 criteria for euthanasia

- Any turtle meeting triage level 1-4 criteria;
- Debilitated turtles with a tumor score of 1 and one or more of the following concurrent abnormalities:
  - Ocular tumors obscuring visual field
  - Unresponsive or minimally responsive
  - Emaciation
  - Major non-healed traumatic injury (including entanglement and vessel strike injuries)

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[1]*Debilitation* is defined as any of the following abnormalities: profound weakness or lethargy; emaciation; inability to forage, dive, swim, or forage; obstruction of the mouth, glottis, or cloaca by tumors; or loss of buoyancy control.
[2]Specifically refers to tumor invasion of the eye, not just external growth.

Biosecurity measures for captivity and field research

Green turtles in captivity

FP is an infectious disease, so appropriate biosecurity is needed to prevent transmission to FP-free 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 variants of the virus have not been extensively studied across sea turtle species, some variants have been documented in multiple 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 particular variants of ChHV5.

Another feature of herpesviruses across taxa is that the virus can hide 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 US and near certainty of even higher rates of ChHV5 infection, all green turtles are considered to be potentially infected and should be managed to minimize exposure to other species while in captivity. Green turtles have developed FP during the course of rehabilitation at multiple facilities (FWC, NCWRC, unpub. data), which further supports that these measures are prudent and necessary. In addition, tumors are known sites of viral replication and are believed to play a significant role in transmission (Work 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). For facilities in which multiple tanks or rehabilitation spaces share water-handling systems, these systems should be segregated into three groups, non-green turtles, green turtles without tumors, and turtles with tumors. Other sea turtle species with FP are managed the same as green turtles with tumors with regard to biosecurity. It is anticipated that accommodation of these measures will require significant alteration of some existing facilities. Means of segregating systems should be implemented as soon as feasible within FP endemic areas and should be incorporated into any remodeling plans or design of new facilities.

All of the measures outlined in Table 2 were developed out of 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. Herpesviruses are readily killed by a number of disinfectants, exposure to ultraviolet light, and desiccation.

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

- Green turtles *without tumors* are maintained using water handling/filtration system separate from those used for other species.
- Turtles *with tumors* are maintained use water handling/filtration systems that are separate from turtles without tumors. Turtles that develop tumors in captivity are immediately placed into separate systems
- Barriers in place or sufficient distance between tanks to prevent splashes and aerosol (water droplets) contamination.
- Prevention of 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 of disposable gloves and foot baths when handling turtles or entering enclosures.
- Use of dedicated equipment and/or disinfection using virucidal solutions according to manufacturer recommendations.
- Thorough disinfection of tanks between patients.
- Removal of marine leeches upon admission (i.e., through mechanical removal and/or freshwater baths).

Biosecurity and FP during capture and handling of green turtles

Measures to prevent transmission of FP during the course of 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. Basic elements that must be incorporated are provided in Table 3. Various options such as disinfectants are available to disinfect equipment and surfaces, but most solutions require a prolonged contact time to ensure disinfection. 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. Most solutions require clean surfaces (i.e., washing to remove debris prior to application) in order to be effective. Drying and exposure to sunlight (UV) also will inactivate herpesviruses. Although prevention of FP transmission is the focus of these guidelines, 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 any turtles with tumors.
- Thoroughly clean and rinse surfaces in contact with turtles, e.g., boat decks, followed by application of virucidal solution.
- For equipment such as tangle nets, dip nets, etc., rinse thoroughly and allow to completely dry with exposure to sunlight as frequently as possible.

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Background and Data Review: Preparatory Document for Meeting

Fibropapillomatosis and Sea Turtles: Guidelines for Field Response, Captive Management, and Rehabilitation

Background

Fibropapillomatosis (FP) is a neoplastic disease that occurs globally in wild populations of sea turtles and affects mainly green turtles (*Chelonia mydas*)(Jones et al. 2016). FP rose in prevalence in Florida and Hawaii most noticeably during the 1980's. In Hawaii, disease prevalence has shown signs of decline over the last couple of decades (Chaloupka et al. 2009); however, there is no evidence that FP is abating in the Southeast U.S. and 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 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). 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 benign (few external tumors) or malignant. In-water studies have documented spontaneous regression of tumors. Of those turtles observed to have FP and that were subsequently encountered, 32% (Bennett et al. 1999) and 64% (Ehrhart et al. 2016) exhibited regression. A subset of turtles experience more 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. Severely tumored 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. 2008) and Florida (Foley et al. 2005), and is regularly encountered by stranding responders, resource agencies, and rehabilitation facilities. 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 (FWC and NCWRC, unpub. data). 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 1980's, the green turtle nesting population was small and listed as endangered under the Endangered Species Act of 1973 (ESA). Treatment of 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) at the time of stranding, and lack of availability of rehabilitation facilities.

Current Challenges Related to Rehabilitation

Over the last decade, an increase in the numbers of green turtles in coastal areas of the Southeast U.S. has been accompanied by an increase in green turtle strandings. The number and proportion of stranded turtles with FP found in Florida has also notably increased (Figs. 1, 2), resulting in greater numbers of turtles with tumors being admitted into rehabilitation facilities. 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 and is sporadically encountered in other areas of the Southeast U.S. 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 (mainly funded by government and private sector) 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 (creation of new facilities, expansion of existing ones) will be unable to meet demands should numbers of affected turtles continue to increase at the current rate. Costs per animal are very high relative to critical sea turtle conservation and recovery needs.

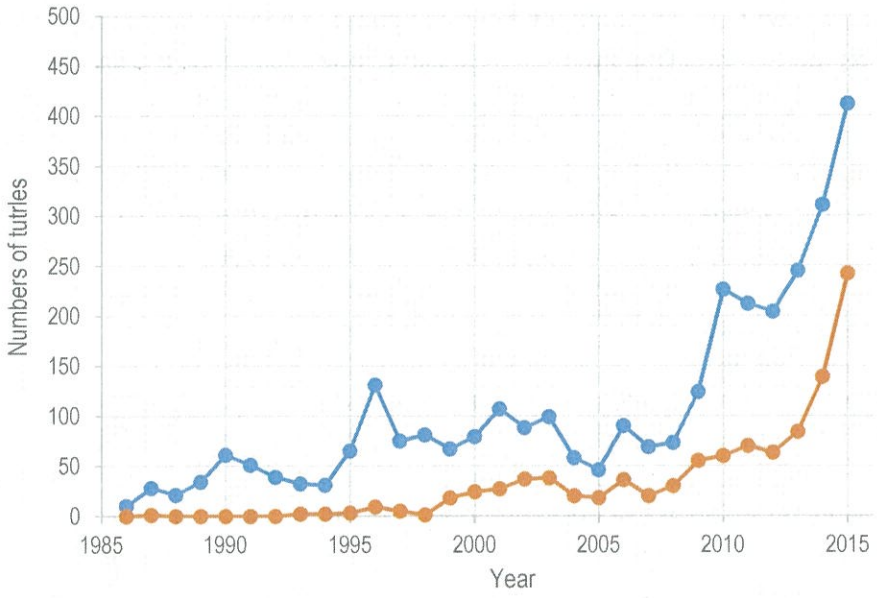

Figure 1. Graph showing the number of green turtle strandings with FP (blue line) in Florida and admissions of live green turtles with tumors into rehabilitation facilities (orange line).

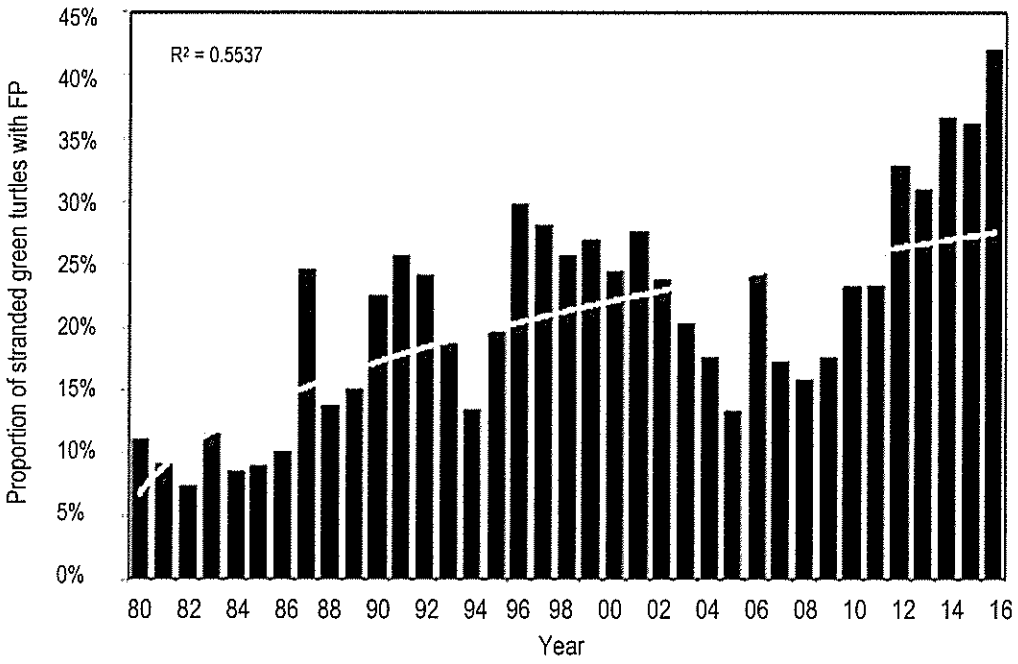

Figure 2. Graph showing the proportion of green turtle strandings with FP in Florida and upward trend from 1980-2016 (courtesy of FWCC).

Because the steady increase in FP cases risks placing existing rehabilitation and response efforts on an unsustainable path, we reviewed rehabilitation statistics related to FP in preparation for the upcoming meeting in September. As part of this review, rehabilitation efforts in Florida over the last 10 years were examined. The review focused on Florida because of its long history of rehabilitating sea turtles with FP and current planning needs related to this disease.

Review of rehabilitation effort and outcome in Florida

Since the early 1990s, the Florida Fish and Wildlife Conservation Commission (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 over time 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 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, and eliminate the one-year holding period, which has since been removed from the FWC guidelines and is no longer practiced by most facilities. This review covers data collected since 2006 because this period most closely reflects current rehabilitation practices. For any statistical comparisons, p-values <0.05 were considered significant. The extent of tumor formation is scored on a scale of 1 (mild) to 3 (severe), hereafter indicated as tumor score (TS), based on criteria described by Work and Balazs (1999) (Table 1).

Table 1. Numbers of each size class of tumors used for placement into a particular tumor score category (from Work and Balazs 1999).

	Tumor score			
	0	1	2	3
Tumor size				
(A) <1 cm	0	1-5	>5	>5
(B) 1-4 cm	0	1-5	>5	>5
(C) >4-10 cm	0	0	1-3	>4
(D) >10 cm	0	0	0	>1

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 or insufficient available information (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 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 and 360 (38.1%) that were euthanized. An additional five turtles (5.3%) 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 FP-free greens (831/1577, 52.7% released) and FP-free loggerheads (*Caretta caretta*, 598/1246, 48.0% released).

There was clear evidence of interaction between other conditions (fishing gear-related injuries and other trauma) that could not be further investigated using the available data; therefore, much of the subsequent discussion focuses on those turtles (n=630) in which FP was the main identifiable problem noted on the stranding report. For those animals, probability of successful rehabilitation was inversely related to TS; more severely afflicted animals had a lower probability of release and higher probability of spontaneous death or euthanasia (Table 2). These findings concur with physiologic effects of FP where animals with TS2 or greater have a poor prognosis for survival because of anemia of 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 lightly tumored turtles was due to co-morbidities and were not attributable to FP, but case-specific data were not available to further characterize cause of stranding in these cases.

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). Length of rehabilitation for turtles with FP (excluding co-morbidities) is shown for years before and after the 2011 recommendations in Table 3. 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 and occurs in over 80% of admissions to The Turtle Hospital (D. Mader and B. Zirkelbach, pers. com).

Table 2. Percent of green turtles that were released, died, or were euthanized in Florida from 2006-2016 partitioned by tumor score (1-fewest tumors to 3-most severe) based on Work and Balazs (1999).

FP tumor score	n	Released	Died	Euthanized	Total deceased[1]
1	58	25 (43.1%)	24 (41.4%)	9 (15.5%)	33 (56.9%)
2	278	63 (22.7%)	125 (45.0%)	90 (32.4%)	215 (77.3%)
3	254	27 (10.6%)	112 (44.1%)	115 (45.3%)	227 (89.4%)
Total	590	115 (19.5%)	261 (44.2%)	214 (36.3%)	475 (80.5%)

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

Table 3. 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. Values for 2006-2010 are shaded; those for 2012-2016 are unshaded. Tumor score (1-fewest tumors to 3-most severe) based is based on Work and Balazs (1999).

FP tumor score	Number of days to release			Number of days to death			Number of days to euthanasia		
	n	Median	Range	n	Median	Range	n	Median	Range
1	1	117.0	-	5	0	0-1	4	78.5	13-543
	22	113.5	2-477	16	10.0	0-369	3	3.0	1-6
2	5	388.0	118-477	19	3.0	0-176	13	12.0	0-372
	56	236.5	27-667	101	27.3	0-401	73	5.3	0-663
3	9	423.0	227-755	30	1.0	0-650	30	6	0-443
	18	188.5	86-700	72	1.0	0-120	72	6.5	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. 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 turtles with moderate tumor grades that died spontaneously or are euthanized, 34% were expended on turtles with the most severe tumor grade, most of which are 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. 3).

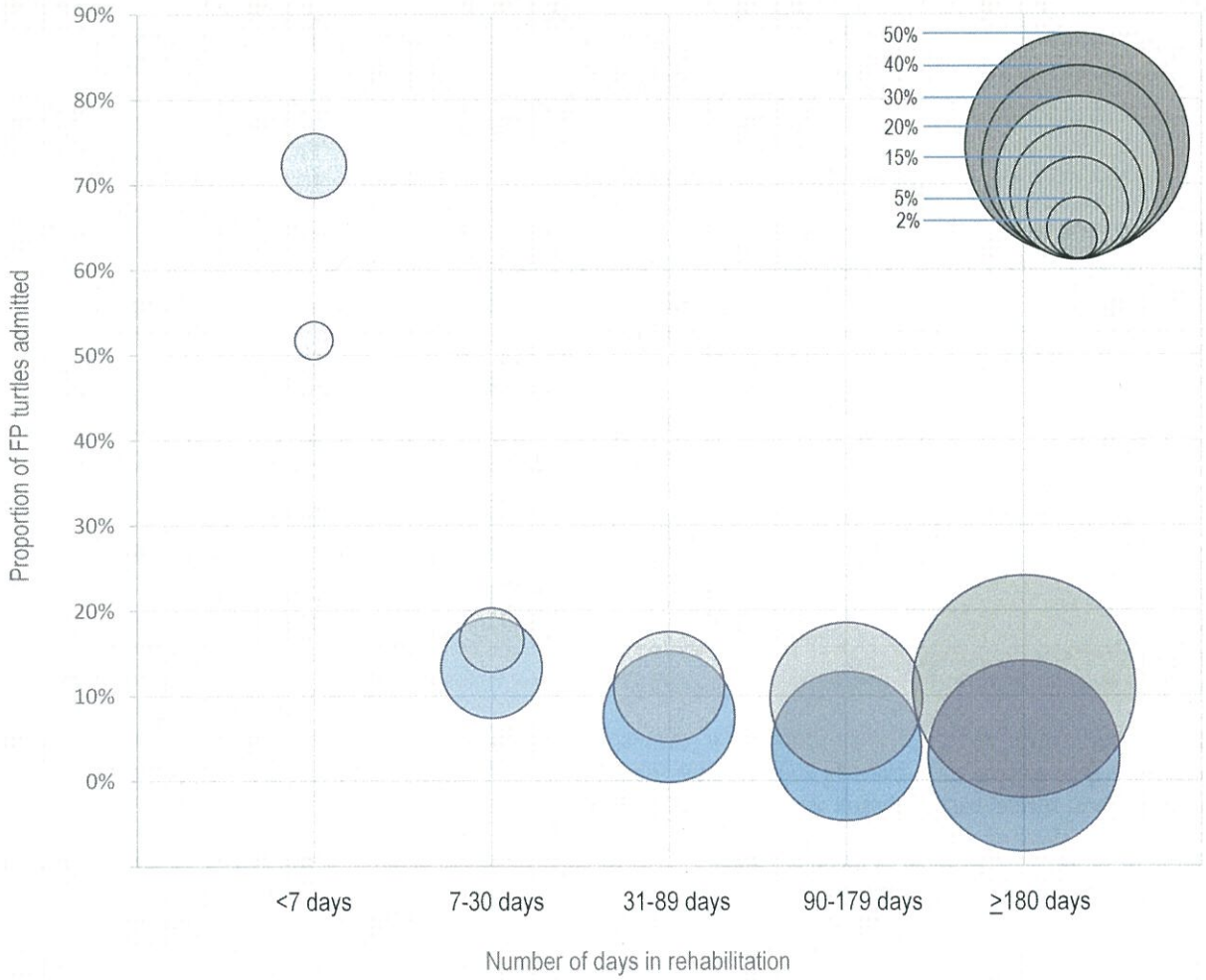

Figure 3. Duration of rehabilitation for green turtles with tumor scores 2 or 3 that did not survive (2012-2016 data). Euthanized animals (n=145) are shown in gray; those that died spontaneously (n=173) are shown in blue. The size of the circle reflects the proportion of combined total days in captivity for all turtles each outcome group (euthanized vs. spontaneous death). The larger the circle, the greater the proportion of rehabilitation effort. For turtles that ultimately did not survive, 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. Tumor score (1-fewest tumors to 3-most severe) is based on Work and Balazs (1999).

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Feedback Instrument

Fibropapillomatosis and Sea Turtles: Guidelines for Field Response, Captive Management, and Rehabilitation

1. Which of the following best characterize your work with sea turtles and fibropapillomatosis (select all that apply)?

   A. Veterinarian (rehabilitation)

   B. Veterinarian (research)

   C. Sea turtle biologist

   D. Resource agency staff

   E. Other: _____

2. Which of the following best characterizes your opinion of the draft Guidelines?

   A. The draft Guidelines are acceptable as written.

   B. Minor revisions are required (please describe in the space below)

   C. Major Revisions are required (please describe in the space below)

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

A. Strongly agree

B. Somewhat agree

C. Disagree

Please explain:

4. Are there any major changes or additions not described under Question #2 that you think would benefit any aspect of the draft Guidelines?

A. Yes

B. No

Please explain:

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

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