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Compilation and Review of Sea Turtle Rehabilitation Protocols and Career Guidance from Conservation Professionals in the Eastern United States

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COMPILATION AND REVIEW OF SEA TURTLE REHABILITATION PROTOCOLS AND CAREER GUIDANCE FROM CONSERVATION PROFESSIONALS IN THE EASTERN UNITED STATES

by

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ABSTRACT

Seven species of sea turtle are found on earth and all are either threatened or endangered. Unfortunately, these animals are under duress due to numerous anthropogenic causes. The increasing concentrations of greenhouse gases in our atmosphere has led to extreme global weather fluctuations, which leads to the cold stunning events seen among turtles in the north eastern United States every year. Illegal fishing practices and illegal boating lead to severe and critical injuries. Coastal development destroys integral nesting grounds. The rehabilitation of sea turtles is one solution to the preservation and conservation of these species. This thesis analyzes current rehabilitation protocols among multiple facilities and highlights the careers of conservation professionals in order to provide insight to undergraduate students interested in marine conservation.

After interviewing staff and researchers at three different institutions, I compiled and organized information regarding successes, unexpected outcomes, details of sea turtle patients' injuries and histories, enrichment plans, and veterinary procedures (if applicable). The information was analyzed to determine similarities and differences in rehabilitation strategies and outcomes seen among the interviewed institutions.

All three institutions had similar baseline protocols for incoming patients. After these baseline protocols were completed, each institution also utilized creative solutions to continue care for the turtles that expanded past the baseline protocols. The study also identified how the normal protocols for each institution were affected by drastic changes, including the 2020 SARS-CoV-2 pandemic and climate change.

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PREFACE

From snorkeling adventures to the movie Finding Nemo, humans have been falling in love with the graceful, quirky, marine reptile known as sea turtles for thousands of years. I myself fall into that category of people. I was sixteen when I had my first experience with a sea turtle in rehabilitation. That turtle's name is Harbor, and he is a juvenile Green sea turtle. Harbor was critically wounded in a boat strike off of the coast of the south eastern United States. After a long battle with a badly fractured carapace, rear flipper paralysis, a shattered pelvis, and a particularly difficult case of bubble butt syndrome (when air is trapped in between the shell and prevents the turtle from diving), Harbor had made his way for a long-term rehabilitation stay at my local aquarium. I found myself immediately drawn to the goofy turtle bouncing around in the water, seemingly unable to get his movements completely under control. With his big dark eyes, round little head, and bouncy movements, it was love at first sight. My first thought when meeting Harbor was awe. I couldn't believe this little turtle had gone through so much and was still alive. My second thought was anger. I hated that he had experienced so much pain and that maybe, just maybe, the accident that wounded him could have been prevented. From that moment I knew I wanted to get involved. I spent time as an independent study student researching Harbor and his injury in attempt to see if he would ever gain any function back in his rear flippers. I interned at the aquarium to learn as much as I could about the process and to learn from the expertise of those working in the sea turtle rehabilitation program. It is because of Harbor that I conducted this study. With this thesis, I had a unique opportunity to dig into the dynamic field that is sea turtle

rehabilitation. I learned as much as I could from professionals in the field, but I hope that this project will result in more than just my own personal academic growth. I hope that this study may encourage others like it. More networking and protocol analysis can allow for more development in the field. I also hope that this study could spark an interest in the field for anyone who may be new to the topic and happens to come across this paper. I believe that the most effective method for progressing conservation is to generate interest in the field. If this project can generate even a small spark of interest in sea turtle conservation and rehabilitation for a single person, I will consider this project a success.

TABLE OF CONTENTS

TABLE OF FIGURES

INTRODUCTION

Sea Turtle Biology

Earth's oceans house seven species of sea turtle: the Flatback sea turtle (*Natator depressus*), the Olive Ridley sea turtle (*Lepidochelys olivacea*), the Kemp's Ridley sea turtle (*Lepidochelys kempii*), the Loggerhead sea turtle (*Caretta caretta*), the Hawksbill sea turtle (*Eretmochelys imbricata*), and the most commonly known Green sea turtle (*Chelonia mydas*) ("IUCN Red List", n.d.). While each species has its own unique features, the anatomy of all sea turtles is relatively similar. All sea turtles have a head (with a sharp beak), a protective shell, four flippers, and a tail.

Sea turtles can be divided into the hard-shelled group or the leathery-shelled group (Wyneken, 2001). Leatherback sea turtles are the only member of the second grouping, as the 6 other species have hard scale-like features called scutes (Wyneken, 2001). The positioning of these scutes is one of the factors that allows for identification of the individual species. The shell as a whole can be divided into two major parts, the carapace (on the dorsal side, or top, of the turtle) and the plastron (on the ventral side, or bottom, of the turtle) (Wyneken, 2001). The scutes appear on both the carapace and the plastron but are named according to their location on the shell. The principal carapace scutes are the marginal, lateral, vertebral, nuchal, and inframarginal scutes (Wyneken, 2001). The principal plastron scutes are the intergular, gular, humeral, pectoral, abdominal, femoral, and anal scutes (Wyneken, 2001).

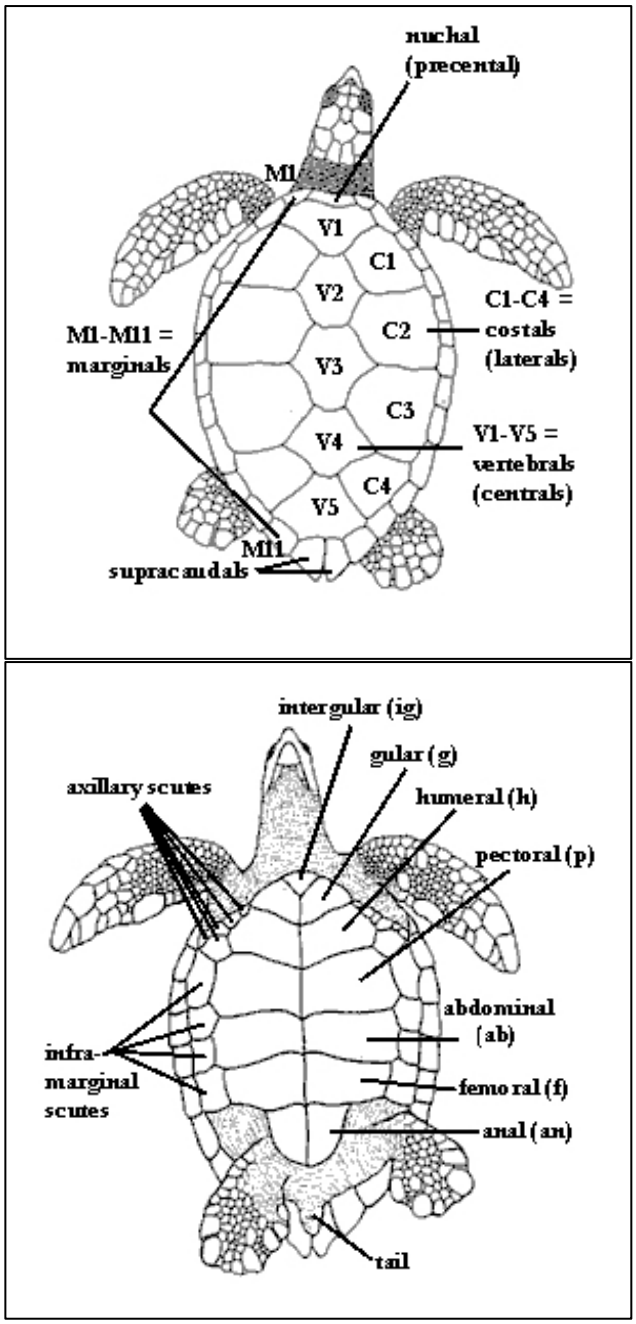

Figure 1. Diagram of scutes and their location on the carapace (top panel) and the plastron (bottom panel). Wider Caribbean Sea Turtle Conservation Network. (n.d.). *Basic Biology of Caribbean Sea Turtles Terminology*. WIDECAST. www.widecast.org/biology/terminology/.

Sea turtles have four flippers, two at the anterior end and two at the posterior end, with the larger flippers at the anterior end. The anterior flippers are used for propulsion while the posterior flippers are used for steering, similar to a rudder on a boat. Each flipper has either one or two claws, depending on the species (Wyneken, 2001). While the obvious purpose of these flippers is locomotion, scientists have recently found that the flippers can also be used to manipulate prey and foraged food (Fujii et al., 2018). In addition to propelling and steering, the newly discovered behaviors associated with the flippers being used for prey manipulation are digging, striking, tossing, leveraging, swiping, holding, pounding, and corralling (Fujii et al., 2018). Some of these flipper movements have been seen before in other well-known turtle behaviors, such as digging nests or striking a predator.

The last major externally visible anatomical features of sea turtles are their skull and their beak. The principal features of the skull are the neurocranium, the splanchnocranium, and the mandible (Wyneken, 2001). The first two terms describe the brain case and upper jaw while the mandibles make up the lower jaw (Wyneken, 2001). These larger features are made up of multiple smaller bones (Wyneken, 2001). The overall shape of the skull varies among species. For example, the Hawksbill turtle has a sharper and more pointed beak than the other six sea turtle species and can be quickly identified upon a quick look at its skull.

Internally, these marine tetrapods are incredibly complex, but they have the same basic systems as other vertebrates. The skeletal structure of marine turtles, which is composed of both bone and cartilage, is made up of the appendicular skeleton, the axial skeleton, and the skull (Wyneken, 2001). Each bone in the turtle falls into one of these

three sections, except for the plastron, which is part of both the appendicular and the axial skeleton (Wyneken, 2001). When one looks at only the exterior of a sea turtle, it may seem that not a lot of the animal actually moves. It is only with an internal look that we can see for ourselves just how much movement occurs with every small movement of flippers, tail, or head. While one vertebra is attached to the carapace, seven other vertebrae are mobile (Wyneken, 2001). This allows for efficient muscular movement in the body and the flippers as the turtle propels itself through the water.

The muscular system of sea turtles consists of the axial muscles, the ventral muscles, the forelimb and respiratory muscles, and the posterior muscles (Wyneken, 2001). These four groups fulfill the muscle functions of flexion (bending movement at a joint), extension (straightening movement), protraction (outward movement), retraction (inward movement), abduction (ventral movement), and rotation (turning movement) (Wyneken, 2001). The turtles' axial muscles reside in the neck (operating the jaws) and the tail, although very little is known about the axial tail muscles (Wyneken, 2001). The ventral muscles can be found underneath the plastron and are involved in locomotion and respiration (Wyneken, 2001). This muscular system is large and spans the width the of the turtle's body. The forelimb and respiratory muscles are nearer to the head of the turtle and lie beneath the turtle's neck and flipper skin (Wyneken, 2001). As the name of their system suggests, these muscles aid the turtle in locomotion and respiration along with the ventral muscles. The posterior muscles are located at the posterior end of the turtle around the rear flippers (Wyneken, 2001). Because these muscles are responsible for controlling the turtle's steering system, if they or the nerves that control them are damaged, the turtle would face serious consequences. While it may survive, life in the

wild without adequate control over trajectory could greatly shorten the lifespan of an individual.

From the day sea turtles enter the world, their life is incredibly difficult. As oviparous reptiles, sea turtles begin their life in an egg buried in the sand on beaches all over the world. Females can lay over a hundred eggs, called a clutch, in one nest (Lohmann & Lohmann, 2006). After two months under the hot sun and warm sand, the hatchlings will dig themselves out of the nest and head towards the water, which they can identify due to the lightness of the oceanic horizon (Lohmann & Lohmann, 2006). Coastal areas with bright lights close to the shore can confuse the hatchlings and cause them to head in the wrong direction. This crawl to the ocean also leaves the hatchlings vulnerable to predation. There is no guarantee of survival for the hatchlings for even a minute after they emerge from their egg.

Once the juvenile turtles make it to the shoreline, they begin the pelagic (open water) phase of their life cycle. The turtles first navigate using the direction of the waves and then are able to maintain a seaward path by using the earth's magnetic field to navigate (Lohmann & Lohmann, 2006). This is an ability they will retain for their entire life. In addition to the magnetic field, the turtles rely heavily on the major ocean gyres to keep them on course. The turtles cannot afford to get lost due to the nature of their reproductive cycle. The young turtles must survive in the neritic zones of the open ocean until they reach sexual maturity (Stubbs, 2020). Periods of intense vulnerability await all surviving turtles as they will wait up to fifty years to become sexually mature (Stubbs, 2020). It is at this time that females migrate to the shores where they themselves were born to lay their own clutch and the cycle begins again.

The habitat of sea turtles changes based on the species of turtle and the age of the turtle (Yong, 2014). Attached trackers to hatchlings demonstrated that juvenile turtles will seek refuge in *Sargassum* clumps (Yong, 2014). *Sargassum*, a genus of brown macroalgae, floats in large clumps at the ocean's surface and provides the turtles protection from the otherwise barren open ocean (Sargassum, n.d.). Except for the turtles' brief periods of life in the *Sargassum* or on the shore, their home is the pelagic zone of the ocean. The water column of the ocean is also known as the pelagic zone and consists of the neritic province that includes waters from the low tide mark to the continental shelf break, and the oceanic province that includes all ocean water that exists past the continental shelf (Britannica, 2020).

Sea turtles fill many necessary ecological niches in ocean ecosystems and different species provide different services to their environment. For example, green sea turtles spend their lives grazing sea grass beds (Wilson et al., 2010). If a sea grass bed becomes too dense, it could severely decrease the amount of sunlight that the species within the Sargassum see. This means that the biodiversity of photosynthetic organisms in this ecosystem could decrease or disappear altogether. In their place, sea slime molds could overrun the remaining, thickened sea grass beds. The actions of green sea turtles grooming the sea grass beds helps maintain the health and biodiversity that are crucial to this ecosystem (Wilson et al., 2010). Hawksbill turtles also fulfill a specific ecological niche. Similar to the green sea turtles, the hawksbills also act as gardeners in their habitat. Hawksbill turtles commonly feed on sea sponges that are capable of taking over valuable rock space for many different species of corals (Wilson et al., 2010). By keeping the sea sponge populations at a biologically manageable level, the turtles are protecting the

incredibly complex coral reef biodiversity that makes up one of the most beautiful ecosystems in the world.

Sea Turtle Conservation

Knowing the important roles sea turtles play in the world oceans creates solid evidence as to why we as humans need to try and protect their populations. As long-lived species that migrate over great distances, individual sea turtles may face innumerable threats and dangers for over a century. In addition to overharvesting and illegal harvesting (international trade in sea turtles is banned by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)), some of the most common causes of injury or illness in sea turtles are ingestion of plastics or other non-naturally occurring materials, entanglement in fishing gear, exposure to crude oil, trauma, exposure to extreme temperatures, and many different diseases (Orós et al., 2016).

Exposure to extreme temperatures has become a more common problem for sea turtles over the years due to changing climate. The phenomenon that occurs from these changes is called a cold stunning event. The event begins when the seasonal temperatures in the fall drop slower than normal (Griffin et al., 2019). The turtles do not begin moving south early enough in this instance and they become trapped in cold, and quickly cooling, ocean waters (Griffin et al., 2019). This is especially a problem in Cape Cod Bay, where the Cape acts like a wall for turtles trying to get to warmer southern waters. The turtles that become stuck in the cold-water contract severe cases of hypothermia and later pneumonia (both of which prove to be fatal) (Griffin et al., 2019).

Some of the problems are inherently easier to combat than others. For example, it is much easier to regulate fishing gear to be sea turtle friendly than it is to regulate the

global climate crisis that is responsible for the massive cold-stunning events occurring in northern temperate waters. Conservation professionals have been fighting the issues that they can as fast as possible. One of the ways sea turtle populations are being protected is through set conservation guidelines and legislation. The International Union for Conservation of Nature (IUCN) Species Survival Commission (SSC) is one group that has tackled the creation of set guidelines. The 232-page document outlines seemingly every possible scenario affecting sea turtles and offers credible solutions that can be implemented now and in the future. The more people that follow researched guidelines like the IUCN/SSC guidelines, the better chances sea turtle populations will have of recovery.

Sea Turtle Rehabilitation

One component of conserving sea turtle populations is to rescue and rehabilitate individuals that become injured or ill. The rehabilitation process for a turtle begins when it is found either floating at the surface or stranded on the shore. Stranded turtles are often found by the general public in the United States' many coastal areas. After a call has been made that a turtle has been found, it is either picked up or taken to the nearest facility capable of triaging the turtle. The triage protocol for incoming individuals differs by facility, but some general procedures are almost universally followed. For example, the very first step for every turtle admitted to a rehabilitation facility is a basic medical exam. Upon intake, aquarists and biologists will measure and record the turtle's body weight, visually examine the entire exterior of the animal, and provide fluids (Sturgeon, 2019). These three basic procedures provide the basis for every single turtle's continued rehabilitation. The body weight allows caregivers to track growth increases or decreases

and determine a diet plan for the remainder of the rehabilitation process. The visual exterior examination allows for the most emergent and critical issues to be stabilized. This immediate attention greatly increases the turtle's chances of survival, just as going to the emergency room after a car accident increases a human's chance of survival. Providing fluids to the turtles (rehydration) is the first step in restoring their internal health before any in depth tests have been run.

One can infer from the description of the first step of rehabilitation for turtles that a large quantity of materials, time, and space are essential to the successful mass rehabilitation of turtles. The rehabilitation of sea turtles in the United States is closely regulated and monitored by the federal government's Department of the Interior's Fish and Wildlife Service (FWS). The FWS determines for all rehabilitation facilities exactly what they will need to supply in order to receive a permit to operate. They also stipulate the rules to be followed regarding transportation of the turtles, tank size requirements, tank condition requirements, lighting, water quality, water quantity, diet and feeding of the turtles, intermixing of different turtle species, veterinary care, euthanasia, and eventually protocols for release ("Standard Permit Conditions", 2013). Every single rehabilitation program in the United States uses these federally mandated protocols as the baseline for each new protocol they might create.

With a large amount of the rehabilitation process predetermined by the government, how different can one rehabilitation facility be from another? Even with predetermined regulations, the facilities still differ in their approaches and activities. This is because the regulations outline the bare minimum that must be followed by each facility. There is no limit to the expansions a facility can create on those base measures if

they have the space, money, and materials required. As different rehabilitation centers receive funding, they can address existing problems that may not have defined solutions.

Different facilities become better suited for different types of rehabilitation as they gain experience. A small coastal rescue center (such as the Georgia Sea Turtle Center or the Massachusetts Audubon Wellfleet Bay Center) is most likely the first place a newly stranded turtle will be taken. Centers like these are often smaller and more common in a given geographical area so that the travel time for a critically injured turtle is kept as low as possible. The main concern of centers like these is that the quicker a turtle can receive basic care, the more likely it is to survive. In contrast, larger aquarium facilities (including the Pittsburgh Zoo and PPG Aquarium or the New England Aquarium's Quincy Animal Care Center) are few and far between. But these facilities can offer a wider variety of treatment and rehabilitation due to their larger amounts of space available for animal care.

The diversity seen in these facilities alone suggests how rehabilitation protocols and research can quickly become messy and chaotic. Many methods used by rehabilitation facilities up and down the east coast have not been officially published by their creators. This essentially means that the only way to advertise and pass along these newer ideas and approaches is by word of mouth. The more communicative a rehabilitation facility is, the more successful rehabilitation cases they will have. Creativity and an open mind to new methods are what truly push major advances in animal rehabilitation science. Care givers never know if something new could work until they decide to try it. Open information and a large network are crucial to advances in sea turtle conservation.

Research Significance and Goals

In order to continue high quality of care and create progress in the field, conservation and rehabilitation specialists must maintain open communication. One major component of a large and open communication network is the availability of information to society. There are two major reasons for the importance of making information available. The first reason is that the faster a rehabilitation center can find new successful methods, the sooner they can begin trying those methods on their own patients. This goes back to the importance of shortening the process of rehabilitation to increase each individual's chance of survival. The second reason is that easily available information allows people without direct involvement in a rehabilitation center to get involved. As more people express interest in the field, monetary donations to the cause will increase, attention in preventing turtle injuries and assisting stranded turtles will increase, and the rehabilitation center network can be expanded. The larger the rehabilitation network becomes, the more turtles that have a chance at survival.

It is easy enough to say that society should draw its attention to sea turtle conservation and to preach the importance of saving these animals. But saying that something needs to happen is not enough to amass a large following and a great deal of monetary support. The actual, and tangible benefits of sea turtle conservation efforts must also be acknowledged and well-advertised. In order to understand the positive effects of sea turtle conservation, it is also important to understand the risks of losing the species. Sea turtles provide essential functions for the marine ecosystems they inhabit.

To prevent the drastic changes that could be caused by the disappearance of sea turtles, attention must be drawn to the rehabilitation of these animals. By interviewing

multiple rehabilitation facilities located along the east coast of the United States, I aimed to gain perspective on how to create efficiencies and promote effective practices. By comparing the specific protocols used by different institutions, I hoped to identify common themes that could allow standardization of more complex protocols not defined by federal government regulations. Analysis of the present protocols used by different institutions and smaller centers allows for a possible standardization of the more complex procedures that do not have previously set conditions by the federal government. Drawing the public eye to the cause of rehabilitation and conservation can generate a significant growth in resources, both physical and monetary. The preservation of these species is crucial, and all steps must be taken to ensure their survival. The goal of this thesis research is to provide a foundation for both analysis of these protocols as well as creating interest in the field from the general public.

In order to spark my own thinking, I conducted a mini review to determine what research regarding sea turtle rehabilitation has already been conducted. I used the information that I found in the papers to create interview questions that address any holes or misconceptions. The aim of this mini review is to bridge the gap between studies done in the past and the practices that are currently occurring in rehabilitation facilities across the east coast of the United States.

"Ameliorating transport-related stress in endangered Kemp's ridley sea turtles (*Lepidochelys kempii*) with a recovery period in saltwater pools"

I chose to analyze this study by Hunt et al. (2019) due to the discussion of stress and rehabilitation. Very early in my own career, I was taught by all of my superiors to reduce stress for all animals as much as possible. But to a point, stress is somewhat unavoidable. The most important part of sea turtle rehabilitation is the turtles' release, which unfortunately can be a very stressful process for the turtles. The turtles often times have to travel large distances out of water in order to reach a safe place for their release (Hunt et al., 2019). The study focused on how common stress indicators in the blood, such as corticosterone and glucose levels, changed from the start of a transport journey to the end of the saltwater treatment after transport. After taking blood samples from the turtles at three different stages of transport, the researchers found that the stress indicators had risen significantly since their pre-transport tests. They also found that a 6-hour period

in a saltwater pool post transport assisted in lowering stress in the turtles, although a normal, pre-transport level of the stress indicators in the blood was never achieved.

After reading this paper, I had several questions regarding rehabilitation as a whole. First, can it be confirmed that the turtle's pre-transport stress indicator levels are actually indicative of low stress? Second, is rehabilitation as an entire process stressful to the turtle? Third, how do these levels of indicators in the blood compare between turtles in rehabilitation and turtles in the wild? From these questions, I determined that I wanted to focus on how stress is present in turtles during rehabilitation when creating my interview protocol.

"Warming seas increase cold-stunning events for Kemp's ridley sea turtles in the northwest Atlantic"

Over time, the numbers of turtles that are found cold stunned in Cape Cod Bay has steadily increased (Griffin et al., 2019). The authors of this paper discovered that these increased strandings can be attributed to the changing climate, specifically the pattern of warming sea surface temperature in the Gulf of Maine (Griffin et al., 2019). The researchers compared sea turtle stranding data to sea surface temperature (SST) data in order to determine if there were patterns in the increasing number of cold stuns and the current environmental changes. The team used different statistical models such as random forest models and Bayesian count models to obtain their results. By running these models, the researchers were able to predict that the Kemp's ridley turtles will reach an average number of 2,349 cold stunned individuals for the year 2031 based on the current SST increases (Griffin et al., 2019).

After reading this paper, I wonder how much this problem affects all rehabilitation facilities (not just facilities in the northern United States). From my own previous experience, I know that as facilities become overrun with mass stranding turtles, they may send stabilized turtles to other facilities for continued care. Are southern facilities prepared to deal with these sudden intakes if the northern facilities require assistance? In regard to the previous paper, Hunt et al. (2019), how does this turtle exchange affect the turtles' stress? Due to the fact that these environmental changes cause an increase in cold stunning, and it will be a continuing problem, I included questions in the interview protocol that address each institution's preparedness for these types of emergency situations.

"Sea turtle rehabilitation success increases with body size and differs among species"

The researchers in this study attempted to quantify the success of sea turtle rehabilitation by tracking the mortality rates of intake turtles in different Florida rehabilitation facilities (Baker et al., 2015). Interestingly, they found that a high mortality rate occurred in these facilities overall, but that different species had higher rates of survival. Loggerhead sea turtles were the most likely to survive, followed by Kemp's ridley sea turtles and Green sea turtles (Baker et al., 2015). The study also focused on the fact that the benefits of sea turtle rehabilitation are not solely to increase sea turtle population numbers, but also to create an interest and a following in conservation.

Upon reading this paper, I noticed several things that may have been overlooked. One thing is that this paper attempted to quantify the success of sea turtle rehabilitation as a whole by looking at only a singular region of the United States. The problems that a sea

turtle rehabilitation facility commonly encounter most certainly change by region. To confirm this idea, I created questions in my interview protocol that determine the most common illnesses, diseases, and injuries at each facility. The one thing I did really support in this paper was its focus on the importance of conservation education. The authors noted that even if an individual turtle's medical story was not a success, the information that people gained from being involved in the process is invaluable. I decided after reading this paper that I wanted to give a large portion of my focus to the role all people play in sea turtle rehabilitation. I created interview questions that explored how involvement from the general public and marine science/ biological science undergraduates can assist in promoting and advancing sea turtle rehabilitation and conservation.

METHODS

In order to gain a more comprehensive understanding of the methods used by sea turtle rehabilitation facilities and the career possibilities in sea turtle conservation, I interviewed representatives from three different sea turtle rehabilitation centers using a common set of questions and a procedure that was approved by the University of Maine Institutional Review Board.

Interview Protocol Creation

I created the interview protocol from both my own personal previous knowledge on sea turtle rehabilitation and the research done for this thesis (see Case Studies above). The protocol features four sections of questions; background questions, facility-specific questions, rehabilitation protocol questions, and wrap up questions (see Appendix 1). Using the background questions, I aimed to collect career details about the facility representative participating in the interview for the purposes of creating the Career Spotlight chapter of this thesis. For the second section, I asked facility-specific questions to establish the location and size of each facility, as well as the species of sea turtle they most frequently worked with. The rehabilitation protocol questions had two goals. The first goal was to collect the rehabilitation methods that have been or are currently in use at each facility. The second goal was to gain each representative's thoughts and opinions on the effectiveness and efficiency of the methods they use. The wrap up questions were written with multiple purposes in mind including prompting discussion of current events and the changes they cause in a "normal" set of protocols, determining what allows for a successful rehabilitation program, and how sea turtle rehabilitation can be furthered. The

entire protocol allows for a comprehensive analysis of information that may or may not be published. Some methods are commonly used among multiple facilities, but are only known through networking among those facilities. Because rehabilitation and conservation are fields that are becoming increasingly dependent on networking, the questions were created to prompt thought and discussion while bringing potentially new information to light.

Conducting Interviews

The first step in conducting the interviews with facility representatives was to get project approval from the Institutional Review Board (see Appendix 2). Following approval from the Institutional Review Board, I sent recruitment emails to six different sea turtle rehabilitation facilities. Three responses for participation were received. I conducted the interviews with each facility representative via Zoom, a professional video chat application. All interviews lasted between twenty-five and sixty minutes and followed the order of questions indicated in the interview protocol (Appendix 1). With participant permission, the recorded interviews were saved to the University of Maine's encrypted Google system.

Interview Analysis

I uploaded the interview recordings to Otter.ai transcription in order to create the first transcript of each interview. I then edited each transcript to accurately match each interview recording and to remove personally or institutionally identifying information. In order to make comparisons across the interviews, I used an Excel spreadsheet to record the key points of each participant's responses to the questions. After each interview was concluded the transcript complete, the answers to each question were typed in the code

sheet to allow for easy comparisons. Both the code sheet and the interview transcripts were used for analysis in the results and discussion. The recordings of the interviews were deleted immediately after the completed transcripts were reviewed for accuracy. Each institution was assigned a number in order to maintain confidentiality. They will be referenced as Facility 1, Facility 2, and Facility 3 throughout the results and analysis.

RESULTS AND DISCUSSION

Quantitative Interview Data

The three interviewed facilities all varied in size and location in the United States. Quantitative descriptions for the facilities can be created by identifying their size and location. From these quantitative descriptions (Table 1), it is easier to infer why each facility utilizes certain protocols.

Facility	Species Rehabilitated	Maximum Facility Capacity	Average Annual Number of Intakes
1	Kemp's Ridley, Green, Loggerhead	14	14-17
2	Kemp's Ridley, Green, Loggerhead, Flatback, Olive Ridley, Hawksbill, Leatherback	Normal: 30 Mass Stranding Events: 70-90	100+
3	Kemp's Ridley, Green, Loggerhead, Leatherback	325	350

Table 1. Facility statistics including the species they rehabilitate, their maximum turtle capacity, and the average number of turtle intakes.

Based on the metrics in Table 1, Facility 1 is the smallest rehabilitation program, Facility 3 can be defined as the largest rehabilitation program, while Facility 2 handles the greatest diversity of sea turtle species. These statistics contribute to factors such as the amount of standardization in their protocols or the chances of encountering mass stranding emergencies at each facility. All facilities interviewed currently rehabilitate or

possess proper permits to rehabilitate Green sea turtles, Kemp's Ridley sea turtles, and Loggerhead sea turtles. Leatherbacks are able to be rehabilitated at two of the facilities interviewed but have only been rehabilitated in actuality by one facility. Olive Ridley's, Flatbacks, and Hawksbills are able to be rehabilitated at one facility. Note that not every rehabilitation facility rehabilitates or is able to rehabilitate every species of sea turtle. This is due to both the aforementioned permitting restrictions by the United States federal government as well as the geographical locations of the facilities. The east coast of the United States has both temperate and subtropical waters, so the species of sea turtle that commonly appear on the coastlines differ according to latitude.

The average annual number of intakes is just above the maximum capacity for all three facilities. While each facility has the ability to reach full capacity in the event of a mass stranding, they will not remain at this capacity year-round. As mass stranding turtles are released, spots open for new turtles. Also, not all cases require a full year of rehabilitation, while others may take longer. This allows for fluctuations in the total intake values by year. In years where coastal weather patterns see major fluctuations, more intense cold stunning events occur. This in turn leads to a large increase in intake numbers and these facilities more likely will reach maximum capacity.

Each facility was asked to identify the most common injuries and illnesses seen in their intake turtles (see Figure 2). The answers scored in Figure 2 do not cover all illnesses that these facilities currently see or have previously seen, only the most common. There are a multitude of other various injuries and illnesses that could appear in a turtle in need of rehabilitation.

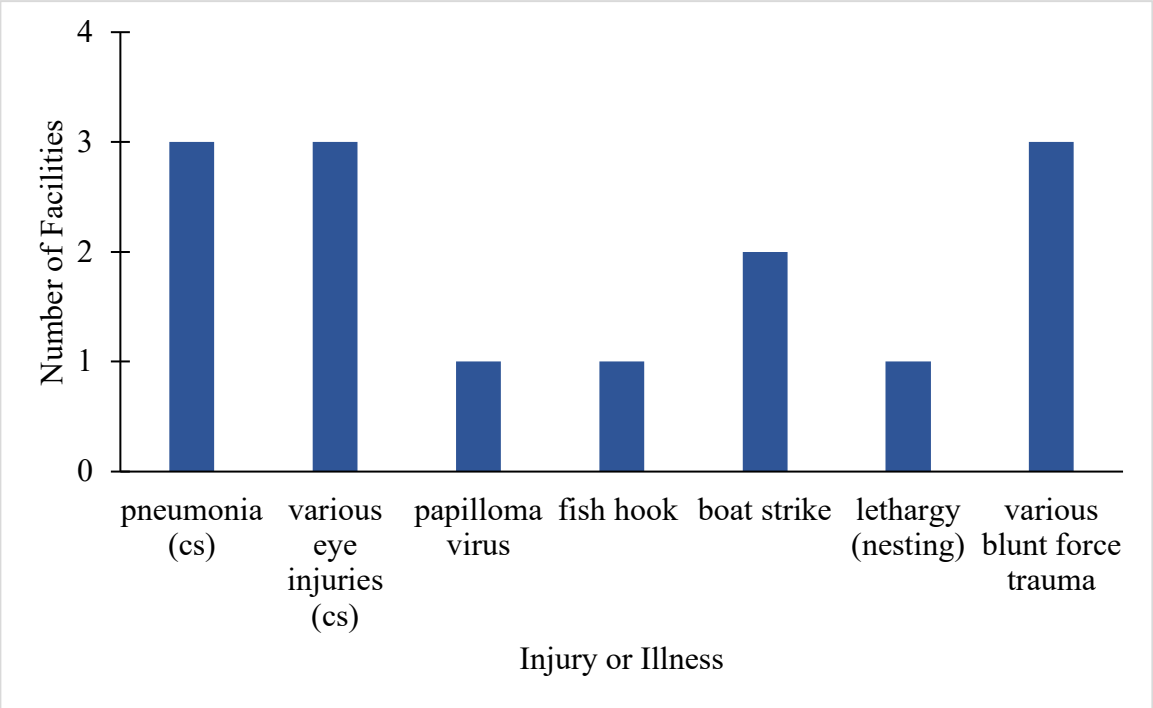

Figure 2. The most common illnesses identified by each facility scored by the number of facilities that named them. "(cs)" stands for cold stun and indicates that the injury or illness was precipitated by a cold stun event.

All three facilities interviewed commonly dealt with victims of cold stun events, so they consequently all deal with multiple types of pneumonia as well as various eye problems such as osteomyelitis and retinal tears. The illnesses and injuries treated by these facilities vary with season. For example, recreational boating increases in the summer which in turn leads to an increase in boat strike victims. In addition, cold stun victims are often part of mass strandings that occur around November, so injuries and illnesses caused by cold stunning are increasingly more frequent in the winter months. Various other injuries can occur year-round, but do not occur with enough frequency to be considered as most common by the representatives interviewed. Finally, the descriptors of each facility's maximum capacity and average number of intake patients help to define the turnaround time for rehabilitated turtles. A smaller facility, for example, may see a longer average

turnaround time for their patients because they will intake fewer turtles. They will see fewer cases with quick turnaround because the turtles that require long term care will be holding the available spaces.

Qualitative Interview Data

For the purposes of this research, I have categorized sea turtle rehabilitation into short term and long-term rehabilitation. Short term rehabilitation consists of rehabilitation cases that reach completion from either release or death in under four months. This mostly includes triage work or giving treatments to a patient that will see a quick turnaround. Examples include lethargy from nesting and hypothermia from a cold snap. Long term rehabilitation consists of treating for major infections and injuries that cause a turtle to remain on the unreleasable list as defined by the Department of the Interior for more than 4 months. Examples include extreme pneumonia, boat strikes, and paralysis. All three facilities interviewed participate in both short term and long-term rehabilitation efforts, although two facilities see a greater percentage of triage work.

When asked about determination of a line of care for new patients, several patterns emerged in the facilities' protocols. All facilities begin the rehabilitation process with a full exam (internal and external) of the turtle. After that, all turtles receive fluids of some sort. Two facilities stated that all turtles receive an antibiotic cocktail (if needed) to fight off any emerging diseases as well as vitamins to aid in proper nutrition. One facility gives the vitamins to all turtles except for loggerheads, who are often able to stabilize themselves and do not require immediate injections. While all facilities said that they provide the vitamin cocktails, the vitamins in the injections do differ among the three. After the basics have been met, some facilities continue care in the forms of tracheal

washes, MRI scans, glucose checks, deep water therapy, tube feeding, nebulizing, and other various treatments. The variance from the most basic protocols depends on the funds and materials that each facility has on hand at the time of rehabilitation. The practices that each institution has access to varies according to the location, the size of the program, and the amount of funding.

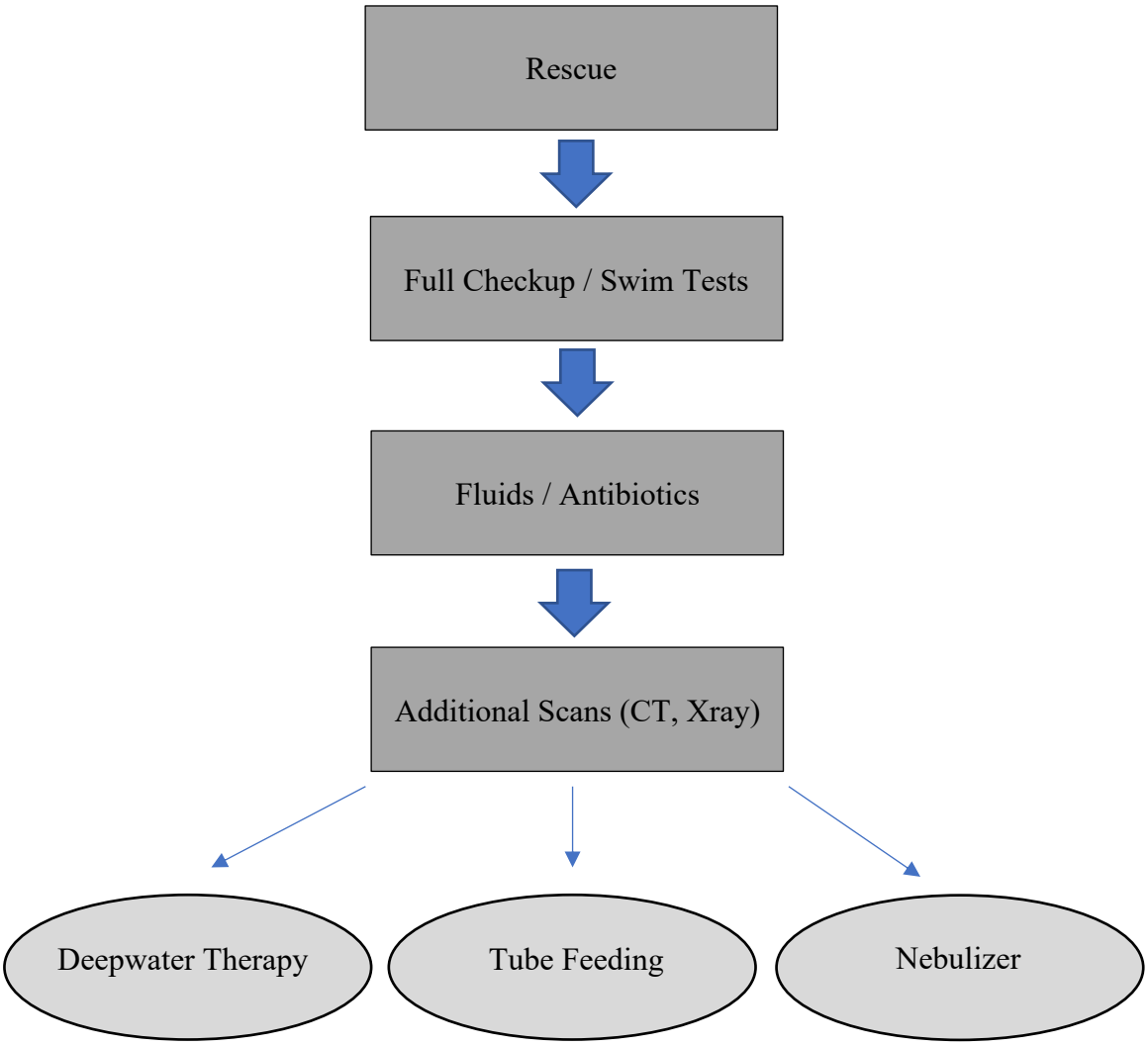

Figure 3. Flow chart of a likely line of care for incoming turtles based on interview responses from all three facilities. Rectangles indicate the common standard protocols followed, and ovals indicate optional practices that are used on a case-by-case basis. Not all of the practices listed in ovals are used consistently by all facilities.

Figure 3 illustrates a basic rehabilitation protocol created from similarities among the three institutions' protocols for incoming turtles. Deepwater therapy, tube feeding, and treatment with a nebulizer are all examples of practices that occur outside of the most basic standardized protocols. Not every turtle will receive or require these forms of care. These practices, although in the same line of the flow chart, may not occur simultaneously. Once deviations from the basic standard protocols take place, the care is typically administered based on a turtle's individualized timeline. The deviations from standard practice are critical to the development of new ideas, the discovery of new results, and solidifying advancements in the field. As one facility representative stated, "[Flexibility] is one of the things that I really try to instill in my employees, not trapping themselves in that box where we have to do X, Y, and Z on every animal that comes in". The other two facility representatives agreed that remaining in the mindset of addressing problems on a case-by-case basis is essential both to learning and to giving the best care possible to patients. While a standardized protocol is an effective and efficient place to start, no facility representative supported the notion that a rehabilitation protocol should be permanent without subject to change.

The importance of flexibility in rehabilitation protocols was also heavily emphasized by each of the representatives across the board through multiple examples. For two facilities, the representative's most difficult cases were ones in which they had to adjust a current protocol to reach a successful outcome. One facility had to adjust a tube feeding protocol to handle a 300lb turtle. The current tube feeding protocol at the time was for smaller turtles and would be impossible with a turtle of this size. A new structure had to be built by the rehabilitation team in order to ensure both the team and the turtle's

safety while providing care. A second example that emphasized the need for flexibility involved a change to a tank design. One facility had a particularly weak turtle in their care and the caretakers unfortunately came in one morning to find that it had drowned and was stuck in the water intake of the tank. The major problem with this situation is that it was impossible to determine what the cause of the drowning was. Was the turtle sucked into the intake and then drowned? Or did it drown due to its weakness and then get sucked into the intake? Either way, in order to ensure that the question never had to be asked again, the facility designed a new water intake system that prevents the turtles from getting stuck. If a turtle gets too weak, it may still unfortunately drown, but now the cause of being sucked into an intake pipe can be ruled out. Flexibility and problem solving in these situations are absolutely crucial in maintaining safe environments for all turtles in rehabilitation as well as for developing new methods and expanding the field of rehabilitation as a whole.

Flexibility is also integral when thinking about the current problems that the world is facing. Two major problems today are climate change and the SARS-CoV-2 pandemic. Climate change is known to cause major fluctuations in local weather patterns, which in turn leads to mass stranding events. These are called cold stun events and result in rehabilitation facilities across the United States being inundated with hundreds to thousands of turtles. This was most recently seen when a severe cold snap hit the state of Texas with full force (e.g., https://www.npr.org/2021/03/13/976105783/texas-cold-stun-of-2021-was-largest-sea-turtle-rescue-in-history-scientists-say). Thousands of sea turtles were found cold stunned and in need of rehabilitation. I asked the facility representatives if, in the face of climate change, they were making preparations to be on top of these

highly likely mass stranding events. One facility, which handles a majority of mass stranding turtles above all other cases, said that their protocols are continuously being evaluated based on predictions regarding mass stranding. In the face of climate change, rehabilitation facilities are in fact stepping up to the challenge of proactively developing measures and protocols. SARS-CoV-2 is another major global challenge that is severely impacting worldwide conservation efforts. The challenges presented by the pandemic were seen to different degrees across all three facilities. One facility found that while decreased staffing was a hurdle, many of their practices were able to continue as before the pandemic. Another facility mentioned that they were only able to accommodate half as many turtles as they usually take. A third facility, however, saw completely unexpected results from their changed procedures. The facility was expecting to see approximately a 40% mortality rate among incoming turtles due to the lack of staff and lack of time. They were forced to develop a more streamlined procedure for caring for the turtles and were shocked to find that it was more effective than originally thought. The eventual mortality rate was only 12%, perhaps due to reduced handling. In the face of these results, that institution is now re-evaluating their current normal protocols to see which procedures will be continued into the future and which procedures will be retired. This example again reinforces the importance of flexibility and open-minded thinking in rehabilitation.

In the interviews, I also asked each institution to self-evaluate their own specific protocols and comment on which of their past and current methods they believed was most effective, which was least effective, and the pros and cons of those methods. The answers for most effective methods included maintaining a minimal rehabilitation time

(meaning the turtle is in the rehabilitation center for as little time as is necessary), providing adequate sunlight and vitamin D, using lettuce feeders or other benthic feeders, and "swimming" the turtles. Maintaining a minimal rehabilitation time means that the turtle is in the rehabilitation center for as little time as is necessary. The facility representative who noted this practice explained that the turtles can start getting additional health issues from being kept in small tanks with other turtles for long periods of time. If turtles are kept in a small space with each other for too long, they will often show aggression towards each other begin to exhibit signs of stress. Getting the turtles quick help and then releasing them has been helpful to each of these institutions in maintaining the maximum health possible. The other facilities agreed with this assessment when asked how they felt about the effectiveness of a minimal rehabilitation stay.

The lettuce and other benthic feeders have been most effective in multiple institutions because they encourage the turtle's natural behaviors and help strengthen them for release. Sea turtles spend a large majority of their time foraging or hunting or a mixture of both. In order to be released, turtles need to prove that they both have an interest in and are capable of obtaining food in their natural habitats. Benthic feeders, which anchor food to the floor of the tank, encourage the turtles to forage as they would in the wild. It must be noted that while this practice has the potential to be effective, it is only effective when it works as planned. Often times, the turtles will pull out the lettuce and allow it to float to the surface where it is easier for them to eat. This means that the feeder is no longer encouraging natural behavior and the benefits to the turtle may be reduced. The last most effective method named was the practice of swimming the turtles,

which means supervising a cold stunned turtle as it swims in a shallow pool and waiting until it starts to get some of its motor functions back. This is a method to allow the turtle to come out of a hypothermic state with the least amount of stress possible while also preventing drowning and maintaining its safety. While this method aims to mitigate stress as much as possible, there is still stress involved. Handling of any type can cause stress in sea turtles, and assisted swims are not exempt. However, the pros heavily outweigh the cons in this situation which is why the facilities cite it as an effective practice.

The least effective methods named by the institution representatives were hand feeding whole food in place of tube feeding and the use of carapace weights in bubble butt cases. The method of handfeeding whole food in the place of tube feeding was intended to increase nutrient intake by the animal but was found to cause too much stress for the practice to be at all beneficial. In the wild, turtles eat a variety of high nutrient items depending on their species. On land, the variety of food resources (sea grass, jellyfish, etc.) that can be obtained by rehabilitators from the oceans is limited. Diet replication with more accessible items is integral for maintaining a turtle's health. A new, higher nutrient tube feeding blend was created to mitigate this problem when handfeeding whole food was unsuccessful. The carapace weights were deemed least effective by multiple facilities for different reasons. One facility said that the weights are difficult to keep in place and often require stressful handling in order to get them in a stable position. A second said that after studying scans of the turtles' lungs, they found that the weights changed the structure of the turtle's lungs over time. When the weights were removed, the lungs went back to their original shape. This facility also noted that they observed no progress in rehabilitation from the practice.

Lastly, I asked each institution representative how their own personal views regarding the field of rehabilitation have changed over the course of their careers. The results were remarkably similar among the three representatives. All three said that they have, in many ways, learned to approach rehabilitation with a higher degree of realism. They expressed that everyone enters the field of rehabilitation wanting to save every animal that comes through the door. They also expressed the harshness of coming to the conclusion that such a successful outcome will never be possible. While it is never possible to save every turtle, the efforts of rehabilitation can be very effective to sea turtles as a whole. One representative said that, in regard to changing views, “You do learn that it is way more important to take what you can do and do the best you can rather than focus on what you should be doing”. Sometimes, the method that may be proven most effective is not accessible. It is important not to get caught up in the mindset that inaccessibility is a dead end, when in actuality it is an opportunity to get creative and find new solutions. Another representative said, “looking back at when I first got into this, you know like anyone else, you're so excited! You want to save everything and anything by whatever means necessary. But I think over time and learning, you realize you have to do the best you can with what you have and that is good enough”. The importance of remembering what you can do is what keeps rehabilitation efforts moving forward.

CONSERVATION CAREER SPOTLIGHT

After each institution representative answered the questions in the interview protocol regarding their facility and their facilities' rehabilitation protocols, they responded to questions about their past experiences and how they entered the field of sea turtle rehabilitation. This information amalgamation now acts as career advice for any individual who wishes to work in sea turtle conservation or sea turtle rehabilitation. While the stories of each individual differed from the others, one common factor is that all of the representatives majored in marine biology for their undergraduate degrees. Majoring in marine biology, or even general biology, teaches the scientific fundamentals necessary for pursuing careers in rehabilitation and conservation. While lab skills or medical knowledge can be acquired in other ways, it is most certainly a leg up to have acquired these skills while attaining an undergraduate degree. These are, however, only some of the skills that will be eventually necessary in jobs of this nature. But none of the representatives had prior specific sea turtle rehabilitation training before they entered the field. Most of the knowledge they now hold, they gained through work experience. This is a unique part of conservation and rehabilitation careers. No matter how much a person learns ahead of time from the books, no information will be more valuable than that which you gain through experience.

And experience is the major key to creating a successful career in rehabilitation and conservation. Each representative emphasized the importance of getting involved. From volunteering at an aquarium that participates in rehabilitation and conservation, volunteering for stranding networks, even working in a vet clinic, every experience builds

an internal bank of applicable knowledge that allows for career success. Volunteering is a very flexible way to get involved in the field because the commitment is less than interning or working for an institution. It is almost like the entry level position to the field. Interning is the more efficient entry level position for career advancement, but it is an option with more difficulties associated with it. Internships in animal husbandry and conservation are typically unpaid positions, leaving them almost a luxury. Very few students emerging from their undergraduate studies loaded in student debt can take the time or money to commit to an unpaid position. Luckily most programs do not offer full time positions, so paid work can be obtained at the same time. While the information learned is absolutely invaluable, there are most certainly pros and cons to taking this path.

No matter what step in the process of attaining a long-term conservation position a person finds themselves on, remaining involved is also crucial to the process. Staying up to date on current events and the current state of conservation can prove helpful later on. Paying attention to the social media feeds of accredited institutions and rehabilitation facilities can allow both for learning opportunities as well as potential employment opportunities. There is no single correct way to be involved in rehabilitation and conservation. The field itself is incredibly dynamic and the only way to prepare for a dynamic field is to commit to both keep an open mind and to learn as much as possible. The path taken to achieve these positions is not set in stone. It is important to remember that all experience is valuable experience. And even the most unconventional of paths has potential to lead to a successful, rewarding, and meaningful career in sea turtle rehabilitation and conservation.

CONCLUSION

The field of sea turtle rehabilitation will always remain a dynamic field. Both new problems and new solutions arise consistently over time. An open mind is necessary to continue advancing in this area. While a standardized protocol is a helpful starting place for all rehabilitation centers, it cannot be the sole method of rehabilitation, as supported by all three participating rehabilitation institutions. It must also be noted that a realistic mindset regarding rehabilitation is necessary to achieve maximum success. In a world where money and resources are not infinite, hard choices must be made in determining which patients receive certain care. It is integral to remember that rehabilitation aims to benefit sea turtles and marine ecosystems as a whole as opposed to the benefit of the individual. Do what you can, with what you have, to save as many turtles as possible. This mindset applies to all people, not just those employed in the field of rehabilitation. Everyone can help the effort of sea turtle conservation by learning about the problems and spreading the message. The future advancements in sea turtle rehabilitation as well as the interest of the general public are the two biggest tools available for protecting the beloved sea turtle.

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APPENDICES

APPENDIX 1

Interview Questions

Background:

- What is your title? How many years have you been at this facility?
- What is your degree?
- How did you get into sea turtle rehabilitation? Did you receive any specialized training prior to working in the field?

Your Facility:

- How long has your facility been in operation?
- What species of turtle do you rehabilitate?
- Do you take part in short term rehabilitation/ critical care, long term rehabilitation, or both?
- How many individuals can you care for at one time?
- How many individuals do you rehabilitate per year?
- How / from where do you receive patients?
- Any other questions/ clarifications that result from the discussion.

Protocols:

- What are the most common illnesses / injuries in the turtles you receive?
- What is the process you go through in determining the proper line of care for a new turtle?
- What methods of rehabilitation are commonly used at your facility regardless of success rates for short term rehabilitation / critical care? Explain.
- What methods of rehabilitation are commonly used at your facility regardless of success rates for long term rehabilitation? Explain.
    - Benthic feeders, pelagic feeders, ice treats, carapace weights, deep water therapy
- Which of the above methods do you believe to be most effective? Least Effective? (Ranked) Why?
- What are the pros and cons of each method?
- If known, approximately how many cases have you dealt with using each of these methods?
- Can you give me an example of a specific case that changed how you approach a certain problem?
    - A newly discovered method, an idea that worked when it was completely unexpected: what changed the game?
- What was your most difficult case and why?
- What have you learned over the years in regard to protocols and methods? Have any of your thoughts/opinions changed over time?

Wrap Up:

- What advice would you give to an undergraduate student or anyone who wants to become involved in rehab, both career and hobby/ charity

- What do you think is the best way to get the public interested and involved in sea turtle conservation?
- How can people help? What does your facility need most from the public?
- Do you feel there is a need for more rehabilitation facilities?
- If it was not already covered, how has Covid-19 changed protocols and rehab efforts? Pros and cons of changes if they are present?

APPENDIX 2

APPLICATION FOR APPROVAL OF RESEARCH WITH HUMAN SUBJECTS
Protection of Human Subjects Review Board, 400 Corbett Hall

PRINCIPAL INVESTIGATOR: Kelsey Davis — **EMAIL:** kelsey.e.davis@maine.edu
CO-INVESTIGATOR: — **EMAIL:**
CO-INVESTIGATOR: — **EMAIL:**
FACULTY SPONSOR: Dr. Sara Lindsay — **EMAIL:** slindsay@maine.edu
(Required if PI is a student):
TITLE OF PROJECT: Compilation and Review of Sea Turtle Rehabilitation Protocols and Conservation Career Guidance from Conservation Professionals Across the Eastern United States
START DATE: 02/16/2021 **PI DEPARTMENT:** Marine Science

STATUS OF PI: FACULTY/STAFF/GRADUATE/UNDERGRADUATE U (F,S,G,U)

If PI is a student, is this research to be performed:

- ☒ for an honors thesis/senior thesis/capstone?
- ☐ for a doctoral dissertation?
- ☐ other (specify)
- ☐ for a master's thesis?
- ☐ for a course project?

Submitting the application indicates the principal investigator's agreement to abide by the responsibilities outlined in Section I.E. of the Policies and Procedures for the Protection of Human Subjects.

Faculty Sponsors are responsible for oversight of research conducted by their students. The Faculty Sponsor ensures that he/she has read the application and that the conduct of such research will be in accordance with the University of Maine's Policies and Procedures for the Protection of Human Subjects of Research. REMINDER: if the principal investigator is an undergraduate student, the Faculty Sponsor MUST submit the application to the IRB.

Email this cover page and complete application to UMRIC@maine.edu

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FOR IRB USE ONLY **Application # 2021-02-04** **Review (F/E): E Expedited Category:**
ACTION TAKEN:

- ☒ Judged Exempt; category 2 Modifications required? Yes Accepted (date) 2/16/2021
- ☐ Approved as submitted. Date of next review: by Degree of Risk:
- ☐ Approved pending modifications. Date of next review: by Degree of Risk:
  Modifications accepted (date):
- ☐ Not approved (see attached statement)
- ☐ Judged not research with human subjects

FINAL APPROVAL TO BEGIN **2/16/2021**
Date

10/2018

AUTHOR'S BIOGRAPHY

Kelsey Davis is a third-year senior at the University of Maine graduating with a B.S. degree in Marine Science. She has been involved in the field of sea turtle rehabilitation since 2016 and has been both an independent study student and an intern for the Pittsburgh Zoo and PPG Aquarium's Sea Turtle Second Chance Program. She was also accepted to Georgia Aquarium's Mammal and Bird internship program in the spring of 2020. Kelsey was raised in Pittsburgh and resided there until she moved to Orono for her undergraduate studies. She hopes to continue in the field of aquarium science and conservation education post-graduation.