

From Norris to Now

A comparison of historic and present-day management and research on spinner dolphins
(*Stenella longirostris*) around the Island of Hawai'i

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From Norris to Now

Heather Heenehan

Abstract

The spinner dolphins (*Stenella longirostris longirostris*) of the Island of Hawai'i use shallow, protected, warm and easily accessible bays during the day to rest and thus are targeted for swim-with dolphin programs. Since these interactions occur when the dolphins should be resting there is growing concern about the potential effects of these interactions and whether management interventions are required. Dr. Kenneth Norris was a pioneer marine mammal researcher and studied these spinner dolphins until the mid 1990's. Using Kenneth Norris' work as a historical baseline, I examined several key aspects of the spinner dolphin biology, research and management and how each has developed or changed since Norris and his colleagues originally studied the population. This project is presented as a set of web articles on the Spinner Dolphin Acoustics, Population Parameters and Human Impacts Research (SAPPHIRE) Project website.

Introduction

To the marine mammal world, Kenneth Norris (1924-1998) is a familiar name. He was a world-famous marine mammal researcher who spent many years in Hawai'i, mostly on the Island of Hawai'i researching the Hawaiian Spinner Dolphin (*Stenella longirostris longirostris*). The books that Norris and his colleagues wrote based on their spinner dolphin research provide great historical perspective on these animals. His colleagues include Bernd Würsig, Randall S. Wells, Melany Würsig, Shannon M. Brownlee, Christine Johnson and Jody Solow. These books provide current researchers and managers a historical perspective on spinner dolphin biology, research and management.

The goal of this Master's Project is to understand the complex everyday relationship between humans and spinner dolphins that occurs in the bays of the Island of Hawai'i. To provide context for this issue I conducted a retrospective analysis of the research and

management related to the spinner dolphins and how things have or have not changed since Kenneth Norris studied the population. The project explores how the historical perspective (From Norris) fits with the current perspective (to Now): How have things changed since Norris and his colleagues studied the spinner dolphins? Are there things that Norris discussed in his works that still ring true today? How has management failed the spinner dolphins since the time when Norris' research stopped? What do we know about these spinner dolphins?

The spinner dolphins get their name from their remarkable aerial behaviors. Their behaviors range from nose outs to complete tail over head spins. According to the Pacific Island Regional Office, from a Southwest Fisheries Science Center survey, "the best available population estimate is approximately 3,300" dolphins, yet little is known about how the population has changed over time. Nevertheless, *S. longirostris* is not currently listed under the Endangered Species Act.

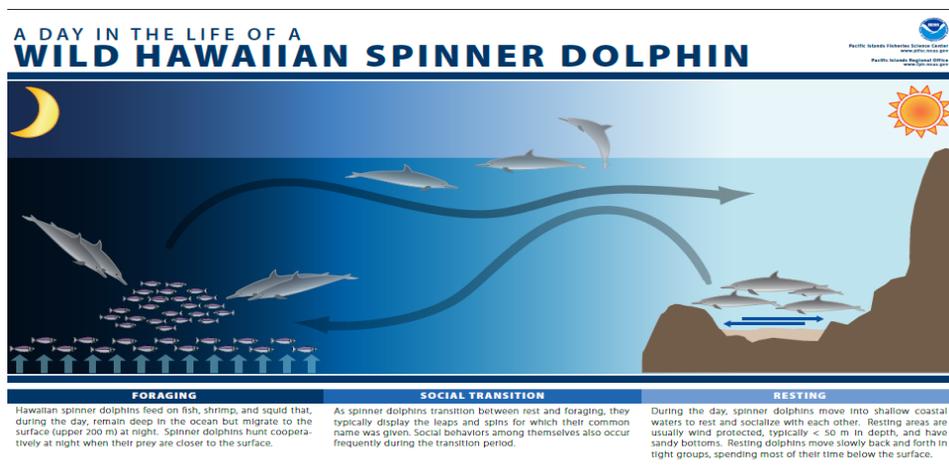


Figure 1 A Day in the Life of a Wild Hawaiian Spinner Dolphin according to NOAA
<http://www.fpir.noaa.gov/Library/PRD/Spinner%20Dolphin/Swim%20With%20page/Spinner%20Dolphin%20poster%20revsk.pdf>

Although we know little about this group of dolphins, we do know that they are predictable creatures with a daily schedule that involves moving into shallow bays for rest, relaxation and socialization during the day and heading out to sea to forage at night. Since these bays are also easily accessible to humans, there are daily interactions between the dolphins and humans. Beyond humans going to these bays to swim with the spinner dolphins, they also go to swim, snorkel the reef, kayak, and fish. Thus some of the interactions are purposeful and done while in pursuit of these dolphins while others are incidental and might occur as a kayaker paddles to a snorkel spot or as a boat moves past one of the resting bays. I will refer to all of this behavior as spinner-related tourism. In response to concerns about these interactions, the Spinner Dolphin Acoustics, Population Parameters and Human Impacts Research Project (SAPPHIRE, the main project) was funded to explore the complex relationship between Hawaiian spinner dolphins, tourism, culture, economics and marine protected areas and how intensive tourism may be impacting the spinner dolphins. This Master's Project is a part of the larger SAPPHIRE Project and is featured on the SAPPHIRE Project website. SAPPHIRE aims to understand how intensive tourism may be impacting Hawaiian spinner dolphins and to inform management decisions. This subset of the project aims to understand change or lack of change in spinner dolphin research and management.

The SAPPHIRE project focuses on four different bays along the Kona coast (west coast) of the Island of Hawai'i: Honaunau Bay, Kauhakō Bay (Ho'okena Beach Park), Makako Bay and Kealahakua Bay. SAPPHIRE is a joint research project between Murdoch University in Australia and Duke University. It is funded by the National Oceanic and Atmospheric Administration (NOAA) and the Marine Mammal Commission.

This Master's Project addresses several areas that are critical to effective spinner dolphin management and provides context for moving forward. This project synthesizes what is known about the animals and highlights gaps in our knowledge. In particular, little is known about the effects of spinner-related tourism and swim-with spinner dolphin programs even though it is a growing tourism sector. NOAA, the Pacific Islands Regional Office (PIRO), and Pacific Islands Fisheries Science Center (PIFSC) are working on a management plan to protect the Hawaiian spinner dolphin. The suggested approach is to implement time area closures to reduce interactions between the spinner dolphins and humans during times when the dolphins should be resting and socializing. Thus this project could help inform conservation efforts. It can also help us better understand how the spinner population responds to a constantly changing environment and adds to the body of research already done on the spinner dolphins. As previously mentioned, this was a well studied population until the mid 1990's, so with this retrospective analysis I have tried to compare and contrast Norris' research with current research and findings. The major conservation implication of the SAPPHIRE Project and this Master's Project is to better understand these dolphins so we can successfully protect them so that generations to come can view and enjoy them.

Kenneth Norris pioneered the research on the Island of Hawai'i spinner dolphins. Norris and his colleagues focused on Kealahou Bay, one of the four SAPPHIRE bays. The core concept in this Master's Project is that Ken Norris, in his research from 1974 until the mid-1990's, provides baseline data for the biology and ecology of spinner dolphins. Along with many journal articles, he published two books from his research The Hawaiian Spinner Dolphin and Dolphin Days: The Life and Times of the Spinner Dolphin. His book, The

Hawaiian Spinner Dolphin covers topics that include social dynamics, acoustics, dive behavior, foraging ecology, abundance, etc.

My research questions are: How has our understanding and knowledge about the spinner dolphins, their habitat, their biology, etc. changed since the time that Ken Norris *et al.* studied them from 1974 to the mid 1990's? What have we learned since that time? What still rings true? Each chapter that I wrote for the SAPPHIRE website explores a particular theme or subtheme. These chapters provide background information, introduce important concepts and make comparisons across time.

My goal was to conduct this retrospective analysis in the hopes that it would help stakeholders (general public, policymakers, etc.) understand the some of the major parts of the spinner dolphin issue. What I present in this report is not the whole collection of chapters I wrote. Rather, I have focused on the "Norris to Now," the retrospective analysis, in each of the articles I wrote. The articles can be found on the following website:

<http://www.nicholas.duke.edu/spinners/NtN-Folder/dolphin-stories>. The goal of this report is to offer a glimpse at the continuum that exists in spinner dolphin research and management. There are some topics where scientists and managers have progressed with leaps and bounds, answering questions and developing new hypotheses while for other topics there has been little progression since Norris' research. I wanted to offer a shorter version of the narrative I created so readers can quickly see the "Norris to Now" in each of the topics. I hope that this will give people an opportunity to understand the SAPPHIRE Project and its research and how that compares to previous research. In addition to the main goal of comparing and contrasting the history of the spinner dolphin research with

current research I hope that the set of articles on the SAPPHIRE project website will help people stay up to date on the project and learn more about the project.

Materials and Methods

My major sources of data for the historical baseline are Norris' two books [The Hawaiian Spinner Dolphin](#) and [Dolphin Days: The Life and Times of the Spinner Dolphin](#). In addition, while I was in Hawai'i I collected acoustics data with the field team by placing an acoustic logger in the water to record dolphin vocalizations, boat noise and other sounds. Other sources of data include materials from my coursework and course projects, photos, videos, the journal I wrote in while in Hawai'i, and papers and articles published since the time Norris' research concluded. A full list of references can be found in the Literature Cited section of this report. I also used conversations with important stakeholders including managers and scientists to inform my articles.

The majority of this report will show the comparison between historical research and current research and explain a timeline outlining the history of the spinner dolphin research and management. Each article is a chapter on the website and is an easily digestible version of that chapter's research. Through the sources of data listed above and help from experts, I wrote chapters on various topics addressing where we are now, what is the "state of the art" knowledge, and what has changed. In this project I formatted this information to highlight the retrospective analysis portion of these articles. Again, the full chapters can be found online. In addition to being on the SAPPHIRE website, the video I made was featured on a blog for a travel course to Midway Atoll and one of my entries was featured on the Nicholas School of the Environment website as a guest blog. In addition I

wrote entries for Dr. David Johnston's website and posted new blog articles to social media outlets including LinkedIn and Facebook to increase readership. These chapters will eventually form a manuscript for publication.

From Norris to Now

Chapter 1: From Norris to Now

In this story I introduced myself and my Master's Project. Since this was the first article in this retrospective analysis I wrote about why I think it is important to look at an issue across time (how I will be approaching these stories) and introduced my project as I did in the introduction of this report. To better understand an issue I think it is important to take a step back and think about the history of that issue. To ask questions like... who came before me? Who was looking at this say 40 years ago or 20 years ago? What did they think? What did they find out? What were their concerns? We can learn a lot from the lessons of yesterday and in the case of the spinner dolphins, these lessons come from a marine mammal researcher named Kenneth Norris. Kenneth Norris really pioneered the research on the Island of Hawai'i spinner dolphins. So there is a lot to gain from taking a look back at the research of Norris and his colleagues. You can't move forward without looking back. There are things that change, new information that throws old theories and ideas out the window but the historical perspective is extremely important. So this project will explore how that historical perspective (From Norris) fits with the current perspective (to Now).

Chapter 2: An “Old Man’s Book” and a Grad Student’s Master’s Project

With this article I wanted to begin to tell the tale of the SAPPHIRE Project and Kenneth Norris’ project. I compared the objective and research questions along with the focus and the team for both.

Every project starts with an objective. It starts with a research question. Kenneth S. Norris’ research questions included,

What... was it like for a dolphin to live in a society of many dozens of animals, to swim many kilometers a day, and to dive a dozen times an hour to depths of 100 m... or more? Who were the dolphin’s enemies and how were they dealt with? How did wild dolphins catch food, sleep, communicate, give birth, mature and die out in the ocean? How did they use both their vision and their echolocation at sea? (Norris *et al.* 1994, 1)

Now these seem like simple questions. At the time, these types of field studies were in their infancy. Norris knew that there were things you could learn from a dolphin in captivity but so much more you could learn from a dolphin in its natural habitat. But Norris says “At the time it was unclear if this could be done to any useful degree” (Norris *et al.* 1994, 1). The core questions for my project are relatively basic, and follow sequentially. 1) What did Norris find? 2) Does it still hold true today? The answers to these two questions will provide insight into how science and management have addressed human effects on dolphins in Hawai‘i.

Every project needs focus. Defining the who, what, when, where and why, so how do they compare between the two projects. Who: For both projects it is the Hawaiian spinner dolphin, *Stenella longirostris*. What: For Norris it was learning about spinner dolphin

biology, ecology and social dynamics. For this project, it is looking at how things have changed and how that may apply that to increasing interactions between humans and these dolphins. When: For Norris, 1970's to the 1990's. For this project I started on the project in summer 2010 and will hand in my Master's Project in spring 2011. Where: The Island of Hawai'i. Why: For Norris, it was to understand how wild dolphins lived. For the current project, the major conservation implication is to understand how we can ensure the sustainability of spinner dolphin populations for future generations.

The very same reasons that spinner dolphins are accessible for tourism purposes make them accessible to researchers like Ken Norris and my team. Norris also mentions that spinner dolphins would let swimmers, boats and other vessels hang around them in the clear waters where they swam and that you could study the dolphins by land and by sea in their resting bays. From my experiences this summer I'm not sure that the dolphins let boats and swimmers hang around without being affected.

Norris described the time when the spinner dolphins begin to rest in their bays as a "touchy time" when "intrusion" was a concern (Norris *et al.* 1994, 3). Norris also recognized the fact that spinner dolphins are "extremely sensitive...to intruders" and that their work "did indeed influence the schools [they] watched" (Norris *et al.* 1994, 3). Interestingly enough, Norris mentions that "On the water we did not easily perceive the reactions of the entire school relative to us. But from the clifftop, their edginess toward one of our teams on the water was clearly observable against the dimension of the entire bay" (Norris *et al.* 1994, 3). We saw the same touchiness in the bays this past summer.

In the 1990's we knew so much about the spinner dolphins because Norris and his colleagues approached the spinner dolphins "from as many viewpoints" as they could (Norris *et al.* 1994, 3). The SAPPHIRE Project aims to do the same.

Norris describes his project as an incredible learning experience. The "insights came as fast when we were packing up our camps as they did when we first began" (Norris *et al.* 1994, 4). I felt the same way in the two months that I worked in Hawai'i with the field team. Norris also discusses the benefits of having a diverse team on his project. With diversity you get different expertise, different knowledge and different approaches and when you put that all together the project is so much better off. This summer, in the first field season, we had just such a blend of people. Not only in knowledge and expertise but also countries and states.

The Hawaiian Spinner Dolphin, according to Norris, is an "old man's book" (Norris *et al.* 1994, 4). Norris wished that his book would introduce people to spinner dolphins and all that he came to know about them. He also saw his work as preliminary - since his research led to so many new questions to answer. I write this not as an old man near the end of my career but as a young scientist and aspiring manager hoping that these entries will help people understand how we have progressed since Norris.

Chapter 3: Life History of the Spinner Dolphins: The Stenellas and the Spinners

In this article I explored the life history of the spinner dolphins as a whole. What do we know about the "Stenellas" and what do we know about the spinner dolphins. With this article I aimed to tell the story of the spinner dolphins.

The life history of an animal is “the history of changes undergone by an organism from inception or conception to death.” We started to write the story of the spinner dolphins when John Gray discovered the species, *Stenella longirostris*, in 1828. More than 100 years later Ken Norris and his colleagues continued to add to this story by studying the Hawaiian form of the spinner, *Stenella longirostris longirostris* and now the SAPPHIRE Project, more than 175 years later, continues to study the Hawaiian Spinner Dolphin.

The four subspecies of spinner dolphins are *Stenella longirostris longirostris*, *Stenella longirostris orientalis*, *Stenella longirostris centroamericana* and *Stenella longirostris roseiventris*. But there are other dolphins in the genus *Stenella*. Perhaps the story of the other *Stenellas* is that there really isn't one. They have been referred to as a “wastebasket” group in terms of phylogenetics (Norris *et al.* 1995, 15). Ignacio Moreno and his colleagues (2005) indicate that “the genus is considered an artificial and non-monophyletic assemblage” citing both LeDuc *et al.* (1999) and Perrin (2001). One of those other *Stenella* species that might appear to share the same story as the spinner dolphin is the Clymene Dolphin, *Stenella clymene*. Ken Norris and Bill Perrin both mention *Stenella clymene* when addressing the life history of spinner dolphins. Bill Perrin is a “Senior Scientist for Marine Mammals” for the National Marine Fisheries Service at the Southwest Fisheries Science Center. An interesting link between Perrin and Norris is that Perrin won the 2011 Kenneth S. Norris Lifetime Achievement Award. According to the Society's website,

The Society for Marine Mammalogy established the Kenneth S. Norris career achievement award in honour of the Society's founding president and one of the truly great figures from our past. The Norris award is an acknowledgement of exemplary lifetime contributions to science and society through research, teaching, and service in marine mammalogy.

Back to the life history of the spinner dolphins and *Stenella clymene*. This dolphin is part of the genus *Stenella* but is not part of the spinner dolphin story. The Clymene dolphin has certain characteristics that could easily deceive someone. In fact, Norris originally described the Clymene Dolphin as a “geographic variant” to the spinner dolphin. The Clymene Dolphins may look like a spinner and spin but they are not a spinner dolphin.

We know a lot more about the “where” part of the spinner dolphin story now in comparison to when Kenneth Norris studied the species. Norris indicated that “the spinner dolphin appears to be an abundant though rather sketchily known form...throughout this range” and further suggested that “we know rather little about most of the world’s spinner dolphin populations” (Norris *et al.* 1995, 15). In this case, I think it is a testament to how much we can learn about a species in 15 years. Norris described the distribution of spinner dolphins cautiously while Perrin in the most recent, 2009 version of the Encyclopedia of Marine Mammals confidently lists the four subspecies and where these spinner dolphins are located. In fact, at the time Norris published his landmark book, Perrin had only just recognized but had “not named” the dwarf spinner dolphin (Norris 1995, 15). This dolphin has since been named *Stenella longirostris roseiventris*. The four subspecies of spinner dolphins are “the globally distributed *S. l. longirostris* (Gray’s spinner), the eastern tropical Pacific (ETP) endemics *S. l. orientalis* (eastern spinner) and *S. l. centroamericana*” which you can guess is from Central America and *S. l. roseiventris* which can be found in “central Southeast Asia” (Perrin 2009, 1100).

Kenneth Norris in [The Hawaiian Spinner Dolphin](#) (1995) and William Perrin in [The Encyclopedia of Marine Mammals](#) (2009) describe the spinner dolphin aerial behavior in

similar style and this behavior certainly hasn't changed over time. Norris *et al.* state that the spinner dolphins "burst from the water and... rotate rapidly about their longitudinal axis for as many as about four revolutions before falling back into the water" (Norris 1995, 14). Perrin says, "It can be seen at a great distance as it spins high in the air and lands in the water with a great splash" (Perrin 2009, 1100). Both descriptions are similar and seem to reflect a sense of awe in the behavior of this species.

Why do they spin? Sure we know they do - but why? What's the point of this part of the spinner dolphin story? Norris believed that the spinner dolphins spin for the sound it produces; the reentry into the water "produces a sharp, smacking sound that he speculated would mark the location of the spinner animal to schoolmates swimming nearby" (Norris 1995, 14). This hypothesis has not been confirmed; the reason "the spinner spins is unknown" (Perrin 2009, 1102). Perrin (2009) acknowledges Norris' original hypothesis but provides competing hypotheses as well.

Throughout the history of the spinner dolphins they have faced various threats. And each of these threats is an important part of the spinner dolphin timeline. Norris noted that the tuna fishery was a major threat to the spinner dolphins as a whole (not as much for the coastally-associated Hawaiian Island spinner dolphins though) especially before the Marine Mammal Protection Act which was enacted in 1972. This fishery reduced the eastern spinner dolphin (*Stenella longirostris orientalis*) population to "to less than one-half of its original size" and they are not recovering as expected (Perrin 2009, 1102). Most recently, several authors indicate that interactions with "dolphin-watching boats is emerging as a new threat to spinner dolphins" (Perrin 2009, 1103). This threat is a new

arc in the Hawaiian spinner dolphin story, and unfortunately it is becoming an even more important piece of the story. The life history of an animal is “the history of changes undergone by an organism from inception or conception to death.” Hopefully the effects of human interaction will not lead to the latter for either individual spinner dolphins or for the species as a whole.

Chapter 4: Life History of the Spinner Dolphins: The Hawaiian Spinner Dolphin

In this article I explored some of the important components of the Hawaiian spinner dolphin life history. Spinner dolphins, although they are distributed worldwide, do not have a worldwide lifestyle. The Hawaiian spinner dolphins have a coastal lifestyle.

Lactation in these dolphins lasts for between 15 and 18 months according to Norris (Norris *et al.* 1994, 187). Norris calls this “the most variable component of their reproductive cycle” (Norris *et al.* 1995, 187). Perrin actually cites possibly an even longer range for lactation of between 1 and 2 years for these dolphins. No matter what the uncertainty, calves depend on nursing from their mothers for at least a year after they are born.

Newborns are easy to pick out of a crowd because 1) they are obviously smaller than the adult dolphins in a bay but 2) they also exhibit fetal folds. Norris claims they are “difficult to see in Hawaiian Spinners” (Norris *et al.* 1994, 263). These young dolphins require a lot of care and time to mature. The young dolphins have a lot to learn and start to learn their aerial behaviors and from my experience in the bays, practice makes perfect. One day in Makako Bay for about 45 minutes, the “Keiki Nai’a” (meaning little spinner dolphin) was the ONLY dolphin in the bay “spinning”. As we tried to call out behaviors for our recordings we would say, “Well, I think it was trying to spin... but not quite... we’ll call it a

spin.” Or “I think that was its best attempt at a leap.” It was fun to sit and watch this young dolphin attempt these amazing aerial behaviors and although they weren’t always perfect, they were almost more impressive.

This is how Norris describes young dolphins in the bays. They state “Dolphin calves are frequently among the most active members of a school” (Norris *et al.* 1994, 269). Then they go on to say that,

Calves were sometimes remarkably aerial, even during times when the remainder of the school was resting... During one rest period, we watched such sorties during a span of about an hour when two calves repeatedly executed aerial patterns that were poorly enough defined that we could not fit them easily into our aerial behavior...Aerial behavior is a practiced pattern that seems to require a learning period during the young and juvenile years to be perfected.

As I read this paragraph I felt connected to Kenneth Norris and his colleagues. Some things just don’t change. Sometimes there isn’t a difference between the “Norris” and the “Now.” Kids will be kids. I can imagine all of their research team on their own boat watching the dolphins, probably laughing and smiling while watching the young dolphins attempt these aerial behaviors just as we did that day.

Norris described the spinner dolphin mating system “polygynandrous” where “both males and females can have many partners” (Norris *et al.* 1994, 188). Perrin and Mesnick in a 2003 article describe the mating system “a more open, promiscuous or polygynandrous mating system” and Perrin (2009) referred to it simply as promiscuous. This is a marked difference between the eastern tropical pacific (ETP) spinner dolphins. Perrin and Mesnick (2003) state that more male Hawaiian spinner dolphins participate in reproduction than

the ETP spinner dolphins. A major take away from all of the types of mating systems mentioned is that they are NOT monogamous.

Both Norris and Perrin discuss seasonal reproduction among the spinner dolphins. Norris calls the seasonality in Hawaiian spinner dolphin reproduction, diffuse seasonality (Norris *et al.* 1994, 189). According to Norris from a 1984 study by Barlow, there are peaks in reproduction in “late spring and summer” and “another in mid-winter” (Norris *et al.* 1994, 189). NOAA does not recognize seasonality in spinner dolphin mating season. They state that “there is no known mating season for the Hawaiian spinner dolphin” and Perrin (2009) says that “ovulation may be spontaneous.” Gestation, according to Norris, is about 10.7 months (Norris *et al.* 1994, 187). Perrin says “about 10” and NOAA says 11 months. So we can say that generally 10 to 11 months is about average for the Hawaiian spinner dolphins with regards to this life history trait (Perrin *et al.* 2009).

Social Behavior and relationships between dolphins are another interesting topic for spinner dolphins. Hawaiian spinner dolphin social structure has been described as a “fission-fusion” system, meaning that dolphins live in a fluid society with a lack of “long-term group fidelity and social stability” (Karczmarski, Würsig *et al.* 2005). Another way to say this is that “social organization in Hawaiian waters is fluid, with schools composed of more or less temporary associations of family units, the associations may vary over days or weeks” (Perrin *et al.* 2009, 1102). There is now some evidence that Hawaiian spinner dolphin behavior is not consistent across the islands.

One relationship that Norris discusses from observations of captive spinner dolphins is what some call the “auntie” dolphin. These dolphins help the new mother with the new

calf. Norris actually witnessed the birth and quick death of a spinner dolphin in captivity and how the female dolphins and male dolphins acted towards the new calf. Sometimes they were helpful and at other times they were aggressive. Perrin also mentions “male coalitions” among the spinner dolphins (Perrin *et al.* 2009, 1102). These types of coalitions are also known for bottlenose dolphins.

Norris also acknowledges the diurnal (day-night) behavior of the spinner dolphins by saying “Wherever populations of these dolphins associate with land, at about dusk after a daytime rest period is over, these predictable animals move a short distance offshore to feed” (Norris *et al.* 1995, 14). They take advantage of “a halo of nutrients and pelagic food organisms at specific points along its shores” (Norris 1995, 14). Perrin hardly mentions this diurnal behavior. He acknowledges it by stating that “in other tropical waters, spinner dolphins are usually associated with islands and coasts, venturing out to deeper water to feed” and then says “while resting in shallow reef areas during the day, their feces may constitute an important resource for reef fishes” (Perrin 2009, 1102). This behavior is recognized by many other articles published since the 1990’s.

Chapter 5: Spin: A video on Midway Atoll Spinner Dolphins

This entry was a video from a travel Marine Conservation Biology Class to Midway Atoll and Oahu. This video covered some of the changes on Midway in regards to the programming focused on spinner dolphins. It also discusses spinner-related tourism which is a relatively new concern for the spinner dolphins. Mostly, it serves as a summary of some of the basics of the Hawaiian Spinner Dolphin and discusses the Hawaiian Spinner Dolphins of Midway Atoll. I was able to interview John Klavitter, the Acting Manager of the

Refuge. He gives a historical perspective on the types of programs that used to occur on Midway and what might occur in the future related to the dolphins. It also begins to tackle some of the current issues involved with the spinner dolphins mainly on the Main Hawaiian Islands.

http://www.youtube.com/watch?v=aRTECwasaTA&feature=player_embedded

Chapter 6: Communicating Science on the Web

This article explored the role of science in policy making and the importance of communicating science to others and utilizing web tools like blogs. These types of tools, especially at the stage of development they are at today, were not available to Norris during most of his career. But even Kenneth Norris worked to share his science with more than just marine mammal scientists by writing Dolphin Days. This book is easy to read and gives readers a good sense of the life and times of the Hawaiian Spinner Dolphin. I wonder how Kenneth Norris would have used the web and the recent development and advances in these types of tools.

Chapter 7: The Big Picture- Using Social Sciences

This article begins a set of articles that help frame the SAPPHIRE Project and the spinner dolphin issue in the bigger picture. This article uses the work of Elinor Ostrom and applies common pool resource theory to the spinner dolphin resting bays.

Kenneth Norris and his many colleagues approached the Island of Hawai'i spinner dolphins with a suite of research methods. The reason for a suite of method was to better understand these dolphins. Norris says in Dolphin Days,

I wanted to see my newfound dolphins from the cliff, from the water, at sea, nearshore, during the day and night, and from the air. Then, just as a painter blocks in a painting, spinner dolphins might come into focus in something like the totality of their lives (71).

The SAPPHIRE Project aims to do the same, to understand spinner dolphins from many different perspectives by combining acoustics with theodolite tracking and photo identification. Since Norris and his colleagues studied spinner dolphins there has been an effort to not only approach this issue with various natural science research methods but to add social science to the mix as well. The SAPPHIRE Project and all of the students dedicated to this project aim to do just that, to use social and natural sciences to understand this issue.

This article was in many ways inspired by an entire course I took last semester on policy analysis that focused on the work of Nobel Prize winner, Elinor Ostrom. Most of this work on common pool resources and collective action has been since the work of Norris and his colleagues. Ostrom's first book on the topic was Governing the Commons: The Evolution of Institutions for Collective Action and was published in 1990. So this area has grown tremendously since Norris and his colleagues published The Hawaiian Spinner Dolphin in 1994 and Dolphin Days in 1991. Ostrom received the Nobel Prize for this work on common pool resources and collective action in 2009. Applying some of Ostrom's ideas, I explore the spinner dolphin resting bays as a common pool resource.

The four bays being studied by the SAPPHIRE Project (Kealakekua, Makako, Kauhako and Honaunau) are known resting bays for the spinner dolphins. These bays are close to productive feeding areas offshore and hypothetically provide protection from predators.

The bays are mostly sand bottom, most likely so the dolphins would be able to see the predator's outline against the bottom (It's a hard hypothesis to test!). Ken Norris also recognized the importance of these bays. He asked "What did the island and this cove mean to them?" (Norris 1991). He subsequently answered with "the island provide a bit of surcease: land to return to, a place to sleep near, away for a time from the struggle in the glassy three-dimensional sea where there is no place to hide" (68). Norris also recognized how these bays are affected by human activity,

Kealakekua's waters are a reserve now, but many boats continue to use the bay, where they swing at moorings set in the sandy parts of the bay bottom. These boats encroach upon, the spinner "sleeping grounds," and if their number increases, if the dolphins' needs aren't considered, the animals will leave, and their span of tenancy which began before that of any man, will end as they quietly slip away into the offshore sea (Norris 1991).

Most approach this issue assuming that the spinner dolphins themselves are the common property resource. While this might be true, the situation may be viewed in a different light. It could be argued that the resting bay is the common pool resource of interest, instead of the dolphins themselves.

I wanted to write this story because I spent an entire semester thinking of the spinner dolphin resting bays as a common pool resource, and how that may apply to the current situation in Hawai'i . Most importantly, it is an entirely new way of thinking about the bays and approaching management of the bays. Common Pool Resource Theory has emerged almost entirely since Norris published his two books.

Chapter 8: The Big Picture- History and the Social Construction of Spinner Dolphins

This article explores the role WWII, media (books, TV, movies, commercials), oceanaria and aquaria, the environmental movement, and the U.S. Marine Mammal Protection Act (MMPA) all play in shaping the spinner dolphin issue in Hawai'i. There are many factors and forces that have affected this issue and shaped its evolution. This review provides the greater backdrop for the present issue, and gives us insight into why people care passionately about it. Much of this hasn't changed since Norris studied the dolphins. Each of these factors has developed, there are new movies, commercials, etc. but many of the major themes come from decades before Kenneth Norris studied the spinner dolphins.

Spinner dolphins are charismatic megafauna. They were when Norris studied them and they are today. People look at these dolphins and think that they are smiling back at them and immediately feel like they have a connection to them. I don't think that this has changed much since Kenneth Norris studied them since many of the factors that shaped the issue today occurred before Kenneth Norris started studying the spinner dolphins. These dolphins play, have relationships with other dolphins and are intelligent creatures. These characteristics clearly contribute to the human fascination with these creatures, but is that all? I think that this fascination and interest in marine mammals, but more specifically dolphins, also stems from books, movies, television shows and commercials. It comes from advances in technology and communication paired with economic growth that has made technology and various modes of communication more accessible and more commonplace.

World War II got people out on the ocean in numbers like never before. When these soldiers returned home they had a new appreciation for the ocean; it wasn't as foreign to

them or their families. When the soldiers returned home in the 1950's they came back to television shows like Flipper and Sea Hunt. Families sat down to watch these shows and the fascination began. Originally these television programs "aimed simply to entertain" but later changed "to educate viewers about wildlife biology and conservation" (Lavigne, Scheffer *et al.* 1999). In addition, Jacques Cousteau was a major "influence in generating interest and shaping attitudes toward marine mammals" (Lavigne, Scheffer *et al.* 1999). Through these new media outlets, people started to learn more about dolphins and their intelligence. This gave some people hope that one day they too might be able to interact with them. The economic growth during the mid-1900's led to wider access to this type of technology and led to the development of true marine and ocean policy. People began to care about the ocean in ways they never had before.

In addition to television shows like Flipper or Sea Hunt, "books and magazines... sound... and motion pictures have in recent decades brought marine mammals to the attention of millions of people" (Lavigne, Scheffer *et al.* 1999). Growing up I remember reading books about people who lived with the dolphins and children who were rescued by them. Books like these add to the fascination with dolphins and their almost mythical nature. More recent movies and television series like Earth, Blue Planet and Life feature compelling marine mammal examples and highlight their amazing natural history including their social relationships. These are newer approaches to getting the environmental message out to the general public and these in particular are mostly after Norris stopped studying the spinner dolphins. This helps us associate with these animals and again helps increase the desire to interact with them. They also give people the opportunity to learn about these animals and to care about them.

The existence of aquaria and oceanaria also give people the opportunity for close-up encounters with dolphins and other marine mammals in captivity. At one point in recent history, it was estimated that “more Americans visit zoos and aquariums yearly than attend all professional, baseball, basketball and football games combined” (Lavigne, Scheffer *et al.* 1999). Animals in captivity also facilitate research. Kenneth Norris supported the use of animals in captivity for research because at that point “three-quarters of what we really know about... the dolphin has come from captive partners in experimentation” (Twiss, Reeves *et al.* 1999). Spinner dolphins were kept in captivity at the Sea Life Park on Oahu and Kenneth Norris helped create this exhibit. Norris was approached in 1961 about opening the new exhibit and the last spinner dolphin was released from the park in the summer of 1983. Norris later wrote in Dolphin Days that the captive dolphins at the Sea Life Park “had taught us a great deal” (285). Norris’ support wasn’t just for research on captive animals either. He indicated,

Without these dolphins to watch and wonder about, few of us, I fear, would care... Of course these days there is much discussion about whether we should keep dolphins at all. In this debate, their contribution to our understanding is seldom considered seriously. This leads to a paradoxical situation. The more we learn from captive dolphins, the more people care about them (286).

This debate about keeping marine mammals in captivity still exists. Encounters with cetaceans in captivity eventually led to demand for an even more natural experience - viewing them in the wild and in some cases swimming with these animals in the wild (like the programs on the Island of Hawai‘i, and elsewhere). Of course we have been reminded in the past few years that swimming and interacting with dolphins and whales even for trainers at places like SeaWorld isn’t completely safe. Hopefully this helps people

understand that wild animals, even those in captivity, are not predictable. We cannot manage dolphins, or their behaviors, even in captivity, and we certainly cannot do it in the wild. Since Norris left Kealahou, “interest in viewing marine mammals in the wild has grown substantially” (Lavigne, Scheffer *et al.* 1999). Norris barely mentions swimming with spinner dolphins in his books, his major concern at the time was the unsustainable interactions between spinner dolphins and the tuna industry. Spinner-related tourism especially the swim-with industry on the Island of Hawai‘i are relatively new in this regard, and thus is a new concern. In fact, it seems that there is growing concern that these seemingly “less invasive” ways to view and interact with marine mammals, including dolphins, are not so benign. In some cases our desire to view them in the wild, and interact with them is actually having an impact on their populations.

The environmental movement and shifts in “attitudes toward the environment... is often dated from the publication of Rachel Carson’s Silent Spring” in 1962 (Lavigne, Scheffer *et al.* 1999). This resonates with me, as I currently work and study right across the inlet from the Rachel Carson National Estuarine Research Reserve System. The environmental movement also stemmed from other movements like the Civil Rights Movement. These play a large part in any policy issue related to the environment or marine policy, and ultimately how we view marine mammals as resources. This movement drew attention to the fact that we were impacting our environment in myriad ways. Ken Norris wrote, “We were all part of the larger worldwide realization, during the 1960's, that we humans were dealing with our world, and all the things it in, in ways that had to be changed” (Norris 1991). Television, radio, movies, and other media vectors had a role here as well. TV and other forms of communication raised awareness. The environmental movement came right before the

major burst of legislation including the National Environmental Policy Act, Endangered Species Act and Marine Mammal Protection Act to name a few.

The environmental movement led to increased awareness and a burst in legislation including the Marine Mammal Protection Act. One of the major drivers in passing the “was increased public awareness of the vast numbers of porpoises being drowned incidental to commercial fishing” (Norris, 1991, 69). Dolphins were part of the reason the Marine Mammal Protection Act was created and played a large part in the 1994 amendments when people became aware of the relationship between tuna fisheries and dolphins. These conflicts further exposed people to the plight of marine mammals and dolphins worldwide. Ken Norris was actually on the First Committee of Scientific Advisors for the U.S. Marine Mammal Commission, and being an expert in spinner dolphins was consulted about the tuna porpoise issue. He was involved when the government closed the US tuna fishery because it went against the newly established MMPA. Norris led the effort to send scientists out to sea with fishermen to see what exactly was happening in the tuna nets and to understand this dolphin kill. His time out with the fishermen helped fishermen establish dolphin-friendly practices. Since then the number of dolphins killed in this fishery has decreased significantly thus reducing concern for this issue. This has opened the door for concern for things like swim-with programs.

There is a greater shift in attitudes towards marine mammals apparent in the spinner issue, and in the end this shift may be the root cause. Attitudes “shifted from a focus on their killing and material utilization to a more aesthetic interest in observing these creatures in the wild, in captivity, and in various media forms” (Lavigne, Scheffer *et al.*

1999). “Traditionally,” marine mammals, “were viewed mainly from a utilitarian perspective,” how they would be used as a resource (Lavigne, Scheffer *et al.* 1999). Today we see a movement towards the attitude that animals “have intrinsic rights” and that they are valuable outside whatever we use them for whether that be oil during the whaling era or for swim-with programs today. In fact, we often now consider dolphins as parts of a larger system, important components of marine food webs that are linked across time and space. These new attitudes, often referred to as aesthetic and ecologicistic attitudes focus more on the non- consumptive use of marine mammals and have, led to “a dramatic increase in the viewing of marine mammals in their natural habitats”(Lavigne, Scheffer *et al.* 1999).

The fact that people want to interact with spinner dolphins in the wild stems back to the fascination and awe people have with these creatures - they play, have relationships with other dolphins and are intelligent creatures. Much of this is perpetuated by media and communication. This is not a new phenomenon, and these issues have been dealt with in terrestrial systems long before Flipper aired on TV.

Chapter 9: The Big Picture- Norris, the Spinner Dolphins and the MMPA

The Marine Mammal Protection Act (MMPA) is more than just the only major piece of legislation involved in this issue. The MMPA is a thread woven through throughout the entire story of Kenneth Norris, the spinner dolphins, and of the human interactions with the dolphins in their resting bays.

As mentioned in the previous story, the plight of the spinner dolphins in the tuna industry was a major reason for the creation of the MMPA and Kenneth Norris served as an expert

on the topic. In addition, Norris actually helped with the initial stages of the MMPA. In fact, Norris and his colleague Dr. Carleton Ray came up with the term optimum sustainable yield. This term led to the compromise of optimum sustainable population (OSP). This term, OSP, is the main objective of the MMPA.

Kenneth Norris was also an early proponent of something we now call ecosystem based management. He said that in general “marine management... suffered because all conservation efforts focused on species and not on the environments of the animals involved. A lawyer writing a new law typically constructed protective rules for a given species but forgot to protect the world in which it lived.” And through the work of Norris, Carleton and others, Norris calls the MMPA, “in a modest and awkward way, the first US ecological management law” (Norris 1991).

The marine policy involved in this issue really hasn't changed since Norris was involved and since his colleagues studied the Island of Hawai'i spinner dolphins. The Marine Mammal Protection Act was and continues to be the only major piece of legislation involved in this issue. The language of this act has failed to protect the spinner dolphins from harmful interactions with humans in the coastal waters of the Island of Hawai'i. Since Norris stopped studying the spinner dolphins, the National Marine Fisheries Service added that take under the MMPA also includes operating a vessel “which results in disturbing or molesting a marine mammal” which has implications for this issue as most activities in these bays require a vessel, either a boat or kayak (NMFS, Alaska Regional Office 2008). So although the MMPA prohibits take and harassment, we still have take and harassment of these animals in their resting bays. In addition, the MMPA was not written with an exception for wildlife viewing like it has for scientific research. Scientific

researchers apply for permission to take animals during their research. Tour operators do not have this option so they should be conducting programs so that they do not “take” or “harass” animals (71 FR 57923).

The MMPA provides the mandate for the National Marine Fisheries Service to protect the spinner dolphins. The Hawaiian spinner dolphin is targeted by “swim-with” the dolphin programs on the Island of Hawai’i and on other islands as well and affected by other spinner-related tourism. Managers, scientists, local residents and tour operators have voiced their concern especially about the effects of “swim-with” programs on these dolphins. The National Marine Fisheries Service announced their plan in 2006 to implement time area closures to reduce interactions between humans and dolphins and started funding research to investigate the current status of the spinner dolphins and how they respond to time area closures. According to an update sent out February 16th 2011 by the Protected Resources Division of the Pacific Islands Regional Office, “We are moving forward with the proposed rule and draft EIS to reduce disturbances to Hawaiian spinner dolphins from human interactions. You can expect to hear more about the management strategies in the late spring or early summer.”

Chapter 10: The Bigger Picture- The Total Ecology Approach Recap!

The total ecology of an issue is a combination of the biophysical, human and institutional ecologies (Orbach 2009). Orbach’s description of total ecology is recent, but the idea of understanding the issue from various different viewpoints is not. Kenneth Norris recognized that each of these pieces of Orbach’s total ecology is an important part of the equation. I think that Norris would agree, from reading about how he valued learning

about the history and culture of Hawai'i, that it is important to address and understand each of these three components. The biophysical ecology component includes the place (the Island of Hawai'i but more specifically the Kona coast of the Island of Hawai'i), the resting bays and the focal species, the Hawaiian spinner dolphin. Another important piece of the biophysical ecology is the predictable diurnal behavior of the Hawaiian spinner dolphin. The human ecology component focuses on the people and behaviors "that affect or are affected by... the defined biophysical ecology" (Orbach 2009). The people involved are exclusive "swim-with" tour operators, non-exclusive "swim-with" tour operators (tour operators that do other snorkel programs in addition to "swim-with" programs), snorkel tour operators (not "swim-with" programs), tourists on those programs, researchers, managers (from NOAA, NMFS, and the Marine Mammal Commission (MMC)), residents and other recreational users. The behaviors of concern include swimming or snorkeling with the dolphins, kayaking with the dolphins, kayaking swimming or snorkeling (not with the dolphins just in the same bay), paddle-boarding (with or without the dolphins), and researching. The behaviors that many are particularly concerned with are the ones where people intentionally seek access to the dolphins in the wild. The final portion of the total ecology of this situation is institutional ecology. This part incorporates the agencies with authority and responsibility and those with rules that matter to the humans involved (Orbach 2009). NOAA and NMFS are the major players in this ecology. NMFS, a line office within NOAA, has the authority and responsibility to protect marine mammals as mandated by the MMPA and prepared their Notice of Intent to take regulatory action on this issue in 2006 (71 FR 57923). The regional office and science center involved are the Pacific Islands Regional Office (PIRO) and Pacific Islands Fisheries Science Center (PIFSC).

Chapter 11: The Bigger Picture- Policy Solutions and Alternatives

Since this is a newer issue, these policy solutions are not something that Norris had to think about. Norris' major concern, and one that he was highly involved in, was the issue of dolphin mortality in the tuna fishery. If Norris were still alive I'm sure he would have been called on as an expert as NMFS works on new regulations to reduce interaction between humans and spinner dolphins in their resting bays. These policy solutions were proposed only in the last five years in response to the growth in the swim-with programs and concern about spinner-related tourism on the Island of Hawai'i in the last fifteen years. Norris did recognize the issues that could arise if interaction continued in resting bays but this issue is really the now part of "From Norris to Now." The policy solution for this issue will likely require three steps. The first is that NMFS needs to enforce the MMPA and the current infractions. The second step is to create policy to make enforcement and protection easier. The third step will be to enlist partners to give NMFS more resources to protect the spinner dolphins.

NMFS has the mandate to protect marine mammals under the MMPA. This hasn't changed since Norris studied the dolphins but the issue they are dealing with is new. To enforce the MMPA and do something about these interactions, NMFS has suggested time area closures (77 FR 57923). These closures would close the bays by time (during peak resting time) and by area (closing parts of the bay) and would reduce the number of interactions between humans and spinner dolphins. The alternatives include prohibiting certain activities in resting bays (swimming with the dolphins), a minimum distance limit, a full closure or the no action alternative (77 FR 57923). The minimum distance limit option would likely make the existing voluntary guidelines enforceable. These guidelines are

similar to whale watching regulations that exist for humpback whales in Hawai'i and Alaska. Alaska's humpback whale regulations were created in 2001 to be consistent with Hawai'i's distance limits (established by the Hawaiian Islands Humpback Whale National Marine Sanctuary Act in 1992, the actual regulations can be found in the Federal Register from 1995). Hawai'i's regulations include a 100 yard limit, time restrictions, prohibit leapfrogging and state that human activities shouldn't "disrupt the normal behavior or prior activity of a whale" (60 FR 3775; NMFS, Alaska Regional Office).

We can learn important lessons from these more recent humpback whale regulations.

According to the Alaska humpback whale regulations, "a combination of measures would be more effective than merely having an approach distance" (66 FR 29505). Although the spinner dolphins are not endangered like the humpback whale, they do have "localized aggregations" for resting like the humpback whales have for feeding which makes them accessible for tourism activities (66 FR 29503). We need to find a way to make sure that human activity does "not cause a change in the behavior of the animals" (NMFS, Alaska Regional Office). However, to understand how tour operators are changing behavior we would need a baseline, a time or place when we could observe undisturbed spinner dolphins to understand their normal behavior. The policy or suite of policies implemented needs to afford the dolphins the opportunity to rest in their resting bays.

The Hawaiian Islands Humpback Whale National Marine Sanctuary (HIHWNMS) or State of Hawai'i could be enlisted as partners to aid in protection of the spinner dolphins. The main focus of the HIHWNMS is the humpback whale. However, during the last management plan review in 2002, the sanctuary received comments about expanding to include other resources (HIHWNMS and DAR 2007). The HIHWNMS is again under management plan

review and is considering expanding to other resources including the spinner dolphin (HIHWNMS and DAR 2007). The sanctuary has guidelines for spinner dolphins within its boundaries (50 yard distance limit among others). If the sanctuary does expand to include protection of the spinner dolphins, they would not be protected in the four bays in this study because current sanctuary boundaries do not include these bays. The boundaries would have to expand as well.

To enlist the state of Hawai'i as a partner in protecting the spinner dolphin, the federal government would have to grant the state management rights to protect the non-listed spinner dolphin.

NMFS has proposed time area closures as the suggested management approach. Time area closures, if enforced and monitored well, would likely do the best to protect the spinner dolphins. Time area closures would protect the resting bays and limit interactions ultimately helping this population maintain Optimum Sustainable Population (See MMPA article for more on this topic). I believe the time part of the closure (versus the area closure) would have greater success in reducing interactions in the resting bays. If users are not allowed into the bays while the spinner dolphins are resting, the dolphins will not be harassed during that time. With time closures, care must be taken to keep boats from sitting outside the bays and waiting for the dolphins. This behavior could prevent the dolphins from entering the bay and prevent them from resting. There is evidence that dolphins are most susceptible to disturbance when they are entering their resting bays and that resting dolphins are more difficult to disturb (Norris *et al.* 1994, 3). Thus time closures should include the time when dolphins enter these bays. If bays are closed during "spinner dolphin resting time" this would include mid-morning. Norris *et al.* report that

the dolphins slow down and rest between mid-morning and mid-afternoon for four or five hours (Norris *et al.* 1994, 75, 117). If the bays were closed during this time it would have a great impact on reducing interactions because mid-morning is a busy time for spinner-related tourism and other activity in the bays. If time area closures were implemented there would be effects on more than just the “swim-with” tour operators.

The MMPA’s use of the term habitat could be used to protect the bays. There is evidence that if the dolphins are disturbed while they are in the bay that they will leave that bay (Norris *et al.* 1994, 3). It is unclear where the dolphins go when they leave the bays and whether or not they go to another bay to rest and the quality of that bay. They might go to another bay if it is not already full of dolphins. If a bay is full of dolphins then the overflow dolphins will move up and down the coast until it is time to head back offshore to feed (and not rest) (Norris *et al.* 1994).

I realize that some of the options suggested by NMFS are not the most popular with stakeholders. There is great support for certain aspects of the NMFS proposal and alternatives.

A major theme that emerged from this research and my experience is that the one size fits all approach likely won’t work for these four bays. In addition I suggest exploring the option of giving the state of Hawai’i rights to manage the spinner dolphin. Outreach and education efforts are also essential to reduce the interactions between humans and spinner dolphins in their resting bays. These efforts can increase the number of people who know that the dolphins go to these bays to rest, and that they approach swimmers to make sure that they are not a threat to them.

Chapter 12: The Bigger Picture: Tourism and Eco-tourism in Hawai'i

Swim-with programs and spinner dolphin tourism on the Island of Hawai'i are framed in the bigger picture of eco-tourism, cetacean based tourism and tourism in Hawai'i. I wanted to use the next few articles to write about the history of tourism in Hawaii, eco-tourism in Hawai'i and how eco-tourism can better incorporate Hawaiian values.

Tourism in Hawai'i began in the late 1800's when visitors headed to the islands by steamship to see the volcanoes. The islands became known as the "Paradise of the Pacific" by the 1930's. Then World War II stopped regular tourism on the islands but the increased military presence provided great exposure to the islands (Beletsky, 2000, 2-3). Things changed again in the 1970's around the same time Norris started his studies on the spinner dolphins. People became motivated "to see natural habitats and ... wildlife before they forever vanish from the surface of the earth" (Beletsky, 2000, 4).

Tourism is a major part of the state's economy and has been a major part of the economy for many decades. Today somewhere in the order of 7 million visitors come to the Hawaiian Islands every single year. It is a 10 billion dollar sector. Tourism accounts for about a quarter of the labor force and in 2003 contributed about 171 million dollars to the state's economy and an additional 232 million dollars from a transient accommodation tax established in 1996. (Cusick, McClureb *et al.* 2010) In addition to the money received from the tax, a direct financial benefit, there are also indirect benefits of tourism. "Direct and indirect tourism expenditures represent the largest economic activity in the state and support nearly a quarter of all jobs." (Cusick, McClureb *et al.* 2010)

These numbers haven't always been this high, in 1930 only about 20,000 people visited, by 1970 the numbers were over 1 million. When Kenneth Norris finished his studies the number of visitors per year was close to what they are today at 6.7 million. By 2000, 6.9 million people were visiting the islands every year. Eco-tourism is another type of tourism and a relatively new term. This term was introduced toward the end of Norris' stay on the Island of Hawai'i and has developed since then (note the years on the references in the next few paragraphs). According to Centre of Tourism Policy Studies, Hawai'i has defined eco-tourism as,

Nature based travel to Hawaii's natural attractions to experience and study Hawaii's unique flora, fauna and culture in a manner which is ecologically responsible sustains the well being of the local community, and is infused with the spirit of aloha aina (love of the land) (Encyclopedia of Ecotourism, 2001, 109).

According to the Hawai'i Tourism Authority (HTA), eco-tourism is,

An economically, socially and environmentally sustainable activity that responsibly and authentically connects visitors with Hawaii's natural and cultural landscapes resulting in beneficial exchanges among these landscapes, the host community and the visitor." (Cusick, McClureb *et al.* 2010)

The Pacific Islands Eco-tourism public policy and planning guide generally agrees with these two definitions but instead defines the term by giving four goals, "protection of the environment...economic sustainability...cultural integrity and enhancement...and educational value." Even from these select few definitions, it is easy to see that definitions can be similar but they are certainly not identical, and thus they can be problematic. How does a state implement eco-tourism if there is no one definition, if no one can agree on

what eco-tourism even means? But one these definitions do share is a focus on nature alongside culture and the local community.

So why even bother talking about eco-tourism and Hawai'i? The author of Hawaii: The Ecotravellers' wildlife guide asks this question in the introduction: "Why write a book for wildlife watchers about a place where most people visit only to lie in the sun, swim in the ocean and relax" (Beletsky 2000). The author's answer, because "there's a growing audience for this kind of book" (Beletsky, 2000, xiv). And I think we see this in the growing effort for things to be "green," sustainable, and eco-friendly. Sustainable living and travel,

Existed throughout the Hawaiian Islands prior to the 1800's. Individuals traveled within and between islands by wind and human power, and food from local sources was consumed. In comparison, most of us today routinely travel in devices fueled by imported petroleum, and our food is, for the most part, imported. While our mobility has increased, so has our dependency on resources that are not from these islands. (Cox and Cusick 2006)

Today we have a new interest in sustainability. There is interest in eco-tourism in the Hawaiian Islands and people think that eco-tourism has "economic potential." (Cusick, McClureb *et al.* 2010) And tack on that Hawai'i is easy to access and in a stable country and it becomes an ideal travel destination for ecotourists.

Eco-tourism isn't the major player in Hawai'i's tourism industry. Mass tourism has been the major player in the tourism market in Hawai'i bringing in more than 7 million visitors in 2006. (Cusick, McClureb *et al.* 2010) However, there is interest in different types of tourism in Hawai'i. Some of these other types of tourism include "cultural heritage, health and wellness, agriculture and nature based tourism" that encourage "tourists to leave

resort enclaves and have direct experiences with natural and cultural landscapes” (Cusick, McClureb *et al.* 2010).

In the 1990’s, towards the end of Norris’ stay on the Island of Hawai’i, there was a spike in interest in eco-tourism in Hawai’i. People were hopeful for eco-tourism’s entrance into the tourism market and believed that eco-tourism might be really good for Hawai’i. Of course not every article completely supported eco-tourism, many of them had their concerns, but in general it seemed that people were on board with the idea. So why didn’t we see eco-tourism being broadly marketed for Hawai’i?

In the 1990’s people seemed extremely supportive of eco-tourism but we know that this support wasn’t enough to get eco-tourism established in the state. There were issues with having large landowners plan for eco-tourism ventures. In addition, September 11th had a significant impact on the number of tourists getting to the Hawaiian Islands (Cusick, McClureb *et al.* 2010). Efforts shifted to just returning to and restoring pre September 11th levels of tourism and not eco-tourism (Cusick, McClureb *et al.* 2010). Much of the focus has been on re-establishing and “maintaining Hawai’i’s share of the global tourism market.” (Cox, Saucier *et al.* 2008) One promising statistic for the development of eco-tourism in Hawai’i today is the fact that the average Hawaiian tourist’s profile actually fits with the average ecotourist profile. (Cusick, McClureb *et al.* 2010) The ecotourist market profile puts an average ecotourist between 35 and 54 years old with most being college graduates according to The International Eco-tourism Society’s fact sheet from 2000. (Society 2000)

More recent media attention has focused on the fact that Hawai’i still has potential to develop eco-tourism and to attract a new group of tourists to the islands. Tourism in

Hawai'i is going to have to make changes if the state is going to give eco-tourism and sustainable tourism a go (Cusick, McClureb *et al.* 2010). However, "for Hawai'i to embrace eco-tourism doesn't mean a change in focus but it does mean that there is another attraction in the islands of Aloha to make it a principal holiday destination." (Moore 2001) Eco-tourism in Hawai'i is just another facet of tourism for people to enjoy.

Any eco-tourism policy in Hawai'i needs to focus on the environment, the economy and the local people to be successful and truly eco-tourism. (Pacific Islands Eco-tourism Policy and Planning Guide) The "challenge" will be achieving a balance "between traditional ways and modern practices." (Pacific Islands Eco-tourism Policy and Planning Guide) This policy should aim to protect certain areas to ensure that the natural areas will persist and be able to support this type of tourism for years to come. Another important part of the process is stakeholder involvement to ensure that the policymakers hear the voices of the local people and hopefully listen to those voices to create appropriate policy. The planning and policy guide also stresses the importance of having "indigenous entrepreneurs" on board.

Chapter 13: The Bigger Picture: Cetacean Based Tourism and Spinner Dolphins

With this article I wanted to discuss the spinner dolphins and cetacean based tourism. One thing that relates the last article on eco-tourism is that this type of tourism depends on maintaining the integrity and beauty of natural destinations so it is important and essential for the success of this type of tourism to protect habitat and wildlife from degradation.

Some consider whale watching or cetacean tourism eco-tourism. Yet others argue this claim. In the public testimony for the Spinner Dolphin Human Interaction Environmental Impact Statement, taken from five different public scoping meetings in 2006, Lucy Gay says,

I find that very contradictory to portray tour operators who take visitors to see our natural world as being supportive of eco-tourism. Because for me, ecotourism is defined -- it implies that there is an issue of sustainability, that there is respect for the environment, for the geographic characteristics of the place, the aesthetics, for the heritage and for the well-being of the local people. I don't see any of these aspects of eco-tourism evidenced by the situation we now find ourselves in, very close relative to management action of dolphins.

Whether you consider spinner dolphin tourism, eco-tourism or not, one thing that is certain is that this type of tourism has created conflict between spinner dolphins and humans. In the public testimony, Carl Jellings, a resident of Waianae on Oahu spoke about spinner dolphin tourism on that Island. This information, although it is anecdotal, is extremely important for understanding the swim-with dolphin industry. From the years in this description you can also see how recently this industry has been established in Hawai'i. These tours began a couple of years after Norris published his second book The Hawaiian Spinner Dolphin in 1994. The,

First dolphin tours that started coming off of Waianae I think was in '95 or '96. They started with one boat. I think in '97 we had three boats. In 2000, we had five boats. In 2006, we have twelve boats. By the end of next year, we'll have two more boats coming out of Ko'olina.

If eco-tourism and spinner dolphin tourism catches on even more than it has in the last 15 years, there will be more swim with spinner dolphin programs and more human dolphin interaction. This is going to have to result in even more education on these topics and

interactions (Amante-Helweg 1996). Kenneth Norris spends most of his book Dolphin Days on the plight of the Eastern Tropical Pacific spinner dolphins and their interaction with tuna fishing and not as much on the Hawaiian spinner dolphins. Norris hardly mentions swimming with spinner dolphins. He does say that one of his original key informants used to interact with dolphins in Kealakekua Bay. One thing that Norris does warn about in his book Dolphin Days is the threat of increased human interactions with spinner dolphins during their resting time.

Kealakekua's waters are a reserve now, but many boats continue to use the bay, where they swing at moorings set in the sandy parts of the bay bottom. These boats encroach upon the spinner "sleeping grounds," and if their number increases, if the dolphins' needs aren't considered, the animals will leave and their span of tenancy, which began before that of any man will end as they quietly slip away into the offshore sea (Norris 1991, 67).

Chapter 14: The Bigger Picture: Hawaiian Culture and Values and Tourism

At this point, I'm sure you have picked up on the fact that this isn't an easy issue. It is extremely complex and requires careful and respectful consideration for many different viewpoints. With this article I wanted to bring in Native Hawaiian culture and values and this group's take on swimming with spinner dolphins. If at this point you're thinking, finally, she'll talk about a group of people with a single viewpoint, you would be greatly mistaken. The Native Hawaiian community is very much divided when it comes to opinions on spinner-related tourism and swim-with programs. With this article I wanted to use the spinner dolphin public testimony as the major reference because this testimony is a record of social opinion. I first want to discuss the relationship between Native

Hawaiian culture, values and the tourism industry. Then I will try to illustrate the diverse opinions Native Hawaiians have towards swimming with spinner dolphins.

Tourism is extremely important to Hawai'i's economy but tourism has also drastically changed the state and the people who live in Hawai'i. "The development of tourism broke down some of Hawai'i's social isolation and exposed workers and communities to outside values and customs" (DBEDT 2006). In regards to developing a better tourism industry,

Residents of all islands voiced the need for the industry to encourage more Native Hawaiian participation in tourism as a way to promote cultural authenticity... Hawaii's tourism industry is generally seen by many Native Hawaiians as having... contributed to a degradation of their cultural values, compromised their cultural integrity...diminished their presence in Hawaii's visitor centers, devalued their wahi-pana (sacred places) and seriously compromised a Native Hawaiian sense of place in places like Waikiki. (11)

It is important to have tourism in Hawai'i that Native Hawaiians can be proud of and be a part of. This type of tourism would be "in harmony with our ecosystems" and work towards "enhancing natural beauty and protecting the islands' natural resources...perpetuate...customs and traditions... reinforce....Hawaii's heritage...and protect...sense of place..." (DBEDT, 2006, 72) It is also important to have tourism that reflects Hawaiian values like lōkahi (harmony), mālama `āina (nourishing the land), ho`okipa (hospitality), kuleana (responsibility) and aloha (welcome).

There are approximately 180,000 visitors to the Hawaiian Islands daily according to the summary report "Planning for Sustainable Tourism." And "the State's current set of comprehensive projections expects tourism arrivals to reach 10.8 million by 2030" (22).

Again, tourism is important to Hawai'i and its economy. I think one way to take steps that

make tourism more sensitive to native Hawaiian values is to incorporate some of the ideas of eco-tourism to ensure that tourism is sustainable and does its best to preserve the natural environment and support the local people. Eco-tourism was a major topic in the last article.

So now, how do spinner dolphins and swimming with dolphins fit into the Hawaiian culture? I already said that this is a fractured community and that there is no single or holistic viewpoint that encompasses the entire group. All of these quotes come from the public testimony from 2006. In some cases it is difficult to determine if these people are in fact Native Hawaiians so I can only say that all of the opinions use Hawaiian culture and values to support their opinions. I think that these opinions will illustrate the many opinions and viewpoints present toward swimming with spinner dolphins.

So let's look at quotes from a woman who supports swimming with dolphins. Mahealani Kuamo'o-Henry is a cultural teacher and Hawaiian spiritual Kahu-priestess. Mahealani states in her public testimony that the proposed NMFS regulations,

Would prevent me, my ohana, family and others, from engaging, interacting and swimming with our ocean ohana, our dolphins, nai'a, who share our homeland of Hawaii... My Hawaiian ancestors and ohana members today freely interact with our ocean 'aumākua, and yes, they are 'aumākua to us, guardians and guides, our family, our ocean family.

She says swimming with this ocean family is a common practice. 'Aumākua are a bit more difficult to explain than the other values I explained earlier. "Aumākua are "family or personal gods" that will warn and reprimand "mortals in dreams, visions and calls." Mortals are not to harm or eat 'aumākua (Pukui and Elbert 1986).

Now, quotes from a few people who do not condone swimming with dolphins. Jimmy Medeiros, a Hawaiian cultural environmentalist, said that he wanted to “speak out on behalf of the nai’a.” Medeiros does not condone swimming with the nai’a and says that it is “inappropriate and unacceptable.” The last person to speak in the spinner dolphin public meeting in Kona was Mikihala Roy, a “lifetime resident of Kona and Oihi” she is “also the president of Kulana Huli Honua, Foundation of the Search for Wisdom, a nonprofit foundation based here in Kona and here in Kamakahonu.” She says that the nai’a are ohana (family) and talks about a “strong connection between the people and the nai’a.” Ms. Roy says that “the nai’a are esteemed, beloved family to us” so they should be respected. Leinani Loa also talks about the dolphins always having been ‘aumākua. Ms. Loa talks about how as keiki (children) growing up at Honaunau, the Place of Refuge, they were,

Taught by our parents and our kupuna to respect everything that was around us and as for the spinner dolphins they were always there in the bay and they always were left alone... As keiki, we understood that this ocean belonged to them as well as all other marine sea life and we were entering their environment. Not ours. Theirs.

Ms. Loa spoke about how angry she was to see that people,

Cannot respect the living things in the ocean, and that whenever we approach them, they give us this attitude, like, I paid my ticket to come here so I have every right to do whatever I want, whatever I want and however I want.

Isn't it amazing that Mahealani and Leinani use some of the same words but have very different opinions? Like I said, this community has very different views and opinions. I hope that this illustrates some of those differences but also will speak to how views and opinions differ in other groups involved in this issue. If you thought this group would have

a single viewpoint, imagine how complex and complicated the views of tour operators and other groups might be.

I have been using these past few articles to discuss the bigger picture. Kenneth Norris tried to use different research approaches to learn about the dolphins but Kenneth Norris also knew that politics, culture, language, etc. are all part of the equation and that you must be “be “up for solving such equations” because they are part of just about every field biologist’s work” (Norris 1991, 153). Norris liked learning about the history of where he did his field work. As outsiders to Kealahou Bay, Norris stresses that he and his team “had to try and cross the cultural barrier... to understand the world we had invaded so that we could know how to act with subtlety and consideration” (155). Norris even recognized how the bay that he worked in was a battleground where ancient Hawaiian culture and patterns “were pitted against the predatory sprawl of commercial America.” He echoed many of the sentiments above that the tourist culture, “often mocks, and worse, ignores the dignity of their past, making cardboard cutouts of their lives and history.” To gain the trust and respect of his neighbors in Kealahou Bay Norris did what he could to embrace the culture and to honor it in a respectful way. Norris and the rest of the team put on a luau to introduce the team and their project to the people of Kealahou Bay. They invited Leon Stirling who was minister at a Baptist church in Kailua-Kona to welcome everyone at the luau. Stirling set the tone by saying,

I am just a man. I can't do anything special for you but I can ask that you be a friend to the nai'a. Don't do anything to harm them, for they were here long before any of us, even the Hawaiian people. What you visitors to Hawai'i take from the islands try to give back to her in full measure.

Norris took the time to understand Hawaiian culture and values. He made sure to introduce himself and to try to show the people who lived at Kealahou that he respected them and their culture. The SAPPHERE project aims to do the same, to be considerate and respectful of the Hawaiian culture. Unfortunately I don't think everyone is so considerate. If eco-tourism develops in the state and tourism becomes more sustainable, eco-friendly and considerate of local people, then people who visit the islands will have ways to learn about Hawaiian culture and values and to do the same.

Chapter 15: A day in the life of a Hawaiian spinner dolphin: Overview

These next few articles focus on what a Hawaiian spinner dolphin's day is like. I will use this one as more of an overview. In the next two I discuss the progression and development in knowledge in the areas of spinner dolphin foraging and rest. Much of the information in this article was established by Kenneth Norris. There are a few small pieces of this overview that are recent discoveries but those will be further explained in the next two. I explore the differences between a person's schedule and a spinner dolphin's schedule and invite readers to think about the differences and how interruption of any of the dolphin's activities could impact their health and well-being. Think about how the interruption of your activities affects your health and well-being.

Chapter 16: A day in the life of a Hawaiian Spinner Dolphin: Feeding

The title of the entire collection of articles is From Norris to Now and emphasizes comparing historical and present day management and research. When my advisors and I came up with the idea for this collection of articles I wanted to try to address what Norris

knew when he and his colleagues studied the population and what we know now. In some articles this is hard to do because we haven't learned a whole lot since Norris and his colleagues set up camp on the Island of Hawai'i. But foraging is different. This is one of the most exciting articles for me in the sense that we have learned so much since Norris and his colleagues tracked and followed spinner dolphins to see where the dolphins went at night and started to understand their feeding patterns. Through the work of scientists like Kelly Benoit-Bird and Whitlow Au we have learned A LOT about spinner dolphin feeding and have actually started to answer questions that Kenneth Norris and his colleagues asked when they studied the dolphins and have confirmed some of the initial thoughts of Norris and his colleagues. This article showcases what we can learn from a population if research continues.

So what did Norris and his colleagues know? What did they find out?

They knew that the dolphins can travel very far during feeding. Through radio-tracking they found that "they had traversed almost the entire length of the Kona Coast in a single night" (Norris 1991, 172). At this time Norris wasn't sure if the dolphins had a "favorite spot" to feed. Through this tracking they found out that they didn't go to a certain spot, they zig-zagged around following their food.

Dolphin schools from the various rest areas move a rather short distance offshore then traverse back and forth along the island slope all night, edging toward shore as dawn approaches (Norris *et al.* 1994, 91).

They knew they were feeding off of a layer that moved close to the surface at night called the deep scattering layer. The dolphins feed on the mesopelagic organisms that are part of this layer.

Spinner dolphins feed on vertical migrant or scattering layer organisms that rise from deep water near dusk and on benthic organisms that may be hidden during the day and that are deep below the surface when the sun is high (Norris *et al.* 1995, 76).

They knew that sound was something they should be thinking about. Norris asked in Dolphin Days “what kinds of sounds did they make in the dark, and what might they be used for (204)?” They found that clicks were used throughout feeding which makes sense when you think about echolocation allows an animal to “see” with sound when they cannot see with their eyes. “Since the spinner dolphin feeds in black nighttime water, the prey must be followed by using echolocation or bioluminescence” (Norris *et al.* 1994, 218). However, they also found that the dolphins whistled constantly. This is an interesting difference between Norris’ findings and more recent research.

They suspected the feeding was maybe “somehow a group process” (81) and knew that the dolphins were organized and somewhat synchronized seeing as they “swam in well-formed schools” (204).

They knew that the dolphins are nocturnal feeders (Norris and Dohl 1980).

They knew through studies of stomach contents that they eat squid, shrimp and fish (Norris *et al.* 1994, 225).

They knew that there must be some way the dolphins stayed coordinated.

They swam in well-formed schools that obviously required a means of communication between animals. We suspected that more than the click trains were required to achieve such nighttime synchrony, since clicks were emitted in directional beams, hardly suitable for keeping an entire school informed (Norris 1991, 204).

They knew this and they suspected whistles or some other acoustic communication mechanism be used to communicate and stay synchronized and “pass information rather quickly across the school in dark water” (Norris and Dohl 1980). This is restated in Benoit-Bird and Au (2009) that “it was hypothesized that the strong group coordination is maintained by acoustic communication.”

But Bernd and Melany Würsig, two of the people on Norris’ team joined by Frank Cipriano say in a chapter of Dolphin Societies, “we know rather little about group sizes and behaviors of spinner dolphins while they are feeding at night” (103). Kelly Benoit-Bird and Whitlow Au would find a way almost 20 years later to figure out group size and how spinner dolphins behave while they are feeding.

So what do we know now?

That the dolphins are following the scattering layer they feed on “both vertically and horizontally” (K. J. Benoit-Bird and Au 2003). Au and Benoit-Bird refer to this layer as “the mesopelagic boundary community” (Au and Benoit-Bird 2008). The reason the dolphins need to follow this layer both vertically and horizontally is because they are time limited and have “high energetic needs” (K. Benoit-Bird and Au 2009a). “This limitation lends support to the idea that spinner dolphins need to follow both inshore/upward and offshore/downward migrations of their prey” (K. J. Benoit-Bird and Au 2003).

That the dolphins “need to consume an estimated minimum of 1.25 large prey items per minute to meet their maintenance energy needs” or “3-4 average sized prey” per minute (K. J. Benoit-Bird and Au 2003; K. Benoit-Bird and Au 2009a). This highlights the need for spinner dolphin feeding to be extremely efficient. Spinner dolphin feeding isn’t limited by

the amount of prey, “spinner dolphin foraging is limited by time” (K. J. Benoit-Bird and Au 2003).

The dolphins have a complex pattern of coordination they use while feeding. This is how Benoit-Bird and Au describe this coordination fully described in their article “Cooperative prey herding by the pelagic dolphin, *Stenella longirostris*.” This description comes from their other 2009 article “Phonation behavior of cooperatively foraging spinner dolphins.”

First, 8–14 pairs of dolphins swam in a widely spaced line in which they search for an existing patch within the prey field. Second, dolphins reduced their interpair spacing, a stage termed “tight line,” and began to undulate their swimming path up and down. During this phase of foraging, the density of prey began to increase as the prey avoided the dolphins and piled up on itself as snow in front of a plow. During the third phase of foraging, dolphins formed a circle around the increased density prey patch which distributed the prey more evenly over the circle. Finally, individual pairs of dolphins moved inside the circle to actively feed on the most dense regions of the patch while other animals continued to maintain the patch by swimming around it. Two pairs of dolphins moved into the circle at the same time, from opposite sides of the circle for about 10 s of feeding before taking their place at the circle’s edge and allowing the pairs behind them into the circle. Each pair of dolphins got an average of 45 s inside the region of most dense prey in each approximately 5 min foraging bout.

And the dolphins know to take advantage of this 45 seconds by finding the patch with the highest density while inside the circle (K. Benoit-Bird and Au 2009b). And for those of you who are visual this is the pattern they found as reprinted in their 2009 Phonation Behavior article.

The dolphins are potentially using clicks “directly or indirectly to cue group movement during foraging, potentially by detecting other individuals’ positions in the group or serving

a direct communicative role” (K. Benoit-Bird and Au 2009a). The original prediction was that the dolphins use whistles to coordinate their efforts but they didn’t record many whistles (K. Benoit-Bird and Au 2009a). They also predicted that “echolocation would be used primarily to target individual prey... This would suggest that clicks should be identified when animals were inside the circle” when it was their turn to feed, “however, the number of clicks detected when animals were inside the circle was amongst the lowest measured” (K. Benoit-Bird and Au 2009a). So what were the clicks they recorded being used for? Benoit-Bird and Au suggest that they are used in “transitions between stages when animals were changing formation” and “this suggests that clicks may be important in coordinating the group” (K. Benoit-Bird and Au 2009a). Almost like a football coach calling the play. One call coordinates a whole set of movements. This is an interesting idea because Benoit-Bird and Au are suggesting that clicks are being used for communication. So clicks are potentially multi-purpose sounds!

The dolphins feed cooperatively so that they can aggregate their prey and deal with the time and efficiency limitations of their feeding (K. Benoit-Bird and Au 2009a). They use “precise coordination in... four-dimensional patterns to increase prey density by up to 200 times” (K. Benoit-Bird and Au 2009b). This cooperation has emerged because the dolphins are better off working as a group than they would be working on their own (K. Benoit-Bird and Au 2009b, 2009a). “Spinner dolphins worked collectively to achieve densities of prey that did not occur in the habitat in the absence of this dolphin behavior” (K. Benoit-Bird and Au 2009b).

There was no evidence of cheating in these coordinated feeding patterns. The dolphins take turns feeding inside the circle thus supporting the evolution of this cooperative feeding strategy (K. Benoit-Bird and Au 2009b).

With advances in technology, Benoit-Bird and Whitlow Au were able to support some of Norris' ideas and to answer some of the questions people had about spinner dolphin foraging. The major difference: the research continued after Norris stopped and someone continued to ask and try to answer questions related to spinner dolphin foraging ecology. Maybe it was because Whitlow Au who was extremely interested and kept on it and recruited Kelly Benoit-Bird to work with him on the topic. Maybe they wanted to try out a new piece of technology with potential applications to finding out how spinner dolphins feed?

Chapter 17: A Day in the Life of a Hawaiian Spinner Dolphin: Resting

As promised this part of the Day in the Life series will focus on spinner dolphin resting. I hesitate to call it sleep because it really isn't sleep like we think of it. I also want to introduce the concept of vigilance. This concept is extremely important and helps highlight why rest is so important for these dolphins. And why am I spending a whole article on rest? Norris *et al.* (1994) said it best, "no pattern during the dolphin day is more distinct than rest" (81).

Before we launch into talking about resting in more detail I should point out that rest is not the only class of activity in the bays. There are, according to Norris *et al.* (1994), "at least two major classes of activity" that "take place during bay residence: rest and active

swimming-socializing. Rest may be the primary reason for residence in bays” (75). Why? Because rest’s “duration of 4-5 hr[s]” lines up “with the minimum” amount of time dolphins spend in these bays (75).

As I mentioned in the overview of the daily life of the spinner dolphin, dolphin rest is nothing like the type of rest or sleep we’re accustomed to. Dolphins rest one hemisphere of their brain at a time. And why would a dolphin do that? Dolphins live in the open ocean, in a very open sea with very little protection. The Hawaiian spinner dolphins find protection in shallow bays and choose to rest there, but even there they are still vulnerable. So the dolphins rest one hemisphere at a time so they are aware enough to be able to react to something if it is necessary (and breathe!). From what I can find, this research was discovered by L.M. Mukhametov and described in 1987 but Mukhametov did research in 1977 and 1984 that probably led up to his discovery in 1987. “Dolphin sleep is unlike typical mammalian sleep in that slow wave sleep occurs in one hemisphere at a time and rapid eye movement (REM) sleep is apparently reduced or absent” (Goley 1999).

Before scientists knew that dolphins rest like this, which was towards the end of Norris work on the Island of Hawai‘i spinner dolphins, Norris and Dohl published their 1980 article stating that the Hawaiian spinner dolphins rested. They defined resting behavior as making longer dives, reducing aerial behavior, reducing acoustic activity and swimming synchronously with other dolphins in the bay (Norris *et al.* 1994, 81-87). Norris describes rest elsewhere in Dolphin Days like this,

By the time they swam below our cliff-top seat they moved almost furtively, tightly bunched and they spent nearly all their time below the surface. This... condition we came to think of as rest. It occurred in mid-

to late morning, and always over a patch of white coral sand lying close inshore near the black cliff of Kealakekua. Rest lasted from four to five hours, and ended with remarkable abruptness (73).

This type of resting behavior, according to Norris, is much like a school of fish. Norris says that “school members coming into the bay suppress their individuality, tighten and in effect their schools come to be structured much like those of schooling fish” (Norris *et al.* 1994, 148). This schooling behavior gives the group of dolphins protection, safety in numbers. He called it “the carpet formation” and talks about how “all we heard from those carpet formations were a few faint clicks” (75). During rest the dolphins “became all but silent” and rely on their vision rather than on sound (Norris *et al.* 1994, 80).

The dolphins also seem to make decisions as a group. Norris talks about how the first interaction with a group of dolphins “is a touchy time.” He warns that if the dolphins “hadn’t yet made some sort of group decision to sleep” they might leave but “if we let them descend toward rest, they would stay and tolerate us quite well” (Norris *et al.* 1994, 219). My experience out on the water seems to support this idea that if you approach the dolphins slowly and carefully that they “tolerate” you in the bay with them. This happened on one occasion, I think I have talked about this day before, the one where we arrived as the only boat in the bay and approached the dolphins slowly and carefully. The dolphins tolerated our presence that day. If we got a little too close they would move a little farther away but for the most part we shared the bay that day. That soon changed when 10 boats showed up for swim-with dolphin programs and the dolphins left the bay. I remember sitting on the boat, timing the dives of the dolphins, they would be under for about 2 minutes and then almost like clockwork they all would surface together and then dive

again. I think that this period of time, before the other boats arrived, was one of only a handful of times that I think I saw a group of spinner dolphins rest.

I have talked about the resting bays before but just as a refresher, these bays are very important for the dolphins. They provide a place to rest, protection from predators (theoretically) and are within close proximity to feeding grounds offshore. According to Norris the dolphins used Kealakekua Bay “on about 70 percent of calm water days” (Norris, 1994, 31). Norris even talks about where “the dolphins always headed... the same place in the bay—that patch of white coral sand right at the base of the cliff, and right next to the boat moorings. And there, day after day, they swam quietly in the curious pattern of dolphin rest” (Norris *et al.* 1994, 76-77). According to Courbis and Timmel (2009) there has been a shift in the high use area from a study done in 1968 to the studies done by Norris and more recently by Courbis and Timmel in 2009. The dolphins now use an area closer to the “keyhole.” This is a piece of the cliff that looks like a keyhole and the dolphins are protected in this area. Boats are not supposed to go past this keyhole into the dolphin sanctuary. Speaking of boats, Ken Norris talks about the fact that boats at the time he studied K Bay “were accepted as parts of the landscape” (Norris *et al.* 1994, 135). Are the boats still accepted as a part of the landscape of the bay? Our boat was accepted that day on the water in Makako Bay and we saw acceptance in other bays as well. But we also saw dolphins that didn’t seem to accept the boats at all. Maybe it was the number of boats, or perhaps the noise they created in the bay, or the snorkelers they dropped in the water...

Although rest is a predictable diurnal behavior, there is a fair bit of variability in rest according to Norris. I am very curious whether the data and the information that comes out

of the SAPPHIRE Project will support this variability. Norris talks about how the amount of time spent in the bays varies “throughout the year” (157). “The average number of hours a dolphin school occupied Kealakekua Bay varied... from 6.9 hr in summer...to 5.1 hr in winter” (Norris, 1994, 47). The dolphins rest for about four to five of these hours (Norris *et al.* 1994, 69). Norris *et al.* write, “the visually mediated rest period begins around midday and extends into the afternoon. It is a time of tight, cohesive, slow-moving schools” (141).

In addition “the size of the bay-dwelling schools” changed “drastically from day to day” (166). We now say that these dolphins exist in a fission-fusion society. Norris saw this as well. “Their associations seemed to be something that happened only now and then. It was like old friends meeting for a gab session before each went his way” (167).

One thing to mention is that all bays are not equal. There are bays that are better than others, have dolphins more often than others and bays that support more dolphins than others. Norris hypothesized that “the depth and width of the offshore shelf near a rest cove seemed to determine whether or not it would be occupied by dolphins. If the ocean was shallow for a long way before the island drop-off was reached, dolphins were not likely to use it” (174). Norris follows this up by saying “if it took too much energy commuting to a rest cove, the cove would go begging, no matter how nice its sandy spots might be” (174).

In The Hawaiian Spinner Dolphin Norris *et al.* specify close by saying that “feeding dolphins...often approached or traveled over the 1000-fathom contour... the closer to shore this contour runs, the more likely we were to sight spinner dolphin schools there” (Norris *et al.* 1994, 41). This makes sense. Would you want to swim to a resting bay that is not convenient for feeding because it is far from potential feeding grounds? I would say no, I

would want to stay as close to my food source as possible so when it was time to eat, it requires the minimum amount of energy to get offshore and find a place to forage.

Variation also exists in the carrying capacity of a bay. The carrying capacity is the number of dolphins a certain bay could support, essentially the ideal number of dolphins in a bay.

Norris hypothesized that it was “related to the area of white sand: a large sand area, a lot of dolphins; a small sand area, a few dolphins” (174). This seemed like “the most obvious feature that could determine these ‘carrying capacities’ of rest sites” (Norris, 1994 51).

Although I didn’t see it while I was out in Hawai’i, Norris also talks about how if a bay was full of dolphins, for example, if Kealakekua “had its full complement of... dolphins, newly arrived schools passed it by without entering” (173). And sometimes the reason for not entering a bay is related to weather. Norris found that “when storms roiled the waters in rest coves, the dolphins would leave for quieter, clearer waters where they could see their predators” (174-175).

Since Kenneth Norris and his colleagues studied the bays there have been a few studies with application to this article. In a study by Courbis and Timmel, they found that mean group size is consistent with Norris *et al.* from 1994. Courbis and Timmel report the mean dolphin group size to be 27.1 dolphins plus or minus about five. However, there are some major differences between the findings of this study and the research done by Norris and his colleagues. Courbis and Timmel write “comparison of the results of our study with previous studies indicates that the pattern of aerial behaviors during the day has changed over time in Kealakekua Bay” (Courbis and Timmel 2009). More in relation to rest but also indicating that something might have changed, Courbis and Timmel found “small peaks in

mean aerial behavior per hour in the morning and late afternoon” but “those peaks were not significant” which,

Suggests the number of aerial behaviors occurring in the midday, during what was considered the rest period by Norris *et al.* (1994), has increased, and/or the number of aerial behaviors occurring in the morning and late afternoon has decreased” (Courbis and Timmel 2009).

This is tempered by the fact that similar results to what Norris *et al.* describe were found in studies on O'ahu by Lammers in 2004. Courbis *et al.* warn that the “changes in preference” for certain areas of a bay (mentioned before) “could be precursors to abandonment of the bay as vessel traffic continues to increase” (Courbis and Timmel 2009). They also stress how changes in behavior, especially changes to resting behavior could have serious biological effects.

Because rest is one of the most important activities for spinner dolphins in Hawaiian bays, changes in resting patterns are potentially biologically important. Although Norris and Dohl (1980) describe rest as very quiescent, only occasionally punctuated by aerial behavior, in our study, there was some aerial activity during times when the group was at rest. Unlike during Norris and Dohl's (1980) study, dolphins never went without aerial behaviors for large portions of the day during our observations. Interruption of rest by approaching vessels and swimmers was frequently observed during our study and rarely observed during Norris and Dohl's (1980) study. Others have also reported disturbance of spinner dolphins at rest. For example, Würsig (1996) reported that spinner dolphins in Kealahou Bay prematurely curtailed resting during repeated boat and swimmer approaches (Courbis and Timmel 2009).

Another study showed that “rest appeared delayed and compressed” in the dolphins they studied on O'ahu at Maku'a Beach even though the average time spent in the bays in this

study was actually comparable to what Kenneth Norris found (Danil *et al.* 2005). Another more recent article highlights the difference in behavior of spinner dolphins in the remote Hawaiian Islands. “There is no fission fusion effect” there and the dolphins have more geographic and social fidelity (Karczmarski *et al.* 2005). This is in stark contrast to the fission fusion society Norris and others describe for the main Hawaiian Islands. Other articles about spinner dolphin rest on O’ahu find different behaviors associated with these dolphins as compared to those on the Island of Hawaii” (Lammers 2004).

One common thread to most of these recent articles is that they warn readers about the danger of increasing interaction and changes in behavior. This relates to the idea of vigilance. When the word vigilance or being vigilant is used what do you think of? I think of someone standing watch and looking out for danger. Vigilance is essentially anytime when an animal needs to be more alert and be able to process information. Think about all the times in the day you have to process information. When you interact with others, when you’re driving to work, when you’re making meals, when you’re on the phone, etc. So when do spinner dolphins need to be vigilant? Basically all night when they’re feeding offshore. That’s quite a long time and feeding as we have learned requires complex patterns of coordination and you can imagine is tiring physically and mentally. So when do the dolphins take the time to rest and get back the energy they need to go back out and do it all again successfully? I think you have a pretty good idea. In these bays we have been talking about. The dolphins need this time in their resting bays to regain what is called a “vigilance decrement.” Think about when you’ve had a bad night’s sleep, nightmares, couldn’t fall asleep, couldn’t stay asleep whatever it might be. Now how do you feel the next day? I don’t

know about you but I know I feel tired and confused and I don't process things very well and it usually ends up that I say funny things because I just don't have the amount of energy I need to be "vigilant" and to process all of the information I need to process during the day. Spinner dolphins need time to recover from feeding offshore all night. They do this in their resting bays during the day. So what happens when there are 10 boats in the bay or people who swim up to the dolphins, or 20 kayaks paddling around? How do you think that affects the spinner dolphins? If they're not getting the time to rest what do you think that might be affecting? Their ability to feed, their ability to interact with other dolphins, possibly reproduction? When you don't get the time you need to rest, what does it affect? I'm sure no one would disagree with this statement, rest is important for people. So why wouldn't it be for spinner dolphins? And let's face it, their daily lives aren't easy!

Chapter 18: Population Abundance- How many spinner dolphins are there?

So you might ask, "Heather, how many Hawaiian spinner dolphins are there?" Or better yet, "Heather, how many dolphins frequent the waters around the Island of Hawai'i?" And I would have to say, we really don't know. Or I guess I could say "well that's a very good question" because that usually means I have no idea. So this will be a very quick article because honestly there is no good answer to that question. Very little work has been done on estimating the number of Hawaiian spinner dolphins. And this makes this question very frustrating. This seems like a vital piece of information, a pretty standard piece of information and yet no one can answer it, or I should say no one can really answer it well.

In January 2011, NOAA put out a new fact sheet on the spinner dolphin. This sheet is a collection of frequently asked questions and the best answers we have for them. Some of

these questions have been answered in previous blogs like “what time of day do they go out and search for food” or “what do spinner dolphins eat?” But this new favorite question also appears on this fact sheet.

Q: How many spinner dolphins are there? And the answer, according to this fact sheet,

“Scientists are not sure how many dolphins live in the Hawaiian Islands. The most recent estimate of the spinner dolphin population is 3,351 individuals. This number comes from a (2002) ship line-transect survey done with the U.S. Exclusive Economic Zone (EEZ) waters surrounding the Hawaiian Islands. This estimate is probably low because the ship could not get into shallow waters where spinner dolphins are found during much of the daytime. The most closely studied population of spinner dolphins is located around the Big Island of Hawai‘i. According to 1989-1992 photo-identification data, there are an estimated 2,334 individuals in this area.”

So what about this 2002 survey... The survey was done in summer and fall of 2002 and submitted to Marine Mammal Science and published in 2006. This survey looked for all types of cetaceans, not just spinner dolphins. This article says “there is little quantitative information on the abundance of cetaceans around Hawai‘i” (Barlow 2006). One thing to remember is that this survey wasn’t done to determine the population abundance of spinner dolphins. “The motivation for this survey was to determine if cetaceans in this area are sufficiently abundant to support the levels of bycatch estimated for the Hawaii-based longline fishery” (Barlow 2006). Barlow is critical of the abundance numbers achieved by this survey and says, “even though abundance could be estimated for most of the species known to exist in Hawaiian waters, the precision of these estimates is generally poor... all

abundance estimates are based on less than 25 sightings of each species in the study area” (Barlow 2006). Barlow talks about the spinner dolphins and says that

The dolphin that people most commonly associate with Hawai‘i is the spinner dolphin, but our study indicates that they are mostly concentrated near the main Hawaiian Islands and are not very abundant outside our Main Island stratum” which is where the survey focused its effort (Barlow 2006).

And the subsequent question on the fact sheet...

Q: Is the spinner dolphin population declining? And the answer is basically we don’t have enough information right now. These two questions and modifications of these questions are two of the major questions that led to the SAPPHIRE Project. Since there wasn’t a good answer NOAA decided to fund the SAPPHIRE Project and to try to get good numbers for these questions to inform their decisions. So even though we really can’t answer this question well, the exciting part is that the SAPPHIRE Project has methods in place to answer these questions and my colleagues and friends are working on the data as I write.

So why haven’t we gotten a population abundance estimation? Yet another good question. It isn’t because people thought it was a useless piece of information. In Courbis and Timmel (2009) only two years ago they say how “Renewed efforts at photo-identification may also be useful in assessing whether animals are using multiple bays and if they return to specific bays multiple times. This could also provide insight into calving and mortality rates.” Norris *et al.* say “our study does not allow us to resolve the dynamics of the Hawaiian spinner population nor to provide a very precise estimate of numbers frequenting the island of Hawai‘i” (139). But the numbers they do give are that “the minimum number of dolphins

within the population that frequents the shore of the island of Hawai'i at 960 animals" and after talking about a few assumptions and caveats Norris *et al.* arrive at a number of between 1,000 and 2,000 dolphins (140).

So hopefully we'll get a better estimate of population abundance soon from the photo-identification work on the Island of Hawai'i.

Chapter 19: Sounds of the Spinner Dolphin

I want to use this article to talk about spinner dolphin acoustics. This, like foraging, is another topic that has seen research continue since Kenneth Norris and Shannon Brownlee studied the dolphins. In the article about dolphin rest I talked a little bit about spinner dolphin acoustics, really just that the dolphins depend on vision rather than sound when they're resting. I want to use this article to talk about the sounds the spinner dolphins make and more about spinner dolphin acoustics.

The dolphins make different classes of sounds: clicks, whistles and burst-pulse sounds (Norris *et al.* 1994, 169). Clicks are quick and are mostly associated with echolocation.

They are "broadband" meaning they cover a very wide range of frequencies. The clicks span a great range of frequencies, much greater than if you look at a single whistle.

Whistles come in all shapes and sizes. And all of the other sounds are the burst-pulse sounds. These burst-pulse sounds sometimes sound like buzzes, quacks, chirps, meows, barks; basically they can sound like a circus.

Kenneth Norris pioneered the research on the Big Island's spinner dolphins and their acoustic activity. Norris and his colleagues focused on Kealakekua Bay. The general pattern is that the dolphins are noisy when active and silent while resting (Norris *et al.* 1994).

As the dolphins traverse slowly back and forth over sandy bottom, and if the school is of moderate or small size, only sporadic low level clicks and occasional whistles are heard. Overall sound abundance correlates generally with activity level, being low in low activity states such as rest and the slow-moving part of zig-zag swimming and high when schools are moving more rapidly (Norris *et al.* 1994, 161).

Norris and Brownlee also discuss the incredible capability dolphins have to extract “meaningful signals from considerable levels of noise” (Norris *et al.* 1994, 165). Noise in these bays includes sounds from living things like snapping shrimp and other animals, but also from non-living things like wind and water flow as well as anthropogenic sources like boats and snorkelers. The ocean is quite a noisy place and the dolphins need to be able to pick out the important things from all that noise.

Dolphins are clearly adapted perceptually to extract information from the background of ocean noise. Both their click trains and whistle emissions seem to be conformed to maximize the animal's opportunity to do this. The clicks are given in long, repetitive trains having a repetition rate that is idiosyncratic to a given emitting animal, and whistles are usually signals that change frequency in a rather stereotyped pattern over time. (Norris *et al.* 1994, 166)

Back to what Norris knew about the different types of sounds the spinner dolphins make: clicks, whistles and burst-pulse sounds. Clicks are produced during all types of behaviors and at all times of the day but are least frequent when the dolphins are resting (Norris *et al.* 1994, 178). Most whistles, according to Norris, “sweep upward in frequency” (Norris *et al.* 1994, 176). Whistles are produced throughout the day but are most frequent at dusk and

night-time. The abundance of whistles “does not vary more than about two-fold over the day” (Norris *et al.* 1994, 178). An interesting outcome from Norris’ work was that they did not see any sine whistles in their recordings. This was not the case for the recordings from this summer, sine whistles accounted for about half the whistles recorded in Kealakekua Bay one day. As for the burst-pulse signals; there are two types, repetition rate and multiple transient signals (Norris *et al.* 1994). How I remember the difference between the two is that repetition rate signals are repeated clicks. You can see that the sound is made up of individual clicks, these usually sound like buzzes. Multiple transients cannot be resolved into simple click trains (Norris *et al.* 1994, 170). Norris *et al.* refrain from classifying or describing burst-pulse signals further because these signals sound like cows (moo’s), ducks (quacks), birds (chirps), dogs (barks) and hyenas. Their main point though is that the dolphins are “acoustically silent” during rest.

Since Norris, Bazúa-Durán *et al.* (2002) classified the spinner dolphin whistles into six types of whistles: constant frequency, up-sweep, down-sweep, concave, convex and sine (Bazúa-Durán and Au 2002). And it was exciting that in just one day we heard each of these types of whistles!

Also since Norris and Brownlee, there have been even more studies looking at the characteristics of these whistles. The mean beginning frequency for whistles of the Hawaiian Spinner dolphin is 10.4 kHz, mean end 12.4 kHz, mean minimum 9.1 kHz and mean maximum 13.7 kHz (Oswald, Barlow *et al.* 2003). Bazúa-Durán *et al.* (2002) found the mean beginning frequency is 12.02 kHz, mean end 14.91 kHz, mean minimum 10.68 kHz and mean maximum 16.50 kHz.

Another researcher that has spent a lot of time on the sounds of the spinner dolphins is Marc Lammers. Some of the major findings and topics for Lammers' research include the following: that spinner dolphin whistles have harmonics (Lammers 2003). Lammers also researched whistles and burst pulse sounds and how these two types of sounds are used differently (Lammers 2003, 2006). He states that whistles are used for maintaining contact and to keep a group coordinated while burst pulse sounds are more directional and used in closer contact signaling (Lammers 2003, 2006).

I now want to give you a little taste of the now part of spinner dolphin acoustics as it relates to the SAPPHIRE Project This information comes from preliminary acoustic data collected during July and August 2010. I analyzed this data and compared two of the resting bays on the Kona coast of the Island of Hawai'i. What I found from this preliminary data is that Kealakekua Bay and Ho'okena (Kauhako Bay) display different amounts of acoustic activity and provide a possible gradient of sound between a more active bay (Kealakekua) and a quieter bay (Ho'okena). As the project continues over the next three years we will be able to confirm or reject results from this preliminary study. The two focus bays have very different characteristics. Kealakekua Bay and Kauhako Bay (Ho'okena Beach Park) are different in terms of the user groups that use the bay, major interactive behaviors in the bay, the location of the bay and the activity in the bay. Ho'okena is a quiet bay with significantly less activity than Kealakekua.

Some of my results include:

- All six whistles (upsweep, downsweep, sine, constant, concave and convex) were recorded in both of the bays. (Norris didn't record sine whistles, kind of strange).
- The most common type of whistle for both bays was upsweep! (Same as Norris!)

- The amount of acoustic activity in both of the bays was strikingly different between the two bays. The maximum number of whistles in a 30 second recording was 75 for K Bay and 41 for Ho'okena. The mean or the average for K Bay was 19.4 while the mean for Ho'okena was 5.8 whistles per recording.
- The number of whistles in Kealakekua Bay decreases with a decrease in the number of kayakers present in the bay.

We eventually hope to make links between acoustic behavior, aerial behavior and human activity in the bays. Linking acoustic behavior to behavioral state isn't a new idea. This has been in the literature since Bengtson and Fitzgerald in 1985 (they were studying manatees). The most recent article by Bruno Díaz López suggests that whistles in bottlenose dolphins can predict behavioral state (Díaz López 2010). In my preliminary study I found that acoustic activity seems to correlate with the number of behaviors in Ho'okena. An increase in acoustic activity is matched by an increase in the number of behaviors.

Norris and Brownlee (1994) stated that the dolphins are acoustically silent during rest. My results did not agree with this former finding. Dolphins are not acoustically silent for any extended period of time. This could mean that the dolphins are not resting. Or it could be that the amount of sound we recorded is the new minimum level of sound in the bays, the "new silent." It might be that the dolphins aren't silent anymore. The situation in these bays has changed dramatically since the time that Norris studied them. This might be the new "resting" or this level of sound might imply that they are not resting like they used to before the increase in cetacean tourism. Another complicating factor is that the timing of rest behavior could be different for each of these bays. Dolphins could enter the bays

earlier and rest earlier than these recordings. Another thing to note is that the technology Norris was using was obviously different than what we are using today. I would love to get my hands on some of the recordings Norris made and sometimes I think about how cool it would be to go to the bays today and use the equipment Norris and Brownlee used to record the dolphins years ago. During the last few months, my SAPPHIRE Project colleagues have been deploying the loggers and I hope that the recordings they have made will help answer some of these questions about what is normal, when acoustic activity is low in each of the bays, etc.

In regards to whistles produced by the spinner dolphins I found that the number of whistles varies by much more than two-fold over the few hours we recorded, disagreeing with Norris' statement that "abundance does not vary more than about two-fold over the day" (Norris *et al.* 1994, 178). Future recordings will give us a much longer time series and understand how these sounds vary throughout the day.

From these preliminary files, Ho'okena seems to be quieter than Kealakekua in terms of the amount of dolphin sound and the number of whistles. As I continue to process and analyze files it will be interesting to see if this pattern continues and how the other bays compare as loggers are deployed in the other two bays now. But what we don't know about these files is what stage of rest the dolphins were in while we were recording. These recording sessions were opportunistic; we went out looking for the dolphins. Sometimes it took 30 minutes and sometimes it took a couple of hours. It is possible that dolphins rest earlier in Ho'okena and the recordings we made that day were actually of dolphins coming out of rest. More recordings will help clear up some of this uncertainty. In addition, it would be useful to get a baseline where tourism (and human effects) is not an issue.

As I mentioned, further research will help confirm or reject the preliminary results from this study. SAPPHIRE project research assistants are collecting data to remove some of the biases and limitations included in this study. The SAPPHIRE project is set to collect acoustics data along with theodolite tracking and photo identification information for the next two years. So stay tuned!

Chapter 20: Women in Science and Women and the Spinner Dolphins

This week I had the honor of hearing Dr. Jane Goodall speak at Duke University. She created a path for future researchers and scientists, especially women. I was so excited to hear her speak. Jane Goodall started her work on chimpanzees 50 years ago and now she travels the world talking about her experiences for the better part of the year. Her work and her “I can do anything” attitude led to more acceptance for women in science and appreciation for the insight and perspectives women bring to science. Listening to her was like listening to the grandmother of women scientists.

She talked for a few minutes about her childhood and how that allowed her to become Dr. Jane. She told stories of taking earthworms to bed, watching chickens lay eggs and reading books like Dr. Doolittle that helped create the dream of going to Africa, living there and writing about it. But Jane said that at the time, she was “a mere girl” and that people laughed when they heard this dream because “girls didn’t get to have adventures like that.” It was a different time and for the most part girls didn’t have adventures like that. But boy did she show them. And who told her she could do it? Mom.

At 23 years old she set off to Africa. This too was very unconventional in the 1960's. It certainly wasn't common to have a young woman set off to live in Africa. But she wasn't going alone. Her mother first decided to let her go and then decided to be a companion for Jane in her travels. Jane said that her mother was really the brave one and that while they were there her mother helped boost her morale when it needed boosting and opened up a clinic with some medical supplies they were sent with which established a great relationship with the local people. Jane learned in her 50 years at Gombe National Park that good chimpanzee Moms are patient, protective, affectionate, and supportive. I think her mom was all of those things and more.

The idea for this article came from a few pages in Kenneth Norris' Dolphin Days book where he actually talks about Jane Goodall. Then I found out that Dr. Jane was going to be speaking at Duke and quickly figured out how we could get a live telecast down to the Duke Marine Lab in Beaufort. I want to quote a fair bit of what Kenneth Norris says in Dolphin Days about women in science and women involved with his project in Hawai'i.

"You may have noticed that most of the young scholars at Hana Nai'a were adventurous women" just like Jane Goodall who set off on her life's adventures at 23. "That happened because a quite remarkable change has swept over the science of animal behavior in the last three decades (when I entered field science in the late 1940's nearly all field work was dominated by males, women, it was assumed, didn't do rugged field work)" for they were mere women" as Jane Goodall would say. "Women scientists in unprecedented numbers have now moved into the tropical forest, onto the tundra and everywhere else on earth along with the more traditional "field men." Meetings of the Animal Behavior Society are

now delightful assemblies populated by men and women alike.” Norris saw this progress in the 50 years between when he started his field work and when Dolphin Days was published. And how did Norris feel about women entering the ranks of “field men?” He calls it refreshing.

It’s not just that the numbers of women are so refreshing...but the viewpoints brought by women have forever changed the face of science. They have helped to make it complete in a deep scientific sense. Jane Goodall, with her remarkable work on chimpanzees, was certainly among those who led that vanguard. She showed that a very patient and undemanding person could break down the barrier between humans and animals and make friends. She let animal behaviorists move into the space discovered earlier by cultural anthropologists who found they could learn most... within the society they chose to study (Norris 1991).

Norris calls himself an “archetypical male” in the chapter and admits that some of the things he learned early on are “hard to shake loose.” But he realizes that the things that women began to take notice of and record were important and totally different than what the men were looking for before they arrived on the scene.

I agree with Norris, probably because I am a result of this movement and this change, that, “the change... is the splendid indication of both science and a people coming of age. It now seems so obvious to me that in order to truly understand a wild animal society or parenthetically our own, we need both these viewpoints in equal measure.” This book came as a reflection on his time spent studying the spinner dolphins so Norris says that “none of this was much on my mind when the young women began to drift into the Hana Nai’a camp. Each of them simply seemed like somebody with a lot of ideas, a lot of energy and integrity.” And that is really all that matters.

Today the young women on the SAPPHIRE Project greatly outnumber the men involved. And that is thanks to people like Jane Goodall who paved the way for people like me and all of my other friends on the SAPPHIRE Project and other projects in the US and around the world. It is also thanks to people like Kenneth Norris who saw the value in including women in projects like Hana Nai'a and gave women like Shannon Brownlee, Melany Würsig and Jody Solow a chance. Women used to be a minority in science. This wasn't that long ago, the 1940's according to Kenneth Norris. By 1960 Jane Goodall was making a name for herself. By 1962 Rachel Carson published Silent Spring, catapulting the environmental movement into full gear. By 1982 Rachel Smolker started the Monkey Mia Dolphin Project. All of these women have been role models for me. I vividly remember standing in the library of my elementary school and picking out a children's biography of Rachel Carson. In high school I convinced my chemistry teacher that my book report on a chemist could be a book by Rachel Smolker, even though she clearly wasn't a chemist. This story isn't unique. I know this isn't just something I did when I was little. I have friends who picked other strong women for book reports and projects, other women who paved the way in their respective areas of science.

Another woman that paved the way, quite a long time ago was a woman named Mabel Osgood Wright. I didn't know about Mabel until only about a week ago when I pitched the idea of writing something on women in science to Dr. David Johnston. He immediately started searching his bookshelves for a book called Conserving Words: How American Nature Writers Shaped the Environmental Movement by Daniel J. Philippon (2004) talking about how I needed to read the chapter about her. This book's focus is "on the individual nature writers whose actions had influence on their-and our-world" (xii). Mabel Osgood

Wright represents one of five cases Philippon discusses, cases where “a nature writer was prominently involved in the formation and development of an environmental organization” (2). She wrote The Friendship of Nature in 1894 and continued writing and publishing books through the early 1900's. Her work was instrumental in reviving the National Audubon Society (2).

The chapter on Mabel highlights her work in the Connecticut Audubon Society and the National Association of Audubon Societies. “In addition, it discusses the importance of the flower garden as a locus for women’s efforts in the conservation movement” (73). Wright actually “helped to broaden the audience for environmental reform” by including suburban women and taking conservation to their backyards (73). Mabel used the garden as a way to celebrate nature but also to empower women to “foster change through both publication and public action” (80). Mabel was on the forefront of women in science and conservation and what is even more impressive is that most of this came before women were given the right to vote (81). As a sign of the times, Mabel actually submitted much of her original writing anonymously to the New York Times, even her husband didn’t know she was writing to The Times (82). Her early pieces formed her book The Friendship of Nature which was well received by critics and readers. Mabel inspired people with her writing and got people excited about nature and learning from it. She even discusses “threats to plant habitat and animal populations” and was “outraged” by the use of bird “parts, skins and feathers... to decorate women’s hats” (86).

Something that made me smile while reading the chapter on Mabel was her work educating children about nature and writing children’s books. Some of my most rewarding

experiences have been in classrooms giving presentations to young children and getting them excited about the ocean and its creatures, much like Mabel did during her bird classes.

Mabel is credited with helping revive the National Audubon Society, this “second attempt... succeeded in part because of the community-based efforts of women” (94). The goals of her Connecticut Audubon Society, “discourage the purchase or use of the feathers of any birds... discourage the destruction of birds and their eggs, and do all in their power to protect them” (94). These guidelines also suggested the establishment of a “Bird Day” in Connecticut schools. Mabel later got involved with Audubon on the national level and when she “resigned from the board... the remaining members informed her that “the unanimous feeling was that this Association, the subject of ornithology, and the cause of conservation of wild life all owe to you the deepest debt of gratitude for your service” (96).

So although it may not seem like a lot, Mabel was extremely important in establishing women in conservation and science. She used children’s books, magazine articles, books and talks to spread the word and get others excited about conservation. She got people to act. Her work paved the way for women after her who influenced women like Jane Goodall, Rachel Carson and Rachel Smolker who influence and pave the way for people like me. I cannot speak for them but I’m sure these women or others like them paved the way for Dr. Kelly Benoit-Bird a scientist who worked on spinner dolphin foraging ecology and just received the “Genius Award” given out by the Society of Marine Mammalogy (She just got a MacArthur Foundation prize too!). They paved the way for Dr. Carmen Bazúa-Durán who focused her work on the sounds of the spinner dolphins.

All of this thanks to a movement and a change, a change instigated by some people who will probably never be recognized as much as they should. All of the eagles and the feathers that guided all of these women and helped them achieve great things.

Discussion and Conclusions

As this project developed I thought that it would be interesting to put this retrospective analysis into a timeline. I would include the important dates for publications, management and policies among other important events (See Appendix). I thought that looking at this timeline might point out some interesting things.

Something that is extremely evident from looking at the timeline is the topic and the authors of the majority of the research published since Norris passed away in 1998. This is when the acoustics research greatly increased related to the sounds the spinner dolphins make and how these sounds relate to foraging. Some of the key research since 1998 was done by Whitlow Au, Marc Lammers, Kelly Benoit-Bird and Carmen Bazúa-Durán. This research is associated with the University of Hawai'i and Dr. Whitlow Au is the common thread among each of the other researchers. Dr. Au has spent many years researching and finding people who are interested in spinner dolphin research but especially research that involves acoustic techniques.

From looking at the first part of this timeline it is easy to see the foundation being set for the research and the interest to come but also the swim-with industry and the conflict that would come later. People were being exposed to TV shows and books that introduced

them to marine mammals. Places like SeaWorld were opening up around the country and the number of visitors to Hawai'i was also increasing.

A few specific events acted as catalysts for the concern for Hawaiian spinner dolphins. In particular, the meeting of the Marine Mammal Commission held in Kona in 2004 led to an increase in spinner dolphin research especially research focused on interactions between humans and spinner dolphins. This meeting and the information that started to appear in the Federal Register stimulated the increased attention and concern for these species and we can see this concern in the topics of published research and the creation of the SAPPHIRE Project.

Although spinner dolphin ecology and management encompasses many different areas, some major themes emerged from my retrospective analysis. One of these themes is that there is a continuum or a spectrum in spinner dolphin research and management. In some cases we have continued to make great strides in spinner dolphin research. In areas like foraging and acoustics, scientists like Marc Lammers, Whitlow Au, Kelly Benoit-Bird, Carmen Bazúa-Durán and others have continued to ask questions, create hypotheses and study the Hawaiian spinner dolphins. However in other areas research has been lacking (effects of tourism on the population) or completely missing (population abundance). By failing to continue research especially in areas like population abundance and effects of tourism on this population we have lost the ability to move forward. We have seen that when research stops it puts future management effort at risk. When research continues in the long-term scientists can answer questions and move forward with the science. When

research stops, like it did for many topics after Kenneth Norris packed up his camp, it really hindered forward progress. Essentially we keep asking and answering the same questions.

When NMFS brought the time area closure to the table people started asking questions, relatively simple questions, questions we would have been able to answer if scientists had continued to study this population. When NMFS put out their notice of intent and suggested time area closures to reduce interactions between humans and spinner dolphins there was a public outcry that NMFS didn't have enough information to make that kind of decision. The public said that NMFS didn't have a good abundance estimate, didn't know the effects of tourism on the spinner dolphins, didn't know if there was a decline in population and didn't know if there was a negative effect. This was partly true, NMFS didn't have all the information they would have liked. If we had continued research on the Hawaiian spinner dolphins this would have been one of the most well-studied populations of cetaceans in the world. We would have been able to answer questions about the trajectory of the population and whether the population has declined since the rise in spinner-related tourism. Around the world scientists like Lars Bejder, David Lusseau and others are looking at the effects of tourism on cetacean behavior. The science has progressed but at some point it left the spinner dolphins behind. At some point focus shifted to other areas of the world, to different cetacean populations, to different areas of interest, but when it did, it put these dolphins in jeopardy. Now the focus is on them and NMFS decided to fund the SAPPHIRE Project to investigate these questions quantitatively. The SAPPHIRE Project will gather baseline information now and then gather information after the rule is implemented. The new data can then be compared to this baseline information and will help inform and tailor NMFS' next steps. We knew so much about the

population when Kenneth Norris studied the dolphins and we have learned a lot since then, but there are still things that are lacking. To move forward we need good abundance estimations and we need to quantitatively address the effects of tourism on these dolphins. The good news is that the SAPPHIRE Project was funded to do just this, now we just have to do it.

Another major theme is that a one science and a one size fits all approach isn't the best approach for management in the bays. More broadly though, a one size fits all approach isn't appropriate for a retrospective analysis like this one. I found value in using both natural and social science in this analysis. Social science is an important component that has been lacking in this issue. How do people feel about the dolphins? How do people feel about closing bays? What do they know about the dolphins and what they're doing in the bays? Not only is this important information for NMFS as they move forward with their proposed regulations but it is also important for continued education efforts. What is that people need to know that they don't know now? What is the best way to get that information out? All we have is the public testimony from the scoping meetings as a record of public opinion on this issue; but this likely has a certain bias. It could be that the people only on both extremes came to these meetings to voice their opinions (those who were greatly in favor and those who were greatly opposed to the proposed regulations). It is important to understand the general sentiments of the population, not just of these two extremes.

In addition, I think it is important to explore the idea of community-based stewardship in Hawai'i. Is it possible to get the community involved and organized to take steps to protect

the dolphins? Maybe we find out that it is too hard, the opinions are too varied and it isn't possible to get people to self organize and self govern. Or maybe we will see that in the bays where self governance has emerged, people can take on this larger goal of protecting the dolphins without top down government regulations.

Taking the time to research and try to understand each piece of the total ecology equation is important and can help avoid conflict down the line. It can also help stakeholders understand why certain things are true in a given situation. They might be related to culture, history, values, or something else but taking the time at the start to learn about these areas can be very useful. I have found that looking at the spinner dolphins from various different viewpoints gives me a better understanding of this very complex issue. I don't look at a bay and only think about the habitat it offers the dolphins. I think about a bay in terms of the human users of that bay, the sound of the dolphins in the bay, the history of that bay, the bay as a common pool resource, etc.

Yet another theme is that there will be new theories and new fields that will emerge and change the way we think about certain issues. One example from this project is from Elinor Ostrom and common pool resource theory. This theory offers a new way to think about the spinner dolphin resting bay and could suggest that self governance is possible for these bays. The important thing is to be open to these new ideas.

There is still a great opportunity for future research on this population. The research that follows the time area closures will be extremely important to assess the success of these closures. Some of the areas I researched show more room for growth while others are well-developed. One question that has emerged from this project is why have some areas

progressed and not others? Perhaps it is thanks to people like Dr. Whitlow Au who come at the issue with the unique set of tools and knowledge to quickly find out a lot about a certain topic. Dr. Au has also successfully found people like Kelly Benoit-Bird, Marc Lammers and Carmen Bazúa-Durán to collaborate with who are also great scientists. So maybe it is a team of great scientists and researchers with the perfect set of tools, knowledge, passion and focus that together push research forward in that area. Or maybe it is due to advances in technology that have applications to certain areas like foraging and acoustics. It could be because of funding agency preference or preference for research that has some conservation application or can help resolve a problem. In this case, the needs of the National Marine Fisheries Service have had a hand in scientific progress. But there are greater themes woven through the spinner dolphin story and they have certainly had a hand in the evolution of this issue and thus how it has progressed. What new theories will emerge in the next fifty years and how will that affect developments in spinner dolphin research and management? What areas will see increased research attention in the near future?

The most important thing is to recognize that humans are a part of this system. People are critical in all of this. We have an effect on the ecosystem and we are strongly coupled with this natural system. So it is important to understand not only the biophysical ecology component but also the human and institutional ecology components as well. Policy is the management of humans and human behaviors. So it is impossible to understand an issue without understanding the human element. This is why I think the social science aspect and understanding the Hawaiian community is integral to NMFS' success. It will also be imperative to continue to identify and support the people who care about this work and

can do the work in a rigorous way. The National Marine Fisheries Service should invest in long-term research on this population. If research stops after the initial funding for the SAPPHIRE project is done, we will be back where we started when Kenneth Norris finished his work. We will know so much about the population. But what will happen? Will we continue to study the population or let important areas like population abundance and effects of tourism slip again?

The SAPPHIRE project is a great first step to regaining an understanding of this population. I hope that after the three years are up that many of the aspects of this project continue. I hope that rigorous mark recapture photo identification continues, that we continue to keep tabs on the populations and continue to monitor the possible effects of this type of tourism on the spinner dolphins.

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Appendix

Timeline: From Norris to Now, By Heather Heenehan	
1828	John Gray describes the spinner dolphin
-to-	
1928	
1929	
1930	Hawai'i becomes the "Paradise of the Pacific"
-to-	
1940	
1941	
1942	
1943	
1944	
1945	End of WWII
-to-	
1955	
1956	
1957	
1958	1st Sea Hunt Broadcast
1959	Introduction of Commercial Jet Service
1959	
1960	
1961	Norris approached about Sea Life Park Exhibit, Last Sea Hunt Broadcast
1962	Rachel Carson publishes <u>Silent Spring</u> launching the environmental movement
1963	
1964	1st Flipper Broadcast
1964	SeaWorld San Diego opens
1965	
1966	
1967	Last Flipper Broadcast
1968	1st Episode of The Undersea World of Jacques Cousteau, his most influential series
1969	Kealakekua Bay established as a Marine Life Conservation District
1970	People want to visit Hawai'i to see "natural habitats and wildlife," The number of visitors to Hawai'i is over 1 million
1971	

1972	US Marine Mammal Protection Act
1973	SeaWorld Orlando opens
1974	Kenneth Norris Starts his research on the Hawaiian Spinner Dolphin, Watkins and Schevill publish their article "Listening to Hawaiian Spinner Porpoises"
1975	Last Episode of The Undersea World of Jacques Cousteau
1976	
1977	
1978	
1979	
1980	Norris and Dohl publish "Behavior of the Hawaiian Spinner Dolphin" in Fishery Bulletin
1981	
1982	
1983	Last Spinner Dolphin Released from Sea Life Park
1984	
1985	
1986	
1987	
1988	SeaWorld San Antonio opens
1989	
1990	Ostrom's first book on Common Pool Resource called <u>Governing the Commons</u>
1991	<u>Dolphin Days</u> is published , Other possible start of dolphin tours, specifically on Oahu
1992	Hawaiian Islands Humpback Whale National Marine Sanctuary Established
1993	
1994	<u>The Hawaiian Spinner Dolphin</u> is published, MMPA Amendments
1995	Potential Beginnings of Swim-with tours, Federal Register: Hawai'i Humpback Whale Regulations
1996	Hawai'i implements a transient accommodation tax, Lammers and Au: "Broadband recording of social acoustic signals"
1997	
1998	Kenneth Norris Passes Away , Hawai'i Wildlife Law Passed, Norris and Pryor: publish Dolphin Societies
1999	<u>Conservation and Management of Marine Mammals</u> Published, LeDuc <i>et al.</i> : Genetics
2000	Discovery Cove opens in Orlando, The number of visitors to Hawai'i nears 7 million,
2001	First Episode of the Series Blue Planet, Federal Register: Humpback Whale regulations implemented in Alaska, September 11th
2002	HIHWNMS Management Plan Review, Cetacean Abundance Survey Conducted, Bazúa-Durán and Au: "The whistles of Hawaiian Spinner dolphins"

2003	Benoit-Bird and Au: Spinner Dolphin Foraging Article published, Lammers and Au: Directionality in the whistles of Hawaiian spinner dolphins, Lammers <i>et al.</i> : 2 Other spinner dolphin acoustics articles
2004	Marine Mammal Commission Meeting Held in Kona , Lammers: "Occurrence and Behavior," Bazúa-Durán: Spinner dolphin acoustics article published, Bazúa-Durán and Au: "Geographic variations in the whistles of spinner dolphins"
2005	Karczmarski, Würsig, <i>et al.</i> Spinner Dolphin of Midway study, Moreno et al: Genus <i>Stenella</i> is non-monophyletic and artificial, Ostrom Publishes <u>Understanding Institutional Diversity</u> , Wild Dolphin Foundation writes Petition Letter, Danil <i>et al.</i> : Study of dolphin behavior on O'ahu
2006	NMFS Advance Notice of Proposed Rule Making, Public Scoping Meetings held for new spinner dolphin regulations, J. Barlow publishes the results from the 2002 Abundance Survey in Marine Mammal Science , Lammers et al: Another acoustics article on spinner dolphins
2007	Deflour: Study of spinner dolphins and dolphin watching on O'ahu
2008	Au and Benoit-Bird: Spinner Dolphin Foraging Article published
2009	Earth Film produced by BBC, Courbis and Timmel: "Effects of vessels and swimmers on behavior..." Newest version of Encyclopedia of Marine Mammals published, Elinor Ostrom receives the Nobel Prize, Benoit-Bird and Au: Two Spinner Dolphin Foraging Articles published, Hu <i>et al.</i> : Study on the "Economic Values of Dolphin Excursions in Hawai'i"
2010	SeaWorld trainer Dawn Brancheau dies, SAPPHIRE Project Starts , Andrews and Karczmarski: "Rolling Stone and Stable Homes..." Cusick and McClureb: "Representations of ecotourism in Hawaii" HIHWNMS Management Plan Review: possibility of including spinner dolphins in the sanctuary
2011	
to	
2030	The number of visitors is expected to be 10.8 million