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Inspiring Conservation Leadership

Nicks n Notches

Annual Summary from the Chicago Zoological Society's Sarasota Dolphin Research Program

January 2017

The mission of the

Chicago Zoological Society

is to inspire conservation leadership by connecting people with nature.

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The Role of a Reference Population

Randall Wells, Director
The Chicago Zoological Society's Sarasota Dolphin Research Program

Concerns for dolphin populations typically arise when there is a significant increase in stranding rates, or when populations are exposed to threats in the environment such as toxic chemicals or biotoxins from harmful algal blooms. It is often not possible to clearly identify cause-effect relationships for impacts on dolphin populations. Except for cases such as those involving attached fishing gear, for example, the proximal reasons for dolphin morbidity or mortality, or for population decline, are often not obvious, or they are obscured by secondary disease processes by the time they strand.

In the absence of a clear "smoking gun," investigations of dolphin populations of concern often apply a "weight of evidence" approach, based on comparative studies across populations. These studies look for patterns of consistent differences between populations in terms of health, reproduction, and/or population parameters. Resulting correlations are then investigated through targeted hypothesis testing research when possible, and by delving into available scientific literature from laboratory and field studies, to try to identify underlying mechanisms that could reasonably connect the observed differences with the hypothesized causes. Alternative hypotheses are developed and examined, leading ultimately to the most parsimonious explanation that can be supported, and not refuted, by the available data.

Comparative approaches require appropriate reference datasets for comparison. The Chicago Zoological Society operates "the world's longest-running study of a wild dolphin population," and this research has led to the development of "the gold standard" in terms of a reference population. Decades of data collected on the health, reproductive parameters, survival, behavior, and population parameters of the long-term resident Sarasota Bay dolphins provide unique baselines for comparison, and these have been used by NOAA and others to help to: 1) define health problems as well as declines in survival and reproduction, and quantify impacts resulting from the *Deepwater Horizon* oil spill, 2) identify and quantify health and reproductive effects of PCBs from a superfund site in Georgia, and 3) identify health issues associated with an unusual mortality event from biotoxins in the Florida panhandle. In addition, published research findings on health, reproduction, and social structure, and reference ranges for body condition and stress hormones, are applied frequently to the benefit of dolphins under human care.

In addition to the reference data from Sarasota Bay dolphins, the comparative approach also benefits from development and testing of field techniques that occurs because of the wealth of background information available on the long-term resident dolphins. The application of well-tested, standardized research approaches across studies greatly facilitates comparisons.

The comparative approach has proved incredibly effective for advancing our knowledge of the animals and their ability to respond to threats, and for informing legal cases leading to restoration of impacted populations, as with the *Deepwater Horizon* oil spill, for example. However, the reference data must meet rigorous scientific, and in some cases legal, standards, and this can only be done through continuous and consistent data collection and management. Disruptions to the data stream can have profound implications. It must also be recognized that baselines may change over time, especially in response to global climate disruption. Continuation of the long-term efforts of the Sarasota Dolphin Research Program provides opportunities to both detect and characterize changes resulting from climate change, and also to remain current as baselines shift.

Your involvement in helping the Sarasota Dolphin Research Program and its many collaborators to continue to meet this important need for dolphin conservation is much appreciated.

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In This Issue

Our Approach Toward Helping Dolphins

Our desire with each research and conservation project in Florida or elsewhere is to contribute to a better understanding of the structure and dynamics of populations of small cetaceans (dolphins, whales, and porpoises), as well as the natural and anthropogenic factors (factors of human origin) that impact them. We use an interdisciplinary and collaborative approach in conducting studies of bottlenose dolphins within a unique long-term natural laboratory. The primary goals of our program include:

1. collecting biological, behavioral, ecological, and health data of importance to the conservation of small cetaceans, especially bottlenose dolphins;
2. providing requisite information for bottlenose dolphin conservation to wildlife management agencies;
3. disseminating the information generated by our program to scientific and general audiences in order to aid dolphin conservation efforts;
4. using our model program to develop and refine hypotheses regarding bottlenose dolphins in other parts of the species' range as well as other species of small cetaceans;
5. using the established natural laboratory to develop and test new research tools and methodologies of potential benefit to conservation efforts;
6. training cetacean conservation workers and students from around the world in the use of these techniques;
7. applying our unique expertise to dolphin rescue operations and post-release follow-up monitoring; and
8. applying the information we gather from free-ranging dolphins to improve the quality of care for dolphins in zoological park settings.

The collaborative work done toward achieving these goals is conducted under the umbrella of the "Sarasota Dolphin Research Program." This name links the efforts of several organizations and individuals that work together to ensure the continuity of the long-term dolphin research in Sarasota Bay. The SDRP has been operated by the Chicago Zoological Society (CZS) since 1989. Dolphin Biology Research Institute, a Sarasota-based 501{c}3 non-profit corporation established in 1982, provides logistical support with its fleet of small research vessels, towing vehicles, computers, cameras, field equipment, etc. Since 1992, the program has been based at Mote Marine Laboratory on City Island in Sarasota Bay, with office, storage and dock space, and easy access to boat launching ramps. The SDRP maintains academic connections including graduate student opportunities primarily through the University of Florida, the University of California, Santa Cruz, and Duke University.

All of our bottlenose dolphin research in the United States is conducted under NOAA Fisheries Service Scientific Research Permit No. 15543 and Institutional Animal Care and Use Committee approvals through the appropriate institutions.

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The field team in Barataria Bay, Louisiana at the end of the 2016 health assessment project to investigate the persistently high rate of reproductive failure in dolphins following the Deepwater Horizon oil spill.

Deepwater Horizon follow-up health assessments in Barataria Bay

Cynthia Smith, National Marine Mammal Foundation and Randall Wells, Chicago Zoological Society

In the aftermath of the *Deepwater Horizon* (DWH) catastrophe, impacts to bottlenose dolphins in heavily oiled coastal areas of the northern Gulf of Mexico were well documented. Necropsies of the recovered carcasses and comparative studies of live dolphins within the DWH oil spill footprint vs. those from reference sites such as Sarasota Bay confirmed lung injury and adrenal gland lesions consistent with known effects of oil or petroleum-associated compounds. In addition, a high incidence of reproductive failure was concluded from a lack of calves being observed during monitoring surveys of pregnant dolphins – only 20% of documented pregnancies in Barataria Bay resulted in observed live calves, as compared to 83% for the reference population in Sarasota Bay.

Although the exact mechanism of reproductive failure has not yet been determined, proposed factors include compromised maternal health (specifically, lung disease), direct oil-related toxic effects to the reproductive system, complications related to adrenal system dysfunction, and immune system perturbations leading to an increased susceptibility to reproductive pathogens. The underlying factors for the observed reproductive impairment are a critical but lingering research question. Addressing this question is essential to understand the process for bottlenose dolphin recovery specific to the DWH oil spill, and also to assess population risk and predict recovery trajectories for future spill events involving dolphins or other less-well-studied cetaceans.

With support through the Gulf of Mexico Research Initiative environmental effects and science of ecosystem recovery theme, we initiated a multi-year project in 2016. The project is adapting and testing cutting edge medical technologies for evaluating potential reproductive system disorders, and integrating these technologies for dolphin capture-release health assessments in Barataria Bay. Recent advances in diagnostic ultrasonography for cetaceans developed by the NMMF were adapted for field studies and applied in recent Gulf dolphin studies (2010-2014) to identify manifestations of lung disease. This project is expanding the ultrasonographic techniques and adding new medical diagnostics for identifying fetal/placental abnormalities and maternal disease conditions that are likely to result in a negative outcome. In addition, conditions such as lung and adrenal gland disease that were described in dolphins from Barataria Bay following the DWH spill are continuing to be assessed to determine trends of disease recovery and potential association with reproductive outcome. During July 2016, 38 dolphins were sampled and examined in Barataria Bay. Ten of these received satellite-linked transmitters, and these are showing a continuing strong pattern of local residency to Barataria Bay and vicinity.

The project also involves retrospective and prospective analysis of samples from the Navy's Marine Mammal Program to develop insight into diagnostic indicators and their change over the course of a pregnancy in relation to reproductive outcome. In addition, the project is also characterizing disease states from dolphin carcasses recovered near Barataria Bay in order to assess trends in fetal distress, in utero infections and fetal characteristics.

Although the Barataria Bay and other nearshore dolphins were certainly not the only cetacean species or populations exposed to DWH oil, their coastal, shallow-water distribution and their small size relative to other continental shelf and pelagic species makes them the most accessible cetaceans to study oil-spill related health and reproductive effects. They also provide an opportunity to evaluate change in disease prevalence that indicates recovery from such effects over time. The paired studies using the Barataria Bay and Navy dolphin populations not only provide a mechanism to refine and validate new and innovative diagnostics, but also lend additional insight into the progression of disease that increases the risk of a negative reproductive outcome.

Bottlenose dolphin being released with a satellite-linked tag following health assessment in Barataria Bay, Louisiana in 2013. Oil spill clean-up operations continue in the distant background. Photo by NOAA.

Human interactions in Sarasota Bay

Katie McHugh, Chicago Zoological Society

Human population and recreational use within coastal ecosystems is rising, and dolphins and other wildlife face increasing problems due to frequent interactions with boating, fishing, and wildlife viewing activities within their ranges. Close encounters with boats or fishing gear can injure or kill dolphins, and repeated disturbance from human activities disrupts critical natural behaviors including feeding, nursing, or resting. In addition, intentional or accidental feeding by people contributes to risky unnatural behaviors such as begging, scavenging, and taking bait or catch directly from active fishing gear, which put dolphins and their dependent young in harm's way.

As of 2016, more than 40% of resident Sarasota Bay dolphins have been observed engaging in behaviors of concern and ~20% have suffered from human-related injuries such as boat strikes and entanglements or hookings. Many more individuals have faced frequent harassment from recreational boaters and tour operators. To improve this situation, the SDRP works to understand and alleviate adverse human interactions (HI) by conducting research in the long-term "natural laboratory" of Sarasota Bay, including monitoring HI trends and testing mitigation techniques, providing rescue and post-release monitoring support for injured animals, and participating in education and outreach efforts intended to reach a wide audience.

We recently completed a study funded by the Mississippi-Alabama Sea Grant Consortium which used long-term archives alongside new data on human interactions and prey availability to determine the primary factors contributing to the spread and persistence of unnatural foraging behaviors in Sarasota Bay, and connections between risky behaviors and human-related injuries.

This research is crucial to effective outreach and management efforts, and several publications from the work are forthcoming.

Fortunately, HI observations in Sarasota Bay remain less frequent as compared to major hotspots in the southeastern USA. However, with new individuals incorporating unnatural behaviors into their repertoires and suffering from boat or fishing gear-related injuries each year, we are committed to a sustained focus on reducing potentially dangerous behaviors by both dolphins and humans. To this end, and with support from the Disney Conservation Fund, we are developing a solution-focused community conservation program aimed at engaging local user groups whose activities can put dolphins at risk. Through these new programs, stakeholders will learn best practices for boating and fishing near wildlife, reducing marine debris to reduce entanglement, and reporting injured animals to facilitate intervention. Stay tuned for ways in which you can join us in these efforts!

Personal watercraft operators demonstrating what NOT to do when viewing wild dolphins. On average, dolphins in Sarasota Bay encounter boats every 6 minutes, with repeated disruption to their behavior. Make it a positive experience for all by maintaining a safe distance of at least 50 yards and putting your engine in neutral when dolphins are near.

A comparative analysis of the spatial and temporal distributions of bottlenose dolphins and recreational boating in Sarasota Bay, Florida

Fernando Noriega Betancourt, University of Florida

About 5% of resident bottlenose dolphins in Sarasota Bay bear scars from having been struck by boat propellers. While many people consider dolphins to be too quick and nimble to be struck by boats, this is clearly not the case. For my Master's thesis, I evaluated the spatial and temporal distribution patterns of recreational boating and bottlenose dolphins in Sarasota Bay to investigate some of the factors that might lead to boat strikes.

Analyses were conducted in a geographic information system (GIS) based on two previously compiled datasets. The first depicts recreational boating patterns based on 1,973 digitized travel routes, totaling more than 30,000 km in length and 1,552 destinations from map-based mail surveys conducted in 2003 and 2005 by the Florida Sea Grant Boating and Waterway Planning Program at the University of Florida. The second dataset consists of monthly, boat-based, bottlenose dolphin photographic identification surveys completed during 2002-2006 by the Sarasota Dolphin Research Program. The dataset includes 1,656 dolphin sighting locations, representing 5,227 dolphins, and 20,006 km of survey boat travel routes. Relative abundance, encounter rate and concentration of dolphins and boating activities were calculated and compared for 4 seasons, 3 depth categories, and 6 habitat types to determine which seasons and areas have a high relative risk of co-occurrence that may lead to injury or disturbance.

Boating activity was highly seasonal, reaching its peak among sampled boaters (primarily Florida residents) during May-July, and dolphin abundance within my subsection of the SDRP study area was highest during August-October. Dolphin concentration was greatest in 1-2.7 m depths and boating concentration was greatest in depths >2.7 m during all seasons. Dolphin concentration was greatest in the habitat "Pass" in all seasons except during May-July, when boating activity peaks, and was also most highly concentrated in the habitat "Pass." Location Quotient Analyses were performed to evaluate concentration levels in each depth category and habitat type relative to the entire study area. Dolphin concentrations were higher than expected in depths 1-2.7 m and >2.7 m and in "Channels" and "Passes." Boating concentrations were higher than expected in depths >2.7 m and in "Passes," "Channels," and "Open Bay." Dolphin locations were concentrated in areas where recreational boats follow predictable routes. Also, "Passes" and "Channels" constitute areas where boaters are less likely to engage in other activities than at other habitats (i.e., "Sandflat"), thus, dolphins may quickly resume their activities once a vessel has navigated through rather than enduring its presence for a long time. The results from the present study could be of use in the development of management strategies and educational programs.

Clockwise from top left: Sarasota residents 2151, F222, Otter, and Noah all bearing propeller wounds from close encounters with boaters. The damage isn't just cosmetic; Otter eventually succumbed to the severity of his injuries 5 days after his wounds were first documented by SDRP staff.

Testing tackle modifications and fish descender tools for reducing dolphin depredation and scavenging of sport fish

Steve Shippee, along with Katie McHugh and Randall Wells, Chicago Zoological Society

Dolphins face risks of injury because they frequently approach sport fishing vessels and piers in Sarasota Bay, as well as at offshore reefs and coastal fishing piers along the Gulf coast. Interactions include scavenging of fish that are required to be released and depredation of caught fish from angler's lines. We are studying tools to reduce interactions between dolphins and recreational anglers. Our tests focus on devices used by anglers to return live fish to depth and the application of a modest tackle enhancement called a Depredation Mitigation Device (DMD).

We evaluated two descender devices: one is a simple barbless hook that resembles a large bobby pin, called the Shelton Fish Descender® (SFD). The SFD is attached to a weighted line and the pin is inserted through the lip of a live fish, which is then lowered quickly down to depth and released with a tug on the descent line. The SFD is best suited for shallow water use with smaller size fish. Several other devices are commercially available that use a spring-loaded grip to hold the fish, the most practical of which is the Seaqualizer®. It grips the fish by the lip and will not release until reaching a preset depth. This device is best suited for offshore reef fishing in depths of 70-150 ft, where scavenging by dolphins is a common problem. We employ underwater cameras to observe the effectiveness of these fish releases near dolphins; one camera is mounted close to the device to view the fish descent/release, another is hung below the boat to capture a wide angle view of any dolphins that are attracted to the descended fish.

Top: Seaqualizer® pressure-release descender.
Bottom: Shelton Fish Descender® device.

During April-May 2016, we conducted field trials in Sarasota Bay to test if SFD devices are practical around dolphins interacting with inshore anglers. A series of fish-release trials were conducted near dolphins that were known depredators. At each trial, we recorded dolphin identities, distance, movements, and whether animals appeared to respond to the fish descent. In total, 22% of 18 trials occurred while animals were actively patrolling, The SFD worked successfully on 50% of trials, but proved unreliable since fish often wiggled free at the surface or did not release as intended. The results suggest that a different type of device that securely holds the fish would be a better solution. We were somewhat encouraged by the fact that under most circumstances nearby dolphins were not attracted to released fish, but on one occasion a patrolling dolphin did chase a fish that came off at the surface.

Since 2014, we have tested Seaqualizer with over 30 sport fish released during the course of 16 deep-sea fishing trips at reefs offshore of Destin and Pensacola, FL. Dolphins only approached our boats on two trips, and we did not observe any interactions with them during the fish descents. We find the Seaqualizer easy to deploy and reliable. Testing will continue until a sufficient number of observations are made to determine effectiveness of using fish descents to reduce scavenging, and we are optimistic this method has great promise.

Part two of the project is to test a DMD prototype design. Prior studies showed that metal wires and chains attached near hooks on fishing tackle may decrease depredations, since metal is acoustically obvious to dolphin sonar and they avoid wires and hard fishing tackle. We created an inexpensive prototype affectionately called a "Porpoise Popper" that will release metal chains when pulled on suddenly. The device is placed just before the baited fishing hook, but does not "pop" until either a large fish takes the bait, or the hooked fish is grabbed by a larger animal. Once triggered, chains fall from the barrel and flail around the fish. Our testing suggests no difference exists in catch rate between normal hooks vs with a popper, and that the devices are easy to use and reload. Trials will continue until sufficient observations in the presence of dolphins are made to determine whether the poppers are effective, with a goal to distribute them to anglers and gather their feedback on the DMD performance and potential improvements. Sport anglers that have reviewed the prototype are very supportive of our concept.

A well-used "Porpoise Popper" in loaded condition (measured in inches).

In addition, we are conducting angler surveys on three shoreline fishing piers in Fort Walton Beach, Navarre, and Pensacola where dolphin interactions are commonly reported. We record their experience level, attitudes about dolphins around the piers, if they have encountered dolphins, and if they follow "Dolphin Friendly Fishing Tips." The survey results will be used to guide future consideration if other tips can be added specific for Gulf pier fishing. Due to the frequency of dolphin interactions at these piers, we believe most anglers will eagerly welcome any type of approved mitigation device to reduce dolphin depredations.

In summary, we are encouraged that fish descending may discourage dolphin scavenging of discarded catch, and that a simple DMD prototype might be effective in reducing dolphin interactions with fishing lines. While no simple solutions exist to reduce dolphin-fishery interactions, we hope testing and promoting new device

concepts will eventually produce valuable tools for sport fishing and dolphin conservation.

Assisting this project are Hannah Roth, Christina Toms, Courtney Nelson-Seely, and Gisele Nieman, along with a multitude of volunteer anglers and dolphin observers. We thank Chris Verlinde and Laura Tiu of Florida SeaGrant/IFAS for helping with fishing trips and devices. This study is funded by a grant from the Mississippi-Alabama Sea Grant Consortium and support from the Chicago Zoological Society.

Dr. Shippee displays a fish caught using gear outfitted with a "Porpoise Popper" device, seen here in its deployed state.

Population consequences of red tides and water temperature on Sarasota Bay dolphins

Lisa Schwarz and Dan Costa, University of California, Santa Cruz, Randall Wells, Jason Allen and Elizabeth McCabe, Chicago Zoological Society

When and how much disturbance will cause populations to decline? That is one of the main questions researchers and decision-makers face when they have concerns about changes in the environment or human impacts on species. The question becomes more difficult to answer when the sources of disturbance become more subtle and varied because, oftentimes, these disturbances do not directly cause mortality or lowered reproduction. Instead, the effects are seen through longer-term changes in individuals' health. Our goal is to determine when reduced health leads to lower reproduction and survival as well as understand the characteristics of disturbances that lead to reduced health. Instead of experimentally manipulating individuals and populations, long-term datasets allow us to investigate how natural environmental variability affects health and populations. The unique suite of mark-recapture and dolphin prey data (see Allen, p.18) collected by the Sarasota Dolphin Research Program provides us with an unprecedented ability to look at long-term trends in a bottlenose dolphin population with fluctuations in red tide and water temperature. We are also able to begin to look at how red tide and temperature affect dolphin prey species. We have found that dolphin survival declines with longer red tides the year before. When there are no red tides, survival declines as winter water temperatures decline. Lower reproduction and earlier mother-calf separation were also correlated with longer red tides in winter. In addition, longer red tides are associated with lower overall available energy for the dolphins as their prey decline. Using the long-term health assessment data, the next step is to determine how these changes in red tide, temperature, survival, and reproduction are reflected in the health of the dolphins. This research is supported by the Office of Naval Research.

Red tide harmful algal blooms can kill many fish, reducing prey availability for the dolphins that remain in the area.

A collaborative effort to help Chinese white dolphins

Carolyn Cush and Randall Wells, Chicago Zoological Society

Chinese white dolphins (also known as Indo-Pacific humpback dolphins, *Sousa chinensis*) inhabiting the Pearl River Estuary (PRE), including coastal waters of a portion of southern mainland China and adjacent waters around Hong Kong, face a number of severe threats. Among these threats are high-speed ferry operations, large-scale construction projects, fishing, and agricultural and industrial pollutants. As part of a larger Chinese White Dolphin Conservation Research Framework, a workshop was held during 30 March-1 April, 2016 in Hong Kong to initiate the development of a population viability analysis (PVA) to evaluate the current status of the PRE population and the risk of future population decline or extinction in the presence of human-induced threats.

To provide data to support the PVA and to facilitate long-term monitoring of the population, a collaborative effort among PRE Chinese white dolphin researchers and the SDRP is underway to adapt the Gulf of Mexico Dolphin Identification System (GoMDIS, see Cush, p.18) to improve population estimates, characterize life history parameters, and understand ranging patterns. This system will be known as PREDIS, Pearl River Estuary Dolphin

Identification System. These animals can be identified not only by their dorsal fin markings, but their coloration as well. Young animals are darker in color, and as they grow will become more white/pink, yet retain identifiable spotting patterns on their bodies. The PREDIS system will allow the research groups to search animals using a combination of fin characterizations and coloration to conduct between-site matching. This will also allow them to keep their research interests separate but share necessary data for joint analyses.

The researchers are submitting basic metadata to standardize and combine their efforts for upload to an offline PREDIS database, modeled after GoMDIS, and images will be processed and uploaded to a collaborative online portal specifically for this group. This photo-ID platform will allow them to search other project catalogs, submit, circulate and confirm matches, as well as serve as a visual reference for the locations of the images submitted. We have received our first test set of data from St. Andrews University's Sea Mammal Research Unit (SMRU) Hong Kong office, which we are using to modify the GoMDIS database for PREDIS.

Chinese white dolphins off Hong Kong.

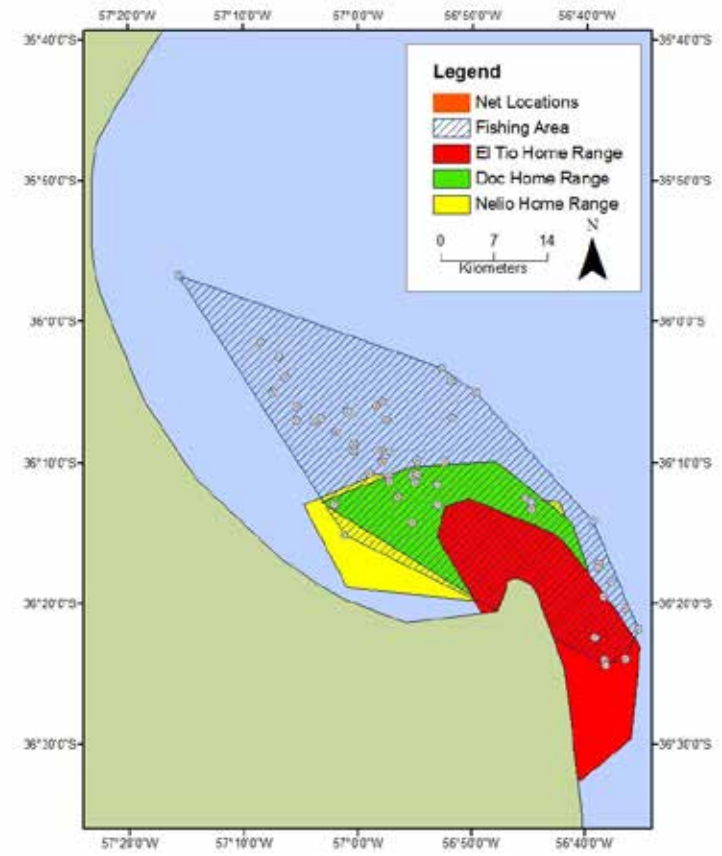
Update on conservation efforts for Franciscana dolphins in Argentina

Pablo Bordino, Aquamarina

Research and conservation efforts to reduce Franciscana dolphin deaths in fishing nets have been a major focus of my efforts for decades. In October 2015, the Argentinean government through the Federal Fishery Council approved the National Action Plan for the Conservation of Marine Mammals (PAN MM), focused on interactions with fisheries. This initiative was the result of a participatory process with the cooperation of national and provincial government agencies, scientific and academic institutions, and Non-Governmental Organizations. It was also part of other national conservation action plans for sharks and rays, seabirds, and sea turtles, which seek to contribute to ecosystem management of fisheries in the Argentine Sea. During this process, it was clearly established that some species require particular attention due to their conservation status, and the Franciscana dolphin was considered the most threatened marine mammal in the Argentine Sea.

The implementation of acoustic pingers to make dolphins aware of the presence of fishing nets to mitigate their bycatch in gillnet fisheries, and the development of habitat use and zoning maps for conservation and management were recommended as short-term actions in the PAN MM. The Action Plan confirmed that our previous efforts evaluating the effectiveness of pingers and other bycatch mitigation tools, and the study of the home range and habitat use of Franciscana initiated more than a decade ago, have been worthwhile, and have conservation management implications for the species in Argentina.

In the next months, a trial implementation of pingers will be conducted in Bahia Samborombon. Since 2005, habitat use studies of Franciscana dolphins, as defined through radio and satellite-linked tracking, have been conducted in this region in collaboration with SDRP. The tracking studies allowed us to understand the overlap of habitat use with gillnet distribution, and to establish areas of highest bycatch risk. We found that these areas were not necessarily the areas with the highest fishing effort. Our previous work has improved knowledge of the behavioral ecology of the species, but also anticipated the priority needs and conservation actions for Franciscana. Our results provide relevant information for appropriate experimental design and fishery management initiatives in an area inhabited by an isolated dolphin population with the highest bycatch rate in the Argentine Sea. We are planning to establish a gillnet-free area based on the home ranges identified, bycatch rates reported, and fishing effort distribution. We will also conduct a pinger trial outside this area.



Home range boundaries estimated from tracking data for Franciscana dolphins El Tio, Doc, and Nelio relative to fishing efforts in Bahia Samborombon, Argentina, in 2010. Observed net locations are indicated with circles.

Placement of the suction-cup-mounted jawphone on the lower left jaw and AEP sensors on the animal's dorsal surface. A recording hydrophone is located on the melon of the animal.

Hearing abilities of bottlenose dolphins in Sarasota Bay

Mandy Cook, Portland State University, and David Mann, Loggerhead Instruments

Bottlenose dolphins can hear from about 75 Hertz (Hz, or cycles per second) to more than 150,000 Hz, well above the range of human hearing (20-20,000 Hz). Because they are exposed to a wide variety of both naturally occurring and anthropogenic (human-caused) noise in their environment, there is concern that some of the louder noises may have negative effects on their hearing abilities. Hearing loss in these animals can be especially damaging because dolphins rely primarily on sound production and reception to navigate, forage, and communicate with each other.

We measured the hearing abilities of bottlenose dolphins in Sarasota Bay using an auditory evoked potential (AEP) technique, similar to that used to measure hearing in human infants. Short duration tones of varying frequencies and sound levels were played to the dolphins using a jawphone (a speaker in a suction cup attached to the lower jaw of the animal during health assessments), which takes advantage of the lower-jaw sound conduction pathway in these animals. Sensors in suction cups on the surface of the dolphin's head measured microvolt potentials produced by the brain in response to the tones. The brain's responses to the sounds were then analyzed to determine each dolphin's hearing abilities.

Data were collected from four bottlenose dolphins (2 females and 2 males, ages 12-21 years) during May 2016 health assessments. Overall, our findings from conducting hearing tests over nine years show that the bottlenose dolphins in Sarasota Bay do not exhibit increasing hearing loss with increasing age, nor are male dolphins more likely than female dolphins to have a hearing deficit. Also, these dolphins do not exhibit substantial hearing loss due to daily exposure to environmental noise, including anthropogenic sources of noise. Continued testing in the years to come will allow us to assess long-term changes in hearing of individual dolphins.

Dolphin communication studies: Whistle playback experiments

Vincent M. Janik, University of St. Andrews and Laela S. Sayigh, Woods Hole Oceanographic Institution

We have continued our studies of how dolphins use whistles to communicate with one another. This past year we finalized our analysis of whistle playbacks that were designed to test the hypothesis that dolphins can use voice cues to recognize whistles of other dolphins. Voice cues are what we use to identify the voice of a person we know well, without them having to tell us their name. For these experiments, we played back non-signature whistles of kin and familiar non-kin, following the same protocol that we have used in previous experiments with signature whistles. Since the non-signature whistle stimuli that we played back were highly variable in contour, we predicted that dolphins must use voice cues for recognition if they were capable of identifying the vocalizer. In 40 experiments, no significant difference was found in head-turning responses to non-signatures of kin vs. non- kin, indicating that dolphins were not using voice cues to identify the vocalizer. This finding, plus the fact that dolphins produce individually specific signature whistles that function like names, sets dolphins apart from other non-human mammals studied to date.

We also continued to add to our long-term database of whistles recorded during capture/release sessions. These recordings enable a variety of studies of the structure and function of individually distinctive signature whistles, as well as of non-signature whistles, and provide us with stimuli for our playback experiments. We continue to examine recordings for examples of stereotyped non-signature whistles, such as the "M" whistle that we described last year, and we carried out additional playback experiments of unfamiliar whistles this year, to test the hypothesis that "M" whistles may be a response to unfamiliar whistles.

Together with Dr. Julie Oswald, we also began a new set of experiments this year to look at whether dolphins can discriminate among whistles of different species, even if these whistles are similar in overall contour. Extensive research into the passive detection of different dolphin species has struggled to find consistent differences in their whistles to tell them apart reliably. This raises

A DTAG on a bottlenose dolphin off Bermuda, August 2016.

the question whether dolphins can recognize such differences themselves. Is it possible that the animals learn all the whistles of their associates and treat all other dolphin whistles they hear as strangers? Once another animal is within echolocation range, it is unlikely that a dolphin could not tell one species from another. But communication sounds, like whistles, travel over much greater distances than an echolocation click can. We are trying to work out whether species differences are relevant and detectable to dolphins at these ranges.

Studying communication using acoustic tags

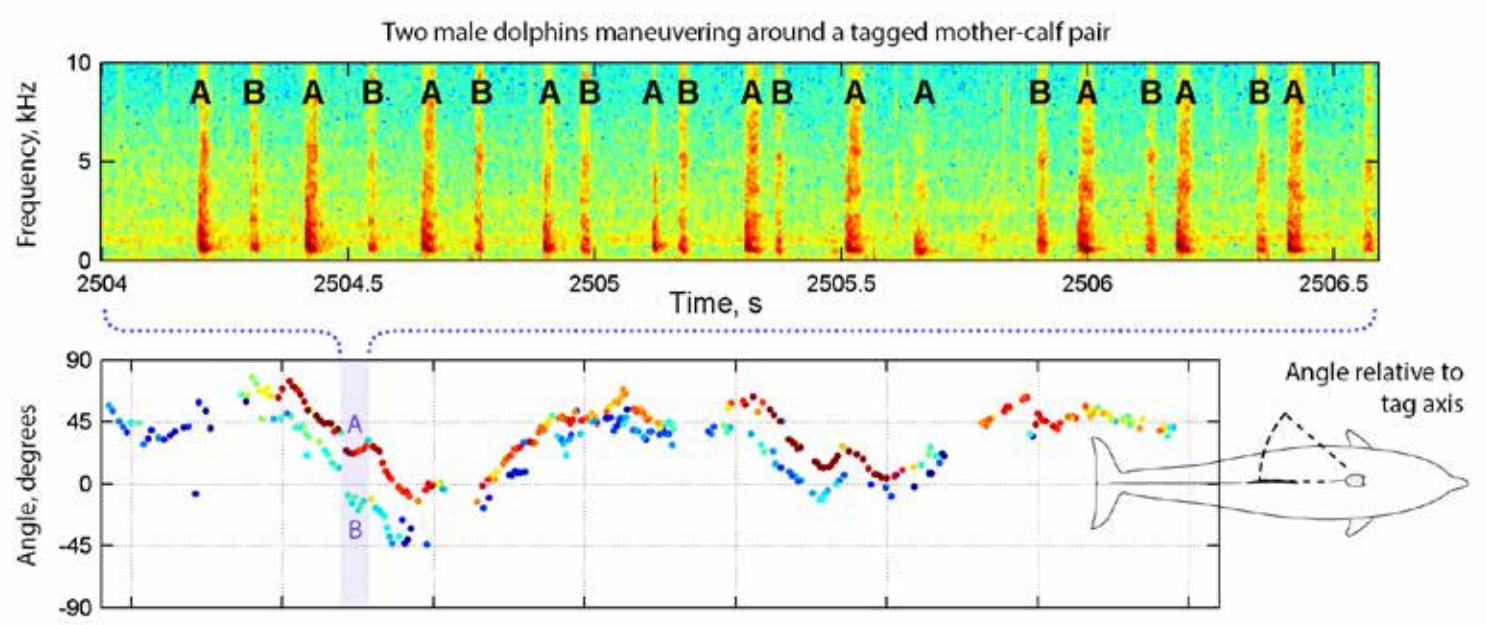
Peter Tyack, University of St. Andrews, Laela Sayigh, Woods Hole Oceanographic Institution, Vincent Janik, University of St. Andrews, and Frants Jensen, Aarhus Institute of Advanced Studies

Bottlenose dolphins are acoustic animals: they navigate and find food successfully, throughout day and night, by listening for the faint echoes generated by their strong, directional echolocation clicks. They find and recognize dolphins using individually specific signature whistles, and they employ a variety of other acoustic signals to interact with others of their species.

For the past 5 years, we have been deploying acoustic recording tags, known as DTAGs, on bottlenose dolphins at the end of their health assessment and prior to release to listen in on these acoustically active animals. We attach these tags to dolphins using four small suction cups, and they stay on for periods of up to 24 hours while recording the movement, depth, and sounds produced by tagged individuals, in addition to acoustic signals from nearby dolphins. We have focused our tagging efforts primarily on closely bonded pairs of dolphins who are constantly close together, and to date we have recorded data from more than 19 mother-calf pairs and 7 male alliances. In combination with vessel-based observations of behavior and social interactions, these accumulating datasets help us understand the social lives and acoustic communication of wild bottlenose dolphins.

At present, these data feed into a variety of research projects pertaining to foraging, energetics, and communication. Two student projects are looking into how pairs of bottlenose dolphins use whistles to maintain or re-establish acoustic contact during separations, how loud whistles are, and how far away functionally different whistle types can be detected. This is especially important to evaluate how vessel noise from recreational vessels affects communication range and information flow between dolphins in a heavily urbanized area such as Sarasota Bay, where a boat passes by dolphins on average once every 6 minutes.

Another ongoing avenue of research involves investigating how bottlenose dolphins use different types of signals during aggressive interactions, mainly between pairs of allied males and females or mother-calf pairs. As interactions become more aggressive, often involving brief chases, males may use high-amplitude resonant pops or jaw claps in addition to very fast sequences of echolocation clicks, called burst pulses. Surprisingly, males also seem to exchange repeated, low-frequency calls (called “quacks” due to their distinctive sound) as they are moving around females. Quacks are easy to separate from other signals, and likely help allied males coordinate activity and synchrony as they are trying to consort with a female. Many of the same sound types have been observed with dolphins under human care as well as in more extreme cases of aggression, including attempted infanticide involving a pair of bottlenose dolphin males and a newborn calf in Savannah, Georgia, confirming their general importance for aggressive interactions with others of the same species. Similar signals have been observed on acoustic monitors in other places around the world, but only thanks to the SDRP field site can we start to understand what the function of such signals may be.



Stereo acoustic tags help us track vocalizing animals close to other tagged individuals to understand how sounds are being used by the dolphins. Here, we illustrate data recorded from a tagged mother-calf pair as a male alliance (dolphins A and B) joins the pair. The upper panel shows a spectrogram of the low-frequency sounds that these males make, while their movement around the female is illustrated in the lower panel; these are the distinctive low-frequency “quacks” believed to be associated with coordinating activity.

How do echolocating bottlenose dolphins adapt their biosonar to find food in different habitats?

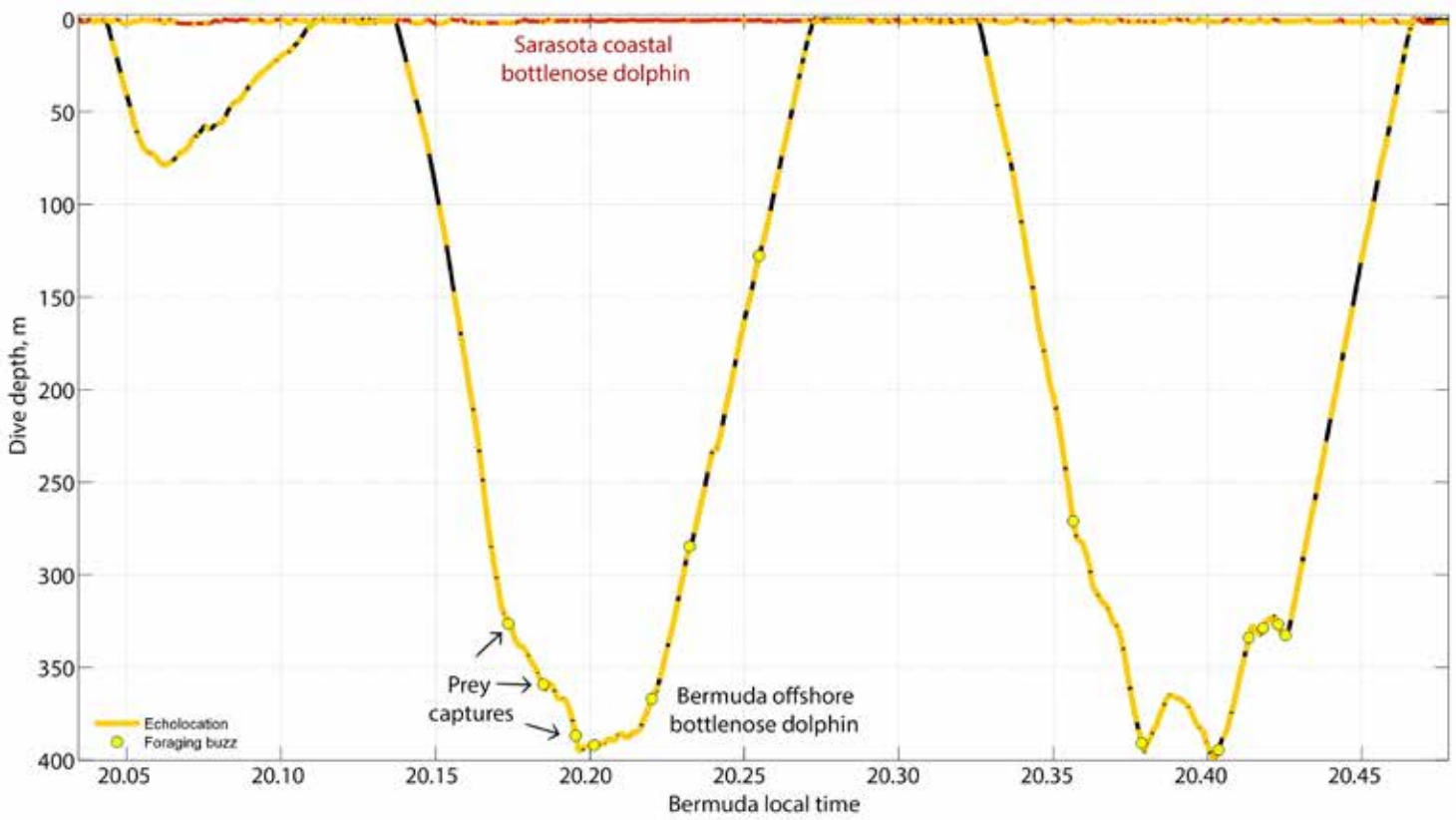
Frants Jensen, Aarhus Institute of Advanced Studies, Andreas Fahlman, L'Oceanografic, Randall Wells, Chicago Zoological Society, and Peter Tyack, University of St. Andrews

Echolocating animals such as bottlenose dolphins depend on actively generated echolocation signals (termed clicks due to their extremely short duration) for ensonifying their environment and detecting and tracking prey. In contrast to how our own vision works, this means that the biosonar behavior of the echolocating predator directly affects how it senses the world – click faster, for example, and you get a faster update on how prey moves but you restrict yourself to looking for prey at shorter range. The environment that you are echolocating in, and the prey that you are searching for, may offer different challenges such as reflections from bottom or ocean surface, or high background noise levels, that animals need to deal with by making adaptive changes to their biosonar behavior. Using acoustic recording tags (DTAGs) we can measure echolocation signal parameters directly as animals search for and capture food in different environments.

In late August 2016, we were able to instrument three offshore bottlenose dolphins in Bermuda with suction-cup-mounted acoustic tags, as part of a study conducted by an international team from Dolphin Quest Bermuda, Chicago Zoological Society and L'Oceanografic in Valencia. These bottlenose dolphins live and feed in a completely open deep-water environment that provides a stark contrast to the shallow coastal habitat of Sarasota Bay dolphins. As a consequence, it looks like they are using echolocation signals that allow them to detect prey over longer ranges compared to the coastal dolphins of Sarasota – not a bad trick when looking for prey at several hundred meters depth. Over the next few years, these data in combination with tags from the Sarasota dolphins will help us understand exactly how animals adapt their biosonar to these acoustically different habitats and, in essence, to understand how flexible the bottlenose dolphin biosonar really is.

Bottlenose dolphin Devonshire upon release off Bermuda. He is wearing a satellite-linked tag on his dorsal fin and a DTAG in front of the fin.

Funding for this project was provided by Dolphin Quest and Office of Naval Research YIP Award # N000141410563 to Dr. Andreas Fahlman.



Coastal and offshore bottlenose dolphins inhabit very different environments. Here is a depth record sampled by the first DTAG deployed on an offshore dolphin off Bermuda while foraging during dives to 400 m. In comparison, Sarasota Bay bottlenose dolphins are limited to activities mostly within 1-10 m of the surface. Note the presumed prey capture buzzes occurring at the deepest points of the dives by dolphins off Bermuda.

Sarasota Bay health assessment project summary: May 2016

Randall Wells, Chicago Zoological Society

The Sarasota Dolphin Research Program conducted a health assessment project during May 4-11 in Sarasota Bay. The program fielded an international team of 140 scientists, veterinarians, and trained dolphin handlers (about 90 per day) to conduct 40 research projects with each dolphin handled. Projects included studies of field metabolic rates, communication studies involving whistle playback experiments and releases of pairs of dolphins with onboard digital acoustic archiving tags, and testing of new health assessment techniques to be used in *Deepwater Horizon* oil spill follow-up studies of dolphins in Barataria Bay, Louisiana later in the year. While unusually bad weather limited field efforts, all of the PIs were able to obtain needed data and/or samples. Overall, 13 dolphins were sampled (including four within-session re-samplings), with four handled for the first time.

Crew aboard the R/V Challenger work diligently to process blood, blubber, blowhole, fecal, gastric, oral, and milk samples for participating projects from up to four dolphins at a time during Sarasota Bay health assessments.

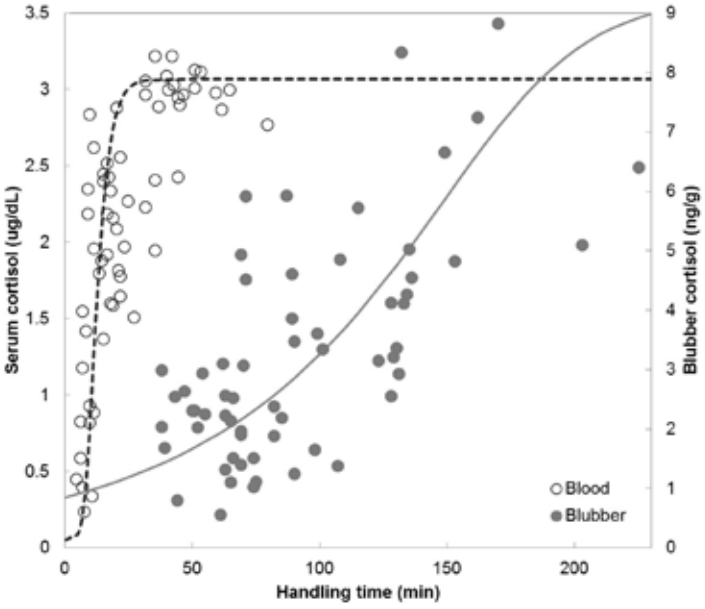
Blubber cortisol in bottlenose dolphins

Nick Kellar, Southwest Fisheries Science Center, National Marine Fisheries Service

Just like humans, bottlenose dolphins must deal with stressful situations throughout their lives. Dramatic habitat changes, prey scarcity, fishery interactions, acoustic disturbances, and harmful algal blooms are just a few of the things that can elicit challenging conditions for these animals. During these stressful conditions, animals often need to tap into their energy reserves to deal with these stressors. One way they do this is by producing the hormone cortisol; the adrenal gland secretes much more of this hormone in times of stress. If the stressor is short-lived, the cortisol boost helps maintain normal physiologic function while the animal is dealing with the ramifications of the stressor (example: abandoning a foraging area to escape painfully loud construction noises). In this way, having a healthy adrenal gland is critical to help dolphins cope in challenging situations. However, if cortisol levels remain abnormally elevated for long periods of time (many days to months), the high hormone levels can impair reproduction, immune response, growth, and development, and make the animal more nutritionally vulnerable when prey is scarce.

Measuring cortisol levels in wild dolphins can potentially help researchers identify populations that are dealing with challenging conditions. However, cortisol is primarily measured from blood samples, and obtaining blood samples from most cetacean populations is next to impossible. On the other hand, skin and blubber samples collected from dart biopsies are commonly obtained from cetaceans all over the world. As such, the objective of this study was to measure cortisol in the blubber from biopsies and to evaluate how the measurements relate to those in the blood for which reference values have been made. There are very few places on earth in which both blood and blubber samples can be collected from the same individuals, but Sarasota Bay, with its special natural laboratory situation, is one of those places.

It has been previously demonstrated that these Sarasota Bay dolphins show healthy cortisol levels that, as expected, rise in the blood following net encirclement during health assessments. We found that the same is true in the blubber, however, the cortisol levels rise much more slowly in the blubber than they do in the blood. Cortisol measurements were obtained from blood and blubber samples of 62 dolphins at various times points after encirclement with a net. Preliminary results indicate that average cortisol levels were twice as high as the estimated baseline levels within 10-15 mins in the blood and within 45-60 mins in the blubber. The levels in the blood appeared to plateau as early as 30-40 mins post-encirclement, while in the blubber they were still increasing at our last estimated time point, at 150 mins post-encirclement. This information greatly helps us understand the relationship of cortisol levels in blood and blubber samples and it indicates that measuring cortisol from dart biopsies of other populations could be a very useful way to assess adrenal health and to evaluate previous stress response activity. Along with other hormone measurements, measuring cortisol levels may represent a way to evaluate whether particular human activities are causing high-levels of detrimental chronic stress in cetacean populations. Once these relationships are established, potential mitigating actions could then be taken- especially in times when animals are more vulnerable. Funding for this project was provided by the Office of Naval Research's Marine Mammals and Biology Program.



Changes in cortisol concentrations in blood (open circle) and blubber (filled circle) relative to the time since the time of capture for health assessment.

The physiology of welfare: Identifying biomarkers of stress and resilience in bottlenose dolphins through non-invasive sampling

Melinda Conners and Lance Miller, Chicago Zoological Society – Brookfield Zoo

Just as in humans, it is possible to learn about a dolphin's health from physiological biomarkers measured in their blood. However, blood sampling is a medical procedure that requires careful handling of animals in controlled conditions, which can be challenging and untenable in some field research applications. Feces and saliva, like blood, are composed of biological compounds that may serve as biomarkers of health and can provide a less invasive and potentially more feasible method for monitoring health in some wild cetacean populations and for animals under professional care.

Our team is developing methodology to identify and measure various biomarkers of health in feces and saliva from the bottlenose dolphin population in Sarasota Bay, and from a group of bottlenose dolphins under professional care residing at the Chicago Zoological Society's Brookfield Zoo in Illinois. Given heightened concern over the exposure of marine mammal populations to various anthropogenic stressors (contaminants, vessel noise, etc.), many recent research efforts have focused on understanding stress physiology of cetaceans, including investigations on mineral- and gluco- corticoid hormones that reflect adrenal activity (indicative of the stress response) in both feces and saliva. We are building on this foundational research by expanding the suite of targeted biomarkers to hormones and immune factors that may serve as indicators of coping resiliency in addition to those indicative of both acute and prolonged stressed states. The steroid dehydroepiandrosterone (DHEA), while a precursor to male and female sex hormones, can also play a role in the physiological stress response in some species. DHEA has been shown to serve as a neuro-protector against the damaging effects of circulating glucocorticoids released during a stress response, and both human and non-human animal studies have shown a positive association between DHEA levels and coping resilience to stressors. Additionally, reduction in secretory immunoglobulin-A (s-IgA), secreted in both saliva and the intestinal mucosa, has been suggested as an indicator of prolonged stress in a number of species.

To date, we have collected 41 saliva and 4 fecal samples from Sarasota Bay dolphins and 200 saliva and 100 fecal samples from animals at the Brookfield Zoo across 2015 and 2016. Currently, we are assessing methods to identify the targeted biomarkers in bottlenose dolphin feces and saliva through enzyme immunoassay analysis. Additionally, we are running physiological validations by examining the correlation between blood and fecal/saliva values and biological validations by assessing concentrations of targeted biomarkers in response to observations of both positive and negative behaviors and social interactions. Ultimately, information from this research will inform animal care management of dolphins in zoos and aquariums to optimize welfare in these animals. Additionally, insights and methodology developed from this research may increase understanding of the resilience and coping effectiveness of wild dolphin populations that experience different exposures to anthropogenic stressors.

Using a cotton swab to collect a saliva sample from a bottlenose dolphin at Brookfield Zoo, where dolphins are trained to work with staff for veterinary procedures.

Lung health of bottlenose dolphins off Bermuda and Sarasota

Andreas Fahlman, Texas A&M University-Corpus Christi and L'Oceanografic, Jay Sweeney and Rae Stone, Dolphin Quest, Inc., and Michael Moore, Woods Hole Oceanographic Institution

Dolphins are air breathing, diving mammals that hold their breath to find food. The amount of food they can obtain depends partly on how long they can hold their breath. Lung disease is therefore a significant problem as it both causes health issues and reduces foraging efficiency. In Sarasota, Florida, the shallow bays provide food at shallow depths and dive durations can be relatively short. The pelagic dolphins in Bermuda, on the other hand, dive up to 1,000 m (more than 3,000 ft) and as they have to swim a much longer distance to the food, dive durations of more than 13.5 minutes have been recorded.

To better understand the physiological adaptations that allow dolphins of the same species to inhabit such divergent habitats and ecological niches, we wanted to compare lung function between the Sarasota Bay and Bermuda dolphins. To do this, we used a custom designed device (called a pneumotachometer) that measures the amount of air the dolphins are inhaling and exhaling, and also measures the concentration of oxygen and carbon dioxide in their breath. Together, the flow and gas concentration are used to determine the metabolic rate. In addition to metabolic rate, we can use these measurements to assess lung health and better understand the adaptations that allow the Bermuda dolphins to dive to depths where the extreme pressure may cause trauma to air filled spaces like the lung. We also use ultrasound to examine

the condition of the lungs. The procedures we use to assess lung function are similar to those used to assess the health of human lungs. If we see large differences in lung health in the dolphins in Sarasota and Bermuda, this may indicate there are problems in the ecosystem. By comparing respiratory health in different populations of dolphins, we can learn more about the health of those populations and the marine environment in which they live. Analyses are underway, and we are specifically looking at comparing the respiratory tidal volumes, which at least preliminarily seem to be larger for Bermuda dolphins than for those of the dolphins in Sarasota Bay. Funding was provided by Dolphin Quest and through an Office of Naval Research YIP award (#N000141410563).

Measuring bottlenose dolphin lung health with ultrasound and a pneumotachometer off Bermuda in August, 2016.

Physiology of deep-diving dolphins off Bermuda

Michael Moore, Woods Hole Oceanographic Institution and Andreas Fahlman, L'Oceanografic

Over the past twenty years there has been a growing interest in stressors such as loud noise from seismic surveys and military sonar exercises that may affect the behavior of whales and dolphins. We theorize that the stress may impact the ability of individual animals to manage their diving behaviors that normally minimize the effects of their routine diving. Recent advances in human diving medicine include the development of an assay for the microparticles that result from damage to cells in the blood and that line blood vessels, following dive stress. Over the past four years we have collaborated with the Sarasota Dolphin Research Program and Dr. Stephen Thom at the University of Maryland to analyze blood samples from dolphins in Sarasota, Cape Cod and Bermuda. We are testing the hypothesis that deep diving animals will have elevated microparticle levels. Preliminary findings from the four bottlenose dolphins sampled and tagged off Bermuda in August 2016 suggest that these deep-diving animals may have elevated microparticle levels.

Measuring dolphin metabolic rates

Jen Maresh and Dan Costa, University of California, Santa Cruz

How much food energy does an adult dolphin need from fish to survive and thrive? How much does a young animal need, and how much milk energy does a mother dolphin transfer to her nursing calf? These are the types of questions we hope to answer for the wild dolphins resident to Sarasota Bay and nearby areas.

To do this, we measured the metabolism (field metabolic rate) of two adult female bottlenose dolphins and their calves using a technique called the doubly-labeled water method. Doubly-labeled water measures field metabolic rates by comparing the amounts of particular isotopes in the blood before and after a few days have passed. To do this, animals receive a solution of water (H_2O) with extra isotopes of heavy hydrogen and oxygen – these heavier isotopes occur naturally in the environment and are harmless when administered at higher concentrations like this. Then, a blood sample is taken a few days later to measure how much doubly-labeled water remains, to determine how quickly the water was used by the body. This rate of water use is a measure of how fast or slow that animal's metabolism was during that time, and therefore how many food calories it utilized. For lactating mothers, the turnover rate of heavy water is also an indicator of milk-energy transfer to nursing calves.

This is our second field season collecting this type of information, enabling us to build upon our sample of four adult females from 2015. Particularly exciting are our measurements of milk transfer rates between moms and calves – the first of their kind for a wild cetacean! We already know something about the content of dolphin milk from other studies: it is higher in calories than human breast milk, containing about 3-4 times as much fat. What we do not yet know is just how much milk mother dolphins need to produce for their calves. Our measurements this year will allow us to not only understand the amount of extra energy mother dolphins need to acquire from fish to support their calves, but also the overall energy needs of their calves and how much of that they are able to acquire for themselves while foraging for fish alongside mom. Funding for this project has been provided by the Joint Industry Program.

A lactating mother like Claire, seen here wither her 8th calf, must increase her prey fish consumption to be able to produce milk high in fat content to support her growing calf.

Characterization of the microbiome among free-ranging bottlenose dolphins

Maria Robles Malagamba, University of Florida

Next Generation Sequencing (NGS) technologies have revolutionized our understanding of the complex role microbial communities play in the health and disease of their associated hosts. However, few reports have investigated the diversity of normal microbiota in marine mammals. The objective of this study, for my recently completed Master's thesis, was to characterize microbial abundance, diversity and richness at six different anatomical sites among free-ranging bottlenose dolphins and their aquatic ecosystem.

Samples were collected as part of the 2015 Sarasota Bay dolphin health assessment, including: respiratory (blowhole and blow plate), gastric, fecal, skin, and genital swabs from each of 14 dolphins (9 females and 5 males including 4 mother-calf pairs), and seven matching environmental water samples. Bacterial diversity and abundance were assessed by PCR amplification of a hypervariable region (V3-V4) of the bacterial 16S rRNA gene for each sample followed by sequencing on an Illumina MiSeq platform. Mixed-linear models were then used to elucidate how patterns of microbial abundance and diversity vary with dolphin body site, age, sex, health status, lactation status, and relatedness (mother-calf pairs). Body site was the variable found to be the major driver of bacterial abundance, diversity, and richness among all variables tested. This study is the first to provide data for the bottlenose dolphin skin and genital microbiomes. Our study is also the first to describe the bacteria genus *Treponema* in a marine mammal. Further research is needed to determine whether this dolphin *Treponema* is a novel species and whether it induces disease in free-ranging bottlenose dolphins.

Microbiome studies such as these are fundamental to understanding the role microbial communities play in the health and disease of marine mammals. Our future research will compare the microbiome of dolphins under human care versus wild bottlenose dolphins.

Rachael Dailey processing blood samples aboard the R/V Challenger to provide an immediate measure of dolphin health while in the field.

Persistent organic pollutant trends in Sarasota Bay bottlenose dolphins

John Kucklick, Jennifer Balmer, Elizabeth Davis, Kevin Huncik, Ashley Boggs, and Amanda Moors, National Institute of Standards and Technology, and Randall Wells, Chicago Zoological Society

Synthetic chemicals are an important part of human society and are used for a variety of purposes ranging from use in materials such as plastic packaging, clothing, and other applications such as use as pesticides and in industry. Generally these chemicals are safe; however, certain types of synthetic chemicals have properties that are damaging to the environment (people included). Specifically, organic (carbon-containing) compounds that are resistant to break down, can move by evaporation from products or applications, accumulate in the food web, and are toxic to wildlife and people are termed "Persistent Organic Pollutants" or "POPs." Some of the best known POPs include polychlorinated biphenyls (PCBs, mainly used in electrical transformers), DDT, chlordane (pesticide), hexachlorocyclohexanes (HCHs; pesticide) and polybrominated diphenyl ethers (PBDEs, flame retardant). Fortunately, many POPs have been regulated by laws or phased out of production because they were recognized as being persistent (don't break down) and generally bad for the environment. For instance the Stockholm Convention (http://chm.pops.int/) is a global treaty aimed at eliminating POPs. Despite regulations and phase-outs, levels of POPs in many aquatic food webs are only slowly declining. This is because materials containing POPs or soils containing pesticides act as reservoirs that can re-supply the environment. POP breakdown is also slow in cold regions such as the Arctic and cold areas act as a place where POPs wafting up from warmer regions can condense (like water condensing on a cold beverage).

So what is the status of POPs in Sarasota dolphins in response to POP phase-outs? Our prior work has shown that POPs in Sarasota Bay bottlenose dolphins were present at concentrations that may be toxic to dolphins and that many different types were present including those named above. Are POPs concentrations declining in dolphins or are they more stable like we see in the Arctic? We set out to answer this question by measuring POPs in dolphin blubber that had been collected from Sarasota Bay during 2000-2016 health assessments. We focused our efforts on measuring POP levels in male dolphins as POP levels in female dolphins are greatly changed through offloading of POPs to their calves. We measured concentrations of PCBs, DDT and its degradation products, chlordanes, and PBDEs.

Our data reveal good news from Sarasota dolphins. Concentrations of POPs are declining at about 21% per year, which relative to marine mammals from the Arctic is a steep rate of decline. POP levels in marine mammals from Arctic locations are generally declining at most only 5 to 10% per year. Our results suggest that regulations and phase out systems of POPs appear to be working. In addition, we think that the warmer water of Sarasota Bay enhances the loss of POPs to the atmosphere. Once in the atmosphere, POPs can be moved away from Sarasota Bay and, with fewer POP sources, concentrations in the food web (and dolphins) go down. Declining POPs in the Sarasota Bay dolphin population may begin to free dolphins from their toxic effects, resulting in better survival of dolphin calves and generally improved health. Support for these analyses was provided in part by Dolphin Quest, Inc.

Bone density assessment of Sarasota Bay dolphins leads to 3-year EPA doctoral fellowship

James Powell, Portland State University

One potential impact of environmental contaminants occurs when endocrine-disrupting compounds alter bone density. As a PhD candidate at Portland State University, I have been awarded a 3-year fellowship from the U.S. Environmental Protection Agency to continue and expand my doctoral research on bone density in bottlenose dolphins. Since starting my graduate program, I have established the first-ever normative distribution of bone density values for bottlenose dolphins utilizing a comprehensive archive of skeletal specimens. I have also developed a custom ultrasound device to clinically assess live, wild bottlenose dolphins in capture-release health assessments. The unique natural laboratory setting of Sarasota Bay and the support of the Sarasota Dolphin Research Program fostered the environment necessary to develop and test the novel technology required to pursue this line of research. Pilot data collected during the 2014 and 2015 health assessments, and the opportunity to demonstrate feasibility and proof of concept of the use of ultrasonic bone densitometry on live dolphins was instrumental in obtaining this fellowship.

The study will use bottlenose dolphins as a model species to investigate the effects of endocrine disrupting compounds on bone density. Environmental contaminants adversely affect health, both through direct damage and through effects on growth and development. Exposure to contaminants is known to reduce bone density, alter bone mineral composition, and result in abnormal bone growth in laboratory animal research. Bottlenose dolphins are an ideal model to further investigate these issues as they are long-lived mammals known to be affected by exposure to contaminants that also affect humans. Bone density can potentially provide a record of an animal's chronic environmental contaminant exposure and provide a mechanism to model similar effects that would be expected in humans under similar exposure conditions.

Bone density profiles will continue to be established for dolphins in the Sarasota Bay community during future health assessments in order to further comparisons to dolphins residing in areas of higher environmental contaminant exposure. In order to further the field of bottlenose dolphin bone densitometry, ultrasound device development is in progress to facilitate assessment of additional skeletal target sites. Current assessments using the initial prototype device are limited to the bones of the dolphin flipper, and additional measurements of bones in other areas of the body, such as vertebrae in the tailstock, may open new research opportunities.

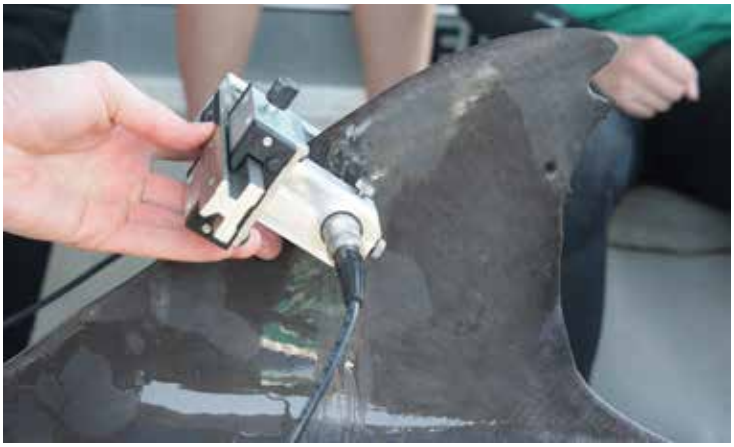
Bottlenose dolphins as gauges of environmental exposure to phthalates

Leslie Hart and Barbara Beckingham, College of Charleston

Plastics in the environment are of increasing pollution concern for wildlife, including dolphins. Phthalates are a group of man-made chemicals commonly used in the manufacturing of plastic and other consumer goods (for example, cosmetics and personal care products), and are leached into the environment because they are not chemically bonded to these materials. Because of this, phthalates are readily available for human and wildlife exposure. Concern over phthalates stems from experimental laboratory animal and human epidemiologic studies demonstrating associations between phthalate exposure and adverse health effects including endocrine disruption and reproductive impairment.

Macro- and microplastics (particles < 5mm in diameter) are ubiquitous in the marine environment and quantities appear to be growing. In addition, there are potential sources of phthalates in storm-water and other effluents that reflect increased population pressures in coastal zones. This suggests that marine wildlife may be vulnerable to chronic chemical plasticizer exposure. Once exposed, phthalates are rapidly broken down into metabolites that have been detected in urine and blubber of large whales. To date, phthalates, or their metabolites, have not been measured in bottlenose dolphins.

We are collecting urine and blubber samples from Sarasota Bay bottlenose dolphins to develop phthalate detection methods for this species, quantify phthalate exposure among Sarasota Bay dolphins, and determine if blubber can be a reliable sampling matrix to monitor environmental phthalate exposure. During the 2016 health assessment, nine samples were collected, including from animals that were recaptured on subsequent days. We are currently in the process of developing detection methods for both matrices, and plan to produce the first measure of these chemicals in bottlenose dolphins. Moving forward, we will continue to collect these samples from Sarasota Bay dolphins to help determine the correlation between urine and blubber concentrations. If blubber proves to be a reliable detection matrix, we hope this study will motivate additional, larger-scale exposure studies to examine differences in phthalate exposure across geographic and temporal space. Funding for this research was provided by the College of Charleston.



Bone density is measured using values of sound passing through bone and a soft tissue space of equal thickness. In humans, the soft tissue space between the bones of the forearm is used as this marker. In dolphins, the dorsal fin is used as it has no bone and is the same thickness as the target bone site on the flipper.

Sarasota Bay resident dolphin community status

Jason Allen, Chicago Zoological Society

We keep track of the dolphins of Sarasota Bay through photographic identification (photo-ID) surveys conducted on 10 boat-days each month. One of the primary goals of our monitoring is to track additions, losses, and condition of the resident Sarasota Bay dolphin community members. Twelve births were recorded in 2016, comparable to 2015. Scooter's fourth calf died shortly after birth, but the other 11 new calves appear to be doing well. One surprising survivor is the 2016 second calf of F165, who survived shark bites it received when only days old (see Wilkinson, p.25)!

Our oldest dolphin, Nicklo, appears to still be doing well at 66 years young. Sadly, two 2015 calves are missing and presumed dead, and we appear to have lost two of the oldest members of our community since our last update, including female Blacktip Doubledip (62 yo) and male RT-3 (52 yo). RT-3 was our oldest known male, and one of the first dolphins ever identified in Sarasota Bay, initially tagged in October 1970.

Our long-term, monthly photo-ID surveys are the core effort of our program, supporting all other projects. More than 47,900 dolphin group sightings since 1970 have yielded more than 142,900 identifications of more than 5,500 individually distinctive dolphins. In support of these identifications, more than 690,000 dolphin photographs are currently archived by the Sarasota Dolphin Research Program. Data from monthly monitoring surveys and all of our photo-ID efforts are archived in a relational Access database (FinBase) designed specifically for bottlenose dolphin photo-ID data and images. Work has begun to integrate this database with our focal animal behavioral follow database, which contains 2,507 follows on 194 individual dolphins from 23 projects during 1989-2016. This database now also includes current and historic opportunistic respiration data taken on potentially compromised individuals. We will begin integrating our dolphin health database in the near future as well. Many thanks to NOAA's Jeff Adams for his continued support as our database guru!

We have been able to continue our year-round, monthly monitoring of the Sarasota bottlenose dolphin community thanks largely to support from the Batchelor Foundation, as well as the continued dedication of our core local volunteers and undergraduate interns. Thanks to these efforts, this community remains one of the most thoroughly studied free-ranging dolphin populations in the world.

Lizzie's sixth calf surfaces next to her during August Population Monitoring Surveys. Lizzie's mom, Killer, also had a new baby this year at the age of 46!

Joker, named for the probable entanglement scar at the corner of his mouth, plays with a blade of seagrass in the shallows near Lido Key. He is part of a five generation lineage residing in Sarasota Bay.

Keeping track of bottlenose dolphins around the Gulf of Mexico

Carolyn Cush, Shauna McBride and Randall Wells, Chicago Zoological Society

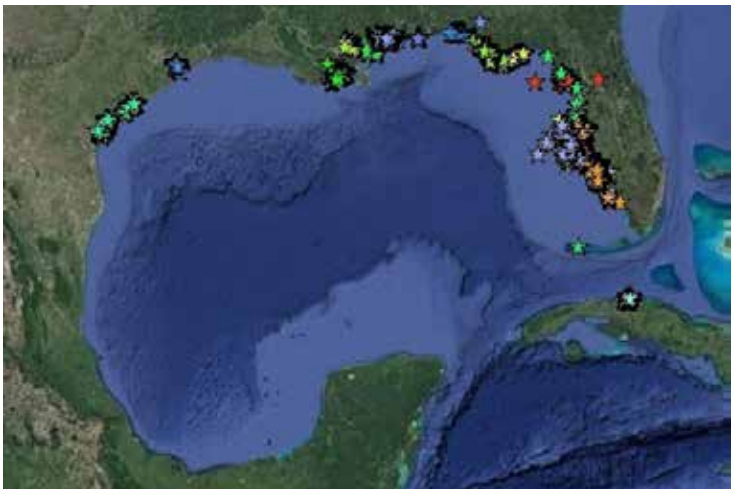
August of 2016 marked the fourth anniversary of our collaborative effort known as the Gulf of Mexico Dolphin Identification System (GoMDIS). Modeled on the Mid-Atlantic Bottlenose Dolphin Catalog curated by Kim Urian at Duke University, GoMDIS serves as a standardized and centralized catalog for bottlenose dolphins throughout the Gulf of Mexico. With continued funding assistance through NOAA and Harbor Branch Oceanographic Institute/Florida Atlantic University, this repository integrates data submitted from collaborating groups around the Gulf which have location-specific photo-identification catalogs.

There are approximately 3,540 miles of coastline in the Gulf. For reference, this is far more than the greatest horizontal length of the contiguous United States, 2,680 miles. We are fortunate to work with an ever-growing number of collaborators, considering the vast amount of coastline that could be surveyed. These animals are certainly not bound by individual researchers' survey areas. By joining together and combining our catalogs into a single repository, we can gain better understanding of dolphin movements and have Gulf-wide, standardized and centralized baseline knowledge of the animals in the instance of another oil spill like *Deepwater Horizon* or another unusual mortality event.

The collaboration has grown significantly over the past four years, from 13 groups representing 23 catalogs to 33 groups representing 48 potential catalogs including Cuba and Mexico. Historical catalogs are being incorporated, which in some cases means re-building catalogs from the 1980s. We were fortunate to have Alex Fields, our NOAA-NGI National Diversity intern, to assist with part of this massive project. We are also incorporating non-photo-ID programs into GoMDIS. This includes rehabilitated/released animals and deceased (but identifiable) animals.

To date, 19 catalogs from the possible 48 have been submitted and processed through GoMDIS. These data are maintained by the Curator in the offline GoMDIS database and are periodically

Left: First seen in 1992, UTLD had a 14 year sighting history in Charlotte Harbor. In 2016 Clearwater Marine Aquarium recovered the carcass of CMA-Tt-1604. Nearly 100 miles north of her known home range, UTLD was matched to this stranded dolphin. Very little would be known about the life of CMA-Tt-1604 or the fate of UTLD without the collaborative power of GoMDIS. This inter-catalog match married data from both UTLD's life and death. By providing a more thorough 24-year history of this individual and a more accurate ranging pattern, matches such as this present significant implications for management agencies.
Photo credit (stranding): Anna Panike, FWC



GoMDIS map interface on OBIS-SEAMAP website (http://seamap.env.duke.edu) using the map application to depict the current coverage of registered bottlenose dolphin sightings around the Gulf.

uploaded to an online portal (OBIS-SEAMAP, http://seamap.env.duke.edu/), facilitating data-sharing and providing our colleagues with a secure, fin-matching interface. This interface holds a repository of approximately 13,992 individuals and 23,983 images available to the collaborators on OBIS-SEAMAP. Over 160 matches have been made with many more to come as contributors continue to submit their catalogs. Further investigation will occur on these matches between the collaborating organizations involved by comparing sighting histories. This will allow us to better determine the ranging pattern of these animals, which in turn will help management agencies to better define stock structure and obtain more accurate abundance estimates.

We have several ideas to further enhance the capabilities of our collaborative effort. By incorporating new collaborator user features in OBIS, such as the ability to map sighting histories, especially across animals matched between catalogs, we would be able to paint pictures of individual movements. We are also investigating the possibility of creating a catalog of animals involved in human interactions, to examine potential areas of concern for managers. Additionally, as GoMDIS is not a real-time system, we will propose creating a real-time intermediary system between stranding programs and neighboring photo-ID programs with the goal to identify stranded or deceased animals in a timely manner.

Developing automatic fin matching software

Reny Tyson, Chicago Zoological Society

Did you know that every month the SDRP staff may take more than 5,000 photographs of dolphins in Sarasota Bay during our population monitoring surveys? This results in more than 60,000 (!) images a year that we have to process (rename, crop to fins, etc.) and then match to our photographic catalog of >5,500 individuals for the central west coast of Florida. As you can imagine, this equates to hours upon hours of work for us and can take even longer when we encounter an unfamiliar or potentially new individual. Wouldn't it be great if we could figure out a way to automate this process? The need for automation is becoming even more pressing as our Gulf-wide collaborative bottlenose dolphin identification catalog, GoMDIS, grows. To date, we have received and incorporated 19 catalogs into GoMDIS, including more than 13,000 dolphins and 23,000 images, with at least one catalog from each U.S. Gulf state as well as Cuba. Based on firm expressions of interest from others, we expect to receive catalogs from many more sites in the near future.

Automatic facial recognition software has been around for a while and has proven to be remarkably successful at correctly identifying people in pictures (have you ever tried to 'tag' your friends in an image you post on Facebook and been shocked when it correctly guesses who everyone is?). Automatic detection algorithms for identifying animals such as zebras, whale sharks, manta-rays, and even humpback whales are proving to be very successful and are now being implemented in several large-scale collaborative catalogs to examine the distribution and movements of

these species. The one thing that animals such as these listed have in common is some sort of patterning or coloration that the computer algorithms can use to correctly match individuals. Bottlenose dolphins lack these features, making the creation of successful algorithms a bit harder as they must rely almost solely on the nicks, notches and scars of the dolphins' dorsal fins. To make matters even more difficult, variations in fin angle or fin side (left or right) in an image hinder the ability of these algorithms to successfully match individuals.

Thanks to donations from friends of SDRP (like you!), we raised enough money during this year's Community Foundation of Sarasota County's 'Giving Challenge' to partner with Duke University and work with WildMe (www.Wildme.org) to support the development of an automatic detection algorithm for bottlenose dolphin fins in Wildbook (http://www.wildbook.org/). The money raised is helping to support a PhD student in the Department of Computer Science at Rensselaer Polytechnic Institute, who will use our extensive photographic catalog of known individuals to develop, test, and refine an algorithm that successfully matches individual dolphins based on their nicks, notches and scars regardless of fin angle or side. Once developed, this program will not only help us more quickly ID Sarasota Bay dolphins, it will help our Gulf of Mexico dolphin research partners identify dolphins in their own regions and support similar dolphin research programs around the world. Thank you to everyone who helped make this endeavor possible!

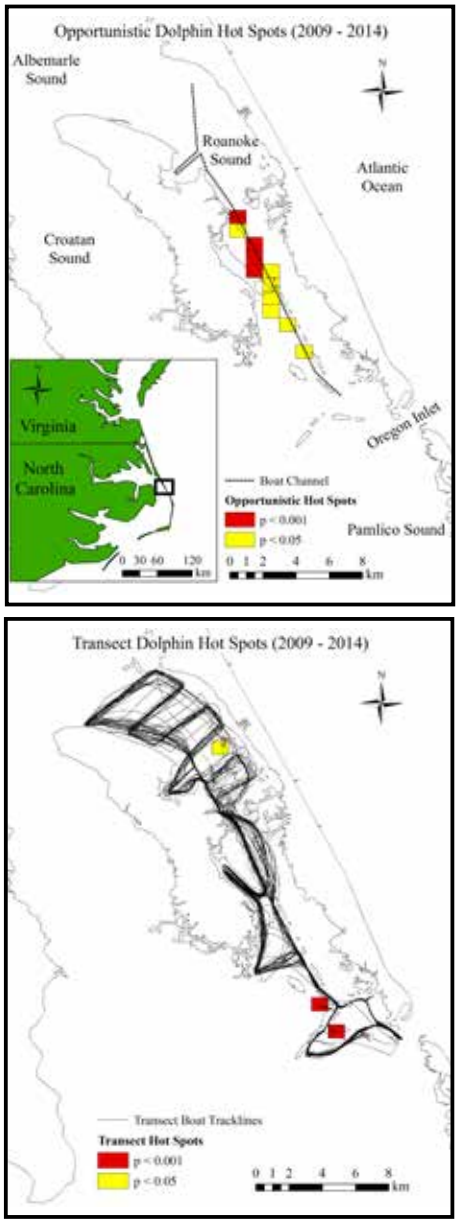
Habitat use by bottlenose dolphins in Roanoke Sound, North Carolina

Shauna McBride, Chicago Zoological Society and Jessica Taylor, Outer Banks Center for Dolphin Research

Bottlenose dolphins may use certain areas in their home range for specific activities such as feeding, socializing, and traveling. Knowledge of habitat use patterns can be important for dolphin conservation. While dolphin habitat use has been studied extensively in Sarasota Bay, Florida and a few other sites, information on habitat use in other areas is limited. The focus of my recently completed dissertation was to examine habitat use by a previously unstudied bottlenose dolphin community in Roanoke Sound, North Carolina. This area is inhabited by a seasonal community of dolphins but it is uncertain as to why they come to this area.

We applied hot spot analyses to determine if dolphins used specific areas more frequently than others. The activities of the dolphin groups, including feeding, milling, socializing and traveling, were also analyzed to determine how dolphins used these areas. We found hot spots used primarily for feeding and traveling.

Another objective of my dissertation research was to compare hot spot results between transect surveys and opportunistic surveys conducted from a local wildlife ecotour boat. Transect surveys cover a standardized route to survey an area, but these surveys can be expensive, and it can be difficult to obtain large sample sizes. Data may be collected more easily from opportunistic surveys, but the wildlife ecotour boat did not survey all of Roanoke Sound consistently, and unequal survey coverage may introduce spatial bias into dolphin sighting data. We found differences between transect hot spots and opportunistic hot spots, suggesting that spatial bias can influence hot spot results. This comparison identified a limitation of spatially-biased opportunistic data, and this limitation should be considered for future analyses of dolphin distribution using data collected opportunistically.



Hot spots of dolphin groups observed during opportunistic surveys (top) and during transect surveys (bottom).

Pensacola Bay bottlenose dolphins

Christina Toms, University of Central Florida

The overall purpose of my PhD research is to: (1) provide the first comprehensive assessment of population dynamics for bottlenose dolphins in the Pensacola Bay system, and (2) to determine the degree of connectivity between populations in the Western Florida Panhandle. This year marks the end of year three of my research and the near completion of my field work.

Pensacola Bay has a history filled with human-related disturbances making it one of the most heavily polluted bays in

Florida. There was a need to establish a baseline of population data from which to monitor dolphin health and population viability over the long term. The past three years have been spent building a bottlenose dolphin photo- identification database for the Pensacola Bay system so that we can quantify abundance, seasonal movement patterns, residency patterns, the affinity that animals have for the area, and to get a sense of how much movement there might be between this and neighboring systems. Our data analyses are still in progress with many photos still yet to process, but initial estimates show seasonal variation in the number of animals that utilize our inshore system, which is what we expect given what we know about how dolphins utilize other inshore systems in the Gulf of Mexico. Currently, there is evidence that abundance is lowest during the summer months but we will see if this holds as the rest of our data are added to the analyses.

This year we finished our remote biopsy sampling effort for the Pensacola Bay inshore system and started collecting samples along the coast. These skin samples will be added to those already available from neighboring dolphin populations so that I can start analyzing genetic data. Population genetic analyses will be done in collaboration with NOAA Fisheries to determine population structure, genetic diversity, migration rates and genetic connectivity between inshore and coastal systems in the Western Panhandle.

Over the past couple of years, our research has also focused heavily on skin lesion issues surrounding a record-breaking flood in Pensacola in 2014. The work we've done characterizing what we saw in our dolphins following the flood has led to a much larger discussion about dolphin skin issues in the Gulf of Mexico and their potential causes. There are other systems that have also experienced extensive skin issues surrounding flood events (for example, see the Galveston Bay article below). We are now working collaboratively to better characterize and measure the problem with the aim of gaining a better understanding of the causes of these skin issues and potential threats to dolphin health.

This research has been supported by NOAA Fisheries SEFSC, the UCF Physiological Ecology and Bioenergetics Lab, the University of West Florida (UWF) Center for Environmental Diagnostics and Bioremediation, the UWF Office for Undergraduate Research Scholarships, the UCF Arnold Haverlee Exploration Endowed Scholarship, and a charitable donation from Frank Toms. Thank you to the numerous interns and volunteers that have helped over the past few years, to the SDRP team for helping me in a pinch this field season, and to Errol Ronje, Steve Shippee, Hannah Roth, Gisele Nieman, and Courtney Seely for their time helping me sample this summer!

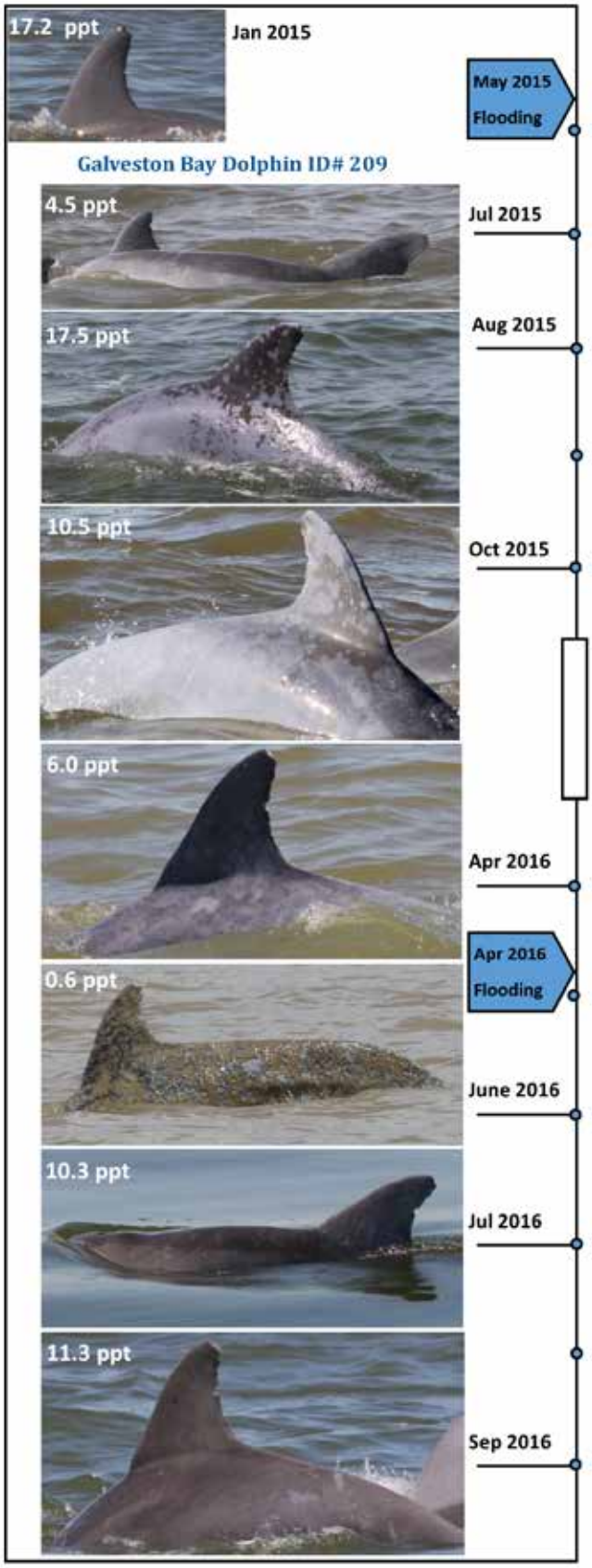
Fluctuation of flood-related skin lesions observed on Pensacola dolphins.
Top: Mom and calf first seen with white heads on April 30, 2015
Mid: Mom seen with rapid progression of skin condition on June 16, 2015
Bottom: Mom seen with normal pigmentation on January 18, 2016.

Galveston Bay bottlenose dolphins

Kristi Fazioli, Environmental Institute of Houston and Vanessa Mintzer, The Galveston Bay Foundation

Bottlenose dolphins in Galveston Bay (GB), Texas, live in one of the most industrialized estuary systems in the country. The Galveston Bay Dolphin Research and Conservation Program (GDRCP) monitors dolphin ecology, health and behavior through year-round photo-identification and remote biopsy tissue sampling, and promotes educational awareness. This year our catalog of unique individuals has increased to more than 400 animals, with more than 200 individuals sighted 3-15 times since 2013. Summer and fall bring an increase of dolphins utilizing the upper portion of the bay, while concentrations decrease during cooler months and many of the same individuals are seen utilizing the lower portion of the bay. We plan to further examine movements and historical sightings of individuals in collaboration with the Marine Mammal Behavioral Ecology group at Texas A&M University, who have been studying dolphins in portions of lower GB since the late 1980s.

GB has a history of frequent fresh water influxes and 2015-2016 were particularly wet years, seeing major spring floods that drastically dropped the salinity in the entire bay. After the May 2015 event, we began seeing skin lesions to varying degrees among many members of the population that have continued through to the present time, with an apparent increase in prevalence after the spring floods in 2016. While we believe these lesions to be associated with prolonged fresh water exposure, there is much to learn from what we are seeing and we are currently developing protocols to investigate the problem further. We are proceeding in collaboration with other programs along the Gulf Coast who have seen similar lesions (for example, Christina Toms in Pensacola, FL, (see previous article). Our long-term monitoring program allows us to track the manifestation of lesions on individuals over time. One such case study is presented in the graphic on p. 22. Dolphin #209 shows high site fidelity during warm months in the very upper portion of the bay where salinity changes are strongest. Skin lesions appeared after the 2015 spring floods and developed and changed through the year, presenting a dramatic change after the 2016 floods but quickly healing in the following months. Detailed environmental data including full water column profiles for salinity, temperature, pH, and dissolved O_2, are collected during every survey.



Timeline of the manifestation of skin lesions on an individual dolphin in Galveston Bay, TX. The surface salinity at the sightings is in the upper left-hand corner. Photos collected under National Marine Fisheries Service Scientific Research Permit No. 18881.

We initiated education and outreach activities this year, including a field assistant volunteer workshop and an exciting collaboration with the Houston Zoo to produce graphic booth displays and educational trunks for schools. Increasing awareness of dolphin communities along the Gulf Coast is an essential part of conservation, and we are happy to have the SDRP charting the way as an example and providing training and expertise for new programs such as ours.

The GDRCP is a partnership between the Environmental Institute of Houston at the University of Houston Clear Lake and the Galveston Bay Foundation. Our graduate student researcher and former SDRP intern, Sherah Loe, has worked countless hours helping us to learn about this population and will be completing her master's thesis on foraging ecology utilizing stable isotope analyses in the coming year. We greatly appreciate support from the Trull Foundation, the SeaWorld Bush Gardens Conservation Fund, Restore America's Estuaries, the Houston Zoo, Tommy's Restaurant and Oyster Bar and many other individual donors, volunteers and interns.

Passive acoustics and abundance estimation

Goldie Phillips, Duke University

Reliable estimates of population abundance are fundamental to the effective management and conservation of any species. However, estimating the abundance of cetaceans, which spend the large majority of their lives concealed underwater, can be difficult. Approaches have been developed, and are being refined for using the underwater sounds of cetaceans, to estimate their numbers. Passive acoustic sensors mounted on the seafloor are often the only viable solution in contexts where abundance estimation involving visual observation methods or towed arrays of hydrophones are impractical (for example, due to rough seas, darkness). My recently completed dissertation research sought to evaluate current passive acoustic abundance estimation methods using recorded signature whistles of Sarasota Bay bottlenose dolphins, through comparisons to true abundance obtained via a census. Because of the limited study area and extensive background data and recordings available for the individually identifiable resident dolphins, Sarasota Bay was well-suited for this kind of ground-truthing research.

Dolphin whistles were recorded by five bottom-mounted acoustic recorders deployed during June-August 2013, and moved periodically to sample a total of 66 point locations within the study area, Palma Sola Bay, as part of a systematic survey design. The methods assessed included conventional distance sampling (CDS), which involves the estimation of distances to animals or their cues (for example, the onset of a signature whistle), conventional photo-ID capture-recapture (CR), which relies on animal photographic capture histories, and combinations or extensions of these two approaches. Of these methods, snapshot mark-recapture distance sampling (SMRDS), a hybrid method that combines elements of distance sampling and capture-recapture with an approach that limits the monitoring period at each point, produced the most accurate estimate. This method relied on auxiliary data in the form of focal animal behavioral follows. However, spatially-explicit capture-recapture (SECR), an extension of CR methods that incorporates spatial data into the estimation process, demonstrated the greatest potential for broad applicability to other species and locations, with minimal to no auxiliary data. Furthermore, when sound transmission loss over distance was considered, replacing traditional straight-line distance in a novel approach to SECR,

estimation accuracy improved. In contrast, conventional CR greatly underestimated abundance, despite attempts to account for major sources of variability. In addition to performing similarly to CR, the CDS method requirement of detecting the same whistle on at least 3 sensors (to obtain distances via localization) made this method inefficient and produced small sizes. Thus, it is not recommended for studies involving only a few sensors. The most appropriate passive acoustic abundance estimation method for a given context will depend on that specific context. It is hoped that the insights provided by this study serve to inform future studies, as well as management decisions, with the ultimate goal of more effective species conservation at other sites, where less is known about the animals.

Support for this project was largely provided by the Chicago Zoological Society, Loggerhead Instruments, SDRP staff and numerous SDRP interns.

SDRP interns, Zachary Emberts (left), just before deploying a buoy used for sound transmission loss measurements, and Alicia Rinaldi (right) getting ready to deploy one of the recorders used in this study. Both of these former SDRP interns are currently enrolled in graduate programs.

On August 30th and 31st, 2016, with support from the Office of Naval Research and Dolphin Quest, we deployed satellite-linked time and depth recording tags on three males and one female off the north side of Bermuda, for studies of lung function and diving (see Fahlman, p. 14 and Moore, p. 15), and ranging patterns. Over the first two months of tracking, the three males (Devonshire, Hamilton, and Pembroke) have remained near Bermuda and nearby banks. After several weeks the female, Paget, went north more than 800 km to a ridge of seamounts. After moving among the seamounts, she moved south, passed east, south, and west of Bermuda, while remaining more than 100 km offshore, and as of November 2nd she is once again approaching the northern seamount ridge (see map).

Defining a population unit for the Bermuda dolphins is challenging, when both localized and long-distance ranging patterns must be considered. More tagging and tracking should help to identify the animals' ranging patterns. In addition, we have provided small skin samples to NOAA scientists for analyses to compare the genetics of the Bermuda dolphins to those of dolphins elsewhere in the North Atlantic.

High-quality locations during October 28th - November 2nd of bottlenose dolphins tagged off Bermuda in August 2016. The dolphin names and tag numbers appear near a large box representing the most recent location.

Diverse ranging patterns exhibited by bottlenose dolphins off Bermuda

Randall Wells, Chicago Zoological Society, Andreas Fahlman, Texas A&M University-Corpus Christi and L'Oceanografic, Jay Sweeney and Rae Stone, Dolphin Quest, Inc.

Bottlenose dolphins have adapted to a wide variety of habitats around the world. We have had the good fortune to be able to study them where they exhibit two extremes of their ranging patterns, from the multi-decadal residents who spend their entire lives in and around the small enclosed bay system near Sarasota, Florida, to those who range widely through the Sargasso Sea, the only sea in the world that is defined by water currents rather than land boundaries. Our initial tagging studies with satellite-linked transmitters in 2003 and 2005 demonstrated that bottlenose dolphins tagged near Bermuda used the deep waters around the Bermuda Pedestal and nearby banks and seamounts.

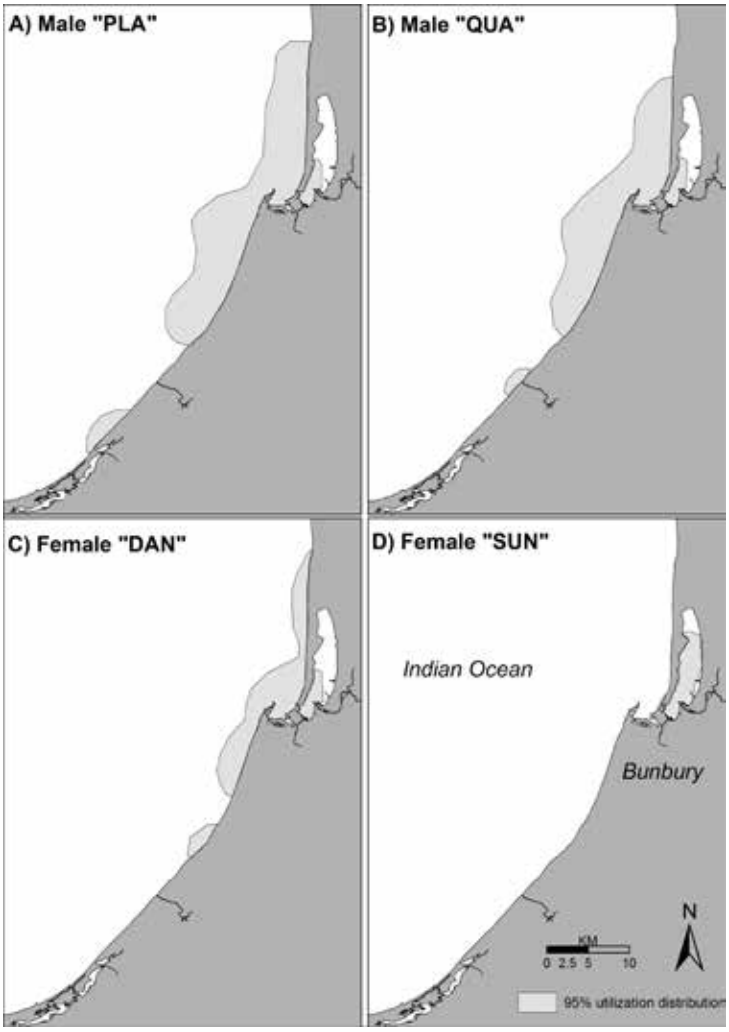
Sex-specific abundance, home ranges and habitat use of Indo-Pacific bottlenose dolphins in Western Australia

Kate Sprogis, Murdoch University Cetacean Research Unit

Within both species of bottlenose dolphins, males and females seem to have different approaches to life. My PhD thesis, complete in August 2015, was undertaken through the South West Marine Research Program (SWMRP) in Bunbury, Western Australia. I completed an integrated analysis of a 6.5 year photo-identification study conducted across coastal and sheltered waters. The most pronounced sex-specific findings of my research were that 1) abundance estimates for males and females were seasonally dependent and influenced by large-scale environmental variables, such as El Niño, 2) abundance estimates and sighting frequencies were generally higher for adult females than adult males, 3) females typically had smaller home ranges than males, 4) both females and males clustered close to the coast in summer and autumn, and

were more dispersed throughout the study area during winter and spring (including offshore waters), and 5) a subgroup of females was segregated from males in a shallow, sheltered estuary across all seasons apart from summer. We suggested that the documented sex-specific and seasonal patterns in dolphin movements and behavior ultimately reflect seasonal fluctuations in prey distribution coupled with mating priorities during the warmer months. Overall, this study enhances available knowledge of the variation in behavioral ecology found among bottlenose dolphin populations and between the sexes, and acts as a model and impetus for future sex-based studies.

Our research would not have been possible if it was not for the help from our dedicated assistants and funding bodies for the SWMRP: the Dolphin Discovery Centre, Bemax Cable Sands, BHP Billiton Worsley Alumina, Bunbury Port Authority, City of Bunbury, Cristal Global, Department of Environment and Conservation, Iluka, Millard Marine, Naturaliste Charters, Newmont Boddington Gold, South West Development Commission and WAPRES.



Examples of Indo-Pacific bottlenose dolphin home ranges in Bunbury, Western Australia. Kernel Density Estimates (95% utilization distribution; light grey polygons) with land barriers (dark gray) are shown for two adult male (A, B) and two adult female (C, D) dolphins.

Scooter tosses a Florida pompano high into the sky. Many Sarasota Bay dolphins utilize the "fish toss" feeding strategy, one of the few techniques that allows us to observe what species they are preying upon.

Fishing for data in Sarasota Bay

Elizabeth Berens McCabe and Sunnie Brenneman, Chicago Zoological Society

Prey fish availability is one of the most important drivers of dolphin behavior, survival, and reproductive success. Since 2004, the Sarasota Dolphin Research Program has explored relationships between the long-term resident dolphins of Sarasota Bay and their prey by conducting seasonal multi-species fish surveys. These surveys allow us to monitor seasonal abundance, distribution, and body condition of the fishes in Sarasota Bay, Florida. Data from this project enable us to investigate fine-scale habitat and prey selection in wild dolphins, and to explore the effects of *Karenia brevis* red tides and other environmental events on different fish species and community structure. This project has facilitated a variety of novel research, including modelling work involving the consequences of disturbance on a dolphin population (see Schwarz, p. 8).

Our standardized multi-species fish survey consists of a winter and summer fishing season (10 sets per month; Jan-Mar; Jun-Sep), during which we catch, measure, count and release fish from the *R/V Flip* using a 183 m purse seine in seagrass habitats. Our 2016 data indicated healthy fish abundances in Sarasota Bay (at least prior to the red tide that began after we completed our fish surveys). In the winter we caught a total of 3,172 fish of 43 different species. This summer yielded 31,681 individuals of 59 different species. After controlling for the influence of small schooling fishes on the mean number of fish caught per seine set (CPUE, or catch-per-unit-effort), winter CPUE was 105.7 and summer CPUE was 792.0.

After severe red tides in 2003, 2005 and 2006 and subsequent increases in summer fish abundance, CPUEs remained fairly steady from 2009-2014. Then, in 2015, summer fish abundance jumped to our third highest overall CPUE since this study began in 2004. This summer fish abundances remained high again, giving us our 6th highest overall CPUE ever. Pinfish, pigfish, mojarra, scaled sardine, Atlantic threadfin herring, and silver perch ranked highest, respectively, in abundance by species. Mullet abundance, which was negligible the past two summers, jumped up to our 7th highest CPUE! Other notable species abundances this summer included hardhead catfish, which ranked eighth highest, compared to the past two years in which they were ranked 16th and 18th. We also caught our first gafftopsail catfish since 2012 and our first snook since

2013. In contrast, winter fish abundance has varied little since our survey began in 2004 (range = 81.2-211.3), despite having sampled through four distinct winter red tide periods as well as cold events. Additional analyses are needed to determine trends in species-specific abundances and body condition.

We thank the many interns and dedicated local volunteers who have worked on this project. The work would not be possible without you! Funding for this work during 2016 was provided by the Batchelor Foundation. This research was authorized by the Florida Fish and Wildlife Conservation Commission (13-0809-SR, Special Activity License) and by Mote Marine Laboratory's Institutional Animal Care and Use Committee (15-6-RW2).

Shark-dolphin interactions in Sarasota Bay: Tracking bull shark movements

Krystan Wilkinson, Chicago Zoological Society and University of Florida

Merry, a female bull shark, was captured, tagged, and released on June 16, 2016 in Sarasota Bay, Florida. Photo credit: Mote Marine Laboratory

Information on habitat use and movements by Sarasota Bay resident bottlenose dolphins is very well known; yet, the reasons for observed movement patterns and habitat choices are not fully understood, especially as they may be influenced by their potential predators, sharks. My dissertation research focuses on understanding the impacts of predatory sharks on the habitat use, survival, and behavior of Sarasota dolphins. Information regarding habitat use of large sharks is extremely limited in coastal nearshore habitats, including Sarasota Bay. By tagging and tracking sharks, I hope to provide a better understanding of habitat-associated predation risk within the estuary and its impact to the dolphin community.

During the May 2016 Sarasota Bay Dolphin Health Assessment Project, we observed F165 with her newly born calf, 1652. The calf had extensive shark bite wounds behind its right eye and on its dorsal fin. After observing the mom-calf pair several times in May, we grew concerned when we did not see them during regular population monitoring surveys in June and July. We were relieved when we finally saw the duo again during August-November; thankfully the wounds appear to be healing well on 1652.

In addition to keeping track of shark-bitten dolphins, this summer we set out for two nights of shark fishing in hopes of tagging a bull shark to gather preliminary movement information. The first night of shark fishing was conducted in the northern half of Sarasota Bay, with no success except for a fantastically large catfish. The second night of fishing was conducted from the Ringling Bridge to the south, with the most effort occurring in Big Pass. During the second night of fishing, we successfully caught two blacktip sharks and one 7-ft bull shark. All three sharks were caught on drumlines in Big Pass. The bull shark was caught at 2:20 AM on June 16, 2016 and was tagged with a continuous acoustic tag, as well as a satellite-linked tag. The female bull shark was named "Merry," and was successfully tagged and released. A few hours post-release, we received four satellite signals roughly 1.8 nautical miles off north Siesta Key. Unfortunately, we have not received any additional satellite-linked tag signals since June 16. Thanks to a scholarship received from the Guy Harvey Ocean Foundation, I plan to continue shark fishing efforts next year to gather more data on shark movements in Sarasota Bay.

This project is made possible from funds graciously provided by an anonymous donation to the Chicago Zoological Society, the University of Florida, Mote Scientific Foundation, and through partnerships with the Sarasota Dolphin Research Program, Mote Marine Operations Department, and Mote's Shark Biology and Conservation Research Program. Many thanks to to University of Florida students Steven Longmire, Ashley Meade, Remy Phillips, and Zach Steinhauser for volunteering countless hours to aide in the success of this research!

F165 was first observed with her 2016 yoy, 1652, on May 10th. The neonate already bore severe wounds on its head and dorsal fin from recent shark bites.

As of November 4th, the shark bite wounds on 1652 appear to be healing well.

Dolphin rescues along the west coast of Florida

Aaron Barleycorn, Chicago Zoological Society

The SDRP is authorized to respond to marine mammal strandings, as a designee under Mote Marine Laboratory's Letter of Authorization from NOAA's National Marine Fisheries Service. Because of our decades of experience and training, we investigate reports of strandings or animals in trouble, and help to rescue or recover them.

Entanglement in fishing gear is one of the biggest threats to Sarasota Bay dolphins. We performed one dolphin disentanglement since our last update. On March 1, 2016 we rescued Bill, a 10-yr-old male resident Sarasota Bay dolphin, from entanglement in a crab trap float line in the Gulf of Mexico near Venice. He was entangled overnight in one of the more than 8,000 traps deployed this time of year for stone crabs within the Sarasota dolphin home range. Bill had managed to get his tail wrapped in the float line of the crab trap, and was weighed down by the trap to the point where he was unable to move, and barely able to get his head out of the water to breathe (see photo at top right). We used a boathook to grab a bit of line floating next to Bill, pulled up line until we got to the entanglement, and then unwrapped the line from his peduncle and fluke. Bill was tail kicking during this time and appeared to have full motion of his fluke. There were some superficial lacerations where the line had wrapped, but they did not go very deep. Once fully disentangled, we released the dolphin and watched him swim away. Bill has been seen 12 times since his rescue, and appears to have fully recovered from his entanglement. His last few sightings have been with 9-year-old male "JoBob." They are showing some signs of forming a male alliance, a bond that could last for the remainder of their lives.

Bill's rescue occurred on the 6th anniversary of our rescue of his younger sister, Nellie, from tightly embedded plastic line behind her head when she was less than a year old. We are pleased to be able to say that previous entanglement or stranding cases Nellie, Scrappy, Ginger, Lizzie, Vidalia, Skipper, F286, and Parcel (rescued off Clearwater in October 2015) have all been seen in 2016, and all appear to be doing well. Skipper and Vidalia have both become independent from their mothers, and Skipper's mom was recently seen with a new calf!

Rehabilitated bottlenose dolphin Octavius is readied for release off Grand Isle, Louisiana, by a team from Audubon and the Louisiana Department of Wildlife and Fisheries, led by veterinarian Tres Clarke (right).

Top: Entangled dolphin Bill, barely above the surface as the rescue boat approached.
Bottom: Aaron Barleycorn disentangling Bill from the crab trap float line alongside the boat. Over the months post-release, Bill appeared to be in good health and engaging in normal behavior.

Supporting dolphin interventions elsewhere

Randall Wells, Chicago Zoological Society

Interventions for dolphins in life-threatening situations are increasing in frequency in the southeastern U.S., involving rescues for on-site disentanglements and releases, translocations and releases, or rescues or strandings followed by rehabilitation and release. Follow-up monitoring remains a crucial component of interventions. Information on the success of the intervention, as judged by the survival and behavior of the animals post-release, can guide decisions about further intervention if the animal fails to thrive in the wild, and can inform future efforts with other animals under similar circumstances. Such information is increasingly important as interventions are being considered among the possible restoration options in response to the *Deepwater Horizon* oil spill and other environmental contaminant situations.

The Sarasota Dolphin Research Program provides follow-up monitoring services to the members of the national marine mammal stranding network through a grant from NOAA's John H. Prescott Marine Mammal Rescue Assistance Grant Program. We maintain a supply of satellite-linked tags and tagging and tracking supplies, and provide tracking services to organizations who request them. During 2016, we provided tags to a number of organizations for possible deployment, and these were ultimately deployed in four cases, involving bottlenose dolphins and pygmy killer whales.

On January 19th, a young female bottlenose dolphin, given the name Lil' Rae, was rescued by NOAA from a small canal near Bay St. Louis, Mississippi, and tagged and translocated to nearby Gulf of Mexico waters. She moved through a fairly limited area, in Bay St. Louis and adjacent Gulf waters, for about two months before her carcass was recovered on March 23rd at the mouth of the Jourdan River in the northwestern corner of Bay St. Louis. Final conclusions from necropsy are pending.

On March 25th, another young female bottlenose dolphin, given the name Alli, was rescued by NOAA and SeaWorld from a lake off the Perdido River in Alabama. She was tagged and translocated to Perdido Bay. She moved through a fairly limited range, including Perdido and Wolf Bays, until her carcass was recovered on June 18th. Final conclusions from necropsy are pending.

On April 28th, a young male bottlenose dolphin, given the name Octavius, that had undergone rehabilitation at Audubon Aquarium of the Americas since his stranding in October during a storm associated with the remnants of Hurricane Patricia, was returned to Barataria Bay, Louisiana for release. I traveled to Barataria Bay to perform the tagging and initial tracking, then continued remote tracking. The dolphin's tag provided location data until June 5th, showing him moving through western Barataria Bay, Timbalier Bay, and Terrebonne Bay. On June 7th he was observed and photographed by NOAA staff with the tag intact, indicating a tag electronics failure issue. Occasional signals without location data were received through August 13th, suggesting that he was still alive at least 3.5 months post-release.

On July 11th, the Institute for Marine Mammal Studies in Mississippi released two male pygmy killer whales that had undergone rehabilitation since their stranding on September 1st, 2015, near Waveland, MS. They were tagged and released off the edge of the continental shelf south of Mississippi. One was tracked through July 26th and the other through October 7th, until maximum dive depths declined and signals ceased. They moved primarily along the shelf edge south of Louisiana, through the Mississippi Canyon and Houma Valley. Their deepest dives exceeded 350 m, and their longest dives exceeded nine minutes.

A net positive for sea turtles

Sunnie Brenneman, Chicago Zoological Society

Since 2004, the SDRP has conducted routine prey monitoring surveys in Sarasota Bay using a purse seine (see McCabe, p. 24). While operating this type of gear we occasionally discover more than just fish hiding inside our compass. In addition to collecting a wealth of data, we have also inadvertently cleared the bay of such marine debris as derelict crab traps, broken sailboat masts, old tires and even trolling motors. This summer, though, our good deeds on the high seas progressed from opportunistic trash removal to opportunistic rescue, rehab and release efforts!

Although no sea turtles have ever entangled in our fishing net, on rare occasion we will have one swimming freely within the compass. When this happens, all effort is immediately focused on safely removing and releasing the turtle back into the wild. This summer, however, we happened upon two green sea turtles suffering from severe monofilament entanglements that would have ultimately proved fatal without our intervention.

Noodle was found in August, sporting severe swelling to his right front flipper. Further inspection revealed the cause: monofilament wound tightly around the limb, gouging deeply into his flesh. We made arrangements with Mote's Stranding Investigations Program (SIP) to transport the turtle to Mote's sea turtle rehabilitation hospital for treatment. X-rays revealed that the entanglement had actually fractured Noodle's femur, necessitating amputation. Thanks to the excellent care provided by hospital staff, Noodle's prognosis looks good! With three and a half healthy flippers to his name, SIP and hospital staff are optimistic that Noodle will return to the wild in the near future.

We discovered Pancake in September, suffering from an entanglement that he had also ingested. Monofilament line wrapped around the turtle's front left flipper and neck. This same line extended into his mouth and out his cloaca, trapping feces that trailed behind Pancake. We again reached out to Mote's SIP for assistance. The entanglement was removed and, after 6 weeks of rehab in the capable hands at Mote's sea turtle rehabilitation hospital, Pancake finally shed the last bit of monofilament that remained in his gut. In preparation for release, animal care staff outfitted him with a PIT tag. On November 10th, due to the extended red tide conditions present in Sarasota Bay, Pancake was driven north to Dunedin, Florida for his return to the wild.

Just hanging out - Pancake waits patiently as Weston Spoon of Mote's sea turtle hospital obtains his weight prior to release.

Education, Outreach, and Training

Education continues to be a major component of our program's activities, directed toward the general public, students, colleagues in the United States and abroad, and wildlife management agencies. The Sarasota Dolphin Research Program is a component of the Chicago Zoological Society's Conservation Education and Training group.

Public Education and Outreach: We work to educate the general public regarding bottlenose dolphins and conservation issues through public presentations at the Chicago Zoological Society's Brookfield Zoo, Mote Marine Laboratory and Aquarium, and elsewhere, articles and interviews, and through volunteering opportunities. We also produce books for the general public and students. For more information on our program's books and publications, please visit www.sarasotadolphin.org.

In response to an increase in dolphins taking bait, catch and discarded fish from anglers, we worked with NOAA Fisheries Service, Hubbs-Sea World Research Institute, and fishing guides and anglers to develop an educational card displaying 10 tips intended to improve the experience of the angler or boater while enhancing protection for dolphins. By making these cards available to boaters, anglers, and the general public, we hope that more individuals will become aware of the risks and legal issues involved when interacting with wild dolphins and choose to engage in responsible viewing and fishing practices when dolphins are present. These *"Dolphin-friendly fishing and viewing tips"* cards were initially developed through the support of the Disney Worldwide Conservation Fund, with additional funding for re-printings coming from Marineland: Dolphin Conservation Center, Harbor Branch Oceanographic Institution, and Fish Florida. We coordinate distribution of the cards, and we will continue to make them available at no cost to those who can effectively distribute them to people likely to come into contact with wild dolphins. The cards are available in English and Spanish as downloads at: www.sarasotadolphin.org.

As a complement to the cards, we helped to develop a 30-second public service announcement (PSA), *"Don't Feed Wild Dolphins."* This animated PSA highlights the dangers of feeding wildlife along with ways that members of the public can interact with wild dolphins in a more responsible manner. This PSA, along with more information on issues surrounding people feeding wildlife, is available online at: www.dontfeedwilddolphins.org.

We have produced brief (2-4 min) educational videos about dolphin conservation and biology, through support from the Disney Conservation Fund. These videos are available through the SDRP website, www.sarasotadolphin.org.

Sharing Scientific Findings and Participation on International and Government Panels: Our efforts to provide information to our colleagues and wildlife management agencies continues, through publication of numerous peer-reviewed scientific articles, through invited presentations at various scientific conferences and through participation in national/international panels such as the NOAA/USFWS Atlantic Scientific Review Group, the NOAA/NMFS Bottlenose Dolphin Take Reduction Team, the U.S. Marine Mammal Commission Committee of Scientific Advisors on Marine Mammals, the Florida Marine Debris Reduction Guidance Plan Working Group, and the IUCN Cetacean Specialist Group.

International Training Opportunities: As a component of the Chicago Zoological Society's Conservation Education and Training group, we provide training opportunities for scientists and students from outside of the United States. These training opportunities allow foreign scientists and students to participate in SDRP field and laboratory research activities and discuss with staff how such activities might be applied to their own situations at home. Standardized research methodologies facilitate comparisons across research sites. During 2016, we had trainees, including interns and graduate students, from: Brazil, Germany, Mexico, Spain, Sweden, the United Kingdom, and Venezuela. Former SDRP intern, Roshni Mangar, also completed her senior honors thesis focused on dolphin ecotourism in Florida and her home country of Mauritius.

Photos aren't the only things taken during population monitoring surveys. Using a YSI multi probe, SDRP intern Amy Alvarez takes salinity and temperature readings from a water sample collected at a dolphin sighting.

Graduate Students: As described throughout this newsletter, graduate students from a variety of institutions, especially the University of California, Santa Cruz, Duke University, the University of Florida, and the University of Central Florida involve the resources of our program as they conduct their thesis or dissertation research. To date, 35 doctoral dissertation and 34 master's thesis projects have benefited from association with our program, through field research opportunities or access to data, samples, or guidance. During 2016, three doctoral students with our program, Amanda Ardente (University of Florida), Shauna McBride (University of Southern Mississippi), and Goldie Phillips (Duke University, previously a SDRP intern), and another for whom samples from our program were crucial, Corey Russo (University of Southern Mississippi) successfully defended their dissertations. In addition, two Master's students, Fernando Noriega Betancourt (University of Florida) and Maria Robles Malagamba (University of Florida), successfully defended their theses. Currently, four doctoral students are making use of resources provided by our program, through the University of Florida, Duke University, Portland State University, and University of Central Florida.

Undergraduate College Internships and Post-Graduate Trainees: At the college level and beyond, we are fortunate to have access through Mote Marine Laboratory to high quality, dedicated undergraduate student interns who volunteer with our program for at least 2-3 months at a time (for more information on internships, please contact Katie McHugh, SDRP Intern Coordinator, at: kmchugh@mote.org). During 2016, 16 interns and post-graduate trainees provided approximately 8,200 hours of assistance to the program.

Elementary and middle school classroom dolphin conservation lessons and activities

Chip Phillips, K-5 Science Lab Instructor

The Sarasota Dolphin Research Program has played a major role in introducing wild dolphin conservation into Sarasota, Florida elementary schools. Now in its fourth year of availability to Sarasota County Public Schools' teachers and students, the Curriculum Guide for Sarasota County Schools "Sarasota Dolphin Conservation Lessons" is a valuable resource for elementary and middle school classrooms. This curricular supplement addresses problems our local dolphin population faces, both man-made and natural, and emphasizes conservation and "best practices" for human/dolphin interaction or proximity issues.

Combining teacher-directed lessons with short videos featuring "dolphin cam" (the underwater view from the dolphin's perspective) and hands-on activities, this curriculum has proven to be a popular addition for classroom conservation and biology studies. In the past two years, over two thousand students in grades K-5 have been exposed to these lessons, videos, and activities, and the feedback from teachers has overwhelmingly been positive.

During the current school year, we're looking forward to having even more students being exposed to this curriculum package. It is our sincere hope that, by exposing Sarasota's youth to marine conservation issues, Sarasota's waters can continue to be a sustainable place for the safety and future well-being of our area's marine mammals. It's never too early to start learning about what we can do to conserve and protect our area's natural resources!

The curriculum is available as a download at www.sarasotadolphin.org/sources-of-information/videos.

Marine debris collected during Sarasota Bay Watch's Monofilament Cleanup event on November 5th, 2016. Left to right: Ronda Ryan (Sarasota Bay Watch), Melanie Gannon (Mote College Intern), Lily Meadows (Mote High School Intern), Kim Bassos-Hull (SDRP/Mote), Dr. Katie McHugh (Chicago Zoological Society).

Working together with government agencies, students and community to reduce marine debris impacts on Florida wildlife and habitats

Kim Bassos-Hull, Sarasota Dolphin Research Program

Marine debris in Florida waterways and along the coasts poses a significant entanglement and ingestion threat to wildlife. Since 2005, the SDRP has been a contributing member of the Florida Entanglement Working Group and more recently since 2013, the Florida Marine Debris Reduction Team. This team is composed of experts from state and federal agencies, not-for-profit research organizations, and stakeholder groups. Dr. Jennifer McGee of FWC and I serve as co-chairs of the Wildlife and Habitats Working Group, with Dr. Katie McHugh as a member. After three years and several meetings, the five working groups developed a draft Florida Marine Debris Reduction Guidance Plan. Currently under agency review, this draft plan will be released for broad stakeholder input in 2017. One of the key actions recommended to understand impacts to wildlife and habitats was conducting more research on marine debris hotspots and collecting data from community cleanups.

Starting in 2015, I worked with Mote educators Kasey Gaylord-Opalewski and Kaitlyn Hofeldt to engage Mote high school interns to walk a number of bridges and piers within Sarasota and Manatee

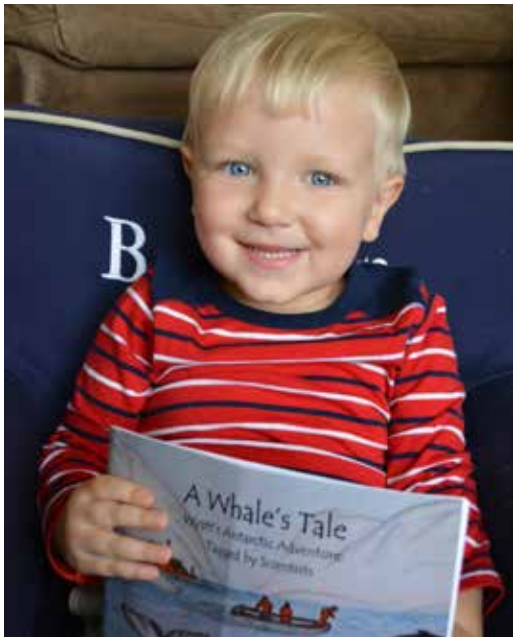
Counties to record numbers of people and fishing lines in the water, wildlife present, and the amount of trash seen. The students were trained to use NOAA's Marine Debris Tracker App to record the trash observed during these surveys. During November 2015-April 2016, 72 surveys were conducted by students and a total of 3,618 pieces of trash were logged (including 1,551 cigarettes, 886 plastic, 493 fishing gear, 225 metal, 103 paper, and 80 glass items). These students have also conducted coastal cleanups as part of the Ocean Conservancy's Coastal Cleanup, Sarasota Bay Watch's Monofilament Cleanup, as well as their own with other students from the community. During Mote's World Ocean Day in June 2016, these students were able to highlight their results to the public as well as engage them in creative ways to learn about marine debris and actions they can take to reduce it. Let's hear it for the next generation helping to spread the word to keep our oceans clean!

A Whale's Tale

Reny Tyson, Chicago Zoological Society

One of the most important things scientists can do is interact and engage with others about their research. Marine mammal research is particularly interesting to the general public and can be used in the classroom as a hook to attract and teach students about science and conservation. Before joining SDRP I used bio-logging tools to study the fine-scale foraging behaviors of humpback whales in Antarctica as part of my dissertation research at Duke University. This research included the simultaneous tagging of a mother and her calf with suction-cup-mounted DTAGs that recorded whale movements and acoustics. I found that this topic appealed to a broad audience (including children) during several public outreach events in which I participated.

This interest gave me the idea to create a storyline based on my research that appealed to children in the development of informative and educational STEAM (Science, Technology, Engineering, Art, and Math) focused resources. Therefore, I teamed up with Gail Tyson, an elementary school art teacher and curriculum writer in central Florida (and my mother!), to create a short film, narrative children's picture book, K-5 curriculum lessons, and hands-on activities based on this research. We developed these products using the calf, named Wyatt, as the main character in an attempt to connect children with STEAM subjects in a fun and engaging manner.



Benji Horton, a budding marine biologist enjoying "A Whale's Tale."

Students using these resources learn about humpback whale ecology, the Antarctic ecosystem, and marine mammal research as they follow Wyatt and his mother Wendy as they migrate to Antarctica, feed on krill, meet other Antarctic species, and ultimately get tagged by curious scientists. Thus far, our "Whale's Tale" products (found on www.BlueSTEAM.org) have been viewed by more than 2,000 visitors from more than 12 countries. In addition, a pre- and post-test of Antarctic and marine mammal facts used by participating K-5, middle, and college classroom teachers has demonstrated that students (>1,800) significantly enhanced their understanding of marine mammal research and Antarctica after using our materials. We hope to continue creating such educational products to engage others, especially our youth, with accurate information on marine mammals. Perhaps "A Dolphin's Tale" would make a good subject for our next storyline!

Conservation research capacity building: Biopsy sampling training

Aaron Barleycorn, Chicago Zoological Society

As described in the article by Nick Kellar (p.13), important information on reproductive status, stress, environmental contaminants, skin lesions, sex, and genetics can be derived from remote collection of a tiny sample of skin and blubber. Biopsy dart sampling is a well-established technique that has been used successfully tens of thousands of times around the world with cetaceans, providing tissue samples without needing to physically handle or restrain an animal. There is a need to increase capacity for using this technique in the southeastern United States and other areas for management purposes. Thanks to a grant from Harbor Branch Oceanographic Institute/FAU, the Sarasota Dolphin Research Program has been able to conduct a second year of biopsy dart sampling training for qualified researchers.

The training begins in Sarasota Bay, where a team of trainees is taught the basic skills needed to safely dart a dolphin, collect associated data, and process tissue samples for analysis, as well as get a chance to watch an experienced team collect samples. After trainees demonstrate the ability to safely, accurately, and reliably hit a target as well as show basic understanding of dolphin behavior, they are allowed to take samples under the watchful eyes of the trainers. When possible, a follow-up week of training is performed in the researchers' own study areas. As they demonstrate the ability to safely collect samples, the trainees are allowed to take on more responsibility and try to lead the team.

During 2016, we worked with two new trainees and also continued work with three participants from the previous year. In addition to the initial training in Sarasota, we spent two separate weeks helping acquire samples from different locations in the Indian River Lagoon (IRL). These samples are of particular importance as they will help us understand how pollution in the IRL is affecting the wildlife in the area, as well as contribute to the basic understanding of the population structure in the area. To date, biopsy dart training has resulted in building capacity and acquiring samples in Sarasota Bay, the IRL, Galveston Bay, Pensacola Bay, the coast of the Florida panhandle, and Puerto Rico. These samples and the ability to collect more will greatly increase our ability to understand the needs of dolphins in the southeastern United States and elsewhere.

Graduate Student and Intern Updates: Where are they now?

From acoustics of Sarasota Bay adult male bottlenose dolphins to studies of the impacts of anthropogenic activities on marine species

Stephanie Watwood, NUWC Newport, Environmental Branch

Starting in 1997, I spent six years with the SDRP as a doctoral student in the Massachusetts Institute of Technology / Woods Hole Oceanographic Institution joint program. I was fortunate to closely collaborate on my dissertation with another SDRP graduate student, Edward Owen. We both were interested in the social dynamics of pair-bonded adult male dolphins, and my dissertation focused on how males use whistles to communicate with one another and mediate the pair-bond. We spent 4 field seasons following just 12 adult males around Sarasota Bay. My time in Sarasota provided invaluable lessons on field biology, boat maintenance, electronics repair, and how to determine which types of clouds are preludes to lightning.

After a post-doc at Woods Hole Oceanographic Institution, I accepted a position with the US Navy in Newport, Rhode Island. In my current position, I conduct research on the impacts of anthropogenic activities on marine species, assist in the management of a portion of the Navy's Marine Species Monitoring Program, and work with a large team to develop models to estimate the impacts of sound exposure on marine species. In these efforts Sarasota has proven a useful training ground. Skills I developed towing a hydrophone array through Sarasota Bay are still in use as I listen for beaked whales on the Navy's much larger hydrophone ranges, while my time spent observing dolphins from a boat enabled me to become an effective marine species observer on Navy ships. Finally, learning to collaborate and work as part of a larger team serves me well in inter-government agency projects, such as a current one studying habitat use and migration of fish and sea turtles in Florida with the Bureau of Ocean Energy Management, NASA, and the Air Force.

Working for the Navy has been rewarding, as I am able to continue pursuing basic research, but also play a role in shaping policy. While this is a career path I never envisioned, keeping an open mind has led me in many directions and afforded many interesting opportunities.

Stephanie Watwood scans for marine mammals from a Navy vessel.

Dolphins and fishermen, there and back

Mauricio Cantor, Universidade Federal de Santa Catarina, Brazil

I joined the SDRP in 2008 as an intern for the research project led by Jessica Powell on the interactions between bottlenose dolphins and anglers. That period was a steep learning curve—for all of us, I guess. Dolphins were learning to relate anglers to a food source. Jess was learning its negative consequences for the Sarasota Bay dolphin community. I was learning the basics.

It was my last year as a Biology undergrad and my broken English and I were very keen to see the research on the famous Sarasota Bay dolphins in action. Three months in those inshore waters expanded my previous experiences among right and humpback whales in Brazil. Much more than the well-equipped facilities, what impressed me the most was the extreme care with the data being collected—and more importantly, the care with the dolphins' well-being. With daily surveys painstakingly collecting data followed by long hours at the lab entering and double-checking them all, the message was clear. The world-class research by the SDRP was founded on passion for the research and the animals.

Inspired by such high standards, I went on to get a M.Sc. degree in Ecology studying Guiana dolphins in the following year. The skills I honed at SDRP were crucial for me to collect the photo-identification data needed. With that box checked, I became increasingly interested in data analysis. My colleagues and I combined mark-recapture modelling with network thinking to unravel the population and social dynamics of Guiana dolphins. Our analyses revealed a population of residents and transients, in which demographic changes were shaping the structure of their society.

That increasing interest in translating cetaceans' social lives into numbers led me to earn a Ph.D. in Biology in Canada in 2016. My Ph.D. work involved understanding how societies and cultures evolve. To do that, I went on a somewhat unusual path: I confined myself in a small sailboat very far away from people and their diverse cultures. I joined a research group that carries out a long-term project on the sperm whales off the Galápagos Islands. There, whales from the same population form cultural clans that communicate with different patterns of clicks—whales with different dialects, if you will. My contribution was to develop a conceptual framework of how animal society and culture influence one another, using sperm whales as a model. We developed computer models that traced back the origin of sperm whale cultural clans, showing that biased cultural transmission of communication clicks are the main mechanism generating their different dialects. And with empirical data, we showed that once clans are formed, other behavioral variants (such as social norms) can emerge over time, differentiating sperm whales from different clans even more.

In my post-doctoral research, I will study another type of interaction between bottlenose dolphins and fishermen. In contrast to the harmful interactions between dolphins and anglers in Sarasota Bay, dolphins and artisanal fishermen from Laguna (Brazil) work together. Dolphins herd mullet schools towards fishermen who throw their cast nets once dolphins give the right behavioral cue. Both fishermen and dolphins catch more and larger fish when cooperating. But given the clear benefits of the interaction, it is still unknown why some dolphins do not partake in this cooperative foraging. Is it too hard or costly to learn? Is the competition for cooperative fishing sites too high? My goal is to shed light on the origin and evolution of interspecific cooperation, by confronting these empirical data with mathematical models inspired by game and network theories.

By heading back to Brazil to study dolphin-fisherman interactions, I am, in a sense, closing the cycle started with the SDRP. I bring in my baggage an important lesson learned at that time: work with passion and everything will follow.

Mauricio Cantor investigating the social culture of sperm whales off the Galapagos Islands.

2016 Intern Perspectives

Political scientists are welcome too

Rafaella Lobo, Duke University Marine Lab

Ever since I can remember, I was passionate about marine life. While other kids would draw pretty mountains, and “m-shaped” birds, I would draw a pretty ocean full of whales and dolphins. Growing up in the middle of Brazil though, 1,500 km away from the nearest coast, “being a whale researcher” soon became a childish dream. I ended up doing International Relations as an undergrad, and came to the US for my Masters in Environmental Politics. In my first year of graduate school, I took “Marine Conservation Biology” as an elective, and realized that nothing would make me happier than to work in marine conservation. Most importantly, I realized how challenging interdisciplinarity can be. I was faced with biologists who did not respect political science as a science, and political scientists who did not see the importance of biology to my work. I guess being somewhat of an academic-masochist, I decided that was my new battle in life.

Rafaella Lobo snaps a photo of MLVN off the bow of R/V Fregata during a Sarasota Bay population monitoring survey.

I soon realized I needed some more hands-on experience on the research/practical side of things. I started volunteering at the Hubbs-SeaWorld Research Institute and, upon graduation, I was thrilled to learn I got accepted as a Sarasota Dolphin Research Program intern. Coming from the middle of Brazil, and being a political science student, I was both very eager and terrified. I did not know what to expect. All I can say is that not even in my wildest dreams did I think I would learn so much on an internship. Everyone at the SDRP is eager to share what they know with the interns, and they are very patient. Unlike most internships, I felt like I was benefiting much more from the position than they were from having an intern. In the program, I not only furthered my knowledge and experience on photo-ID techniques and data collection, I also learned to drive a boat, and take photos of the dolphins; I learned the techniques of purse seine fishing for dolphin prey studies; the collection (and importance) of red tide samples. I learned a lot about acoustics, and how cool GIS can be. I assisted staff members with database management, data entry, biopsy darting, and even got the chance to interact with other programs, such as assisting with dolphin necropsies. And this is just the very summarized version of everything I learned.

When the internship was over, I was not ready to leave. I was still trying to figure out what to do next, so I stayed for a couple more months, helping with an acoustics project. Later in the summer, SDRP staff members learned there was an open position at Duke Marine Lab, to do photo-ID. They recommended me, and it is with great excitement that I took on my dream job, at one of the best laboratories in the world. All those people I look up to so much are now my bosses/co-workers, and I would not be here if it was not for my time at the SDRP.

It all makes me think how life is funny sometimes. After the world spun around the sun a couple of times, here I am, back at watching whales and dolphins, and fulfilling my dreams. I would like to say 5-year-old me would be very proud.

Nicole Arevilca poised and ready to release corks off the back of the R/V Flip to begin a fishing set. SDRP summer interns receive a lot of exposure to the prey monitoring project and gain experience working with nets as well as handling live fish.

Focused on photo-ID

Alex Fields, University of Louisiana, Monroe

I've always considered myself a dreamer. Growing up was hard for me, because I was continuously dissatisfied by the world around me. For a long time my life has been cyclic. I put in work, got a little bit out of it, then I'd get bored and move on. Career wise, I had no idea what I wanted to do, but I did have dreams. I had dreams of magic and wonder. My dreams were of a totally different world. A world ruled by magic and science. A world not ruled by massive egos ripping it apart piece by piece. Mind you, this world was all in my head. That is, it was until 2003. I was 13 year old then. The movie Finding Nemo had just come out in theaters, and I, like many others flocked to the silver screen. It wasn't that the story itself resonated with me, though. I'd enjoyed it, but that wasn't really my takeaway. No, what I embraced was the concept of another world existing right beside my own. One vastly unexplored, and seemingly resilient to the egos of the world I knew. I became infatuated with it. Those feelings remain with me today, and followed me wherever I've gone.

Those feelings led me to apply for the NOAA-NGI Diversity Internship Program in January, 2016. I'd been attending college at the University of Louisiana, Monroe since the fall semester of 2012, and by this time I was starting to feel worn and beat down. My dreams of experiencing the other world firsthand were evaporating just as fast as my confidence that I could escape the chains of the egotistical world. I needed a win. I needed a change of pace that would remind me that I wasn't wrong to dream. When I received the call from Dr. Katie McHugh one afternoon a couple months later, I was frightened to even hope. She had been the only potential mentor in the NOAA-NGI program to reach out to me, but as she described the research that the SDRP conducted with bottlenose dolphins I quickly realized I no longer wanted to hear from the other mentors. This was my big chance to reconnect with the other world, if only for three months. I told her the truth - that I couldn't imagine doing anything else that summer.

Now, as I type this, it is the fall of 2016, and I've found after working with the SDRP as an intern that I've come back with much more than confidence. Working alongside the staff and other interns at the SDRP taught me skills and life lessons as well. The project I'd been working on primarily was the digitization and organization of a Mobile Bay, Alabama dorsal fin identification catalog from the 1980's. The goal was to get these data into a usable form for later use. Dolphins can live for more than 60 years. So, it's probable that the pictures in the catalog could reveal information on unidentified stranded dolphins or living ones whose whereabouts at that time are unknown.

I learned not only skills with spreadsheets, but more importantly I learned about the need for organization and responsibility to diligently do my job. Some were worried I'd get bored with the desk work, but that couldn't have been further from the truth. I was in Sarasota, Florida living right off the beach! My blue world was right beside me every day. I could go out and see it whenever I chose to; and I did as often as I could. Don't think, though, that this was the only work I did. As an intern I had many opportunities to go out on the research boats *Martha Jane, Bob, and Fregata*, and do dolphin surveys. I consider them to be the bread and butter of the entire program. So, I took them seriously. Spending most of the day out on the water like that finally gave me what I wanted. I had unrestricted access with my vast, blue, world. I got to experience the sunny days with gentle breezes, the cloudy days with scattered storms, the hot days forsaken by the wind, and the exciting days with unexpected events. We happened upon injured sea turtles twice while out on dolphin prey fish surveys, and also had a very interesting fiasco with two wasp nests and a tackle box (You should ask Sunnie and Elizabeth about it one day). A skill that I'm really glad to have picked up while I was out there was learning to drive powerboats. So, I want to thank Aaron Barleycorn and Katie for risking their lives and letting me practice.

I truly felt free while I was working with the SDRP. I felt like I'd finally found a way to leave the boring world behind for a much better one. Now, back in Monroe, Louisiana I feel refocused. I've got my confidence back. I don't know if I'll ever end up in Sarasota, Florida again, but wherever I do go it'll be connected to the same mysterious and vast world I found there. Thanks so much Katie McHugh, Aaron Barleycorn, Jason Allen, Sunnie Brenneman, Kim Bassos-Hull, Shauna McBride, Elizabeth Berens McCabe, and Randall Wells for giving me the perspective I've been looking for.

Alex Fields aboard the R/V Bobmako. Learning to take quality field photos is an important skill SDRP interns try to master over the course of their internships.

Professional Activities Summary:

One accepted measure of the productivity of a research program is its record of achievement in providing information to the scientific community, wildlife management agencies, and the public. The following list includes our program's products since the publication of our last annual report, including the relevant work of our collaborators from partner institutions. Copies of specific papers can be obtained upon request, as electronic pdf files.

Theses and Dissertations

Ardente, A. 2016. Investigation of the role nutrition plays in the development of ammonium urate nephrolithiasis in common bottlenose dolphins, *Tursiops truncatus*. Doctoral dissertation. University of Florida, College of Veterinary Medicine.

Leon-Lopez, B. 2016. Bottlenose dolphin signature whistle variation: A perspective on physical characteristics, long-term stability, relatedness, and disturbance effects. PhD thesis, University of St. Andrews.

Mangar, R. S. 2016. Conservation and ecotourism of spinner and bottlenose dolphins in Mauritius and Florida. Senior Thesis. College of the Atlantic.

McBride, S. M. 2016. Habitat use by bottlenose dolphins, *Tursiops truncatus*, in Roanoke Sound, North Carolina. Doctoral dissertation. University of Southern Mississippi.

Noriega Betancourt, F. 2016. A comparative analysis of the spatial and temporal distributions of bottlenose dolphin (*Tursiops truncatus*) and recreational boating in Sarasota Bay, Florida. Master's thesis. School of Forest Resources and Conservation, Institute of Food and Agricultural Sciences. University of Florida, Gainesville, FL.

Phillips, G. T. 2016. Passive acoustics: A multifaceted tool for marine mammal conservation. Doctoral dissertation, Duke University.

Robles Malagamba, M. J. 2016. Characterization of the microbiome among free-ranging bottlenose dolphins (*Tursiops truncatus*). Master's thesis. College of Veterinary Medicine. University of Florida, Gainesville, FL.

Russo, C. D. 2016. A microbiomic approach to the characterization of the impacts and influences of viral, bacterial, and harmful algal bloom toxins on the bottlenose dolphin. Doctoral dissertation, University of Southern Mississippi. Paper 898.

Published Peer-Reviewed Journal Articles, Book Chapters

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Christiansen, F., K. McHugh, L. Bejder, E. Siegal, D. Lusseau, E. Berens McCabe, G. Lovewell and R. Wells. Accepted. Food provisioning increases the risk of injury and mortality in a long-lived marine top predator. Royal Society Open Science.

de Silva, A., C. Spencer, K. C. Ho, M. Al Tarhuni, C. Go, M. Houde, S. de Solla, R. Lavoie, L. King, D. Muir, P. Fair, R. Wells and G. Bossart. Accepted. Perfluorophosphinates in northern pike (*Esox lucius*), double-crested cormorants (*Phalacrocorax auritus*), and bottlenose dolphins (*Tursiops truncatus*) in relation to other perfluoroalkyl acids. Environmental Science and Technology.

Flowers K.I., M.J. Ajemian, K. Bassos-Hull, K.A. Feldheim, R.E. Hueter, Y.P. Papastamatiou and D.D. Chapman. In press. A review of batoid philopatry, with implications for future research and population management. Marine Ecology Progress Series. DOI: 10.3354/meps11963.

Rehman, Z., C. N. Toms and C. Finch. In press. Estimating abundance: A nonparametric mark recapture approach for open and closed systems. Environmental and Ecological Statistics.

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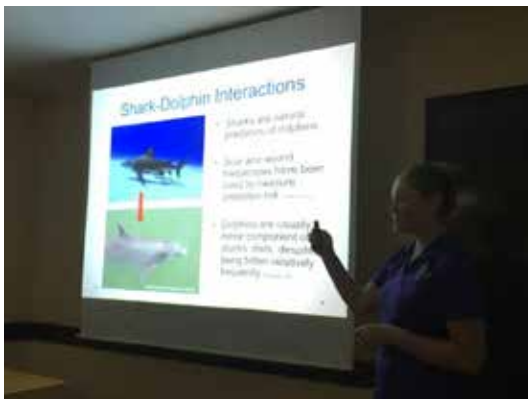

PhD student Krystan Wilkinson giving a public lecture on shark-dolphin interactions in Havana, Cuba

Wells, R.S. Accepted. Identification methods. Pp. xxx-xxx In: B. Würsig, J.G.M. Thewissen, and K. Kovacs, eds., Encyclopedia of Marine Mammals. Third Edition. Elsevier, Inc., San Diego, CA.

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Wilkinson, K. A., R. S. Wells, W. E. Pine and R. R. Borkhataria. Accepted. Shark bite scar frequency in resident common bottlenose dolphins (*Tursiops truncatus*) in Sarasota Bay, Florida. Marine Mammal Science.

Contract and Other Reports

Schwacke, L. H. and R. S. Wells. 2015. The bottlenose dolphin (*Tursiops truncatus*) as a model to understand variation in stress and reproductive hormone measures in relation to sampling matrix, demographics, and environmental factors. Final Report to Office of Naval Research for Award Numbers: N0001413IP20004, N0001412IP20053, N0001411IP20085, N000141110542.

Tyson, R. B. and R. S. Wells. 2016. Sarasota Bay/Little Sarasota Bay bottlenose dolphin abundance estimates: 2015. Prepared for National Marine Fisheries Service Northern Gulf of Mexico Bay, Sound and Estuary Bottlenose Dolphin Stock Blocks B20 and B35, Combined. Southeast Fisheries Science Center Reference Document PRBD-2016-02. 22 pp.

Presentations at Professional Meetings

Allen, D., J. Powell, C. Potter, R. Wells, M. Moore, G. Lovewell and D. Hunt. 2016. Life after death: the vital role of specimen collections in marine mammal stranding response and long-term studies of individuals. National Marine Animal Health and Stranding Conference, Shepherdstown, WV, 5-9 September 2016.

Balmer, B., T. McDonald, J. Adams, J. Allen, A. Barleycorn, P. Clarke, C. Cush, A. Honaker, K. McHugh, T. Speakman, R. Wells and L. Schwacke. 2015. Long-term trends in a northern Gulf of Mexico bottlenose dolphin *Tursiops truncatus* population in the wake of the *Deepwater Horizon* oil spill. 21st Biennial Conference on the Biology of Marine Mammals, 13-18 December 2015, San Francisco, CA. (poster)

Bassos-Hull, K. 2016. Marine megafauna research off Florida's southwest coast: From dolphins to rays. National Marine Educators Association Conference, Orlando, FL. 28 June 2016.

Bassos-Hull, K., J. Allen, S. Gowans, J. Thorson and R. Wells. 2015. Evaluating long-term behavior patterns of two bottlenose dolphins returned to the wild after two years under managed care. 21st Biennial Conference on the Biology of Marine Mammals, 13-18 December 2015, San Francisco, CA. (poster)

Cheney, B., R. S. Wells and P. M. Thompson. 2015. Investigating individual growth rates in wild bottlenose dolphins using remote laser photogrammetry. 21st Biennial Conference on the Biology of Marine Mammals, 13-18 December 2015, San Francisco, CA. (poster)

Curran, M. C., L. Sayigh, and K. Patterson. 2015. Using marine mammal sounds to engage visually impaired students in the sciences. Spoken presentation at the 21st Biennial Conference on the Biology of Marine Mammals, San Francisco, CA, 13-18 Dec 2015.

De Guise, S., M. Levin, E. Gebhard, L. Jasperse, J. T. Sailki, L. B. Hart, C. Smith, S. Venn-Watson, F. Townsend, R. Wells, B. Balmer, E. Zolman, T. Rowles and L. Schwacke. 2015. Changes in immune functions associated with the *Deepwater Horizon* in bottlenose dolphins in the northern Gulf of Mexico. 21st Biennial Conference on the Biology of Marine Mammals, 13-18 December 2015, San Francisco, CA.

Findley, H., T. Stone, R. Scheid and C. N. Toms. 2016. The potential influence of environmental stressors on common bottlenose dolphin (*Tursiops truncatus*) population in Pensacola Bay. Proceedings of the 2016 University of West Florida Student Scholar Symposium & Faculty Research Showcase. Pensacola, FL. (poster, April 2016).

Flower, J. E., J. N. Langan, R. S. Wells, C. Cray, K. Arheart, S. K. Chinnidurai and M. J. Adkesson. 2016. Serum acute phase proteins in bottlenose dolphins (*Tursiops truncatus*) and correlation with commonly utilized inflammatory indices. Annual Meeting of the International Association for Aquatic Animal Medicine, 21-26 May 2016, Virginia Beach, VA.

Hart, L. B., E. S. Zolman, B. C. Balmer, L. Hansen, A. A. Hohn, W. E. McFee, T. K. Rowles, F. Townsend, R. S. Wells and L. H. Schwacke. 2015. "Does this make me look skinny?" – Using reference intervals to identify poor body condition among free-ranging bottlenose dolphins (*Tursiops truncatus*) in the southeast U.S. 2015. 21st Biennial Conference on the Biology of Marine Mammals, 13-18 December 2015, San Francisco, CA.

Herrman, J. M., R. S. Wells, F. I. Townsend, S. De Guise, T. Rowles and L. H. Schwacke. 2015. Intraoral radiology of free-ranging bottlenose dolphins (*Tursiops truncatus*) in the Gulf of Mexico in 2013. 21st Biennial Conference on the Biology of Marine Mammals, 13-18 December 2015, San Francisco, CA. (poster)

Janik, V. M. 2015. How does vocal learning affect marine mammal communication? Plenary talk at the 25th International Bioacoustics Congress, Murnau, Germany, Sep 2015.

Janik, V. M. 2016. The evolution of complexity in marine mammal communication. Plenary talk at the Evolution of Language International Conference, New Orleans, March 2016.

Janik, V. M. 2016. How can zoo research on marine mammal acoustics support conservation efforts in the wild? Invited talk at the Internationales Symposium Forschung & Artenschutz, Tiergarten Nuernberg, Germany, 21 Jun 2016.

Janik, V. M. 2016. Social and self-recognition in bottlenose dolphins. Plenary symposium talk at the 31st International Congress of Psychology, Yokohama, Japan, July 2016.

Janik, V. M. 2016. Current methods in dolphin signature whistle research. Invited symposium talk at the 31st International Congress of Psychology, Yokohama, Japan, July 2016.

Kellar, N. M., S. M. Lane, C. R Smith, T. R. Speakman, B. C. Balmer, M. L. Trego, K. N. Catelani, M. N. Robbins, C. D. Allen, R. S. Wells and L. H. Schwacke. 2015. Reproductive failure rates of two northern Gulf of Mexico (*Tursiops truncatus*) stocks following the Deepwater Horizon disaster. 21st Biennial Conference on the Biology of Marine Mammals, 13-18 December 2015, San Francisco, CA.

Le-Bert, C. R., C. R. Smith, J. Poindexter, R. S. Wells, S. Venn-Watson, E. D. Jensen, and K. Sakhaee. 2016. Differences in urinary biomarkers and acid-base content of prey types fed as risk factors for ammonium urate stone formation in bottlenose dolphins (*Tursiops truncatus*). Annual Meeting of the International Association for Aquatic Animal Medicine, 21-26 May 2016, Virginia Beach, VA.

Leon-Lopez, B., L. Sayigh, R. S. Wells and V. M. Janik. 2015. How stable are signature whistles through time? 21st Biennial Conference on the Biology of Marine Mammals, 13-18 December 2015, San Francisco, CA. (poster)

Lovewell, G. N., S. Albin, R. S. Wells and R. A. Hazelkorn. 2015. Epiphyseal fusion of known-age bottlenose dolphins (*Tursiops truncatus*) in Sarasota Bay, Florida. 21st Biennial Conference on the Biology of Marine Mammals, 13-18 December 2015, San Francisco, CA. (poster)

McHugh, K. A., J. B. Allen, A. A. Barleycorn, K. Bassos-Hull, E. Berens McCabe, S. Hofmann and R. S. Wells. 2015. Long-term human interaction trends within a multi-generational resident inshore bottlenose dolphin community. 21st Biennial Conference on the Biology of Marine Mammals, 13-18 December 2015, San Francisco, CA.

McHugh, K. 2016. Long-term HI trends and gear quantification in Sarasota Bay. Florida Marine Debris Reduction Plan – Wildlife and Habitat Impacts Working Group Meeting. 27 January 2016, Sarasota, FL.

McHugh, K. 2016. CZS Sarasota Dolphin Research Program Update: Human Interactions, Education Programs. 7th Annual CZS Research and Conservation Conference, 3 Mar 2016, Brookfield, IL.

Powell, J. W. B., D. A. Duffield, G. Luo, J. J. Kaufman, C. R. Smith, R. S. Wells and W. E. McFee. 2015. Clinical assessment of bone density in live bottlenose dolphins, *Tursiops truncatus*: Bridging radiographic osteodensitometry of the past with ultrasonic techniques of the future. 21st Biennial Conference on the Biology of Marine Mammals, 13-18 December 2015, San Francisco, CA. (poster)

Reed, L., K. McHugh, and R. Wells. 2015. Post-nuchal depression as an indicator of health in bottlenose dolphins (*Tursiops truncatus*). SACNAS National Conference, October 2015, Washington, DC. (student poster)

Roberts, B., F. Jensen, K. McHugh, L. S. Sayigh, P. Tyack, R. S. Wells and V. M. Janik. 2015. Click rates of wild bottlenose dolphins (*Tursiops truncatus*). 21st Biennial Conference on the Biology of Marine Mammals, 13-18 December 2015, San Francisco, CA.

Robles-Malagamba, M. J., M. T. Walsh. P. Thompson, R. S. Wells, C. Jobin, K. Winglee, A. Fodor and T. B. Waltzek. 2016. Molecular characterization of the bottlenose dolphin (*Tursiops truncatus*) microbiome: Intra-individual and inter-individual variation among free-ranging animals. Annual Meeting of the International Association for Aquatic Animal Medicine, 21-26 May 2016, Virginia Beach, VA.

Salas, S., K. McHugh, R. Tyson, and R. Wells. 2016. Diurnal activity patterns and fine-scale behavior of bottlenose dolphin mother-calf pairs in Sarasota Bay, Florida. Mote Marine Laboratory NSF REU Poster Session, August 2016, Sarasota, FL.

Sayigh, L., C. Stuhlmann, R. Wells and V. Janik. 2015. Insights into the role of non-signature whistles in bottlenose dolphin communication. 21st Biennial Conference on the Biology of Marine Mammals, 13-18 December 2015, San Francisco, CA.

Schwacke, L. H., R. S. Wells, W. McFee, B. Quigley, E. S. Zolman, T. McDonald, N. Kellar, J. Schwacke, A. Hohn, L. Mullin and L. Thomas. 2015. An age-structured model with density dependent fecundity for estimating dolphin population injury following the *Deepwater Horizon* spill. 21st Biennial Conference on the Biology of Marine Mammals, 13-18 December 2015, San Francisco, CA.

Schwarz, L. K., E. McHuron, M. Mangel, R. S. Wells and D. P. Costa. 2016. Data needs to implement a population consequences of disturbance model: Lessons from income and capital breeders. Effects of Noise on Aquatic Life Conference, Dublin.

Schwarz, L. K., R. S. Wells, D. P. Costa, J. B. Allen, E. B. McCabe and K. A. McHugh. 2015. Red tide adversely impacts population viability of resident bottlenose dolphins. 21st Biennial Conference on the Biology of Marine Mammals, 13-18 December 2015, San Francisco, CA.

Smith, C. R., L. Hart, M. Ivancic, K. Colgrove, F. I. Townsend, E. Zolman, B. Balmer, R. Wells, T. K. Rowles and L. H. Schwacke. 2015. Ultrasound evidence of lung disease in bottlenose dolphins (*Tursiops truncatus*) living in the northern Gulf of Mexico following the *Deepwater Horizon* oil spill (2011-2014). 21st Biennial Conference on the Biology of Marine Mammals, 13-18 December 2015, San Francisco, CA.

Smith, C. R., T. K. Rowles, K. M. Colegrove, N. Kellar, S. M. Lane, B. C. Balmer, K. Barry, M. Kinsel, J. Litz, T. R. Speakman, F. I. Townsend, S. Venn-Watson, R. S. Wells, E. S. Zolman and L. H. Schwacke. 2016. High rates of reproductive failure among bottlenose dolphins in the wake of the *Deepwater Horizon* Oil Spill. Annual Meeting of the International Association for Aquatic Animal Medicine, 21-26 May 2016, Virginia Beach, VA.

Smith, C. R., T. K. Rowles, L. B. Hart, F. I. Townsend, R. S. Wells, E. S. Zolman, B. C. Balmer, B. Quigley, M. Ivančić, W. McKercher, M. C. Tumlin, K. D. Mullin, J. D. Adams, Q. Wu, W. McFee, T. K. Collier, N. Kellar, J. Litz, K. Colegrove, D. Fauquier, E. Clarke, C. Chevis, R. Carmichael, E. Fougeres, S. DeGuise, S. Venn-Watson and L. H. Schwacke. 2016. Adverse health impacts of the *Deepwater Horizon* oil spill on bay, sound, and estuary bottlenose dolphins (*Tursiops truncatus*) in the Northern Gulf of Mexico. National Marine Animal Health and Stranding Conference, Shepherdstown, WV, 5-9 September 2016.

Toms, C., T. Och, L. Hartigan, M. Whitehurst, H. Findley and G. Worthy. 2016. A report on the potential influence of a record breaking flood event on bottlenose dolphin (*Tursiops truncatus*) populations in Pensacola Bay, Florida. Southeast and Mid-Atlantic Marine Mammal Symposium. Savannah, GA, April, 2016.

Toms, C. N. and G. A. J. Worthy. 2016. Seasonal movement patterns of bottlenose dolphins (*Tursiops truncatus*) in the Florida Panhandle. Southeastern Ecology and Evolution Conference, March 2016, Tallahassee, FL. (poster)

Toms, C. N. and G. A. J. Worthy. 2015. Seasonal movement patterns of bottlenose dolphins (*Tursiops truncatus*) in the Florida Panhandle. 21st Biennial Conference on the Biology of Marine Mammals, 13-18 December 2015, San Francisco, CA.

Toms, C. N. 2015. Bottlenose dolphin populations in the Western Florida Panhandle: Potential threats and current research. 8th Annual Mattie M. Kelly Environmental Symposium, Northwest Florida State College, October 2015.

Tyson, R. B. and G. Tyson. 2015. Sharing a Whale's Tale: Wyatt's Antarctic Adventure. 21st Biennial Conference on the Biology of Marine Mammals, 13-18 December 2015, San Francisco, CA.

Dr. Reny Tyson presenting at the 21st Biennial Conference on the Biology of Marine Mammals in San Francisco, describing her efforts to make Antarctic whale foraging biology information accessible to children.

Wells, R. S. and B. Hueter (presenter for Wells). 2015. Advances in dolphin research in the Gulf of Mexico. Keynote address. MarCuba: X Congreso de Ciencias del Mar, 16-20 November 2015, Havana, Cuba.

Wells, R. S. and A. Barleycorn. 2015. Sarasota Dolphin Research Program efforts to disentangle free-swimming dolphins. NMFS Small Cetacean Disentanglement Meeting, 1 October 2015, Orlando, FL.

Wells, R. S. 2016. The science of saving cetaceans: The Sarasota Dolphin Research Program's involvement in cetacean conservation efforts in Bermuda, Florida, and beyond. Bermuda Underwater Exploration Institute, 30 August 2016.

Wells, R. S. and A. A. Barleycorn. 2016. Responding to small cetacean entanglements: Changing knotty to nice. National Marine Animal Health and Stranding Conference, Shepherdstown, WV, 5-9 September 2016.

Wells, R. S. 2016. Tag – you're it; selecting tags and attachments for monitoring small cetaceans. National Marine Animal Health and Stranding Conference, Shepherdstown, WV, 5-9 September 2016.

Wells, R.S., K. A. McHugh, J. B. Allen and K. A. Wilkinson. 2016. Movements and social patterns of free-ranging bottlenose dolphins near Sarasota, FL. International Primatological Society/American Society of Primatologists Joint Meeting/Chicago 2016, 22 August 2016.

Wells, R. S., L. H. Schwacke, T. K. Rowles, B. C. Balmer, E. Zolman, T. Speakman, F. I. Townsend, M. Tumlin, A. Barleycorn and K. A. Wilkinson. 2015. Ranging patterns of bottlenose dolphins (*Tursiops truncatus*) in and near Barataria Bay, Louisiana, following the *Deepwater Horizon* oil spill. 21st Biennial Conference on the Biology of Marine Mammals, 13-18 December 2015, San Francisco, CA.

Whitehurst, M. L., J. J. Brown, A. N. Jones and C. N. Toms. 2016. The potential influence of a major flood event on the reproductive success and distribution of common bottlenose dolphins (*Tursiops truncatus*) in the Pensacola Bay system. Proceedings of the 2016 University of West Florida Student Scholar Symposium & Faculty Research Showcase. April, 2016, Pensacola, FL. (poster)

Wilkinson, K. A. 2016. North Florida Marine Science Symposium. Assessing shark-dolphin interaction frequency over time, January, 2016. (poster)

Wischusen, K., R. S. Wells and L.B. Hart. 2016. Rapid assessment of bottlenose dolphin (*Tursiops truncatus*) body condition: There's an app for that. 65th Annual International Wildlife Disease Association Conference. Cortland, New York, 7/31/16 – 8/5/16.

Invited Public, University, School Lectures

Staff and collaborators with the Chicago Zoological Society's Sarasota Dolphin Research Program delivered more than 25 lectures at public and educational institutions both locally and abroad.

Program Operations

Chicago Zoological Society Staff

Jason Allen, BS, Lab Manager
Aaron Barleycorn, BS, Field Coordinator
Elizabeth Berens McCabe, MS, Research Associate
Sunnie Brenneman, BS, Research Assistant
Carolyn Cush, BS, Research Assistant
Allison Honaker, MPS, Research Assistant
Shauna McBride, PhD, Research Assistant
Katie McHugh, PhD, Staff Scientist
Reny Tyson, PhD, Postdoctoral Fellow
Randall Wells, PhD, Program Director

Mote Marine Laboratory Staff

Kim Bassos-Hull, MS, Research Associate

Dolphin Biology Research Institute Officers

Blair Irvine, PhD, President
Michael Scott, PhD, Secretary
Randall Wells, PhD, Treasurer

Doctoral Students

Amanda Ardente, University of Florida (grad. 2016)
Rachel Cassoff, Duke University
Shauna McBride, Univ. of Southern Mississippi (grad. 2016)
Goldie Phillips, Duke University (grad. 2016)
James Powell, Portland State University
Christina Toms, University of Central Florida
Krystan Wilkinson, University of Florida

Master's Students

Fernando Noriega, University of Florida (grad. 2016)
Maria Robles, University of Florida (grad. 2016)

Undergraduate Senior Thesis

Roshni Mangar, College of the Atlantic

Interns and Post-Graduate Trainees

Rebecca Alley
Amy Alvarez
Aminta (Nicole) Arevilca
Karina Brocco-French (Venezuela)
Melanie Chaabane (Germany)
Alex Fields
Zach Lew
Emilia Lindvall (Sweden)
Rafaella Lobo (Brazil)
Clara Meechan
Erin Ryan
Sydney Jane Salas
Samantha Schreck
Marsha Sisney
Kirsten Spray
Kate Weston (UK)

Local and Returning Volunteers

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Dee Allen
Ralph Arden
Perfecto Barba
Trevor Barleycorn
Ed Blair, Jr.
René Byrskov (Denmark)
Leah Crafton
Michael Duranko
Kristi Fazioli
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Jeff Stover
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Laura Torelli
Kristyn Waterwash
Martha Wells

As the lab turns...

Sunnie Brenneman, Chicago Zoological Society

Some exciting new developments have come about in the lives of SDRP staff and close associates since our last issue of *"Nicks n Notches"*. In December of 2015 Krystan Wilkinson said "yes" to a beautiful oceanside proposal from her now fiancé, Joe Schuler. The happy couple will tie the knot next fall. For more details, tune in for our next episode of "*As the lab turns...*"

This past September, Shauna McBride earned her PhD after successfully defending her dissertation on habitat use of dolphins in Roanoke Sound, NC. Congratulations, Dr. McBride!

Wrapping up 2016, a mass exodus of SDRP staff took place in October as several headed to Hawaii to celebrate the nuptials of long-time friend and colleague Michelle Barbieri to her husband and fellow biologist, Kevin Lino. Michelle has been connected with the SDRP since 2001, when she started here as a UNCW undergraduate. It is special, indeed, when professional associates develop into lifelong friends. Fifteen years and three degrees later, she remains near and dear to the hearts of her Sarasota family who count it a privilege to have celebrated this milestone along side her!

Down on one knee: Joe takes Krystan by surprise when their sunset walk on Siesta Key took a turn toward 'forever' with a carefully orchestrated marriage proposal.

Show Your Support for the Chicago Zoological Society's Sarasota Dolphin Research Program

Your gift to the Sarasota Dolphin Research Program will ensure the future of the important research and continued development of an unparalleled base of knowledge about wild dolphin populations. Each year, it costs almost $1.0 million to fund our scientists and our internationally recognized research. Your donation will ensure that we can continue to learn about and help some of the world's most majestic creatures. For more information on how you can help, please contact Chris Jabin, senior vice president of development, at (708) 688-8379.

Special Thanks

The Chicago Zoological Society is honored to recognize the following donors and funding organizations for their generous contributions from November 1, 2015 – November 8, 2016 to its Sarasota Dolphin Research Program through donations, research grants, and/or contracts.

Research Grants/Contracts

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