January 2021

Nicks'n'Notches

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

50 FINS FOR 50 YEARS: IDENTIFIABLE INDIVIDUALS BORN IN EACH YEAR OF THE STUDY

Chicago Zoological Society
Inspiring Conservation Leadership

The mission of the

Chicago Zoological Society

To inspire conservation leadership by engaging people and communities with wildlife and nature

Celebrating 50 years of conservation, research, education, and action

October 3rd, 2020, marked the 50th anniversary of the world's longest-running study of a wild dolphin population, conducted by the Sarasota Dolphin Research Program. On that day in 1970, Blair Irvine attached the first tags to Sarasota Bay bottlenose dolphins, taking the first step that led to demonstrating the local dolphin residency that has been key to all of the research that has followed in Sarasota Bay. Much more on the history of the program appears in the pages of this special issue of Nicks'n'Notches. While we had planned to hold an in-person symposium in Sarasota in October to reflect on decades of scientific findings and celebrate with the friends and colleagues who have made this work possible, the pandemic forced us to take a different path. With the recorded or live help of 25 of our colleagues and collaborators from around the world, we instead held a virtual celebration to mark the official date (recording available at: https://vimeo.com/frontpageprod/download/464727198/74e1a913bc); we hope to hold the in-person symposium within the next year, as the celebration continues. We are also editing a special topics issue of the journal Frontiers in Marine Science entitled: "The Dolphins of Sarasota Bay: Lessons from 50 Years of Research and Conservation," expected to consist of 25 peer-reviewed papers by colleagues, staff, and students, to be published in 2021.

As we celebrate the accomplishments and amazingly productive (and fun) collaborations we developed during our first 50 years, we also look toward the future. We look forward to continuing our existing research and education partnerships, and implementing new ones with institutions such as New College of Florida. We look forward to further developing and refining some of our new field techniques, and expanding our ecological studies of Sarasota Bay, as you'll read about in the following pages. Most of all, we look forward to the opportunity to continue to learn about the dolphins of Sarasota Bay, who we have gotten to know so well over the past half-century, and applying what we learn to their benefit, and to help with dolphin conservation elsewhere around the world. We are extremely grateful to the Chicago Zoological Society for their support of the program for the past 31 years, and for their commitment to our future endeavors.

And thanks to all of you for caring about the dolphins of Sarasota Bay,

Director, Chicago Zoological Society's Sarasota Dolphin Research Program

In This Issue

Our approach toward helping dolphins

Our desire with each research or 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 insure 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, vehicles, computers, cameras, field equipment, etc. Since 1992, the program has been based at Mote Marine Laboratory, with office, lab, storage and dock space within the resident Sarasota Bay dolphins' home range. The SDRP maintains academic connections including providing graduate student opportunities primarily through the University of Florida, the University of California at Santa Cruz, and Duke University, and undergraduate opportunities through a number of schools, including New College of Florida.

All of our dolphin research in the United States is conducted under NOAA Fisheries Service Scientific Research Permit No. 20455 and Institutional Animal Care and Use Committee approvals through the appropriate institutions.

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The Year in Review

Some of our accomplishments, by the numbers

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

The "natural laboratory" situation of Sarasota Bay facilitates cutting-edge work done by a diverse group of specialists who complement the expertise and interests of the SDRP. Over the years, staff, students, and collaborators have produced more than 325 peer-reviewed publications, 4 books, and more than 100 technical reports, and we have made more than 660 presentations to scientific audiences, students, stakeholder groups, and the general public. Perhaps the most meaningful component of our legacy, though, involves training the next generation of conservation leaders. To date, 41 master's and 50 doctoral students have benefited from SDRP data collection opportunities, data, samples, or guidance. In addition, about 400 undergraduate interns have received multi-month training by the SDRP. Foreign participants in our training programs include 70 of the interns, along with 30 post-graduate scientists and 108 health assessment project participants, from 45 countries. A number of the alumni from our training programs have moved into key positions in wildlife management, at NOAA and the Marine Mammal Commission, and elsewhere around the world. The accomplishments of the program over the decades reflect the efforts of many: staff, students, volunteers, and collaborators, and the long-term support of several key individuals and organizations.

Sarasota Dolphin Research Program participation in the World Marine Mammal Conference

Katie McHugh, Chicago Zoological Society's Sarasota Dolphin Research Program

In December 2019, the Chicago Zoological Society's Sarasota Dolphin Research Program (CZS-SDRP) staff and students, along with our colleagues from around the world, had a major presence at the World Marine Mammal Conference (WMMC) in Barcelona, Spain – a joint conference of the Society for Marine Mammalogy (SMM) and the European Cetacean Society, with more than 2,600 participants. Participation by our program staff in professional meetings like this is a crucial part of our scientific communication and provides unmatched opportunities for developing collaborations and building relationships with colleagues to foster new directions for research and approaches to conservation of marine mammals building on our long-term work. In total, CZS-SDRP staff members were involved in 30 conference and workshop presentations featuring new findings and techniques relevant to a wide range of topics including dolphin behavior, communication, health, ecology, life history, sociality, ranging patterns, and conservation in the face of anthropogenic impacts and environmental change (see Products list). CZS-SDRP also contributed to other aspects of the WMMC as well, including organizing and chairing portions of the scientific program and workshops on emerging topics. Program Director and SMM past-president Randy Wells served as both a scientific program committee member and chair of a plenary session on Conservation Interventions. Staff Scientist Reny Tyson-Moore co-coordinated a workshop with Kim Urian from Duke University (former SDRP lab manager and grad student) focused on applying automated systems for dorsal fin matching. While most professional meetings such as these have been suspended or moved online during the global pandemic, we very much hope that it will be safe to bring people together again for the next biennial conference, scheduled for December 2021 in Palm Beach, Florida.

Former CZS-SDRP students and interns reunited during the WMMC in Barcelona in December 2019.

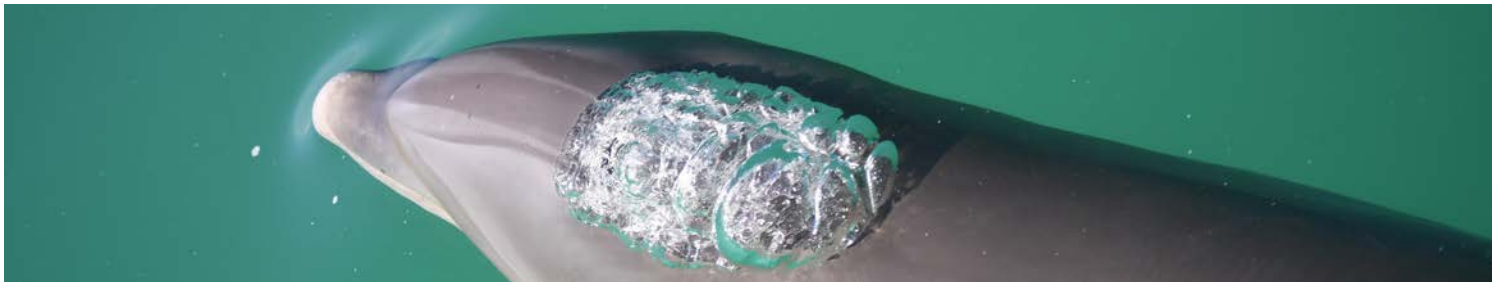
Sarasota Dolphin Research Program project summary

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

The events of the past year have influenced the activities of our research program. While we have been awarded funding for a number of research, education, or conservation projects, the pandemic has forced us to postpone or cancel several of the larger projects, including five that involve capture-release efforts involving teams working in close contact. These delays and cancellations have had adverse implications for program support, as we do not have access to the grant or contract funds until we do the proposed work. We are very appreciative of donor support to fill the funding gaps, allowing our team to remain intact, and to put their new-found non-field time to good use analyzing data and preparing scientific publications.

The following list provides information on some of the funded projects in which we have been engaged over the past year, or will begin soon. These projects are either being led by CZS researchers, or in some cases, these are subawards to the Chicago Zoological Society's Sarasota Dolphin Research Program. The CZS researchers responsible for overseeing the SDRP portions of the projects are listed as Principal Investigators. Funding for the projects is being administered primarily through the Chicago Zoological Society.

	Project Title	Funding Source	SDRP Principal Investigator	Start Yr	End Yr
1	Bottlenose dolphins as sentinels of ecosystem health	Charles and Margery Barancik Foundation	Wells	2017	2022
2	Consortium for Advanced Research on Marine Mammal Health Assessment - CARMMHA	Gulf of Mexico Research Institute VI	Wells	2018	2020
3	Continuation of a National Service Center for post-release monitoring of small cetaceans - I	NOAA John H. Prescott Marine Mammal Rescue Assistance Grants	Wells	2018	2021
4	Franciscana interactions with Argentinian fisheries	Disney Conservation Fund	Wells	2018	2022
5	Trophic ecology of large coastal predators along Florida's central Gulf coast	Mote Scientific Foundation	Wilkinson	2019	2020
6	Marine Megafauna Project	Mote Scientific Foundation	Bassos-Hull	2020	2021
7	Bassos-Hull research projects	Anonymous	Bassos-Hull	2020	2021
8	The Dolphins of Sarasota Bay: Lessons from 50 years of Research and Conservation - manuscript preparation	Chicago Zoological Society Women's Board	McHugh	2020	2020
9	Knowledge sharing for dolphin conservation	Disney Conservation Fund	McHugh	2020	2022
10	Advancing the study of diet and vulnerability to disturbance for cetaceans	National Science Foundation Graduate Research Fellowship	Tatom-Naecker	2020	2023
11	Field testing and accuracy of GPS and satellite-linked telemetry tags for small cetaceans	Chicago Zoological Society Women's Board	Tyson-Moore	2020	2020
12	Sarasota Bay dolphin sampling, health assessment	Dolphin Quest	Wells	2020	2020
13	Preparation of a manuscript on dolphin life history	Irvine Family Donation	Wells	2020	2020
14	Continuation of a National Service Center for post-release monitoring of small cetaceans - II	NOAA John H. Prescott Marine Mammal Rescue Assistance Grants	Wells	2020	2021
15	Rapid detection and response to cetacean strandings and small cetacean disentanglements in central western Florida and capacity building for large whale recovery, necropsy and disposal for greater Florida	NOAA John H. Prescott Marine Mammal Rescue Assistance Grants (through Mote Marine Lab)	Wells	2020	2021
16	Health and movements of Florida's Gulf dolphins	Florida RESTORE Act Centers of Excellence Program - FIO (through Mote Marine Lab)	Wells	2020	2023
17	Developing capabilities for use of Unmanned Aerial Systems for marine research in Sarasota Bay	Mote Scientific Foundation	Wells and Bassos-Hull	2020	2021
18	Towards an understanding of the cumulative effects of multiple stressors on marine mammals – an interdisciplinary working group with case studies	Strategic Environmental Research and Development Program	Wells and McHugh	2020	2024
19	DNA-based diet analysis of coastal predators along the Central West Coast of Florida	Chicago Zoological Society Women's Board	Wilkinson	2020	2020
20	Trophic ecology of large coastal predators along the central west coast of Florida	Mote Scientific Foundation - William R. and Lenore Mote Early Career in Marine Sciences Fellowship	Wilkinson	2020	2021
21	Sarasota Bay dolphin sampling, health assessment	Mote Scientific Foundation	Wells	2021	2021
22	Eugenie Clark Field Research Skills and Leadership Program	Mote Scientific Foundation	Wilkinson	2021	2022



Pandemic impacts on how we do our work

Aaron Barleycorn, Chicago Zoological Society's Sarasota Dolphin Research Program

In March of this year, with COVID-19 spreading rapidly in Florida, the SDRP team needed to adapt new procedures in order to minimize the chance of spreading the virus within our team or into the community. We wanted to strategize a way to continue to collect, enter, and analyze data while minimizing risk. We were incredibly lucky to be in a position to have our jobs when so many of our colleagues were being furloughed or losing theirs, which added to our obligation to continue as much of our work as feasible.

As far as office work went, we set up each staff member to be able to do much of their office work from home. Using remote desktop, Zoom meetings, and lots of phone calls, emails and texts, we were able to perform much of our office work from our home "offices" (I am writing this on my dining room table with our 3-year-old happily typing next to me on an unplugged keyboard). Some aspects of our work required being physically present at our lab, and we set up protocols to minimize risk there as well. Limiting the number of staff present at the same time, mask-wearing, temperature checks, physical distancing, and cleaning shared surfaces has allowed us to be in the building, when necessary, while reducing the chance of transmitting germs to others.

Field work added its own challenges. In order to reduce the size of our "bubble," we temporarily suspended our volunteer program. Many of our local volunteers have been part of our team for decades and provide invaluable time and expertise to the program as well as becoming great friends with our staff. Asking them to stay away was a tough choice. This also required a great deal more staff time to crew the boats adequately. As a result of the pandemic, all of our out-of-town field work was postponed or cancelled, freeing up staff time we could devote to local field work and manuscript preparation. We also had to cancel our May dolphin health assessment project as it required more than 150 people from around the world to work in close proximity

Aaron Barleycorn (L) and Jason Allen (R) during a photo-identification survey wearing masks and socially distancing on the boat.

Aaron Barleycorn working from his COVID-19 home office while training the next generation of dolphin researchers.

for extended periods of time. Mask-wearing, temperature checks, and surface cleaning were also instituted in the field. Physical distancing is much more difficult on a small center-console boat, but with the other measures in place as well as being outside and moving, the risk was minimal. We also split our staff into teams that would only work with each other during the month's field work, and staggered departure and data download times on days with multiple boats on the water, to minimize numbers of people in the lab at the same time.

Although not desirable for the long term, the protocols SDRP put in place in response to COVID-19 have allowed us to complete all of our photo-ID surveys, fish surveys, and perform biopsy dart sampling (details in next article) as an alternative to collect some of the samples we weren't able to collect without health assessments. We have also been able to get the data processed and maintained in "near real-time" throughout the year, and we have been able to put more time into preparing peer-reviewed scientific manuscripts from our data. We all feel incredibly lucky to be able to continue our work during the trying times, and to benefit the dolphins of Sarasota Bay.

Remote biopsy sampling in lieu of capture-release health assessment

Christina Toms, Aaron Barleycorn, Jason Allen, Chicago Zoological Society's Sarasota Dolphin Research Program

We were forced to cancel our capture-release health assessment project due to COVID-19 issues, which was originally scheduled for May 2020. Thankfully, our primary funder, Dolphin Quest, allowed us to reprogram their funding to instead conduct intensive remote biopsy sampling of our previously unsampled Sarasota Bay resident dolphins. These would have been our primary animals of interest for the health assessment this year. Of the original 44 high priority target individuals, we've sampled 20 of them as of September 2020, with an additional 17 lower priority individuals also sampled. While unable to perform crucial

veterinary exams and obtain other types of important samples without capture-release, remote biopsy sampling still affords us multiple subsamples of skin and blubber than can be used to obtain basic background information of importance. For each animal darted, we obtained 5-6 subsamples that are used for a variety of projects, including: sex determination, paternity testing, population genetics, developing an age analysis tool using epigenetics, contaminant research, fatty acid analysis, stress and reproductive hormone analysis, lipid analyses for nutritive condition, with a skin sample archived for future projects. We aim to continue sampling through at least the end of the year. Collecting these vital samples will help reduce the pressure to perform health assessments on these individuals in the future.

Sarasota Bay dolphin community status

Jason Allen, Chicago Zoological Society's Sarasota Dolphin Research Program

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. There have been 13 births in 2020, 10 of which have survived to date. Well-known resident Lightning gave birth to her tenth known calf. We have now documented four females in Sarasota Bay with ten or more calves. F277, the eight-year-old calf of Vespa, is a new mom and seen with her first calf in July.

Unfortunately, we have lost several community members over the past year. Four of these were directly related to human activities. Annie's 2020 calf was entangled in fishing line that cut deeply into his fluke. BARK swallowed a large hook with line, presumably while depredating, and could not survive. In early August, we recovered the carcass of female FHIS. Over the next two days we also recovered F142 and F276 who were interacting with her carcass. We go into more detail in an article later in this issue. Other dolphins lost include Scooter's 2017 calf, F310 (F277's brother), Yankee Doodle, and Eve. Eve's loss, from a boat strike, was especially sad as she was the last calf of the oldest-known dolphin, Nicklo, who gave birth to her at 48 years young. Eve was frequently sighted by our research teams (772 times in her 22 years) and had at least three calves of her own. Unfortunately, her 2019 calf is missing and presumed dead.

Our long-term, monthly photo-ID surveys are the core effort of our program, supporting all other projects. More than 53,800 dolphin group sightings since 1970 have yielded more than 163,000 identifications of more than 5,500 individually distinctive dolphins. In support of these identifications, more than 875,000 dolphin photographs and videos 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 2,689 follows on 220 individual dolphins from 25 projects dating back to 1989. 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 Charles and Margery Barancik 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.

Ginger and her new calf in 2020.

F209 leaps while socializing near our survey boat in March.

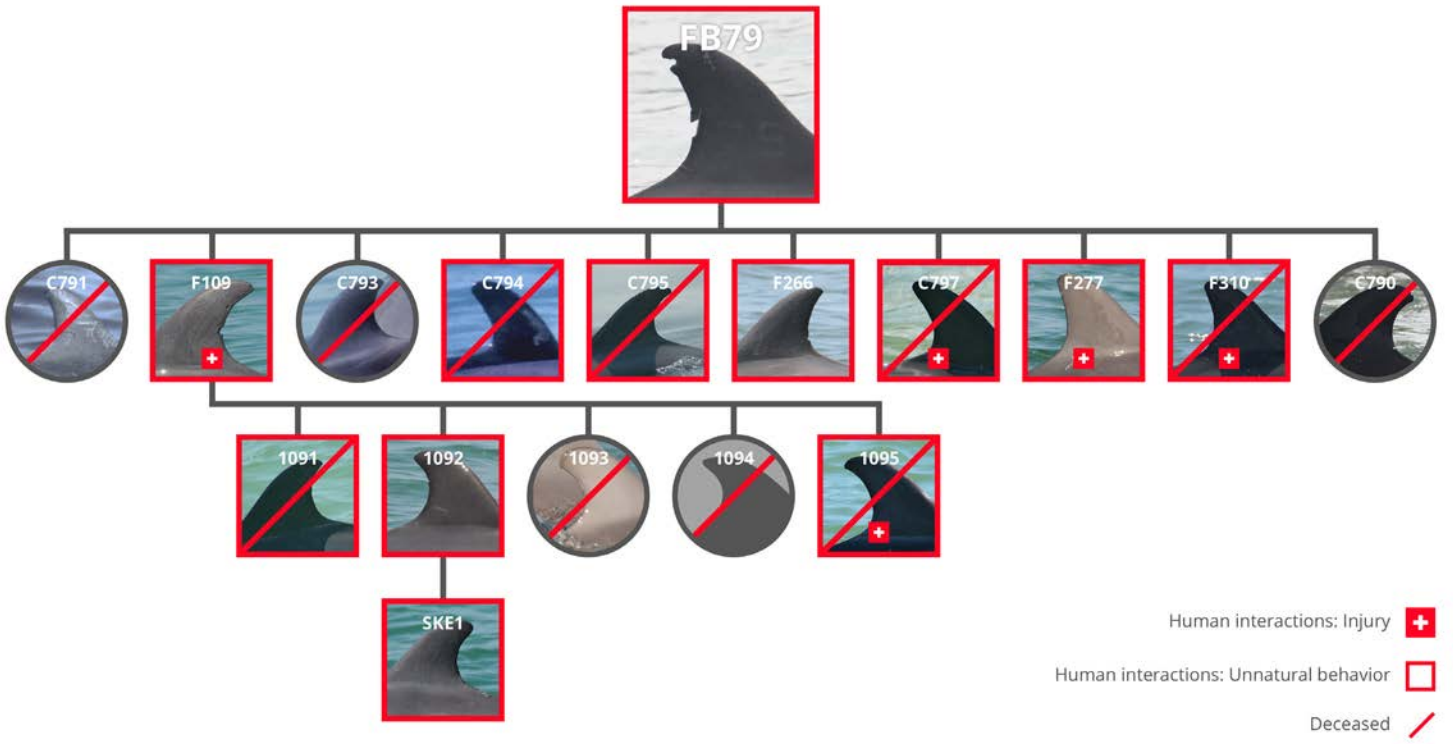
Conservation Research and Action

Human interactions in Sarasota Bay

Katie McHugh, Chicago Zoological Society's Sarasota Dolphin Research Program

Unfortunately, 2020 did not provide a respite for dolphins in Sarasota Bay from the impacts of human activities. Although we did not observe substantial increases in human interaction rates during monthly dolphin population monitoring surveys, we sadly lost a number of long-term resident dolphins to human-related injuries this year. First was F310, the 3.5-yr-old son of Vespa (FB79), who died with fresh wounds from fishing gear on Feb 24th. His 2.5-yr-old niece, 1095, was recovered two days later, and was too decomposed to determine cause of death. However, she also had wounds from a likely boat collision she had survived as a young calf. In August, we tragically lost three other Sarasota Bay resident dolphins as a result of human activities over a two-week span: two adults in their prime reproductive years and the first documented calf of the 2020 season. 1256, the newborn calf of Annie (F125), part of a well-known five generation lineage, was found entangled in fishing line which had nearly severed his tail on Aug 13th. Three days later, BARK (F254), a 31-year-old male, was found with a fishing hook embedded in his throat and fishing line coming out of his mouth. Last, but certainly not least, Eve (F123), a 22-year-old female, died with severe skull fractures after being struck by a boat on August 27th. Eve was born to 48-yr-old Nicklo, who died at age 67, the oldest bottlenose dolphin documented to date. Sadly, Eve only lived a third of the way to her mother's record age.

While each of these deaths is heartbreaking, they are even more devastating because these human-injuries were preventable. In addition, our animals have to contend with increasing boat traffic and boat-based viewing in our study region, and disturbance from these vessels can further impact dolphins trying to feed and raise their calves along the coast. Because of the risks to dolphins from human injuries and disturbance, a key CZS-SDRP priority remains working to expand and improve our community engagement and outreach activities related to human-dolphin interactions of concern. With support from the Disney Conservation Fund, we plan to continue these efforts over the next two years, adjusting our outreach efforts as necessary in the wake of the ongoing global pandemic. In particular, we are seeking involvement from local fishing guides, commercial fishermen, and recreational anglers willing to share their observations via a mobile web app available at https://dolphin.report. We plan to expand community education and outreach efforts in conjunction with our Sarasota Bay Listening Network project, adding new listening stations in places of high education and outreach potential, while creating associated materials focused on underwater ecosystems and sounds, including impacts of noise from boat traffic. We are also establishing stations as part of the Sarasota Science and Environment Council's "Watershed Audio Tour." Our stations will be at the north tip of Siesta Key and at Historic Spanish Point, where visitors can access information from their phones about Sarasota's dolphins and their needs, while overlooking their habitat. Stay tuned for more on these efforts!



Four generations of resident dolphins, Vespa (FB79) and her progeny. Two more members of Vespa's lineage were lost this year with evidence of human-related injuries. Help protect dolphins by giving them space on the water and pulling in active fishing gear when animals are nearby.

The Sarasota Dolphin Research Program plays an important role in a study on cumulative effects of multiple stressors on marine mammals

Peter Tyack, University of St Andrews

Dolphins are not hunted in Florida and there have been significant efforts to reduce lethal entanglements in commercial fishing nets. In this setting many of the most urgent remaining conservation issues involve stressors such as toxins, loss of prey, and climate change. The effects of short-term exposure to any one of these stressors may kill a dolphin but the cumulative effects of these stressors may pose a risk to the population, and we have neither methods nor data sufficient to predict the impacts. In order to help resolve this gap, the University of St Andrews has been funded by the Strategic Environmental Research and Development Program and the Office of Naval Research to conduct a study on the cumulative effects of multiple stressors on marine mammals.

This study involves an interdisciplinary working group that works with case studies designed to explore specific aspects of cumulative effects. Research conducted by SDRP researchers provided critical results for one case study that proposes to test whether the health condition of dolphins affects how they respond to passbys of recreational vessels. We hypothesize that dolphins in compromised health may show weaker defensive responses to the vessel, potentially increasing the risk of injury. Note that most reviews of interactions between stressors focus on cases where the effects of one stressor amplify the response to a second stressor, called synergistic interactions, but here we focus on one stressor reducing the response to a second one.

Previous studies by SDRP graduate students have shown that when Sarasota dolphins are in shallow enough water that they cannot simply dive to avoid danger, they whistle to others in their group, dive deeper and increase their fluking rate, change heading to avoid the vessel, form tighter groups, and submerge for longer periods until the threat passes. We propose to develop protocols in Sarasota to use drones and underwater listening to document these responses to experimental approaches of a vessel under our control. Then we will take this method to Barataria Bay, Louisiana where many of the local dolphins had their health severely compromised by oil from the *Deepwater Horizon* release of oil. We will use the protocol developed in Sarasota to study responses to vessel passbys of adult dolphin subjects in Barataria Bay selected because they have varying degrees of oil-related disease (lung disease and/or compromised cortisol response).

Here we hypothesize that it is a *reduction* in response that may pose the higher risk to the population. We propose to test this latter hypothesis by a cross-sectional analysis of whether scarring from vessels is more common in dolphins with decreased health status. Combining work at Sarasota and Barataria Bay allows us to develop an experimental method to study interactions between stressors, and how their effects influence risk of injury. An important goal of the project is to develop methods to understand how multiple stressors such as changing availability of food, toxic compounds from human caused pollution and natural sources such as red tide, pathogens and disturbance from vessels interact. This will be particularly important for protecting populations living in areas such as Sarasota, which are subject to so many different stressors from humans.

Can someone turn it down? Assessing the behavioral responses of mother-calf pairs of bottlenose dolphins to recreational boat noise

Aimee Kate Darias-O'Hara and Peter Tyack, University of St Andrews

Recreational boat usage is on the rise in coastal areas inhabited by bottlenose dolphins such as those found in Sarasota Bay, FL. Previous studies of bottlenose dolphins in Sarasota Bay have estimated that these individuals will experience a boat passing within 100m every 6 minutes, with more recent studies estimating even higher encounter rates. This study aimed to test whether or not these high encounter rates would elicit a behavioral response from mother-calf pairs in the resident Sarasota community, with mother-calf pairs being selected as they are the most vulnerable social group in dolphin societies.

This study was carried out as a Masters of Science thesis by Aimee Kate Darias-O'Hara at the University of St Andrews, Scotland. We used data collected from digital acoustic tags (DTAGs) which were deployed on mother-calf pairs in the Sarasota dolphin community during 2011-2018, recording the movement and vocalizing behavior of the tagged individuals. Periods of boat noise were categorized from the tags' hydrophone recordings as pre-exposure periods (2 minutes before the start of a boat approach), post-exposure periods (2 minutes after a boat approach) and control periods (no boat noise present). Using the time between the onset of boat approaches, it was found that boat passes should be categorized as single (occurring at least 2 minutes apart) or multiple (occurring less than 2 minutes apart). This allowed for a comparison between when noise from multiple boats was present and when noise from a single boat was present, determining if bottlenose dolphins will demonstrate changes

Speeding boat heads directly for a dolphin.

in their response behavior. Movement behaviors in the form of swim speed, mean dive depth, and surfacing behaviors were extracted, as well as signature whistle use by mother-calf pairs.

We found a significant difference between single and multi-boat approaches, with individuals increasing their swim speeds during the onset of multi-boat approaches, eliciting a horizontal avoidance response. During both single and multi-boat approaches, mother-calf pairs increased their dive depths and durations, with their surfacing behavior becoming reduced during these periods, demonstrating a vertical avoidance response. Signature whistle usage was less likely during periods when boat noise is present, with mothers initiating this response. These behavioral responses appeared to be much more intensified for multi-boat approaches, highlighting that multi-boat presence may be a more prominent stressor for these individuals than single boat approaches. With the abundance of recreational boats increasing in coastal areas, these animals are more likely to encounter multi-boat approaches now and in the future. Further research is needed on this to determine the extent of the behavioral implications of multi-boat approaches. From this, appropriate mitigation and monitoring strategies can be designed. Many thanks to the Sarasota Dolphin Research Program for providing the data for this study, and thanks to Dr. Sophie Smout for her expert advice during the statistical analyses.

Using digital acoustic tags and focal follows to understand the energetic costs of boat disturbance to dolphins

Austin Allen, Andrew Read, Doug Nowacek, Duke University; Katie McHugh, Reny Tyson Moore, Randall Wells, Chicago Zoogical Society's Sarasota Dolphin Research Program; Peter Tyack, University of St Andrews; Frants Jensen, Woods Hole Oceanographic Institution; Andreas Fahlman, Oceanogràfic Valencia

Boat traffic can affect marine mammals in various ways, ranging from direct strikes to changes in behavior. These impacts are being examined (see other articles in this issue) and SDRP research has contributed greatly to our understanding of the conservation effects of boat disturbance. In this project, we aim to quantify the energetic costs of repeated boat approaches. Some types of boat approaches cause dolphins to temporarily increase their swimming speed. We want to know if repeated boat approaches could cause dolphins to use significantly more calories due to this avoidance behavior. Could repeated boat approaches impact daily energy budgets to the extent that survival or reproduction are affected?

We rely on digital archival DTAGs to understand whether dolphins increase their swimming speed before an approach. DTAGs record the dolphins' movements and acoustic environment and are attached by suction cups for up to 24 hours. In 2019 we deployed 8 DTAGs and followed the dolphins after release. During follows we recorded fine-scale behavior and position data on the dolphin and any boats that came within 400 meters in order to recreate their tracks. We are currently modeling the different activity levels (measured by DTAGs) to tease apart the effect of the boat approaches on activity. In order to convert activity level to calories we are developing an activity/energetics correlation by working with dolphins in human care at Dolphin Quest. SDRP's decades long research in the physiology and movement patterns of this population helps us apply this correlation to Sarasota dolphins. Quantifying the energetic costs of boat disturbance will help us understand the impact of cumulative, sublethal stressors in this population and in other areas dolphins and boats coexist.

Changes in vessel traffic and sound in Sarasota Bay from the pandemic

Reny Tyson Moore, and Katie McHugh, Chicago Zoogical Society's Sarasota Dolphin Research Program; Athena Rycyk, New College of Florida; David Mann, Loggerhead Instruments

COVID-19 brought major changes across the globe in 2020, including reducing travel and transport of goods, which in turn greatly reduced one of the greatest sources of sound in the ocean - noise produced from shipping, cruise ships, and other types of vessels. As many oceans got quieter, news agencies around the world released headlines such as "Pandemic offers scientists unprecedented chance to 'hear' oceans as they once were" (Reuters, June 8, 2020) and "Whales Get a Break As Pandemic Creates Quieter Oceans (NPR, July 20, 2020). Many thought that this reduction in man-made sound would give animals a break, allowing them to once again live in a more natural and undisturbed environment. While this may be true for lots of species and regions, the animals in Sarasota Bay saw a different response to COVID-19. Despite stay-at-home orders, boaters took to our coastal waters in droves to "socially distance" themselves as a way to escape the solitude and silence of their homes (or simply just to enjoy our beautiful waters). In fact, Sarasota marine police officers reported significant increases in boat traffic in the months following the stay-at-home orders.

Congregation of boats off Passage Key, at the northern end of the Sarasota dolphin community home range, in April 2020, during the period of the governor's "Safer at Home" Executive Order.

Increased boat traffic in our region can result in an increased risk of dolphin injury and mortality from boat strikes and or interactions with fishing gear. Unfortunately, we saw this effect associated with the pandemic - in just 2 weeks in August, three Sarasota Bay resident dolphins died as a result of human activities. This included 1256, the first dolphin born in Sarasota Bay in 2020, who was found entangled in fishing line; BARK, a 31-year-old male who was found with a fishing hook embedded in his throat; and Eve, a 22-year-old female who died after being struck by a boat.

Increased boat traffic can also increase the amount of boat noise present in the water, which can interfere with dolphins' use of sound for hunting, navigating, socializing, and maintaining contact with one another. The acoustic data collected with our Passive Acoustic Listening Stations (PALS) as part of the Sarasota Bay Listening Network will allow us to explore how the increased boat traffic associated with COVID-19 impacted the acoustic behavior of dolphins and their prey. Since the start of the pandemic we have had several stations recording sound. Preliminary observations of the data suggest that sound levels have indeed increased in the Bay, and that they appear to be related to human activities, such as increased vessel use. In the upcoming year, researchers from CZS-SDRP, Wood Hole Oceanographic Institution, and the University of St Andrews plan to dig into these acoustic data to explore how these changes in human activities may have affected the local soundscape and the animals who call Sarasota Bay home. As part of these efforts we have also offered our data to be a part of the International Quiet Ocean Experiment, an international effort to improve our understanding of ocean soundscapes and effects of sound on marine organisms. Our data will serve as an example of a region where sound appeared to increase instead of decrease in response to the COVID-19 pandemic. Stay tuned to hear (get it?) our results!

Phthalate exposure in Sarasota Bay bottlenose dolphins – Demographic differences

Miranda Dziobak and Leslie Hart, College of Charleston

Phthalates are a class of chemicals commonly added to plastics, cosmetics, cleaning solutions, and personal care products (such as shampoo, lotions). Due to weak chemical bonds, phthalates easily leach into the environment and can be absorbed through the skin, ingested, or inhaled. Because of widespread use of phthalate-containing products, both humans and wildlife face chronic exposure risks, which is concerning given that phthalate exposure in humans is associated with endocrine disruption, reproductive impairment, and abnormal growth and development. Unlike other commonly studied environmental contaminants such as polychlorinated biphenyls (PCBs) or dichlorodiphenyltrichloroethane (DDT), phthalates may not bioaccumulate in dolphins, so exposure patterns are difficult to predict.

In the largest assessment of phthalate exposure in bottlenose dolphins to date, we explored differences among sexes and age classes of Sarasota dolphins. Phthalate metabolite concentrations were measured in urine samples during 2010-2019, revealing prevalent phthalate exposure among Sarasota Bay dolphins (approximately 75% of sampled dolphins were exposed). Further, mono (2-ethylhexyl) phthalate (MEHP) and monoethyl phthalate (MEP) were the two most commonly detected metabolites, which indicate exposure to compounds often added to plastics and personal care products. Preliminary findings indicate comparable phthalate metabolite concentrations between sexes and age classes, suggesting widespread susceptibility to exposure and potential health effects. Using long-term reproductive health data collected for Sarasota Bay dolphins, evaluations of health implications are currently underway.

This work is part of Miranda Dziobak's Master's thesis. Funding for this study was provided by an anonymous donor and the School of Education, Health, and Human Performance Dean's Fund at the College of Charleston.

Phthalate exposure in Sarasota Bay bottlenose dolphins – Comparisons to human reference populations

Leslie Hart and Miranda Dziobak, College of Charleston

Given evidence of pervasive exposure to phthalates commonly added to plastic (mono (2-ethylhexyl) phthalate; MEHP) and personal care products (monoethyl phthalate; MEP) among Sarasota Bay bottlenose dolphins, we compared exposure to human reference populations documented in studies conducted by the Centers for Disease Control and Prevention (CDC). More specifically, bottlenose dolphin concentrations of MEP and MEHP measured in urine samples collected during 2010-2019 were compared to reported human concentrations in the CDC's National Health and Nutrition Examination Survey (NHANES) in corresponding years (2009-2016). Significantly lower concentrations of MEP were found in dolphins as compared

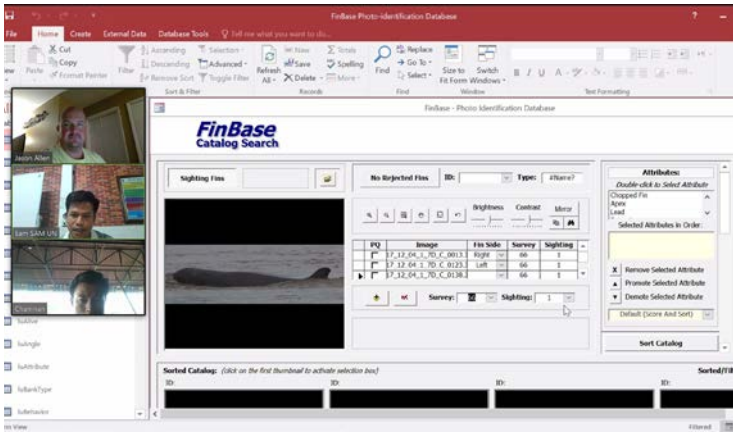
Leslie Hart and Miranda Dziobak processing dolphin samples for phthalate research at health assements in 2019.

to humans, and higher concentrations than humans were found for MEHP. Potential health implications of increased phthalate exposure are still uncertain for bottlenose dolphins, but we can use what we know from human studies as a foundation to develop hypotheses for continued research in dolphins. Long-term reproductive health data collected from Sarasota Bay bottlenose dolphins will enable investigations of exposure linkages with endocrine disruption, reproductive impairment, or abnormal growth and development. Additionally, sources of phthalate exposure in Sarasota Bay dolphins are currently unknown but given the common detection of plastic-associated metabolites, additional studies are warranted to investigate the contributing role of environmental plastic pollution. Funding for this study was provided by an anonymous donor and the School of Education, Health, and Human Performance Dean's Fund at the College of Charleston.

International conservation efforts

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

The pandemic has precluded in-country international conservation work by our team, such as the Disney Conservation Fund's franciscana tagging project in Argentina, but we have participated in virtual workshops and meetings around the world to further conservation efforts. As described below, our efforts to assist Irrawaddy dolphin research in the Mekong River continues, through assistance with establishing their database. In addition, we have consulted on the potential impacts of proposed harbor developments on critically endangered Taiwanese humpback dolphins. As part of a new initiative within the IUCN's Cetacean Specialist Group, named Integrated Conservation Planning for Cetaceans, we have engaged in planning for expansion of conservation research for Atlantic humpback dolphins and franciscana dolphins, identified as among the highest priority conservation situations for small cetaceans. We have also consulted on dolphin rescue operations in Cambodia, Egypt, Ecuador and Australia.



SDRP-Cambodia FinBase virtual training session.

Training and capacity building for Mekong River dolphin conservation

Phay Somany, WWF-Cambodia; Lindsay Porter, University of St Andrews; Jason Allen, Chicago Zoological Society's Sarasota Dolphin Research Program

In response to the high mortality rate of Irrawaddy dolphins in the Mekong River in the past years, WWF-Cambodia and the Fisheries Administration (FiA) of the Ministry of Agriculture, Forestry and Fisheries (MAFF), Cambodia, organized a series of International Expert Workshops, held in 2009, 2012, 2014 and 2017. These workshops included experts from the Chicago Zoological Society's Sarasota Dolphin Research Program (SDRP), the IUCN Cetacean Specialist Group, the Marine Mammal Commission (MMC), The Marine Mammal Center (TMMC) and the University of St Andrews. An important output from the 2012 workshop is the Kratie Declaration on "The Conservation of the Mekong River Irrawaddy Dolphins" which consists of 25 management and research recommendations that now provide the basis for the management and conservation of Irrawaddy dolphin in the Mekong River. In 2017, progress on these recommendations was reviewed and additional recommendations put in place, to promote the continued success of the management strategy. A key recommendation was to build capacity within the Mekong River dolphin team to enhance data management and analytical skills.

An ongoing initiative of this capacity building is adaptation of the photo-identification database "FinBase" for use with the Mekong River Irrawaddy dolphin data. A collaborative effort between SDRP, the Cambodian research team, University of St Andrews' Lindsay Porter and NOAA's Jeff Adams have produced a FinBase customized for this data set, including many translations into the Khmer language. We cannot thank Jeff enough for his time and expertise!

Virtual training sessions balancing the very different field schedules and time zones of Sarasota and Cambodia occurred throughout the spring and summer of 2020. We were all very excited to begin entering data and officially using the database in July. The SDRP looks forward to continuing to mentor the Cambodian team with the use of this specialized database and hope to help improve the practice of management and conservation of the critically endangered Mekong River dolphins, a living natural treasure of the Royal Government of Cambodia, for the next generation. A recent report indicated that the current number of dolphins in the population is about 89 individuals, holding steady over the past several years – let's hope this number increases steadily in years to come!

Behavior, Social Structure, and Communication

40 years of paternity analyses in the Sarasota Bay bottlenose dolphin community

Debbie Duffield, Portland State University; Randall Wells, Chicago Zoological Society's Sarasota Dolphin Research Program

This project represents more than 40 years of genetic work on the Sarasota Bay bottlenose dolphin community. It has been possible because of the combination of years of observational data on this community, the capture-release program and, more recently, the free-ranging dolphin biopsy dart sampling program. This has afforded us with an especially unique opportunity to assess population structure and the relationships of the dolphins within this community. Over the years we have brought a diverse array of genetic tools to the investigation of this community, initially using chromosomal and protein electrophoretic techniques, moving to DNA microsatellites as that technique became popular and available. To date, we have developed DNA microsatellite profiles. for 474 bottlenose dolphins of the Sarasota Bay community.

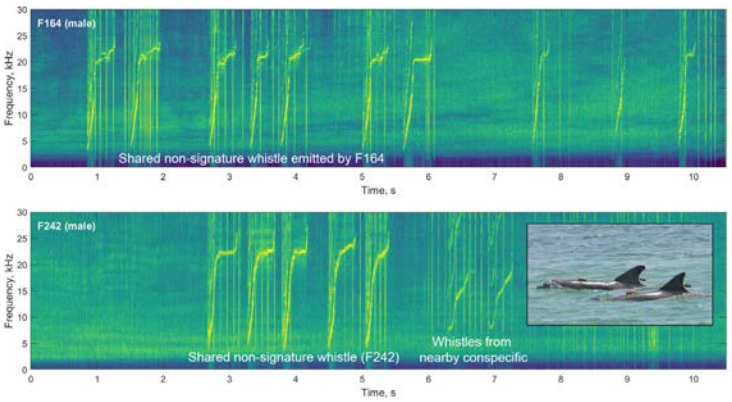
We have now evaluated 205 calves with known dams. For 152 of these calves (74%), sires were identified within the community and for the remaining 26%, all males sampled from the community were excluded. Although the actual percentage of unknown sires has varied over the years, it is clear that a contribution of paternity to the Sarasota Bay dolphin community comes from outside that community. The genetic data and a plethora of additional information have supported the hypothesis that this community is based on long-term residency of female dolphins and their affiliates and that there is reproductive exchange with other communities. For the 152 calves for which paternity by males within the community was established, 133 (88%) of the paternity assignments resulted in only one male being identified as the sire; all other males being excluded. For the other assignments, 2-3 males could have sired the calf, and in some of these cases, the males were related to each other. There have been 52 males out of more 200 males in the community that have been identified as sires, some having sired as many as 7or 8 calves. The age at which males have sired calves has ranged from 10 to 43 yrs. The average age at which males sired a calf is 23 yrs, with most of the sires being males from their late teens to more than 40 yrs of age. For the males that sired a number of calves, they were usually sires over a number of years. We are currently working on a detailed summary of reproduction in the Sarasota Bay dolphin community, as well as patterns of relatedness among the resident female units. In no other bottlenose dolphin community studied has it been possible to individually profile so much of the community with both genetic analyses and long-term behavioral observations for more than four generations.

Dr. Debbie Duffield working in her genetics lab at Portland State University.

Dolphin communication studies

Laela Sayigh and Frants Jensen, Woods Hole Oceanographic Institution; Vincent Janik, University of St Andrews

This year we have continued our efforts to verify and make accessible the large database of whistles that we have recorded during health assessments over the past 35 years. This resource consists of almost 1,000 recording sessions of 295 different individual dolphins, many of whom have been recorded multiple (up to 18) times. Our goal is to go through each recording systematically, which involves meticulous pairing with hand-written (and often somewhat confusing!) notes, linking of multiple channels, and monitoring of verbal comments, so that we can be certain that we are assigning the correct whistles to the correct individuals. We are also making note of non-signature whistles and signature whistle copies, as well as any other interesting observations. After this process of identifying and labelling whistles, we incorporate them into a standardized database format. Our goal is to make this *Sarasota Signature Whistle Database* accessible to a variety of research projects that can improve our understanding of signature whistle structure and function, and to develop artificial neural networks that can automatically detect and recognize individual animals by their signature whistle. We hope to integrate this work with the Passive Acoustic Listening Stations (PALS) that are being developed in Sarasota, which can serve as a test bed for future deployments of similar passive acoustic listening networks in other areas.



Spectrograms of a non-signature whistle exchange between two tagged members of a male alliance. Frequency in kHz is on the y axis, and time in seconds on the x axis. The upper panel shows non-signature whistles emitted by male F164, followed by matching non-signature whistles produced by his alliance partner, F242, shown in the lower panel. Whistles from a nearby dolphin appear at around 6 seconds.

We have begun using our growing database of known signature whistles to quantify the diversity of non-signature whistles used by dolphins tagged with sound and movement recording DTAGs. This investigation, which is being carried out in collaboration with Middlebury undergraduate student Matthew Hyer, has revealed that several male alliances produce a number of shared non-signatures, and often produce these in exchanges. We are excited about the potential for this work to begin to shed light on the unknown functions of dolphin non-signature whistles.

Functional attributes of acoustic signals in bottlenose dolphin communication

Marco Casoli and Peter Tyack, University of St Andrews; Katie McHugh and Randall Wells, Chicago Zoological Society's Sarasota Dolphin Research Program

Scientists studying animal acoustic communication typically start off by dividing the repertoire of the study species into *call types*, each one comprising sounds that are similar to each other. Once these classes of sounds are identified, scientists then investigate the function of each call type in the species' communication, examining the circumstances in which certain sounds are produced and how other individuals respond to them. Another complementary research avenue is to look at how specific *acoustic parameters* of sounds are used to signal specific types of information.

Imagine exchanging the roles of researcher and subject: another species is studying human communication, and is currently examining a heated argument that you just had with a friend. The actual words and sentences that were exchanged are of course important elements to track the nature and dynamics of your discussion, and constitute one possible level of analysis. However, the pitch, loudness and speed of your talking are also key features in order to understand how each of you communicated anger and concern, how you reacted to the behavior of each other, and ultimately to figure out how your argument evolved along time. If said with a different tone, the closing sentence of your discussion "This is the last time that we talk about this" might well have been the point when one of you stormed off, or a moment of reconciliation when you agreed not to go back to this matter again. This exemplifies how some acoustic parameters of our speech broadcast additional information to the meaning of the words that we say. In a similar way, acoustic parameters of animal sounds can convey information independent of call types, and are interesting aspects to focus on when studying animal communication. Since 2017, we started a research project with the goal of applying animal-attached tags to study the role of acoustic parameter changes in bottlenose dolphin communication.

Over the course of its 50 years of research, the Sarasota Dolphin Research Program has played a key role in investigating the complex communication of bottlenose dolphins. One of the milestones of this kind of research in the Bay has been the possibility of deploying suction-cup tags on the animals handled for the health assessment. The high-resolution Dtags that we attach to the dolphins are particularly suited to investigate the role of acoustic parameters for communication, because they collect a continuous record of the sounds produced by the dolphins. This allows monitoring fine-scale changes in call features that would be harder to study if sounds were recorded from a distance, for example from a vessel. Not only does the tag offer a continuous acoustic record, but it also collects detailed data on the dynamic changes in orientation of the tagged individual from turning and fluking. This means that we can match acoustic parameters of dolphin sounds to fine-scale parameters of their movements, such as activity intensity or body orientation, and therefore study communication through the sole analysis of *continuous behavioral metrics*. This brings a number of advantages if we think that the alternative traditional research approach relies on human observers to collect data on behavior: observers can only watch dolphins clearly when they are at the surface, it can be difficult to decide which *type of activity* individuals are performing among a limited list of possible predefined alternatives, and it is not possible to quantify precisely by eye detailed characteristics of movements such as activity intensity.

Lightning and calf with short-term Dtags.

The first phase of our project involved developing a method to calculate acoustic and movement parameters from the Dtag data. In a second phase we extracted parameters from dolphin agonistic interactions in order to test hypotheses about their communication. We used activity intensity as a movement parameter to estimate the intensity of agonism, and we found that: 1) during reproductive encounters, males decreased the pitch of their calls as the intensity of the aggressive context increased; this matched our expectations and parallels what happens in the agonistic interactions of other species; 2) dolphins increased the click repetition rate of their click-based signals as interactions escalated to higher levels of aggression, which matched our predictions based on studies of individuals under human care.

The goal of our work was to explore the use to tags to study communication by means of continuous acoustic and movement parameters. The data from the few interactions that we were able to analyze are not enough to make conclusions about how changes in pitch and click repetition rate allow bottlenose dolphins to signal information during agonistic encounters, but we hope that our study will illustrate the utility of Dtags for carrying out this kind of research. High-resolution tags could be used for similar applications in a number of other species as well, helping us to understand how other animals fine-tune acoustic features of their sounds to convey information.

Veterinary Expert System for Outcome Prediction (VESOP): A model to predict changes in dolphin population vital rates from measures of individual health

Lori Schwacke, Cynthia Smith, and Todd Speakman, National Marine Mammal Foundation; Len Thomas and Louise Burt, University of St Andrews; Marilyn Mazzoil, Dolphin Census Inc; Eric Stolen, Ecological Programs, Kennedy Space Center; Greg Bossart, Georgia Aquarium; Teri Rowles, NOAA Office of Protected Resources; Randall Wells, Chicago Zoological Society's Sarasota Dolphin Research Program

Our project is examining the relationship between the data collected during dolphin health assessments and the survival and reproductive success rates in the population. Methods originally developed or refined in Sarasota Bay for assessing the health of bottlenose dolphins have now been widely applied in other areas of the U.S. southeast coast. These studies are investigating a number of different things, including how exposure to chemical pollutants or harmful algal toxins affect dolphin health. Some of the studies have been part of Natural Resource Damage Assessments (NRDAs) that assess population-level injuries associated with chemical spills and then identify projects to support recovery from the injuries. These various investigations, along with the large and long-term health dataset from Sarasota Bay dolphins, provide the basis for our project, which is examining the relationship between measures of individual dolphins' health and population survival and reproductive success rates.

Our team of researchers has pooled comprehensive data collected during dolphin health assessments from seven different sites along the southeast U.S. coast. To date, we have compiled 830 dolphin health records. The data include standard blood diagnostics, such as complete blood count (CBC), serum chemistry, and hormones, as well as information from physical examinations and ultrasound of internal organs. Each of the seven sites also had dolphin photo-identification studies being conducted during and after the health assessments, providing follow-up information on the individual dolphins. We combined these data, as well as information from the Southeast Marine Mammal Stranding Network, to assess 2-year survival of the sampled dolphins, and birth outcome for female dolphins that were determined to be pregnant. However, for animals we do not see again, we cannot be sure whether they are dead or alive even with robust stranding response and photographic monitoring surveys. To address these unobserved outcomes, we implemented capture-mark-recapture (CMR) models to estimate the probability that an individual survived over the 2-year follow-up period, and also to provide estimates of each population's overall survival rate.

With our comprehensive database and CMR models in-hand, we enlisted help from a team of veterinarians to provide medical interpretations of the data, and develop expert rule-based health panels. Using all of this information, we have developed and are training a computer-based expert system to predict population-level survival and reproductive success rates based on the data collected during dolphin health assessments. Our "Veterinary Expert System for Outcome Prediction" (VESOP) has identified several key health parameters, primarily measures of chronic disease, that predict survival. We have found that dolphins diagnosed with inflammation are 4 times more likely to die within 2 years. Dolphins diagnosed with both inflammation and anemia have only a 50% chance of living for at least 2 years. The VESOP model will ultimately provide a tool for managers to use the data collected during dolphin health assessments to evaluate the health of the population, and predict the likely growth or decline of the population over time.

Len Thomas alongside Lori Schwacke as she measures the length of a dolphin during health assessments near Dauphin Island, Alabama in 2018.

Dolphin cardiac health assessment

Barbara Linnehan, Forrest Gomez, Ashley Barratclough, and Cynthia Smith, National Marine Mammal Foundation; Sharon Huston and Adonia Hsu, San Diego Veterinary Cardiology

CARMMHA (Consortium for the Advancement of Research of Marine Mammal Health Assessments) researchers recently began to investigate the cardiac health of wild dolphins. Studies in the wake of the *Deepwater Horizon* (DWH) oil spill documented detrimental effects of oil exposure on heart health in several species, however, the effects of oil on dolphin cardiac health had not been previously studied. Given the possibility of similar cardiac disease in dolphins exposed to DWH oil, researchers set out to examine the cardiac health of dolphins in the northern Gulf of Mexico and look for evidence of oil-related injury. The dolphins of Sarasota Bay played a large role in this research, serving as a healthy reference population for comparison to the oil-impacted dolphins of Barataria Bay, Louisiana, and helping answer the question, "What is normal for wild dolphin cardiac health?"

The first step in this research project was characterizing normal heart sounds in dolphins and standardizing an efficient technique to auscultate (listen to their hearts) using a stethoscope underwater. NMMF veterinarians and two veterinary cardiologists listened to wild dolphins in Sarasota Bay and Barataria Bay during health assessments, as well

A trained dolphin assumes a voluntary right lateral present and veterinarians auscultate (listen to) the cardiac window.

as dolphins managed under human care. It was discovered that the majority of dolphins auscultated had audible heart murmurs. Heart murmurs are extra heart sounds that result from turbulent blood flow, which occur for a variety of different reasons. Echocardiography (cardiac ultrasound) was used to investigate the sources of their murmurs, and found that the vast majority of the dolphins studied had innocent flow murmurs (i.e. not due to disease). These murmurs arose from benign high velocity blood flow due to their athletic hearts.

In addition, echocardiography was also used to evaluate the heart structure and function. Veterinary cardiologists Drs. Sharon Huston and Adonia Hsu performed echocardiograms on 17 dolphins in Sarasota Bay during health assessments. In comparing echocardiograms from Sarasota Bay to Barataria Bay dolphins, there were several notable differences between the two populations. Dolphins in Barataria Bay had significantly thinner left ventricular walls, a higher prevalence of valvular abnormalities, and smaller left atria. In addition, two dolphins in Barataria Bay were diagnosed with pulmonary hypertension, or high blood pressure, a condition not previously reported in wild cetaceans. Future work is needed to further explore the cardiac differences between these two populations and the relation of these cardiac abnormalities to oil exposure.

A free-ranging dolphin is auscultated while experienced handlers gently restrain the animal during a past health assessment. Veterinarians listen by reaching under, between the pectoral flippers, to access the cardiac window.

Cardiac biomarkers in bottlenose dolphins

Ashley Barratclough and Forrest Gomez, National Marine Mammal Foundation

Blood-based biomarkers are analytes which can provide an indication of health or the presence and severity of disease. In humans, several biomarkers have been established to provide an indication of cardiac health. This allows a simple blood test to provide doctors an indication of the likelihood of a heart attack, for example, or the presence of heart disease. It informs decisions such as what diagnostic tests should be performed to help diagnose and treat the patient. Recently the CARMMHA team (Consortium for the Advancement of Research of Marine Mammal Health Assessments) has been investigating cardiac health in dolphins.

Sarasota Bay dolphins are a world-renowned population of healthy dolphins and can therefore be used as a control or comparison for dolphins which are experiencing health challenges. This study assessed the heart health in Sarasota dolphins to establish “normal” healthy cardiac biomarker levels. These dolphins were compared to dolphins in the northern Gulf of Mexico which have been exposed to environmental contamination as a result of the *Deepwater Horizon* oil spill. One of the aims of the study was to explore the possible impact of oil exposure on cardiac health in dolphins.

This study examined the presence of 13 different blood-based biomarkers in 46 different dolphins from the two different locations. Important differences were noticed in biomarker levels between the two locations and in dolphins which were also suffering from anemia and inflammation. During the health assessment examinations each dolphin has a physical exam from a dolphin veterinarian. The dolphins are assigned a prognostic score in predicting their survival, ranging across good, fair, guarded, poor and grave. We found that dolphins which were given prognostic scores of poor or grave were more likely to have changes in cardiac biomarkers. More research is needed to fully understand which of the 13 biomarkers are both sensitive and specific indicators of cardiac health. This study provided a solid foundation for future research efforts into both dolphin heart health and the implications of heart disease in wild dolphin conservation.

Veterinary cardiologist Dr. Sharon Huston performs transthoracic echocardiogram (heart ultrasound) on a wild dolphin during a past health assessments.

Combining heart and lung measures to assess health and stress in dolphins

Ashley Blawas, Andreas Fahlman, and Alicia Borque-Espinosa, Fundación Oceanográfic; Randall Wells, Chicago Zoological Society's Sarasota Dolphin Research Program; Doug Nowacek, Duke University

Because dolphins are required to balance their time underwater foraging with time at the surface breathing, they have evolved to be efficient breathers with rapid air flow rates and large volumes of air exchanged with each breath. However, to transport the oxygen gained during a breath to the tissues for aerobic metabolism, the dolphin's cardiovascular system must effectively take up oxygen from the lungs through the alveolar membrane and into the blood. One phenomenon that has been proposed to improve this process is respiratory sinus arrhythmia, meaning that the heart rate varies during the respiratory cycle.

In humans, respiratory sinus arrhythmia is suggested to improve gas exchange by matching the ventilation of the air in the alveoli with the amount of blood flowing through the nearby blood vessels. This helps maximize how much gas is exchanged from the lungs to the blood and may reduce cardiac work. Given that breathing rate and heart rate are expected to vary during events of short-term stress, we measured the respiratory sinus arrhythmia of common bottlenose dolphins in Sarasota Bay during health assessments and compared these measurements to those from bottlenose dolphins in human care at Dolphin Quest Oahu, to investigate potential differences in the degree of the respiratory sinus arrhythmia.

To simultaneously measure a dolphin's breathing pattern and heart rate we used a custom flow-meter which is held over the blowhole and a three-lead suction cup electrocardiogram system. Our results suggest that although the dolphins in Sarasota Bay displayed reduced respiratory sinus arrhythmia compared to the dolphins at Dolphin Quest Oahu, when body mass and breathing rate of the dolphins are controlled for, the groups of dolphins displayed comparable degrees of respiratory sinus arrhythmia. This suggests that this cardiorespiratory coupling is responsive to short-term stress as it reflects expected changes in breathing patterns. Ultimately, we suggest that respiratory sinus arrhythmia may be used as a proxy for the degree to which the heart and lungs are working together to maximize gas exchange and that this may inform us about a dolphin's diving efficiency and its ability to maximize time underwater for foraging or other activities.

Measuring lung and cardiac parameters during a 2019 health assessment.

The value of ultrasound for dolphin health assessments: A lung disease case

Ashley Barratclough and Jenny Meegan, National Marine Mammal Foundation

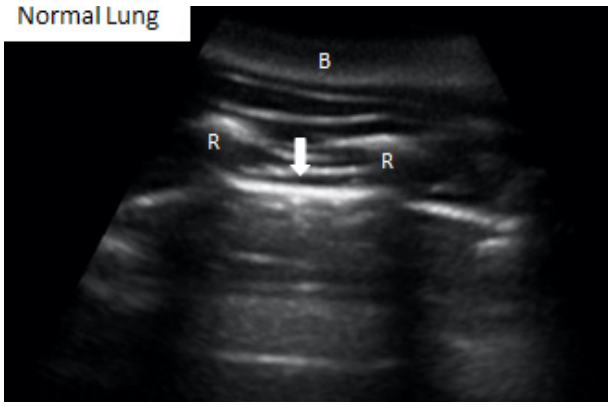
The Sarasota dolphin population provides us with a "healthy control" population for comparison with other dolphin populations that may be impacted by environmental stressors. For example, some dolphins exposed to the *Deepwater Horizon* Oil spill in the northern Gulf of Mexico have been diagnosed with poor health, such as lung disease, in the aftermath of this environmental disaster. To investigate whether oil was a factor, the health of dolphins exposed to oil was compared to the relatively healthy non-oiled dolphin population in Sarasota Bay. One of the most significant findings in dolphins exposed to oil was severe lung disease discovered on ultrasound examination. When we perform ultrasound exams on dolphins living in Sarasota Bay, the majority of the dolphins have either normal lung appearance or mild disease.

As we were unable to perform health assessments in the field in 2020 due to the ongoing global pandemic, we decided to revisit an interesting case from the 2018 Sarasota Dolphin Health Assessments. As part of the SDRP health assessments, each dolphin receives a complete ultrasound evaluation. The use of this non-invasive diagnostic tool allows the team to assess pregnancy status, evaluate lung health, and identify other potential underlying injuries or illnesses such as kidney disease or liver abnormalities. This information provides veterinarians and scientists with real-time health data. While pulmonary disease is not commonly seen in Sarasota Bay, a unique case was discovered during a 2018 health assessment.

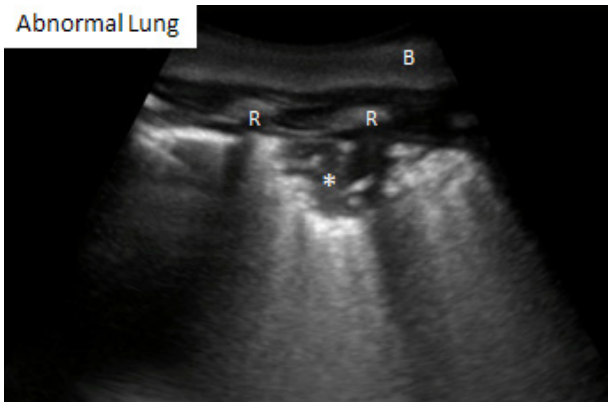
A young male calf F310 was examined and found to have raspy breaths when the veterinarians listened to his lungs with a stethoscope. Ultrasound examination of his lungs confirmed the presence of severe lung disease with partial consolidation of his lower lungs and a possible abscess present indicating severe infection. The lung disease was likely preventing his lungs from filling with air

effectively resulting in the abnormal breath sounds heard through the stethoscope. Additional ultrasound findings in the abdomen of the calf, showed a small amount of free fluid which was likely associated with the underlying disease and systemic inflammation.

A blood sample was taken at the time of the health assessment and submitted to a laboratory to obtain the results. With this degree of lung disease it would be appropriate to see changes in the white blood cell count indicating infection. Interestingly in this case the blood sample results were actually within normal limits. It is possible the calf was not mounting an appropriate immune response to this level of disease. Relying on his blood sample alone to assess his health would have given us a falsely positive indication of his health status. These findings illustrate the value of a thorough ultrasound examination in providing veterinarians and scientists with a real-time complete health profile for each individual dolphin assessed. The carcass of F310 was recovered in February 2020, after he apparently died from entanglement, likely in a net. Histopathological findings following necropsy (animal autopsy) supported the previous lung disease diagnosis from 2018, finding evidence of a prior, now resolved, lungworm infection.



Example of a dolphin (F173) with normal ultrasonographic lung appearance. Blubber layer (B); ribs (R); Lung field (white arrow).



*Ultrasound image of the lung lesion from the case dolphin F310. Blubber layer (B); ribs (R); * region of abnormal lung described as a pulmonary mass/consolidation (*).*

Dolphin breathing behavior changes in response to red tide

Spencer Fire and Glenn Miller, Florida Institute of Technology; Randall Wells, Chicago Zoological Society's Sarasota Dolphin Research Program

Brevetoxins are neurotoxins that are produced during Florida red tides (blooms of the phytoplankton species *Karenia brevis*), and are the cause of most of the harmful impacts on humans and marine life during such events. While brevetoxins mainly cause harm by being present in seawater and in marine prey items, these toxins can also become airborne and enter the lungs of air-breathing animals. For humans, this often occurs when visiting Florida beaches during a red tide, causing irritation of the lungs and airways and frequently resulting in fits of coughing or sneezing. "Chuffing" is an explosive type of exhalation seen in bottlenose dolphins that may serve the same purpose as coughing or sneezing in humans, and is therefore useful as a way to study a dolphin's behavioral response to respiratory irritation due to red tides.

We conducted a series of focal follows (n=66) of Sarasota Bay dolphins, both during red tide events and during non-red tide periods, to observe how often chuffing occurred. Almost 80% of the dolphins followed during red tide were observed chuffing, compared to only 21% followed during non-red tide periods. In addition, the average rate of chuffing (# of chuffs per minute) for red tide dolphins was 10 times greater than that of non-red tide dolphins. While it is not known to what degree airborne brevetoxins are actually absorbed by exposed dolphins through their airways, any disturbance response in wild animals (a change from their normal behavior) can potentially have negative impacts on their ability to thrive. Having a better understanding of the non-lethal effects of red tide on marine mammals helps conservation efforts to study the health impacts of living survivors of red tide events, and ultimately how this affects entire populations like the resident dolphins of Sarasota Bay.

An explosive "chuff" exhalation by a Sarasota dolphin.

Understanding the immune system of dolphins

Sylvain De Guise, University of Connecticut

University of Connecticut scientists engaged in dolphin immunology research.

In the middle of a pandemic, everybody hears about the immune system, its ability to sometimes respond to a virus in some people who do not suffer a disease, while others get very sick and die, at least at times with a dysregulated immune response referred to as a cytokine storm. We also hear about the development of vaccines that generate antibodies and some that generate killer cell response. Well, dolphins have an immune system that is very similar, as we keep discovering.

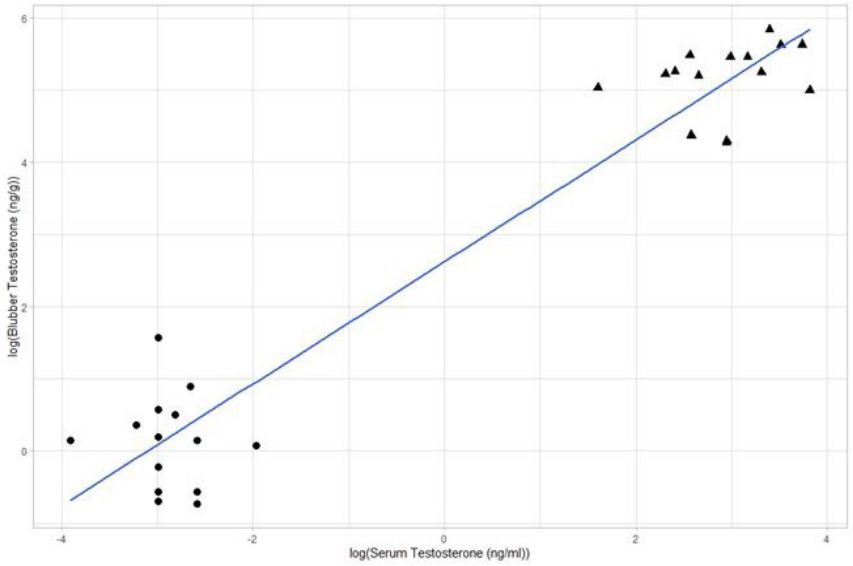
With the help of samples from the Sarasota dolphin health assessment program, we recently published a paper documenting a new, rare but important cell type not previously identified in dolphins, regulatory T cells (Treg). We validated the ability to identify dolphin Treg cells, quantify them in dolphin blood, and assess their responsiveness to regulatory stimulation. This is very exciting as they are the specific cell type that would dampen the immune response and avoid the cytokine storm in people suffering from the severe consequences of COVID 19. Further, Treg cells are the primary target we think may be responsible for the long-term effects of the *Deepwater Horizon* oil spill on dolphins' immune system. The new discovery will allow us to test that hypothesis. More next year…

Demographic, temporal, and biological matrix testosterone comparisons in bottlenose dolphins

Nick Kellar and Kathryn Sherman, National Marine Fisheries Service Southwest Fisheries Science Center; Randall Wells, Chicago Zoological Society's Sarasota Dolphin Research Program

In an extension of our earlier report, we have completed a comprehensive study on testosterone concentrations in the bottlenose dolphins of Sarasota Bay, Florida. Testosterone is the primary sex hormone in males, just as progesterone is in females, and is responsible for regulating sexual development and reproduction. Using samples from 55 individual known-age/sex dolphins in Sarasota Bay, we compared testosterone levels in both blubber and blood. Our goal was to examine how testosterone concentrations compared between the two matrices and to determine if maturity status could be discerned. The 29 paired samples showed a strong correlation between male blood and blubber testosterone concentrations and showed that mature males could be easily distinguished from immature males in either matrix. A comparison of 79 blubber samples further showed that blubber testosterone concentrations could be used to differentiate immature males from both mature males and females. Seasonal blubber testosterone variation was also observed with elevated levels seen during the peak breeding season.

Mature males had, on average, 300 times greater blood testosterone concentrations and almost 100 times greater blubber testosterone concentrations than immature males. Immature males had an average of greater than 6 times the blubber testosterone concentration of females. These findings are significant given that minimally invasive remote dart biopsies can be used as accurately as blood to determine sex and male maturity status. Through this study, quantifying testosterone concentrations from blubber biopsies has been validated as a way to obtain valuable data for bottlenose dolphins. This will allow researchers to acquire age structure data and aid in assessments of overall population health for wild dolphin populations not as well-studied as those in Sarasota Bay.



Relationship of blubber testosterone concentration to serum testosterone concentration for mature and immature male Sarasota bottlenose dolphins; circles represent immature males, triangles are mature males.

Allostatic load in dolphins

Shana Lavin, Wendi Fellner, Mandi Schook, Disney's Animal, Science and Environment, Walt Disney World

There is a need for reliable indicators of welfare and stress across a dolphin's lifetime to advance the conservation and care of this species. Individual responses to stress are critical to an animal's ability to cope with environmental challenges. A large gap in knowledge exists on effective ways to measure stress and the long-term effects of both acute and chronic stress. Steroid hormones, such as cortisol, and various other blood parameters, while informative, can be difficult to interpret as multiple factors can explain increases or decreases in concentrations at any given time.

To overcome these challenges, our team is developing an allostatic load index for dolphins. Allostatic load is the cumulative wear-and-tear in an animal that results from experiences that the animal perceives as stressful, such as giving birth. Allostatic load is a new avenue to explore lifetime stress and welfare in both free-ranging and aquarium-managed dolphins. Indices of allostatic load have been validated and applied in humans. Recently, indices also have been employed successfully in other species and correlated with morbidity and mortality risks.

To build an allostatic load index in dolphins, we selected serum biomarkers related to stress, inflammation, and metabolism. A number of these biomarkers have been validated and show promise for use in this index. We are using samples from both free-ranging and dolphins under human care to validate markers in concert with exposure to lifetime events. The long-studied community of dolphins in Sarasota Bay provides a unique opportunity to evaluate biomarkers in the index and correlate them to significant life events and mortality risk over time. Development of a single index to monitor exposure to lifetime stress and an animal's ability to cope with various events provides a valuable means of informing management strategies for dolphin populations in both zoos and the wild. We look forward to sharing our findings with the community in a future *Nicks'n'Notches*!

Wendi Fellner and Shana Lavin getting to know the Sarasota Bay dolphins on a cold February morning this year.

Hearing measurements of bottlenose dolphins in Sarasota Bay

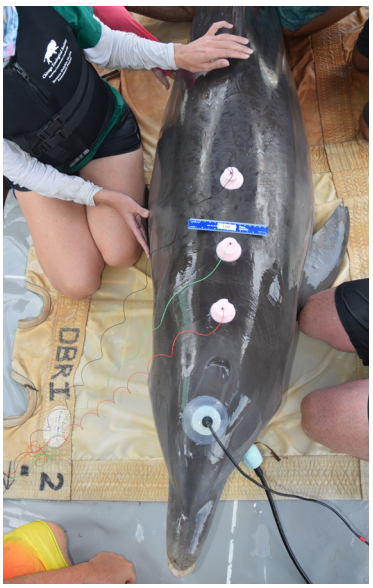
Mandy Cook, Portland State University;
David Mann, Loggerhead Instruments

Bottlenose dolphins rely on sound for communication, navigation, and foraging, especially in murky estuarine environments. Therefore, hearing is one of their primary sensory modalities. With a hearing range of approximately 75 Hertz (Hz) to more than 160,000 Hz, dolphins can hear well beyond the range of human hearing (20-20,000 Hz). Noise in the marine environment - both naturally occurring and man-made - can interfere with a dolphin's ability to hear, and can potentially cause temporary or permanent hearing loss.

We have been measuring the hearing abilities of the bottlenose dolphins in Sarasota Bay since 2003. We use auditory evoked potential (AEP) techniques similar to the ones used to test the hearing abilities of newborn human infants. Because dolphins transmit sounds to their middle ears through fat channels that run through their lower jawbones, an underwater speaker embedded in a suction cup (called a jawphone) is attached to their lower jaw and plays short tones that vary in frequency and loudness. Sensors, also embedded in suction cups, are attached to the head of the dolphin, and detect the brain waves produced in response to the tones. These signals are then analyzed to determine each dolphin's hearing abilities.

To date, our findings show that bottlenose dolphins in Sarasota Bay do not exhibit substantial hearing losses with increasing age, nor are male dolphins more likely than female dolphins to experience hearing problems. In contrast, both of these hearing patterns of hearing loss are commonly observed in humans. In addition, these dolphins are not exhibiting hearing losses due to chronic environmental noise exposure, including man-made noise such as from boat engines of construction. As we continue hearing tests during future health assessments, we will be able to evaluate whether the hearing abilities of individual animals vary over time.

This work was partially supported by a grant from the Portland State University Faculty Association Professional Development Fund.



Dolphin F285 during AEP testing, showing placement of the jawphone on the lower left jaw of the animal and three AEP sensors on the animal's dorsal surface. A recording hydrophone is located on the melon of the animal, between its beak and blowhole.

Dolphin Rescues, Releases, and Follow-up Monitoring

Sarasota Dolphin Research Program involvement in interventions and stranding response

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

We have worked in partnership with Mote Marine Laboratory's Stranding Investigations Program (SIP) for decades, helping to investigate reports and recover stranded dolphins to try to better understand the threats to Sarasota Bay's long-term resident dolphins, and leading rescue efforts for those for which interventions are recommended. We also receive support from two NOAA John H. Prescott Marine Mammal Rescue Assistance Grants to provide tags and tracking services to stranding response programs around the country, for follow-up monitoring of rescued and/or rehabilitated dolphins.

The pandemic reduced the number of interventions and rehabilitation cases during 2020. However, five dolphins were rescued from out-of-habitat situations in southwestern Louisiana following Hurricane Laura. The rescues, by the Audubon Nature Institute and the National Marine Mammal Foundation, on 29 and 30 September and 9 November 2020, moved trapped dolphins from shallow, isolated pools, and returned them to nearby dolphin habitat. We provided satellite-linked tags for the three non-calves, and tracking continues as of 16 November, with the animals using marsh, river, and coastal waters near their rescue sites.

As part of another John H. Prescott Marine Mammal Rescue Assistance Grant, through SIP, we are working with a team of veterinarians to try to develop capabilities for sedating free-swimming dolphins in need of intervention. This capability, which already exists for pinnipeds and large whales, would allow rescuers to save many more dolphins when they are in situations where traditional capture-release techniques are not feasible or safe.

F314 surfacing next to his mother, F279, in Stump Pass in January 2020.

Dolphin rescue updates

Aaron Barleycorn, Chicago Zoological Society's Sarasota Dolphin Research Program

Over the years, the SDRP has been involved in a number of interventions, and we conduct follow-up monitoring of these animals as possible. Updates on the status of some of the rescued individuals appear below:

Scrappy: In July 2006, Scrappy, a juvenile male, was observed entangled in a men's Speedo bathing suit. He had managed to put his head through the waist and one of the leg holes, and the suit had worked its way back to the point where it was cutting into his pectoral fins. On August 3, 2006, Scrappy was temporarily captured, and the suit was removed. Now 22 years old, he and C835 appear to be forming a male alliance, having been seen together several times in 2020.

Ginger: In December 2008, Ginger, a recently independent juvenile female dolphin, stranded on Siesta Beach. SDRP staff was among the first responders, stabilizing her before she was taken to Mote Marine Lab, treated for complications from the stranding, and released two months later. The SDRP radio-tagged her and closely monitored her for two months post-release until the tag transmissions ceased. She has since been regularly seen during our monthly population monitoring surveys. Ginger's story inspired SDRP volunteer Cathy Marine to write a children's book about her time at Mote called "No Dead Fish for Ginger." She had a brand new calf this summer, her third, and both are doing well.

Nellie: In February 2010, the 9-month-old calf of resident dolphin FB25 was seen with plastic twine and a metal hook tightly wrapped around her head. She was temporarily captured, disentangled and released on March 1, 2010. She was named "Nellie" in honor of Dr. Nelio Barros, a great friend and colleague, who had recently passed away. She also had a brand new calf this year, her second.

Lizzie: One of our Sarasota residents, Lizzie, had an eventful 2013. She was given a temporary satellite-linked tag during our health assessments in May, and she and her 3-year-old calf were regularly followed to compare their behavior with and without the tag. During one of these follows SDRP staff noticed that Lizzie had become entangled with monofilament line around one of her flukes. Shortly after, her calf was struck by a boat propeller that left a large gash on his dorsal fin (he is still alive in 2020). Lizzie and her calf were temporarily captured on July 20, 2013, to remove the fishing line and the tag. We still see her regularly in and around the waters of Palma Sola Bay, and she has had seven calves to date.

Bill: On March 1, 2016 we received a report of a dolphin that was entangled in a crab trap line off Nokomis Beach. We went to the dolphin's last reported location from the night before, and found 10-year-old resident dolphin "Bill" with just his blowhole above the water. His tail was wrapped in the float line of a crab trap, and was weighed down by the trap to the point of being unable to move, and barely able to keep

his head above water. We used a boathook to grab a bit of line floating next to Bill and pulled up line until we got to the entanglement. We were able to remove the line without cutting it. Bill was tail-kicking during this time and appeared to have full motion of his fluke. There were some lacerations where the line had wrapped, but they did not go very deep. Now fully disentangled, we released the dolphin and watched him swim away. He hasn't been seen since August 4, 2020, near the time when we lost several resident dolphins to unknown causes. We are hopeful he is okay, and just being extra evasive this year.

F314: On March 11, 2019 the SDRP led a team to rescue an entangled dolphin calf near Stump Pass off Englewood, Florida. We were able to catch him (now F314) and his mom, and remove deeply embedded, life-threatening fishing line. They were both released together after tagging the mother (F279) with a satellite-linked tag. Despite their distance from Sarasota, we have been able to make occasional trips down to the area to check up on them, and we receive reports from the public. The most recent report came in on October 26, 2020, with a photo showing him to be in good condition. Unfortunately, both dolphins still spend a lot of their time around fishing boats.

F316: On April 1, 2019 we rescued F199's calf (now F316) who had fishing line cutting most of the way through his fluke, and who was incredibly emaciated. Honestly, we did not have high hopes that he would survive, but veterinarians determined his best chance was to be released to recover in the wild. Fortunately, F316 did well post-release. We observed him as he steadily put on weight and became more active. His mom has since had a new calf, but F316 appears to be doing well on his own. He was seen on October 14, 2020, within a mile of his rescue site.

Update on Atlantic spotted dolphin Lamda, from The Bahamas

Kelly Melillo Sweeting, Dolphin Communication Project; Randall Wells, Chicago Zoological Society's Sarasota Dolphin Research Program

On October 29, 2018, a male, ~10-yr-old Atlantic spotted dolphin was released off Bimini, in the Bahamas. The dolphin, observed off Bimini since 2013, is known by the Wild Dolphin Project as "Lamda." He was reported to the Bahamas Marine Mammal Stranding Network/ Bahamas Marine Mammal Research Organisation as being in distress near Great Stirrup Cay on August 24, 2018, and after he was stabilized by Atlantis Animal Rescue Team, he left the bay on August 25, 2018. He stranded on Great Stirrup Cay on August 26, 2018 and was transported to Atlantis for rehabilitation. The dolphin was tagged with a satellite-linked location-only tag (provided by a donation to DBRI, not Prescott) before being released off Bimini. Tracking continued through February 14, 2019. Over the first three months of tracking, the dolphin moved back and forth along the SW edge of the Great Bahama Bank, ending up in the waters near his release site, in his previous range. He has been subsequently seen repeatedly near Bimini, as recently as September 19, 2020, and he continues to appear to be in good condition. This case is being published in the journal *Aquatic Mammals*.

Lamda, on September 19, 2020, off the island of Bimini (photo credit: Atmos).

Staying Alive: Long-term intervention success

Katie McHugh, Chicago Zoological Society's Sarasota Dolphin Research Program

We recently completed a large collaborative study evaluating outcomes of bottlenose dolphin rescues conducted to save free-swimming entangled animals in southwest Florida over a 35-year period. This retrospective analysis demonstrated the potential for interventions to achieve long-term success at their primary goal: *helping animals remain in or return to wild populations to survive and reproduce*. Approximately 75% of rescued dolphins survived over multiple years, all living animals remained in their local communities, and all females that had reached sexual maturity successfully reproduced post-rescue. Taken together, our findings strongly support the idea that saving animals with life-threatening injuries can provide benefits not only to the welfare of those individuals, but also to the stability and growth potential of their local populations.

We applied social network and demographic modeling approaches to data from the natural laboratory in Sarasota Bay, which confirmed that rescued dolphins maintained most of their social connections within the community and that their long-term survival supported greater population sizes and growth rates than would have occurred without interventions. Similar methods could be used to assess the potential conservation benefits of interventions in other populations to mitigate human impacts. These findings were recently submitted for publication to a special section in the journal *Frontiers in Marine Science*.

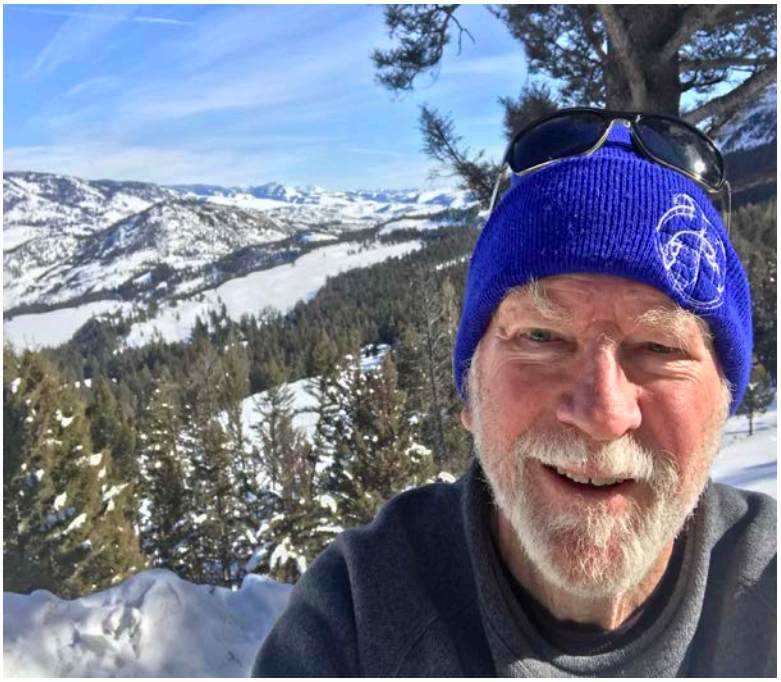
Nellie, who was rescued from a life-threatening entanglement when she was a young calf, produced her second calf in Sarasota Bay this year! She and her calves are among several cases that demonstrate how rescues can help both individuals and their local populations.

The Half-Century in Review

In the beginning…

Blair Irvine, Dolphin Biology Research Institute

In 1970, I was standing on a beach in Sarasota with a friend, watching bottlenose dolphins swim by close to shore. We wondered, did they live in the area, or did they wander up and down the coast, possibly for hundreds of miles or more? No one knew the answer. That simple question, serendipity, and opportunity enabled a small scale effort to find an answer. Dolphin tags were loaned, a local dolphin collector agreed to cooperate, and my research assistant, high school student Randy Wells, also wanted to be involved. We went out with the dolphin collector and tagged some of the dolphins he released. Over time, we discerned that some of the dolphins did indeed live in the area year-round, and our tagged dolphins gave us intriguing hints of a social structure. We published our results in an obscure, and now non-existent, journal, but our findings were noteworthy. Given that modest start, the evolution of the study of dolphins in Sarasota has been nothing short of spectacular. Sarasota is now a model of multidisciplinary conservation research on dolphins, led by the internationally respected Randy Wells. I'm very proud to say that I was able to help out at the beginning.



Above: Blair Irvine, a half-century after founding the Sarasota Dolphin Research Program.

Below: Blair, Randy, and Michael Scott in 1976, with dolphin "Genie."

The following pages include a timeline for the program, first published in the Fall 2020 issue of the Chicago Zoological Society's members' magazine, *Gateways: Engaging People and Communities with Wildlife and Nature.*

CZS' WORLD-RENOWNED SARASOTA DOLPHIN RESEARCH PROGRAM CELEBRATES 50 YEARS OF PIONEERING RESEARCH AND CONSERVATION BREAKTHROUGHS.

If someone had told 16-year-old Randy Wells that his volunteer gig with a Mote Marine Laboratory scientist would help launch his career as director of a program conducting the world's longest-running study of a wild dolphin population, he would have scoffed at the idea. In 1970, Wells, who had grown up in Illinois, had recently moved to Siesta Key, Florida, and was more interested in sharks than dolphins.

The Mote scientist was Blair Irvine who was studying the behavioral interactions of sharks and dolphins. In his spare time, he studied wild bottlenose dolphins on Florida's central-west coast. In 1970, very little was known about the lives of wild dolphins. Irvine and Wells set out to do the first study of wild dolphin ranging patterns to find out if the dolphins roamed widely in the Gulf of Mexico or stayed close to home—home being the coastal area of Sarasota Bay. Little did Irvine and Wells know that their small study, and the work that followed, would make Sarasota Bay the site of one of the most acclaimed dolphin conservation research programs in the world.

A half-century later, the Sarasota Dolphin Research Program (SDRP), as it came to be called, is operated by the Chicago Zoological Society with Dr. Randall Wells at the helm. It's been 50 years since Wells first encountered Sarasota Bay's wild dolphins, and now he is celebrating a rarely achieved milestone in the world of animal research—the SDRP's 50th anniversary.

Currently, Sarasota Bay's "cast of characters," numbers about 170 individuals spanning as many as five concurrent generations. SDRP researchers have known many of the dolphins since birth. In some cases, they also know their parents, grandmothers, great-grandmothers, and great-great-grandmothers. The SDRP has gathered data on the health and physiology, behavior, social patterns, and reproductive success of many of the Bay's residents.

"This information can only come from long-term research and monitoring the same animals over time," said Wells. They found that Sarasota dolphins are long-lived, with females living for as long as 67 years, and males up to 52 years. Furthermore, dolphins, like other marine mammals, are facing an increasing number of disturbances and threats from humans.

"Our main question has been: What does it take for this population to survive and thrive?" said Wells. As you'll see, Wells and his team of researchers have contributed much to our understanding of what it takes—and they continue to do so. A few of their ground-breaking discoveries and conservation success stories are plotted on the timeline that follows.

1970-2020 HISTORIC TIMELINE

1970

Wells and Irvine conducted the **first tagging study of coastal bottlenose dolphins**. They attached plastic identification tags to dolphins' dorsal fins to track their movement patterns. As time and opportunity allowed, they searched for the tagged dolphins and found them—often not far from where they were initially tagged. Spotting the same dolphins multiple times in Sarasota Bay led Irvine and Wells to suspect the dolphins resided there year-round.

SDRP founder, Blair Irvine (left), and Robert Corbin with the first dolphin tagged in Sarasota Bay in 1970.

1972

The **Marine Mammal Protection Act** became law, making it illegal to harass, feed, hunt, capture, import, and kill or attempt to kill marine mammals in U.S. waters. The Act created the U.S. Marine Mammal Commission to provide oversight of actions affecting bottlenose dolphins and other marine mammals, and their ecosystems, to ensure their conservation and long-term survival.

NOAA FISHERIES

Data from tracking and surveys conducted in 1975 and 1976 found that 92 percent of the dolphins Wells and Irvine tagged in 1970 and 1971 had remained in the area. This provided evidence that the dolphins resided for multiple years in Sarasota Bay and surrounding waters. The finding of **long-term residency** was a breakthrough, said Wells. "Once we discovered residency and knew we could find individual dolphins on a predictable basis, the doors were opened to all kinds of research." For example, they would be able to study dolphins within the contexts of their social groups and environment. With further research, the SDRP confirmed that multiple generations of the dolphins lived within the same community home range.

Blair Irvine and associates, Randy Wells and Michael Scott, encountered a tagged dolphin "Genie" in 1976. In 1982, Genie gave birth to her first calf, demonstrating three-generation residency to the Sarasota Bay area for the first time.

1975-76

1974

SDRP researchers were awarded their first grant from the **U.S. Marine Mammal Commission** to fund more dolphin tagging and tracking. The SDRP's data on wild dolphins were considered to have great potential for creating policies to protect and conserve the animals. Michael Scott joined the research team.

The SDRP helped to revolutionize tagging—the use of visual tags, radio tags, and satellite-linked tags—to monitor and study dolphins. (Above): A dolphin with a satellite-linked tag. (Right): A dolphin wears a suction-cup-mounted digital archival tag, or Dtag, with on-board hydrophones, sensors, and computers. Dtags enable scientists to collect immense quantities and varieties of data with minimal impact on dolphins.

1977-79

Opportunistic resighting efforts—using photographic identification of dolphins' distinctive markings—were conducted to monitor the dolphins studied from 1970 to 1976. Wells completed his University of Florida master's thesis: "Home range characteristics and group composition of Atlantic bottlenose dolphins, *Tursiops truncatus*, on the west coast of Florida."

SDRP researchers have continually developed, field tested, and/or refined new gear and techniques, which would eventually be adopted by scientists elsewhere. The most basic work of the SDRP involves recognizing individual animals by a unique set of markings, scars, and nicks and notches on their dorsal fin. The SDRP was among the first groups to implement systematic **photo-identification surveys**. Wells and Scott conducted these surveys in Sarasota on a seasonal basis, and subsequently expanded them into the nearby waters of Tampa Bay and Charlotte Harbor.

1980

A rescue team, including SDRP personnel, stabilized a stranded dolphin in 2008. Ginger, a 3½-year-old resident female, has been known by the SDRP since her birth. She was rehabilitated at Mote Marine Lab for two months and released. The SDRP continues to observe her, as well as her calves, including one born in 2020.

1982

The **Dolphin Biology Research Institute (DBRI)** was organized by the SDRP as a 501(c)(3) not-for-profit corporation to support its research. DBRI provides logistical support, including a small fleet of research vessels, vehicles, computers, cameras, and other field equipment. Funding from Earthwatch, Inc. was used to involve citizen scientists in the SDRP's research. Earthwatch continued to support the SDRP with funding and volunteers for 25 years; some of the volunteers continue working with the program today.

1984

SDRP researchers began conducting **life history studies** of the Sarasota dolphins using brief capture-release. Small groups of dolphins are encircled with a net in shallow water. With assistance from veterinarians, researchers measure the animals; determine their sex; obtain samples for genetic, age, and hormone analyses; and mark them for future identification. They also collect recordings of the whistles produced by each dolphin in support of communication research by Woods Hole Oceanographic Institution scientists.

1985

Building on Mote's early record of stranding response and rehabilitation of marine mammals, initiated by Irvine and Wells in the 1970s, Mote Marine Laboratory formally established a **dolphin-stranding-response program.** Mote partnered with the SDRP to rescue injured, diseased, and stranded animals. SDRP staff, who had led and participated in many marine mammal rescues, were highly skilled in evaluating an animal's condition and situation to determine the appropriate intervention. "A rescue may involve getting the animal off the beach, or out of entangling gear, and back into the wild," said Wells. Or the rescue team may decide an animal needs rehabilitation and follow-up monitoring after the rescue. Many rescued dolphins have injuries involving entanglements and other problems related to interactions with humans.

The SDRP incorporated **health assessments** into their safe and effective capture-release efforts, to monitor the health of individual dolphins and the population as a whole. Over the decades, data collected during health assessments have been used by more than 40 research projects. During the periodic assessments, dolphins are gently lifted aboard a veterinary vessel and thoroughly examined by SDRP scientists, biologists, and veterinarians. Today's assessments include ultrasound examinations to detect the condition of organs, pregnancies, and the progress of pregnancies. The animals are then photographed, sometimes marked or tagged, and released on site about an hour later.

"We've learned about the animals' biology, health, body condition, and age; which dolphins they're related to; environmental contaminants they're carrying; and how they communicate with one another," said Wells. Using long-term health assessment data, researchers can also detect changes within a population of dolphins, such as fluctuations in the rate of successful pregnancies. These data, coupled with long-term photo-ID data, enable SDRP scientists to determine survivorship—or how many dolphins survive from year to year. These kinds of data define the species' normal biology, said Wells. Researchers can use Sarasota Bay dolphins as a reference population when doing comparisons with populations of at-risk dolphins and dolphins in managed-care facilities.

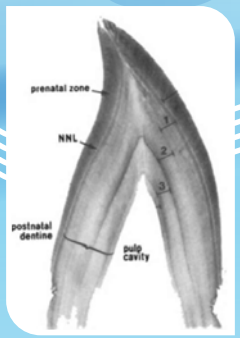
Dr. Wells and his team take measurements of a dolphin during a capture-release health assessment.

1986-87

Wells completed his doctoral dissertation at the University of California, Santa Cruz, entitled "Structural aspects of dolphin societies," and was awarded a postdoctoral fellowship at Woods Hole Oceanographic Institution to continue work with the Sarasota dolphins.

SDRP scientists began using the **focal animal behavioral observation** approach. From a distance, they located, observed, and recorded a dolphin's behavior—including respirations, or how often it surfaced to breathe; its nearest neighbor(s); the size of its group; and habitat use. The dolphin's behavior was recorded at specified (usually three-minute) intervals. Over time, repeated observations enabled researchers to understand how an animal's behavior changed with life stage, varying circumstances, and health.

1988



1989

The **Chicago Zoological Society** hired Wells to continue to direct the operations of the SDRP. The arrangement with CZS has provided the program with operational support and critical staff, and helped kick off a new round of long-term research.

Scientists from the government and other institutions have used the SDRP's long-term data and the natural laboratory of Sarasota Bay to conduct their own studies. For example, a National Marine Fisheries Service (NMFS) scientist developed a method of **precise age determination** in dolphins. With the SDRP's assistance, she tested and confirmed a method of age determination using the number of layers found in a dolphin's teeth. A known age is critical because it enables scientists to interpret an animal's health data and determine the viability and social structure of a population. The SDRP is now working with researchers to use less-invasive methods to determine age. Collaborating with scientists at the National Marine Mammal Foundation, they are helping to refine techniques to estimate age by looking at the degree of bone fusion in X-rays of flippers. They are also working with Florida International University scientists to estimate a dolphin's age from rates of change in the DNA in a skin sample.

SDRP by the Numbers

The SDRP has played a crucial role in educating and training researchers and future conservation leaders around the world. In 50 years of operation, the SDRP has yielded

- 44 doctoral dissertations and 41 master's theses that benefited from research opportunities, samples, data, or guidance provided by the SDRP
- More than 430 undergraduate interns who received training by the SDRP
- More than 100 researchers and students from 43 countries who benefited from the SDRP's training opportunities
- More than 270 peer-reviewed journal articles and book chapters that were written or co-authored by SDRP staff members; more than 100 technical reports that involved SDRP staff as senior authors or co-authors
- More than 439 scientific presentations and more than 278 public and university lectures that were presented or co-authored by SDRP staff members

For more information about the SDRP, go to SarasotaDolphin.org

SDRP scientists and colleagues continue to learn more detail about dolphins' social lives within discrete, adjacent resident communities along the west coast of Florida. By observing individual animals over time, and incorporating genetic studies, they identified three **basic types of dolphin groups.** The nursery group consists of adult females with their most-recent offspring. Juvenile groups are made up of both males and females that have left their mothers, but are not yet sexually or socially mature. The third kind of group involves pairs of sexually mature males, often of a similar age. Male pairs move among female groups and do not take part in rearing calves. Females often use different males to sire subsequent calves.

The SDRP was the first group to find that adult male bottlenose dolphins establish long-term pair bonds that often last until one of them dies. Paired males, like "Racing Stripe" and "Otter" shown above, are often synchronous in their surfacing patterns.

1990

1992

The SDRP developed an increasingly active field program that included graduate students. Wells returned to Sarasota full time and established a base of operations at **Mote Marine Laboratory**. Mote provides office, lab, storage, and dock space, as well as access to boat-launching ramps. In exchange, the SDRP has helped Mote develop marine mammal research and stranding response capabilities.

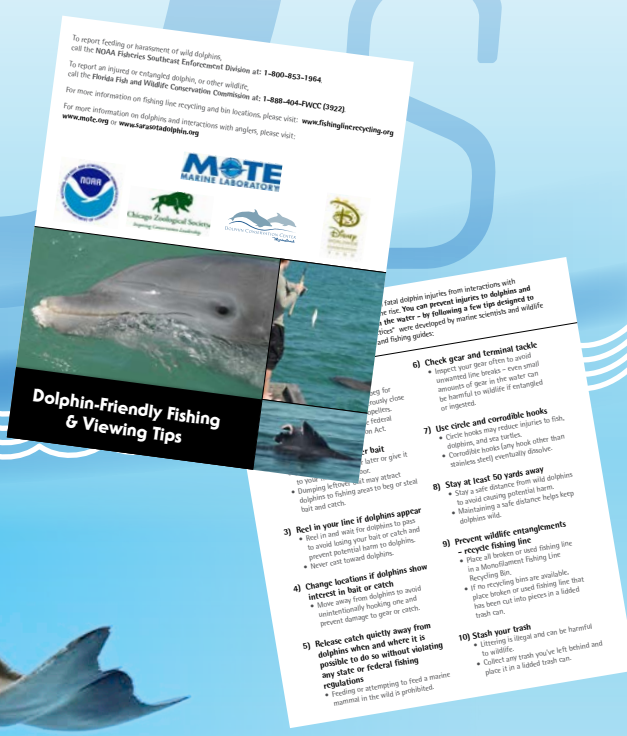
1993

With a full-time presence in Sarasota, the SDRP ramped up its **photo-identification monitoring surveys** of the local dolphins. Since 1993, the surveys have been conducted monthly instead of seasonally and generate much more detailed information.

The SDRP is a leader in the study of the **cumulative impacts of human activities** on coastal bottlenose dolphin populations. Impacts include commercial and recreational fishing that injure and kill dolphins that ingest, are hooked by, or become entangled in fishing gear. Boaters sometimes collide with dolphins. Vessels, and construction and demolition activities, create noise disturbances. Pollutants and trash in the ocean poison and entangle marine animals. Climate change has been a growing threat.

Public education and outreach are important parts of the SDRP's mission. Staff members frequently speak to audiences of all kinds about threats to dolphins. While continuing to support stakeholders' interests, the SDRP educates them about how they can help reduce or eliminate the threats. Over the years, they've created books, an annual report called *Nicks 'n' Notches,* dolphin-friendly-viewing and fishing-tip cards, PSAs, and videos. The SDRP has established an active presence on social media and online at **SarasotaDolphin.org**, where much of this information is available.

[Left]: Feeding or approaching within 50 yards of wild dolphins is prohibited by law. [Above]: This male dolphin, known to the SDRP as "Riptorn," was apparently struck by a boat propeller in 1983. He was one of the few lucky survivors of boat strikes and lived for another 32 years.



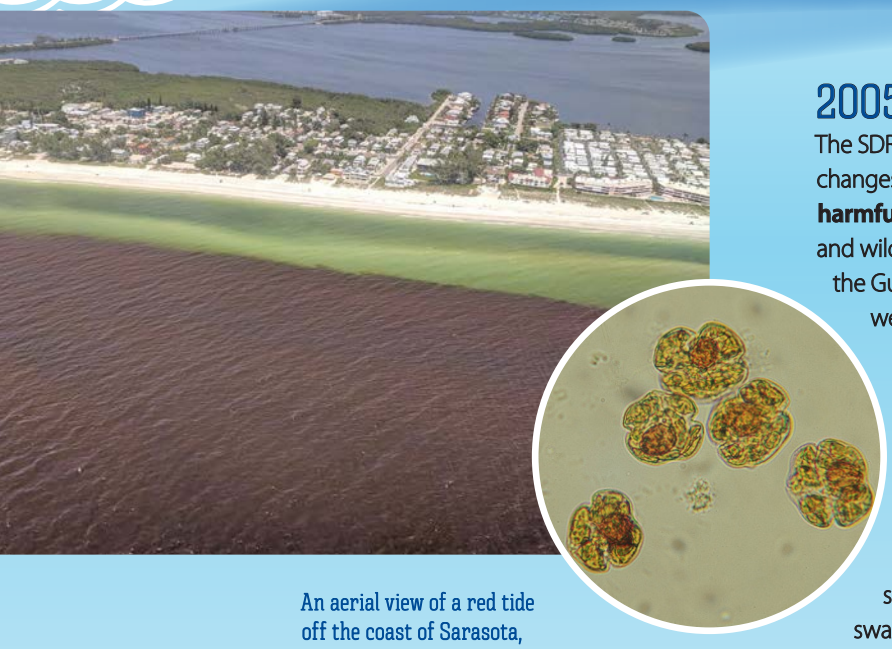
1994

1999

Zoos and aquariums with resident bottlenose dolphins have benefited from the SDRP's research on what wild dolphins eat, what they should weigh, what blood-value ranges should be considered normal, how they behave, the composition of their social groups, and breeding outcomes. For example, a **consortium of researchers at managed-care facilities**, including Brookfield Zoo, has used the SDRP's research findings on the types of dolphin social groupings to make decisions about which dolphins in their facilities will be kept together or kept separate. For example, a pair of bonded males may be kept together. In turn, research on dolphins in managed-care settings has raised questions—about dolphin communication, for example—that led to further studies by the SDRP.

The SDRP established a **long-term, seasonal, fish-monitoring program** to track changes in the abundance and diversity of the primary fish the dolphins eat. "I want to be able to learn about the dolphins from an ecological perspective—what drives them to do the things they do," said Wells. "I need to understand what they are responding to in their environment, and prey availability is one of the main items." During prey fish surveys, researchers use a purse seine net to briefly capture fish in Sarasota Bay to determine fish population diversity, abundance, and condition. The fish are released after they are briefly examined and measured. The surveys occur during three months of winter and four months of summer. The SDRP received federal funding to purchase the needed boat and net and to hire staff.

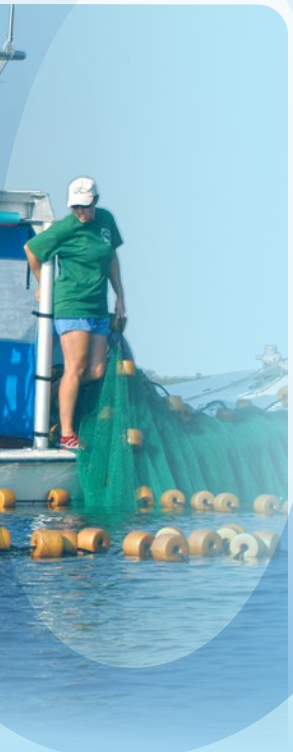
2004



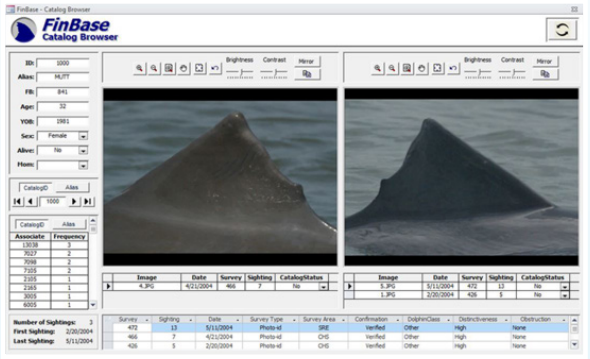
2005-06

The SDRP was the first group to quantitatively document changes to a fish community from a severe **red tide harmful algal bloom**, which produces toxins that kill fish and wildlife. Although red tides are not uncommon off the Gulf Coast of Florida, the red tides of 2005 and 2006 were unusually severe, long lasting, and ecologically damaging. Using data collected from fish surveys, SDRP scientists documented a 75 percent decline in fish populations; the dolphins' primary food source was nearly wiped out and it took two years for the fish populations to recover. In response, the Sarasota Bay dolphins altered their ranging and social patterns. They moved closer to humans, stealing bait at the end of fishing lines and swallowing food illegally thrown to them by boaters. Unfortunately, some dolphins died after swallowing, being hooked by, or becoming entangled in fishing gear.

An aerial view of a red tide off the coast of Sarasota, Florida (above), and a microscopic closeup of the *Karenia brevis* organism that causes these toxic blooms.



Since the SDRP first began its dolphin monitoring surveys, they recorded data from 57,000 dolphin group sightings and amassed more than 855,000 photographs during photo-identification surveys. More than 161,000 individual animals have been identified. To access the massive amounts of data, the SDRP worked with Jeff Adams of NMFS to adapt his **FinBase**, a database designed specifically for storing and managing data and images of individual dolphins. Recently, the SDRP has been involved in developing and testing several programs to automate the matching up of dolphin fins, which can greatly speed up dolphin identification.



2006

Help Fund This Important Research Program

CZS, which operates the Sarasota Dolphin Research Program, lost revenue during the months Brookfield Zoo was closed to the public. Your financial support is critical at this time to support the SDRP and our other programs.

If you can help, please go to **CZS.org/Donate.**

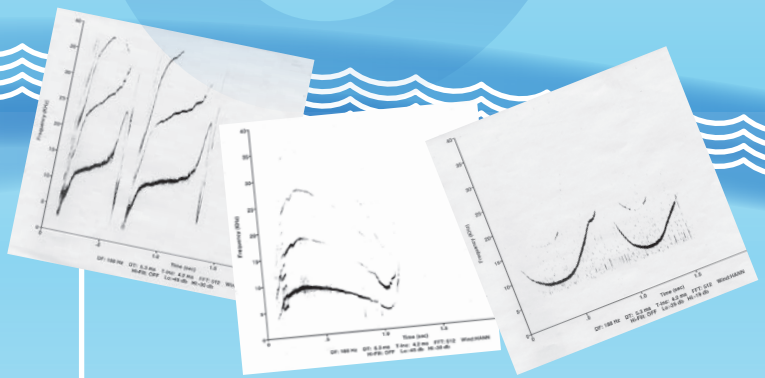
Significant support for the SDRP, in 2019 and 2020, came from Charles & Margery Barancik Foundation; Anonymous (3); The Batchelor Foundation; Mr. and Mrs. Stephen P. Bent; Mr. and Mrs. Edward McCormick Blair, Jr.; James and Elizabeth Bramsen; Dolphin Quest; Allison and Rick Elfman; Florida Restore Act Centers of Excellence Program; Fundación Oceanogràfic; Mr. and Mrs. John P. Grube; Gulf of Mexico Research Initiative; Hamill Family Foundation; Nancy and Jonathan C. Hamill; Harbor Branch Oceanographic Institution; Mrs. Loretta N. Julian; Linda R. Kahn; Ms. Diane A. Ledder; McComb Family Foundation; Mr. and Mrs. Michael A. Mason; Mr. and Mrs. Ira Mirochnick; Mr. and Mrs. Scott F. Moller; Mr. and Mrs. Michael D. Moorman; Mote Scientific Foundation; National Fish and Wildlife Foundation; National Marine Mammal Foundation; National Oceanic and Atmospheric Administration; Mr. and Mrs. James R. Nelon; JoAnnGrace Tameling Schaeffer; Kelley C. Schueler; Mr. and Mrs. Jack Shaffer; Mr. and Mrs. Robert E. Shaw; Melissa and Stuart Strahl; Joan M. Tameling; Nancy C. Tameling; Mr. and Mrs. John W. Taylor III; Mr. and Mrs. Thomas A. Tisbo; University of Central Florida; and the Women's Board of the Chicago Zoological Society.

2010

BP's ***Deepwater Horizon* oil spill** killed large numbers of marine animals and fouled 1,300 miles of Gulf of Mexico shoreline. The National Oceanic and Atmospheric Administration (NOAA) led a team of investigators, including the SDRP, in studies to determine the potential impact of the ecological disaster on dolphins. Since pollutants from the spill did not reach Sarasota Bay, the unaffected Sarasota Bay dolphin community was used as a reference population with which to compare the dolphin communities in heavily oiled areas, such as Barataria Bay in Louisiana. Barataria Bay health assessments results were compared with those of resident dolphins in Sarasota. Researchers found a greater incidence and severity of lung disease in Barataria Bay, and only about 20 percent of the pregnancies led to observed calves, in contrast to 83 percent in Sarasota. The SDRP found a year-to-year survivorship rate of 96 percent for the Sarasota dolphins, compared with an unsustainable 87 percent in Barataria Bay. These findings revealed the devastating impact of the oil spill on dolphins and contributed to British Petroleum settling the case and accepting responsibility for the ecological disaster. Sarasota Bay dolphins have also served as a reference population in the study of the impacts of biotoxins in the Florida Panhandle and PCB concentrations along the East Coast.

2012

The *Deepwater Horizon* oil spill revealed that government regulators lacked important data to effectively manage and protect bottlenose dolphins in the Gulf of Mexico. With funding assistance from the NMFS, Disney Conservation Fund, and Harbor Branch Oceanographic Institute, the SDRP developed and continues to manage the **Gulf of Mexico Dolphin Identification System (GoMDIS)**. This online repository holds and integrates bottlenose dolphin identification catalogs from more than 20 collaborating organizations around the Gulf of Mexico, including Mexico and Cuba. This allows researchers to track the movements of dolphin individuals over a very wide range, determine where stranded dolphins originated, investigate population structure, and detect range shifts resulting from environmental disasters like the *Deepwater Horizon* oil spill.



Above are spectrograms (time along the horizontal axis, frequency on the vertical axis) showing the distinctive shapes of the whistles of different dolphins.

2013

For decades, the SDRP has worked with scientists from Woods Hole Oceanographic Institution and the University of St Andrews, Scotland, who were studying dolphin communication. Of particular interest to the researchers was the role in communication of individually distinctive whistles called **"signature whistles."** Scientists conducted experiments using recordings of dolphins obtained by researchers during SDRP health assessments, and from dolphins at Brookfield Zoo's SEVEN SEAS and Walt Disney World's The Seas. They found that dolphins learned the signature whistles of other dolphins, and used the whistles to call out to them. This work has highlighted fascinating questions about how signature whistles might be comparable to names—a rare concept in the animal kingdom.

A mere 62 years after it was first described by scientists, the vaquita is in imminent danger of extinction. [Left]: The young vaquita was caught as part of the VaquitaCPR project in 2017. It was soon released because it did not adapt to sanctuary facilities. [Photo credit: VaquitaCPR]

2016-17

Wells was asked to co-manage the **Vaquita-CPR program**, a large-scale, international collaboration to try to rescue remaining vaquitas from the threats they face from illegal fishing gear. The vaquita—the most endangered cetacean in the world—is a very small porpoise found only in the Gulf of California, along the northwestern coast of Mexico. Fewer than 30 were thought to remain in the world. They are killed in nets set illegally for endangered totoaba fish, to obtain fish swim bladders for black markets in China.

The SDRP has consulted and collaborated with scientists and agencies all over the world that are working to conserve dolphins and other marine mammals. They include franciscana dolphins in Argentina and Brazil, the baiji dolphin and finless porpoises in the Yangtze River, Chinese white dolphins of the Pearl River Estuary, Mekong River dolphins, and Indo-Pacific bottlenose dolphins in the Solomon Islands.

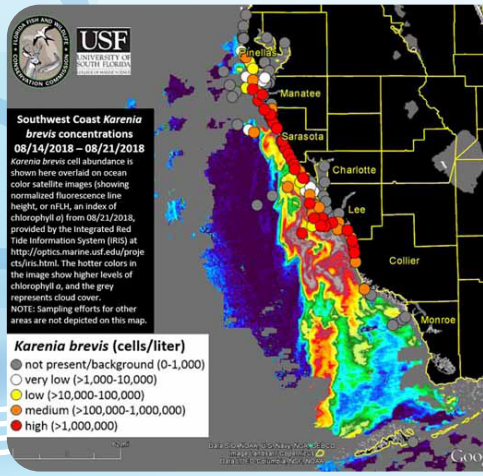
2017

Passive Acoustic Listening Stations (PALS) were installed in 10 locations around Sarasota Bay. Each station has a hydrophone, or underwater microphone, that enables researchers to monitor the sounds made by dolphins, fish, and boat traffic around the clock. In a collaborative effort by the SDRP, New College of Florida, and Loggerhead Instruments, researchers collected huge amounts of acoustic data. A New College graduate student developed a method to sort through the data and pull out signature whistles. Each whistle can then be compared to a catalog of signature whistles with the goal of finding a matching whistle. This will allow scientists to identify and track individual dolphins as they move around the bay.

A young Sarasota Bay dolphin leaps in front of the first PALS on Longboat Key, Florida. The network of PALS will allow scientists to measure the ecological soundscape of the dolphins and track individuals via their signature whistles.

2018-19

Another severe **red tide harmful algal bloom** in Sarasota Bay lasted from the summer of 2018 into January of 2019. Using data from their fish surveys, SDRP scientists again documented a catastrophic decline in the number of dolphin prey fish. They proactively alerted the public about a possible increase in their interactions with dolphins and how these interactions could be avoided. The SDRP's quick action may have prevented dolphin deaths from gear ingestion. Unfortunately, at least four Sarasota dolphins died from red tide toxins. Surprisingly, the fish population bounced back much quicker than it did in 2005 and 2006—showing that the ecological impact of a red tide depends on various factors. In another ecological surprise, Sarasota dolphins experienced a record number of shark attacks in 2019, perhaps in response to the post-red-tide absence of rays, one of the primary prey fish of sharks.



2020

Today, the SDRP's staff members advise and participate in research projects all over the world that involve a variety of marine animals, including whales, porpoises, turtles, sharks, and rays. "The more research we do in Sarasota Bay, the more questions we have and the more refined the questions are," said Wells. The questions are also more complex. "We are now working with colleagues to understand how dolphins respond to multiple concurrent threats. The work we do has become even more necessary over time. Given that there is no better-known cast of characters of dolphins in the world than those in Sarasota Bay, we hope to be able to continue to work with them for many years to come—to help their brethren in Sarasota Bay and elsewhere." ■

Photos taken by the Chicago Zoological Society's Sarasota Dolphin Research Program under a series of National Marine Fisheries Service Scientific Research Permits. Research has been conducted under a series of NMFS Scientific Research Permits, and Mote Marine Laboratory Institutional Animal Care and Use Committee approvals.


C. Toms


E. Berens McCabe


K. McHugh


A. Barleycorn


J. Allen


K. Bassos-Hull


K. Wilkinson


R. Tyson Moore


C. Cush


J. Crossman


A. Honaker


S. Brenneman


K. Breuggen


K. Fazioli


K. Moore


B. Balmer


S. Camilleri

Sarasota Dolphin Research Program
Staff and Students through the Ages


D. Fauquier


S. Fire


S. McBride Kebert


J.& D. Gannon


E. Owen


M. Gryzbek


R. Perrtree


A. Westgate


E. Quintana


S. Nowacek


S. Hofmann


A. Sellas


S. Schilling


C. Shepard


G. Stover


K. Urian


B. Irvine


R. Wells


M. Scott


C. Owen

T. Speakman

Fish population status in Sarasota Bay: Dolphin prey monitoring update

Elizabeth Berens McCabe, Chicago Zoological Society's Sarasota Dolphin Research Program

The Sarasota Dolphin Research Program explores the relationship between wild dolphins and their prey by conducting seasonal multispecies fish surveys to monitor fish abundance, diversity, and size structure in Sarasota Bay, Florida. We were among the first dolphin research groups in the world to establish a long-term fish monitoring program to examine the prey base of a resident dolphin population. 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 on different fish species and community structure across the bay. Since 2004, this project has also facilitated a variety of novel research and new collaborations; most recently, validating changes in biological sound during red tide conditions, and developing fatty acid signature analysis techniques to examine bottlenose dolphin feeding habits. Our 2020 fish survey data and *K. brevis* cell concentration data indicate healthy seasonal fish abundances and red tide-free waters in Sarasota Bay!

Our standardized multi-species fish survey consists of a winter and summer fishing season (10 sets of our purse seine net per month; Jan-Mar; Jun-Sept), during which we catch, measure, count, and release fish from the *R/V Flip* using a 183 m purse seine in seagrass habitats. Last winter we caught a total of 9,002 fish of 59 different species, an average of 300 fish per set. This summer yielded 42,277 individuals of 60 different species, averaging just over 1,056 fish per set. To put these numbers into perspective, we caught our highest winter and second highest summer fish abundances since sampling began in 2004.

These high abundances follow a persistent but patchy bloom of the red-tide alga, *K. brevis*, in Sarasota Bay from August 2018 to January 2019. Analyses of our long-term fish dataset across multiple red tide events during 2004-2019 indicate common response patterns of fish species typically eaten by dolphins (ladyfish, pinfish, pigfish, sheepshead, mullet, spotted seatrout, spot, and Gulf toadfish) to bloom conditions, including sudden and significant declines in abundance, species density, and diversity. We found distinct seasonal shifts in community structure across non-bloom conditions, as well as distinct shifts between non-bloom and bloom conditions during the summer months. The abundance of dolphin prey exhibited a clear lack of resistance to red tide events during years with severe and prolonged summer red tide blooms; however resistance during years with winter red tides varied. Population recovery statistical analyses indicated prey population recovery within 1 year of a bloom event, regardless of season. Standardized catches per set increased each year following a red tide event, unless the following year included a severe summer red tide event, and all time high or near all-time high catches per set occurred 1-3 years after summer red tide blooms, dependent on bloom severity. Based on our work, bloom severity and season appear to be important factors effecting dolphin prey fish resistance to, and recovery from, red tide events.

We thank the many interns and dedicated volunteers who have worked on this project. The work would not be possible without you! Funding for this project was provided by the Charles and Margery Barancik Foundation. This research was authorized by the Florida Fish and Wildlife Conservation Commission (19-0809-SR, current Special Activity License).

Krystan Wilkinson (L) and Elizabeth Berens McCabe (R) examine and measure an Atlantic guitarfish before releasing it during our long-term fish monitoring survey on January 13, 2020 in Sarasota Bay, FL.

A permit on the measuring board before being released back into Sarasota Bay.

Bioacoustic changes associated with the 2018-19 red tide linked to changes in fish abundance

Athena Rycyk, New College of Florida; David Mann, Loggerhead Instruments; Reny Tyson Moore, Katie McHugh, Elizabeth McCabe, and Randall Wells, Chicago Zoological Society's Sarasota Dolphin Research Program

In marine environments, sound is important for many species including dolphins and their prey. By listening to the underwater soundscape we can monitor sound-producing species. When the severe 2018-19 red tide event in Sarasota Bay occurred, our network of passive acoustic listening stations (PALS) detected a drastic and sustained decrease in biological sound. To interpret the decrease in biological sound we looked to the SDRP's fish monitoring program that conducts seasonal surveys of fish abundance. The decrease in biological sound production co-occurred with a decrease in soniferous (sound-producing) fish catch per set of the purse seine net, and species density per set. Except for clupeids, (small, schooling fish species), fish species of all kinds decreased. While red tide was present and fish catches per set and species density per set were lower, there was also an increase in public reports of fish kills to Florida Fish and Wildlife Conservation Commission.

Altogether this means acoustic monitoring of biological sound can serve as an abundance proxy for not only soniferous fish species, but other non-sound-producing, non-clupeid fish species. Our PALS network reports information in real time and will allow us to detect such ecological shifts more quickly than traditional monitoring methods and doesn't require human researchers to risk the negative health consequences of being in the field during red tides. Our findings have recently been published in the journal *Scientific Reports*. Our next steps are to monitor signs of ecosystem recovery (*e.g.*, changes in sound levels and/or biological sound production) and develop tools such as species-specific detection algorithms.

Dolphin socializing by one of the passive acoustic listening stations (PALS).

Shark research in Sarasota Bay, including record numbers of shark bites on dolphins following the 2018-19 red tide

Krystan Wilkinson, Chicago Zoological Society's Sarasota Dolphin Research Program

The past 50 years have provided a unique opportunity for CZS-SDRP staff and students to explore the interactions between bottlenose dolphins and their shark predators, primarily bull sharks. This summer, we welcomed Devin Jordan as a National Science Foundation Research Experiences for Undergraduates (NSF-REU) student to help us identify fresh shark bites on bottlenose dolphins during 2017-2019 using photographs collected during monthly population monitoring surveys funded by the Charles and Margery Barancik Foundation. Since the start of using digital photography during our dolphin surveys in 2004, the average annual shark bite rate was 4.5 (range = 1-8 during 2004-2016). Devin's summer research identified 10 shark bites on resident Sarasota dolphins in 2017, one in 2018 and 18 in 2019, marking the record number of shark bites in a single year since the beginning of the program in 1970.

The spike in shark bites observed during 2019 is particularly interesting as it follows the 2018 severe *Karenia brevis* red tide. This red tide event had a devastating impact on the local environment – killing fish, including stingrays and sharks (among other things) – all of which are also prey of large coastal shark species. The reduction in available prey for large sharks may have contributed to the increase in shark bites on resident dolphins. Overall, there has been a general increase in the annual number of shark bites over the period 1970-2020. This could be explained by a number of factors, including changes to predatory shark and/or dolphin abundance as well as frequency and severity of natural disturbance events, such as red tide, and changes in field efforts that can document these events. This research is ongoing and the outcomes will help us better understand drivers of interaction frequency among these species.

Female dolphin F271 was observed with a fresh shark bite wound in August 2020.

This 7-ft female bull shark was acoustically tagged, sampled, and released in July 2020.

Despite the challenges from the COVID-19 pandemic, we have been able to continue 2020 shark tagging and sampling field work with protective protocols in place. Fourteen bull sharks (6 male, 8 female) have been acoustically tagged, sampled, and released during October 2019 - September 2020, in collaboration with Mote Marine Laboratory's Shark and Ray Conservation Research Program. Acoustic tags allow us to track tagged animal movements via an array of passive underwater acoustic receiver stations located in Sarasota Bay and nearby waters. Thanks to the regional iTAG network – a collaboration between multiple organizations and researchers – and the local Sarasota Coast Acoustic Network (SCAN), we have collected movement data from seven of the sharks so far. Two sharks (1 male, 1 female) tagged in October 2019 were detected along the Gulf coast in the SCAN array in October/November 2019 and again in February/March 2020. The acoustic tags last about nine years, so we look forward to getting more exciting tag detections in the coming years to help us better understand their ranging behavior and habitat use.

In addition to shark tagging efforts, we have collected blood samples and fecal swabs from a variety of shark species to understand the dietary overlap between sharks and the Sarasota Bay bottlenose dolphin community. This project is in collaboration with researchers at Georgia Aquarium, Florida International University and long-time CZS-SDRP colleague Sam Rossman. Preliminary results from the bull shark fecal swabs found mullet, gafftopsail catfish, hardhead catfish, American gizzard shad, and Atlantic thread herring in their diet and one of the bull sharks ate a cownose ray! Results from shark dietary and movement analyses will be integrated with information of dolphin diet and movement from CZS-SDRP to provide a better understanding of the role top predators play in the marine environment.

Funding for this research is provided by an anonymous donation to the Chicago Zoological Society, Mote Scientific Foundation, and the Women's Board of the Chicago Zoological Society.

Tracking rays in Sarasota Bay and Gulf coastal waters using sound

Kim Bassos-Hull and Krystan Wilkinson, Chicago Zoological Society's Sarasota Dolphin Research Program

What goes "beep" and "crunch" at the same time? An acoustically tagged spotted eagle ray eating one of its favorite shellfish prey items! In collaboration with Mote Marine Laboratory's Sharks and Rays Conservation Research Program and Florida Atlantic University's Harbor Branch Fish Ecology and Conservation Lab, we have been conducting research on spotted eagle rays (and other marine rays) in Sarasota Bay and surrounding coastal waters since 2009 to learn more about their biology and ecology (including movement patterns and diet). Understanding how other marine megafauna in addition to dolphins use Sarasota Bay and surrounding waters in space and time and what food resources they depend on helps inform our bigger picture question of ecosystem health and trophic relationships.

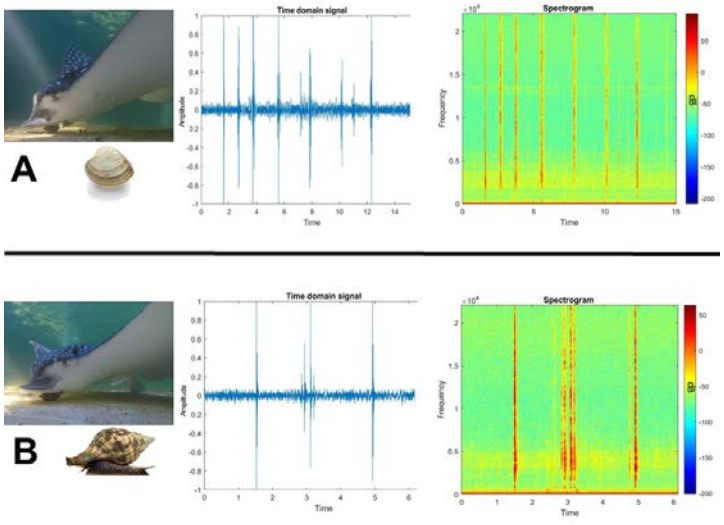
The use of acoustic tags on spotted eagle rays (SERs) and devil rays has allowed us to track their movements since the Sarasota Coast Acoustic Network (SCAN) was initiated in 2016. Through collaboration with the Gulf of Mexico's iTAG and Atlantic/FL Keys' FACT acoustic tag networks, we have received many reports of detections

Krystan Wilkinson (far left) and Kim Bassos-Hull (center) release a large female spotted eagle ray with an acoustic tag in New Pass, Sarasota, in May 2020.

of our tagged rays outside the Sarasota area over the years. We recently submitted our research findings from tracking spotted eagle rays to the journal Marine Biology. During April 2016 through September 2020, 55 SERs were tagged on Florida's west coast and some of these rays have been detected up in the waters off the Florida Panhandle and down to the Florida Keys. One ray was detected near Cancun, Mexico in July 2019! Another ray was detected between Tampa Bay and the Everglades on 466 days from 29 April 2016 to 31 March 2020 and had more than 50,000 detections. Though there was some individual variation in movement of the west coast SERs, most of the movement north was in summer months and south to Charlotte Harbor or the FL Keys in winter months, likely driven by water temperature changes. SERs also seemed to react to red tide presence in Sarasota Bay by moving out of the bay.

We have also acoustically tagged three lesser devil rays since 2019. This filter-feeding ray is considered endangered by the IUCN and data deficient so any movement data we obtain will be important for its conservation.

SERs are noisy eaters, making loud "cracks" and "crunches" as they crush their mollusc (clams and snails) prey in a feeding behavior called durophagy. In 2018 we recorded this behavior in tank feeding trials at Mote and submitted these research findings to Journal of Experimental Marine Biology and Ecology. SERs made more "cracks" over time while eating a single hard clam compared to a gastropod (snail). We plan to take this discovery to the field and record sounds at clam restoration areas and attempt to detect SER (and other durophagous rays) at these sites. Support for these research projects was provided by the Mote Scientific Foundation, the Harbor Branch Oceanographic Institute Foundation, and an anonymous donor.

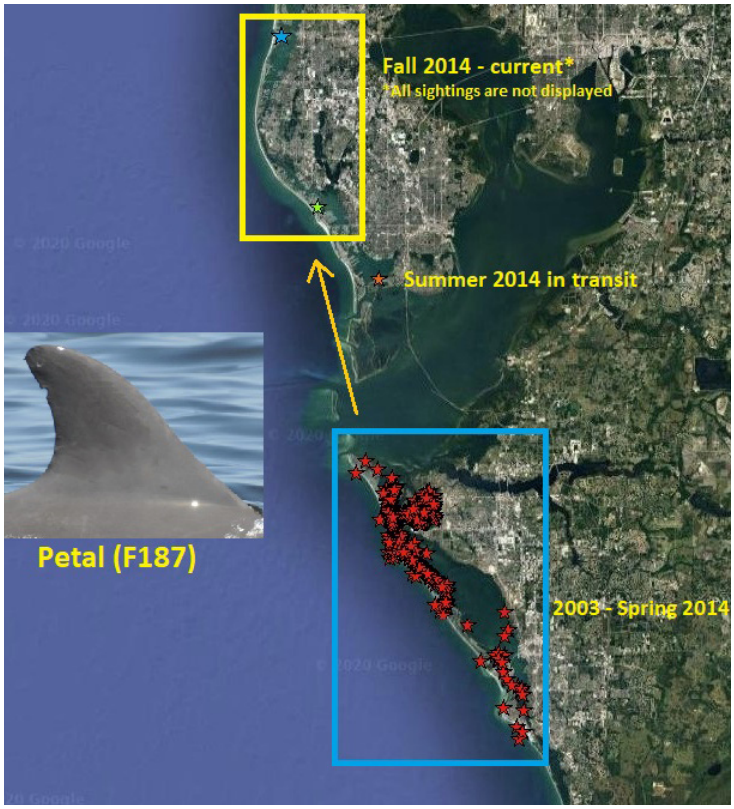


Video snapshot of spotted eagle ray prey capture (left) as well as associated time domain (middle) and frequency spectrograms (right) of representative consumption events for hard clam (A) and banded tulip (B). Time units are in seconds.

Using GoMDIS (Gulf of Mexico Dolphin Identification System) to document a case of apparent emigration of a resident bottlenose dolphin

Carolyn Cush and Randall Wells, Chicago Zoological Society's Sarasota Dolphin Research Program

The Gulf of Mexico Dolphin Identification System (GoMDIS) is a collaborative effort among photo-identification (photo-ID) and stranding groups in the Gulf of Mexico to standardize and archive bottlenose dolphin fin catalogs in one location, accessible online through the OBIS-SEAMAP photo-ID portal, thus allowing for ease of matching between projects. Now in its eighth year, GoMDIS holds 35 catalogs with more than 23,000 animals and roughly 41,500 images. Gulf-wide, more than 1,300 matches between projects have been made to date, strengthening and stitching together data from individual research groups. Many matches have come from the Southwest Florida region, the home of SDRP; this area is unique in that it has several long term photo-ID studies from multiple research groups with slightly overlapping or nearby coverage. Through GoMDIS, we have made more than 500 matches between SDRP's catalog and adjacent areas that have active photo-identification studies. From south to north, this includes the SDRP, Eckerd College Dolphin Project (ECDP), the John's Pass study by Ann Weaver and the Clearwater Marine Aquarium (CMA) photo-ID program.



Former Sarasota Bay resident Petal's range shifted suddenly north to the John's Pass-Clearwater area in 2014. Documentation of this rare emigration case was made possible thanks to our collaborative GoMDIS effort.

Petal and her calf, F280, surfacing alongside her brother Bud in Sarasota Bay before her 2014 emigration to the John's Pass area, more than 30 miles to the north.

The SDRP GoMDIS catalog holds more than 4,900 unique animals but roughly 170 of those animals make up the resident Sarasota Bay community - those that display high site fidelity within a community range as defined by their movements, social patterns and genetics of the dolphins in the region. Interestingly, several of our longer distance between-catalog matches made through GoMDIS (>30mi) have been apparent emigration type movements. Of the SDRP resident animals, only a rare few have demonstrated this type of movement. Here we follow one of Sarasota's former residents, F187, also known as Petal, through her northward home range shift.

Petal was born in 2003 to a 13yo Sarasota resident named Rose. A year after giving birth, Rose died, likely from an infected sting ray puncture when Petal should still have been relying at least partially on her milk. Orphaned, it was feared she was lost as well. However, two months later she was found, alone, and sightings continued year after year documented by SDRP's routine surveys; she appeared to be thriving. At the age of seven, Petal had her first calf, F280, in 2010.

From 2003 through early 2014, Petal's range extended from the north end of Anna Maria Island down to the north end of Siesta Key, with her core area being northern Sarasota Bay and Palma Sola Bay – a typical range for Sarasota residents. In April 2014, at the age of 11, she disappeared from Sarasota Bay, to be discovered a month later by one of our GoMDIS contributors, Ann Weaver, in her study area of John's Pass, 30 miles to the north. While it is not unusual for animals to have larger ranges, it is odd that she stayed and even ventures further north to Clearwater Bay, as discovered by the CMA photo-ID team. By summer 2015 in John's Pass, Petal had her second calf (named Faust), and in the summer of 2019 she gave birth to her third calf (named Fig). These animals continue to be monitored, with Petal and Fig being seen through this past summer.

Despite being orphaned 15 months after her birth, Petal has demonstrated thus far that she can successfully raise offspring. It is unclear what caused her to shift her home range but having the GoMDIS collaborative effort in place will allow us to continue monitoring her movements, giving researchers and wildlife managers insight to assist with population management and conservation efforts. We are grateful for our GoMDIS contributors and the recent support from NOAA's Prescott program and the Florida RESTORE Act Centers of Excellence program, allowing us to continue our ability to maintain and upgrade the GoMDIS database.

Florida RESTORE Act Centers of Excellence Program: Health and movements of Florida's Gulf dolphins

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

We have received three years of support through the Florida Institute of Oceanography to initiate studies of bottlenose and Atlantic spotted dolphins over the West Florida Shelf. The project, administered by Mote Marine Laboratory, involves hoop-netting individual dolphins offshore of Sarasota, Florida, performing health assessments, and tagging them with satellite-linked transmitters before releasing them on-site. The grant also covers the operating costs of our Gulf of Mexico Dolphin Identification System (GoMDIS) for three years. While we have been able to arrange for bow pulpits for both of Mote's offshore research vessels as well as initial tags, hoop-nets, and permit modifications, the start of field work has been delayed due to COVID-19 restrictions for human health and safety.

Dolphins of Bermuda

Robyn Trainor, Dolphin Quest; Jason Allen, Chicago Zoological Society's Sarasota Dolphin Research Program

The Bermuda Cetacean Sightings (BCS) project continues to collect data from dolphin and beaked whale encounters from the waters around the pristine location of Bermuda. BCS support was funded by Dolphin Quest for 2020, with Bermuda locals providing photo-ID efforts on-island and continued data analysis support from the Chicago Zoological Society's Sarasota Dolphin Research Program. With more than 70 dolphin sightings from 2003 to date, the photo-ID catalog has 129 distinctive individuals, with one individual sighted six times over 15 years. Group sizes range from one individual to as many as 100. Beaked whales (of several species) have been sighted 24 times during 2004-2020. This year we have had the opportunity to use the finFindR application to assist with automated dolphin fin matching, which has been beneficial.

Bottlenose dolphins surface close to Bermuda's north east side. Photo by Andrew Stevenson, Bermuda Cetacean Sightings photographer.

Rise of the Machines: Advances in automated dorsal fin matching

Reny Tyson Moore, Chicago Zoological Society's Sarasota Dolphin Research Program; Kim Urian, Duke University Marine Laboratory

Photographic-identification (photo-ID) is an important tool used by many researchers to study cetaceans over a wide variety of temporal and spatial scales. Recently, several automated algorithms have been developed to identify cetacean dorsal fins and improve the efficiency of the matching process. However, there had been little discussion among users regarding the efficacy or accuracy of these systems. To address this, we hosted the "Rise of the Machines - Applications of automated systems for matching dorsal fins: current status and future directions" Workshop at the World Marine Mammal Conference held in December 2019 in Barcelona Spain. The daylong workshop featured presentations from photo-ID, database, and computer vision (CV) experts from around the world (including presentations from CZS-SDRP staff members Jason Allen, Carolyn Cush, and Reny Tyson Moore). Presentations focused on identifying strengths and weaknesses of existing dorsal fin-matching systems; evaluating their success in matching; and assessing their application in photo-ID workflows.

In the months leading up to the workshop we distributed a survey to photo-ID researchers and lab managers to gain a better understanding of the CV systems available and currently being used to match dorsal fins. In our survey we asked respondents to describe the photo-ID methods and systems they/their lab currently use and to discuss the pros and cons associated with these methods/systems. We received responses from 74 researchers representing 22 countries and 36 species (including great white sharks!). We learned that while there has been an explosion in the development and availability of new computer vision programs for photo-ID (*e.g.*, finFindR, curvRank and Flukebook, Photo-ID ninja) very few researchers or research groups are using them yet in practice. Reasons included having small catalogs and believing humans could match fins in these catalogs as fast as a CV system could; not trusting that CV systems can match fins as reliably or accurately as humans; and not being familiar with available CV systems for matching dorsal fins.

Before the workshop we also conducted a mini-experiment to directly compare and evaluate the performance of the different systems used for matching dorsal fin images (*e.g.*, manual versus computer assisted). Thirty researchers representing 29 research groups participated in the experiment, which involved evaluating and matching a test set of bottlenose dolphin (*Tursiops truncatus*) dorsal fin images. While only a few researchers used any form of CV to assist them in their matching process, we found that the grading process (*i.e.*, the process where researchers determine whether or not an image is of good enough quality and the fin in the image is distinct enough to make a match) greatly impacted the outcome of the matching success, regardless of whether a CV or manual system was used. Thus, part of our workshop focused on building consensus on best practices for use of photo-ID methods and CV systems moving forward. These best practices will be particularly important as these systems become more reliable, accurate, and user-friendly, and thus we are compiling them along with results from the pre-workshop survey and experiment, into a manuscript for peer review. We hope to reassess the status of "the rise of the machines" again in 2021 at the next marine mammal conference and determine how marine mammal photo-ID may change as these systems become more prevalent and evolve in our field.

A trailing edge extraction of resident Sarasota Bay dolphin Joker's dorsal fin, which is automated by CurvRank, a computer vision algorithm developed by Weideman et al. in 2017 for matching dorsal fin images.

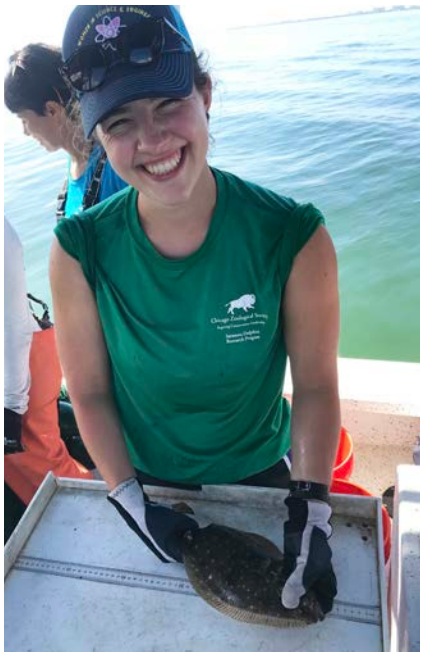
Using quantitative fatty acid signature analysis to study common bottlenose dolphin diet and vulnerability to disturbances

Theresa-Anne Tatom-Naecker, University of California, Santa Cruz, and Chicago Zoological Society's Sarasota Dolphin Research Program

My dissertation research aims to understand how the diets of Sarasota Bay dolphins vary when they are part of different demographic groups (*e.g.*, different sexes, ages, maternal lineages, and habitat-use patterns) and when harmful algal blooms disrupt their access to prey fish. However, studying diet in a predator who feeds almost entirely underwater, in an estuarine environment, requires creativity. While several diet determination methods exist, each with their strengths and weaknesses, I am focusing on quantitative fatty acid signature analysis, or QFASA. Fatty acids are chains of carbon, hydrogen, and oxygen atoms that serve as the building blocks of fat in animal bodies (including in humans!). By comparing the fatty acids found in predators and their potential prey items, we can determine what prey species the predator ate over the previous several months. Accessing that kind of long-term, detailed diet information

is really exciting, and makes it possible to answer all kinds of questions. However, though QFASA has been used in pinnipeds and other marine mammals, it has not yet been validated or applied in cetaceans, for two main reasons. First, it requires an extensive "library" of fatty acid profiles of potential prey species, to compare to the predator fatty acid values. This means collecting and analyzing large numbers of prey samples (*e.g.*, whole fish and squid). Second, it calls for taxon-specific calibration coefficients (CCs) to account for minor structural changes in prey fatty acids when they are incorporated into predators. Estimating CCs involves controlled feeding studies that last at least 5 months, which means working with animals that are under human care.

Fortunately, through the SDRP and its collaborators, I have been able to make significant progress towards validating QFASA for use in cetaceans. Last year, the National Marine Mammal Foundation, long-time SDRP collaborators who manage the common bottlenose dolphins that are under Navy care, generously donated dolphin blubber and prey fish samples from their archives. The quantity of different prey species consumed by the Navy dolphins is recorded every day, equivalent to a controlled feeding study, making these samples perfect for calculating CCs. This spring, in collaboration with Baylor University, I determined the fatty acid signatures of the blubber and prey fish samples. Combining that data with information about the dolphins' specific diets, I calculated the first preliminary cetacean CCs. This past winter and summer, SDRP scientists and interns collected 449 prey fish, across 43 species, during seasonal purse seine net fishing surveys. This coming fall and winter, I will process and analyze the fish in my home lab at the University of California Santa Cruz and at Baylor University, under strict COVID-19 precautions, completing the prey "library".



Theresa-Anne Tatom-Naecker assisting with fish sampling.

In addition to the CCs and the prey library, applying QFASA to determine dolphin diet variation requires the fatty acid signatures of free-ranging bottlenose dolphins. During June 2019's health assessment, which came after a severe red tide harmful algal bloom, small blubber samples were collected from 16 dolphins, and I determined their fatty acid signatures this spring. Thanks to the SDRP's biopsy darting team, blubber samples were collected from a further 37 animals during spring and summer 2020, in a year without any harmful algal blooms. I will determine their fatty acid signatures this fall and winter. With all the pieces — CCs, prey library, and fatty acid signatures from dolphins who did and did not recently experience harmful algal bloom disturbances—in place, I will be able to validate and apply the QFASA model. By comparing QFASA diet results to existing Sarasota dolphin diet estimates from stomach content, fecal matter, and stable isotope analyses, I will confirm that QFASA diet estimates resemble previous findings. With that validation, I can use the detailed, long-term diet estimates that QFASA provides to investigate the relationship between diet, sampled dolphin demographics, and harmful algal bloom severity in the weeks and months before sampling. Understanding natural diet variation and how harmful algal bloom disturbances, which serve as a proxy for other disturbances such as fisheries overexploitation and climate change, impact dolphin diet is critical in order to evaluate bottlenose dolphin vulnerability to disturbances and to better predict and mitigate the effects of all types of disturbances.

I am grateful to an anonymous donor to the Chicago Zoological Society for helping me to start my graduate program. I have recently received a National Science Foundation Graduate Research Fellowship, which will support the next 3 years of my work.

Contact tracing to investigate an unusual cluster of bottlenose dolphin deaths

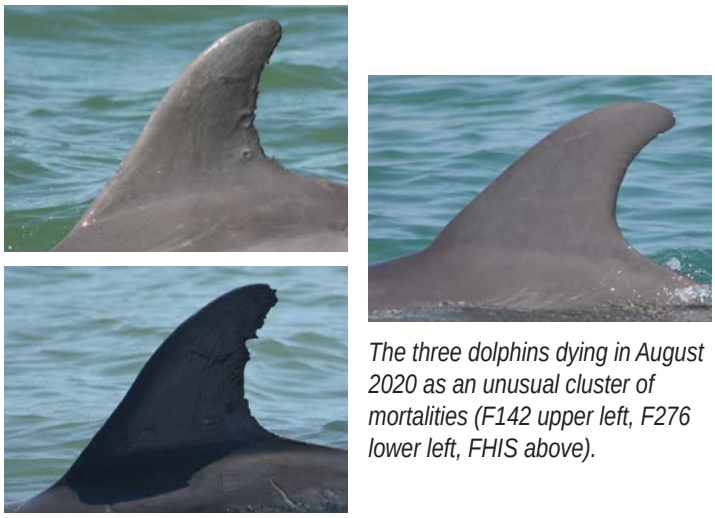
Randall Wells, Jason Allen, Aaron Barleycorn, Kim Bassos-Hull, Chicago Zoological Society's Sarasota Dolphin Research Program

The unique, detailed, long-term background knowledge of Sarasota's bottlenose dolphins compiled by the Chicago Zoological Society's Sarasota Dolphin Research Program over decades makes it possible to apply current human medical surveillance techniques to try to understand unusual dolphin mortalities and their potential impacts.

On August 4, 2020, a dead adult female bottlenose dolphin (FHIS, known to us since 1991) was secured by boat-based Sarasota Dolphin Research Program staff, and delivered to the Mote Marine Laboratory Stranding Investigations Program (SIP) at a nearby boat ramp. Two well-known adult males, F276 (known to us since 1992), and F142 (known to us since 1997), had been interacting intensively with the floating carcass of the female. Within two days, both of these males were also dead.

This was a very unusual cluster of mortalities, with no obvious causes of death identified during necropsies (animal autopsies) by the SIP. Even though they had been dead for only a few hours, the carcasses were very decomposed due to the warm water in the bay, hampering examinations and sample collection. Lab findings suggested that red tide toxicity, COVID-19, influenza, and dolphin morbillivirus could be ruled out as probable causes of death.

Out of an abundance of caution, the SDRP began a parallel investigation of the local living dolphins. The SDRP took a page out of the epidemiology playbook and initiated a program of contact tracing, something that would be possible with very few cetacean populations around the world. Our long-term photographic identification database is composed of sightings of individually recognizable dolphins and their associates. It contains records dating back to 1970, and we continue to add new data on the status of Sarasota's dolphins from monthly photographic identification surveys, supported by the Charles and Margery Barancik Foundation. The database currently includes information from more than 53,800 dolphin group sightings, involving more than 163,000 individual identifications. About 170 dolphins reside in Sarasota Bay, with individual residency spanning decades and including up to five concurrent generations. About 95% of the dolphins using the bay are readily recognizable to the staff of the SDRP.



The three dolphins dying in August 2020 as an unusual cluster of mortalities (F142 upper left, F276 lower left, FHIS above).

We used this database to identify exactly which individual dolphins were seen with the dead dolphins over the prior two months. This resulted in a list of 21 individuals seen frequently in the Sarasota area, plus six more less-frequently-seen dolphins from an overlapping Tampa Bay community. With this contact list in hand, we continued our surveys through the home range of the long-term resident Sarasota dolphin community, with additional protocols of obtaining video-recordings and measuring respiration rates of any individuals behaving abnormally or exhibiting indications of health problems.

After August 4th, into November, we were able to find and observe all but two of the 21 Sarasota associates, including the recently independent, 5th documented calf of FHIS, and they all appeared to be doing well, reducing our level of concern about the possibility of an emerging health threat for Sarasota dolphins. This application of the unique SDRP approach and database reinforces the value of long-term, consistent, and continuous monitoring of the Sarasota dolphin community, and the synergistic strength of collaborative dolphin conservation research.

Testing a newly designed GPS tag, and developing an improved satellite-linked tag design for small cetaceans

Reny Tyson Moore, Chicago Zoological Society's Sarasota Dolphin Research Program

Bio-logging tools (tags) that provide information about an individual's location are commonly used to examine movements and behaviors of marine animals, such as bottlenose dolphins. Historically, locations estimated from these tags have been based on information from Argos satellite systems, but advancements in GPS technology now allow for GPS locations to be obtained with these tools. Given that locations derived from GPS satellites are typically more accurate and reliable than those derived from Argos satellite systems, this advancement represents an exciting development in the field of marine mammal science that will allow researchers to use the power of GPS for tracking dolphins and other small marine mammals in a more accurate and precise way for the very first time. While exciting, there is still a need to develop and test these tools to assess their safety and effectiveness, so we partnered with Wildlife Computers, a world leader in the development of tags and long-time program collaborator, to perform field tests of their newly designed GPS tag for small cetaceans.

During the June 2019 capture-release health assessments, we deployed three GPS tags (SPOT-F-368A, single-point Finmount Fastloc® GPS tags) on resident Sarasota Bay dolphins with the following goals: 1) to assess the health and behavior of the dolphins post-release; 2) to monitor the animals and examine the potential for the tags to be entangled in gear such as fishing line or trash; and 3) to assess the accuracy of the data provided by the tags. In the days immediately following tagging, we conducted behavioral focal-follows of each tagged dolphin to both assess their health and behavior post-release, and to obtain estimates of their true locations for comparison with the tag's GPS locations. Over 8 days, we collected approximately 25 hours of location data for the three individuals (all of whom appeared to be behaving normally and to be in good health), which included estimates of the animal's range and bearing in relation to the follow boat for every tagged animal's surfacing. These estimates of dolphin locations were compared to the locations derived from the tags to assess tag accuracy, which proved to be high (< 30 m).

Tags remained on the animals for 67 to 181 days and transmitted location data for 67, 68, and 126 days. Entanglements were never observed on tags and the animals continued to appear healthy and behave normally during the entire tag deployment durations. Continued monitoring of the dolphins in the months after tagging revealed that algal growth (biofouling) on the tags, particularly on the tag's sensors, was hindering tag performance. Monitoring also revealed a stress point in the tag design as one broken tag was observed. Engineers

at Wildlife Computers used these observations and our experience with finmount tags to redesign the tag to reduce biofouling and the possibility of breakage in future deployments. Together we are working on a manuscript that will be submitted for peer-review that will describe our findings and inform other researchers about this exciting new tool. Many thanks go to the Chicago Zoological Society's Women's Board for funding this research and Wildlife Computers for making these field tests possible.

Wasabi with a fin-mounted Fastloc® GPS tag in 2019.

Successful remote tagging of white sharks with the TADpole

Greg Skomal, Massachusetts Division of Marine Fisheries

For the past 10 years, scientists from the Massachusetts Division of Marine Fisheries, working with the Atlantic White Shark Conservancy, have been using a variety of tag technologies to study the behavior, ecology, and natural history of white sharks in the western North Atlantic. This research is primarily conducted off the coast of Cape Cod, MA, where white sharks aggregate in the summer and fall to feed on a growing population of gray seals. This area is also known to draw thousands of tourists who flock to the beaches for a variety of water-related recreational activities. The research currently being conducted is centered on how the natural predatory behavior of white sharks overlaps with these human activities.

Tagging studies conducted to date include fine- and broad-scale movement patterns, local and regional abundance estimates, predatory behavior, and several aspects related to natural history including reproductive biology and foraging ecology. To date, more than 350 white sharks have been identified at the aggregation and 250 have been tagged with acoustic transmitters and pop-up satellite-linked tags. To ensure that the tagging process does not change natural behavior and impact public safety, the sharks are not lured, hooked, captured, or handled in any way; they are tagged while free-swimming. In the past, this has limited the ability to apply smart-positioning (real-time) satellite-linked tags, which are typically bolted to the dorsal fins of captured and restrained sharks.

In early November, 2020, we successfully deployed real-time satellite-linked tags on two free-swimming white sharks for the first time in the Atlantic using a new tagging device. Called the TADpole (pole-mounted Tag Application Device), this tagging system was conceived and developed by Randy Wells and Michael Moore initially for dolphin tagging, with prototypes designed and built by engineers Tom Lanagan and Jason Kapit at Woods Hole Oceanographic Institution, through support from Dolphin Quest, Dolphin Biology Research Institute, and the Chicago Zoological Society. The TADpole pneumatically applies and secures the tag to the dorsal fin with a single pin in a fraction of a second. The two white sharks did not react in any way to the tagging and simply continued on their way. The success of these initial deployments is very promising for future studies on the movements of marine animals, including dolphins.

TADpole being used to attach a satellite-linked tag to a Great White Shark off Massachusetts, November 2020. Photo courtesy of Atlantic White Shark Conservancy and Massachusetts Division of Marine Fisheries.

Satellite-linked tag deployed from the TADpole on a Great White Shark off Massachusetts, November 2020. Photo courtesy of Atlantic White Shark Conservancy and Massachusetts Division of Marine Fisheries.

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 (SDRP) 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, Disney Conservation Fund, 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. The cards are available in English and Spanish as downloads at through the SDRP website at: https://sarasotadolphin.org/videos-and-downloads/

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 brief (2-8 min) educational videos we have produced about dolphin conservation and biology including a new video on dolphin ranging patterns, are available through the SDRP website, at https://sarasotadolphin.org/videos-and-downloads/

If you have not visited our website sarasotadolphin.org recently, you should take a look. The website has been completely redone by Joker Media and Vetted Communications, with a number of new features. Links to our publications are now provided (sarasotadolphin.org/publications). The dolphins that have been featured as "Fin of the Month" in our e-newsletters over the years are compiled on the website, and in addition to photos and background information, recordings of their signature whistles have also been provided by our collaborator, Laela Sayigh (sarasotadolphin.org/meet-dolphins). Check out sarasotadolphin.org/learn/fun-facts!

Kim Bassos-Hull (left) and Ibrahima Ndong (middle) from Senegal, who received professional training in Sarasota during June 2019, at the World Marine Mammal Conference in Barcelona in December 2019.

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 working groups and 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 U.S. Animal Telemetry Network, the Florida Marine Debris Reduction Plan Research and Data Working Group, and the IUCN Cetacean Specialist Group.

Session chair Randall Wells with his speakers at the plenary session for Conservation Interventions at the World Marine Mammal Conference in Barcelona,Spain in December 2019.

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 2020, opportunities for foreign colleagues to come to Sarasota were limited due to the pandemic. However, graduate students from Argentina, the U.K., and Italy worked with our program, and we had an intern from Brazil.

Graduate Students

As described throughout this newsletter, graduate students from a variety of institutions, especially the University of California-Santa Cruz, Duke University, and the University of Florida, involve the resources of our program as they conduct their thesis or dissertation research. To date, 50 doctoral dissertation and 41 master's thesis projects have benefited from association with our program, through field research opportunities or access to data, samples, or guidance. Over the past year nine doctoral students and five Master's students have been making use of resources provided by the SDRP:

Doctoral Dissertations – Completed

Roberts, Bethany. 2019. Acoustic signals as indicators of animal behavior, presence and location in delphinids. Doctoral dissertation. University of St Andrews.

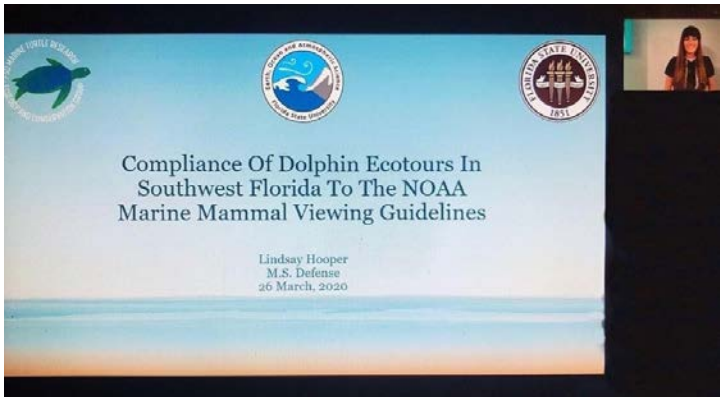
Masters Theses - Completed

Anderson, Austin. 2020. Live classification of signature whistles using convolutional neural networks. Master's thesis. New College of Florida.

Brown, Shelbourne. 2019. Evaluating the use of remote monitoring to establish boater compliance with marine mammal viewing guidelines in Sarasota Bay, Florida. Master of Professional Science thesis, Rosenstiel School, University of Miami, FL.

Hooper, Lindsay. 2020. Compliance of dolphin ecotours in southwest Florida to the NOAA marine mammal viewing guidelines. Master's Thesis. Florida State University.

Left to Right: Sacha Stevenson, Ashley Plunkett, Theresa Tatom-Naecker, Amanda Moors, Christina Toms during the 2019 health assesments.



Lindsay Hooper's masters defense presentation.

Duke University PhD students Austin Allen and Jeanne Shearer during health assesments in 2019 with a DTAG.

Doctoral Dissertations – Underway

Adamczak, Stephanie. In progress. A dynamic state model for assessing the population-level consequences of acoustic disturbance on oceanic dolphins. Doctoral dissertation. University of California, Santa Cruz.

Allen, Austin. In progress. Developing an activity/energetics proxy for common bottlenose dolphins to estimate energetic costs of avoiding vessels. Doctoral dissertation. Duke University.

Asplanato, Natalia. In progress. Abundance, spatial and temporal distribution and trophic ecology of Burmeister's porpoise, *Phocoena spinipinnis*, at the Beagle Channel, Argentina. Doctoral dissertation. Universidad de Buenos Aires, Facultad de Ciencias Exactas y Naturales, Departamento de Ecología, Genética y Evolución.

Beal, Andria. In progress. Epigenetic estimation of age in bottlenose dolphins (*Tursiops truncatus*) using DNA methylation. Doctoral dissertation. Florida International University.

Casoli, Marco. In progress. Mating strategies in bottlenose dolphins: fine-scale behaviour and acoustic during male-male and male-female interactions. University of St Andrews, Scotland.

Shearer, Jeanne. In progress. Foraging kinematics of three cetacean species. Doctoral dissertation. Duke University.

Tatom-Naecker, Theresa-Anne. In progress. Quantitative fatty acid analysis in bottlenose dolphins: Technique validation and application. Doctoral dissertation. University of California, Santa Cruz.

Young, Jordann. In progress. Maternal bioenergetics and reproductive success in bottlenose dolphins. Doctoral dissertation. University of California, Santa Cruz.

Masters Research Projects - Underway

DiMaggio, Kylee. In progress. Impacts of human interactions on bottlenose dolphin reproductive success. Master's thesis. University of Florida.

Dziobak, Miranda. In progress. Characterization of phthalate contamination in common bottlenose dolphins (*Tursiops truncatus*) from Sarasota Bay, Florida, and policy steps to mitigate exposure. Master's thesis. College of Charleston.

Grad Student Update – Where are they now?

Laela Sayigh, Woods Hole Oceanographic Institution and Hampshire College

I hold the prestigious position of having been the second graduate student to complete a PhD thesis focused on the Sarasota Bay dolphins – with the first having been Randy Wells himself! I truly lucked into this honor, by starting graduate school in the Massachusetts Institute of Technology/Woods Hole Oceanographic Institution (MIT/WHOI) joint program just a couple of years after Peter Tyack (my advisor) had begun a collaboration with Randy. Peter had designed suction-cup hydrophones that could be attached to the melon of dolphins while they were briefly handled during health assessments, and greatly improving the process of collecting high quality recordings from known, individual dolphins. This is a rare feat, since dolphins do not make external movements associated with vocalization and their whistles are also quite omnidirectional. So obtaining recordings from known individuals enabled studies about dolphin communication that were not previously possible.

I was a completely green graduate student way back in 1986, fresh out of college, and went to Sarasota before I even got settled in Woods Hole. What an amazing experience to start graduate school with! I am still connected with many of the people who I met in that very first year (which is also a testament to the loyalty and stability of so many involved with SDRP). My PhD thesis focused on development and functions of individually distinctive signature whistles, and involved continued engagement with health assessments as well as hundreds of hours of focal "follows," during which I recorded mothers and young calves, with towed hydrophones. Upon my graduation, I joined the faculty at the University of North Carolina Wilmington (UNCW), where I supervised numerous students who worked on projects in Sarasota. I routinely brought students with me to health assessments from UNCW, and many of them carried out undergraduate and masters level projects on Sarasota data. Some of these students continued with

Laela Sayigh in the lab.

Laela Sayigh collecting data in Sarasota in 2017.

marine mammal research at other institutions. While at UNCW I also began a collaboration with Dr. Vincent Janik, of the University of St. Andrews, and he and I have worked together in Sarasota ever since.

After 10 wonderful years at UNCW, my family relocated back up to Woods Hole, MA, where I began working at the Woods Hole Oceanographic Institution. Four years ago I also joined the faculty at Hampshire College, where I currently work part time, while still also working at WHOI part time. Although my research has ventured into a variety of different avenues, my collaborative work with the Sarasota Dolphin Research Program continues to be up front and center. We continue to build the Sarasota Signature Whistle Library, which now contains almost 1,000 recording sessions from about 300 individual dolphins, many of whom have been recorded multiple times. These recordings have been used in dozens of research projects over the years, including studies of whistle structure, function, development and stability. We recently obtained funding from Dolphin Quest to begin the process of converting this recording library into a rigorous, systematic resource, so that it can be even more widely used and passed onto the next generation of dolphin researchers.

SDRP is truly a model of how a field project should be run – exceptionally rigorous and thorough, and immensely collaborative. I am so fortunate to have had the opportunity to be part of this historic research program for so many years, and look forward to more in the future - there are so many discoveries yet to be made!

2020 Intern Perspective

Experiences with SDRP during the COVID-19 pandemic

Colin Perkins-Taylor, Post-Graduate from Swarthmore College

Growing up, my family went on a lot of ecotourism vacations to places such as the Galápagos Islands, the Brazilian Pantanal, and the Serengeti in Tanzania. I was enamored by all of the amazing animals that I observed on these trips, and because of them I always knew from a young age that I wanted to pursue a wildlife-related career. However, I could never pinpoint specifically what I wanted to do because I was so fascinated by all of the wildlife that I saw that it made choosing just a few species to dedicate my life to impossible. That all changed in the summer of 2017 when following my freshman year of college, I interned with Mote's Sea Turtle Conservation & Research Program (STCRP). During this internship, I fell in love with working at the beach on a daily basis and collecting field data. After my time with the STCRP, I knew that I wanted to be a marine biologist and I never looked back. Since then, I have conducted research on a variety of marine species including shorebirds, sea stars, and humpback whales through other summer internships and a semester studying abroad in the Bocas del Toro Archipelago in Panama. While my passion for preserving marine wildlife has continued to grow, my research interests have skewed towards marine mammals in the past year and a half. Therefore, after graduating (virtually) from Swarthmore College in May 2020, I craved the opportunity to gain more marine mammal research experience.

Despite the COVID-19 pandemic raging for much of the year, I was fortunate enough to be selected as a 2020 summer/fall intern for the SDRP at Mote Marine Laboratory where my entire journey began. While I was grateful and excited to have the opportunity to do anything research-related in 2020 due to the state of the world, I was also very nervous coming into my internship with the SDRP because I had no idea how COVID-19 would impact my experience. In particular, I wondered how I would form meaningful relationships with the SDRP staff members if I was always working independently from home? Furthermore, would I still be able to learn as much about bottlenose dolphins and the research techniques used to study them as I would if the circumstances were normal?

Luckily, during my time with the SDRP I have improved significantly as a marine researcher and formed meaningful connections with all of the staff members despite the challenges presented by the pandemic. This is largely because I was able to explore almost everything the SDRP has to offer by assisting different staff members with their individual research projects while also participating in monthly dolphin monitoring surveys. A few of the research projects that I helped with include analyzing videos taken from a fishing pier for human-dolphin interactions for Dr. Katie McHugh, assessing photos from 2020 for dolphins with shark bites for Dr. Krystan Wilkinson, and working in the field with Dr. Christina Toms and Elizabeth Berens McCabe on their fishing surveys to determine the abundance and distribution of the fish communities that the local bottlenose dolphin population consumes. Additionally, Jason Allen taught me about the online dolphin fin database that the SDRP uses to catalogue all of the dolphins in the population. While these projects allowed me to connect with the SDRP staff members and learn about their backgrounds, I also improved my research skills during the dolphin monitoring surveys. Not only did I record and collect environmental data during these surveys, but I also was able to take photos of dolphins. My photography skills gradually improved each month, and this is certainly a skill that I will continue to utilize in my future research endeavors as photo-identification is commonly used to study various marine mammals.

Overall, I can safely say that I am coming out of my internship with the SDRP a more experienced and better-prepared marine mammal researcher. Beyond my drastically improved photography and field skills, I have a better understanding of the amount of time, work, and dedication that it takes to operate an incredible program such as the SDRP, especially under the difficult conditions of 2020. I did not feel that my SDRP experience was diminished by COVID-19, although we continually followed protocols to minimize potential COVID-19 exposure. Similar to many of the SDRP staff members that I have come to know, I intend to go to graduate school and pursue a career in marine mammal conservation and research. The skills that I have gained as an intern with the SDRP will serve as the foundation for the researcher that I am hoping to become, and I will always be grateful for this invaluable experience. Thank you SDRP, and congratulations on your 50th anniversary! I am excited to see what the next 50 years hold for this extraordinary program!

Colin Perkins-Taylor during a monthly population monitoring survey.

Where are they now?
Former Intern Perspective - 2006

Anna-Marie Laura, Ocean Conservancy

It's hard to believe 14 years have gone by since I interned at SDRP for then Ph.D. student Katie McHugh because the experience is present in the work I do every day advancing policies for a healthy ocean. And every time I see dolphins from the shore or a boat I can't help but try to estimate group size and look for those distinctive nicks and notches.

Graduating from college in 2006 and heading off to a field internship with SDRP was the equivalent of landing my dream job. As a marine science undergrad, I was beginning to understand the importance of environmental policy and public awareness in protecting the ocean and the marine life that fascinated me. I remember being so excited to meet and work with scientists and staff who could help me understand the career options ahead and how to choose a graduate program.

The effort to connect research and educational programs to the local community reinforced for me that keeping the ocean healthy and protecting the Sarasota Bay dolphins required managing and understanding the behavior of the people who live there just as much as the behavior of the dolphins. I saw how programs that educated boaters to keep a safe distance and not feed dolphins or made it easier to throw fishing line and other gear away responsibly, worked hand-in-hand with laws and regulations that prohibited these activities in order to protect marine mammals.

The relationship between people and the ocean came into even sharper focus that summer I was an intern when a massive red tide occurred. I'd never been choked by ocean air before. Thanks to the years of data collected by SDRP and Katie's new research on juvenile dolphin behavior, she was able to show that dolphins spent less time looking for and eating fish during the red tide event. She demonstrated that a red tide event could significantly affect the behavior of the dolphins and jeopardize their health. Red tides are becoming more frequent due to polluted runoff from coastal developments and increasing water temperatures from climate change. Understanding and explaining how a red tide can impact the dolphin population can help people, including lawmakers who write the rules, understand the changes we need to make to keep the whole Bay healthy.

Katie and others, including Damon and Janet Gannon, listened to my interests and told me about a master's program at Duke University where I could continue to explore the intersection of science and policy, and keep studying dolphins. I graduated in 2009 from Duke's Nicholas School of the Environment with a Masters in Coastal Environmental Management and my master's project was, 'Using passive acoustics to monitor for bottlenose dolphin (*Tursiops truncatus*) presence in two military ranges in Pamlico Sound, North Carolina.' With the skills I developed at SDRP, my advisor Dr. Andy Read, believed I could take on a project to better understand the behavior and activity of dolphins living near the Marine Corps Air Station where practice exercises sometimes put them at risk. Andy was instrumental in helping me understand how to continue working at the science-policy interface and he recommended the NOAA Sea Grant Knauss Fellowship, which places recent graduates in the field of marine science and policy in federal agencies as well as in offices on Capitol Hill for one year paid fellowship.

I became a North Carolina Sea Grant Fellow and in 2010 went to work for Senator Sheldon Whitehouse from Rhode Island. Working on Capitol Hill exposed me to the behind-the-scenes efforts to change policy, write new legislation, fund programs, and critically, ways to incorporate science into decision making. It taught me about being a public servant; working on behalf of people my boss represented, learning how to communicate science and policy to the public, appreciating a variety of perspectives, and working together with many stakeholders to make progress. Working for Rhode Island, the Ocean State, meant there were a lot of people who supported ocean and coastal protection and understood the connection between a healthy coastal ecosystem and a healthy coastal economy.

I worked in the Senate for five years as Ocean and Coastal Policy Advisor, and in 2015 decided to pursue my growing interest in international ocean policy. Two projects I worked on in the Senate—passing an international treaty to stop illegal, unreported, and unregulated fishing and trying to establish protected areas in Antarctica—further demonstrated the value of appreciating a variety of perspectives and working across more than just domestic political divides. This interest led me to Rare, an

Anna-Marie as an SDRP intern in 2006.

Anna-Marie (far right) attending the FAO Committee on Fisheries meeting in July 2018 in Rome, Italy, with colleagues and women leaders from Mozambique, Honduras, the Philippines, and Palau.

international conservation and development organization that uses an in-depth understanding of human behavior and promotes community-based management of natural resources to achieve conservation outcomes.

I worked at Rare from 2015 to the end of 2019, ultimately as Director, Policy and Strategic Partnerships, with amazing colleagues in Indonesia, Philippines, Brazil, Mozambique, Honduras, and Europe. I met and spoke with Mayors from around the world about why sustainable use of marine resources is important for their communities. I ate meals in the homes of fishers in Indonesia, met scientists documenting the decline of coastal ecosystems around the world, and spoke at the U.N. on behalf of my organization; experiences that profoundly changed and expanded my world view.

Now, as Director of International Government Relations at Ocean Conservancy, I am continuing to advance national and international policies to protect the ocean and sustainably use its resources. I want to continue working with and influencing government throughout my career because governments should be working towards a better future for all of us, and that means prioritizing a healthy planet. Governments and decision-makers everywhere, at every level, need to listen to what science is telling us about why and how to protect our ocean, preserve biodiversity, and stop climate change.

The skills and knowledge I gained during my internship at SDRP and my time at the Duke Marine Lab prepared me to work in Congress and for environmental non-profits. The people I met along the way, however, and the advice and support I received were even more critical. They taught me the central role science should play in informing policies to protect our ocean and coastal communities. I feel incredibly lucky that the work and people at SDRP pointed me towards my continued education, my career, and the kind of impact I want to have in my community.

Citizen science and Sarasota Bay dolphins: Volunteers and research opportunities

The concept of "citizen science" is nothing new for the SDRP. Back in the 1970's, our tagging and tracking teams were filled out largely with local volunteers. Beginning in 1982 and continuing for the next 25 years, we worked with Earthwatch, an organization that matches interested members of the public with research projects requiring assistance. Some of our more than 1,000 Earthwatch volunteers continue working with us today, providing valuable services and expertise. Until the pandemic hit, we regularly involved members of a team of trained local volunteers in our photo-ID surveys, our health assessments, our seasonal fish surveys, and in dolphin rescues. We hope to be able to re-engage our local volunteers soon.

Cecilia Mould, Amy Cabaceiras, Jessica Barrios, and Letícia Magpali Estevão at the Youth Making Ripples film festival in February 2020 at Mote Marine Laboratory and where they hosted a marine debris themed educational booth.

Listening station opportunities

As our passive acoustic listening station (PALS) network grows around Sarasota Bay, we encourage local coastal residents, educational, and public institutions to become involved! You can contribute by providing waterfront locations for deployment of listening systems and/or support opportunities to use data and sounds from these systems in educational and outreach programming. Over the next two years we are particularly seeking educational and public outreach partners where we can both grow our network and its impact together, while monitoring our shared coastal underwater environment.

Volunteer perspective

Jeff Stover

I come from a family of divers and grew up listening to stories of the life lived on or near the water. In our house while growing up there was ample watching with Jacques Cousteau, from reading National Geographics. Watching as much as possible. And of course Mutual of Omaha and Jim Fowler always jumping out of boats, Jeeps, and other moving transportation. Also viewing super 8's of relatives being on the bottom of the Sea of Cortez and watching schools of hammerheads going over the team of the divers. Or my uncle backing a Moray eel back into his cave with the face plate of his mask (not the smartest thing to do). My father diving around the world. Abalone fishing off the coast of San Francisco. Two uncles diving on Singapore oil rigs and also off the coast of New Orleans doing deep saturation dives. From those stories sparked a lifelong dream: Is there a way for me to be part of and or work around the water?

From right to left: Jeff Stover with fellow long-term volunteers Kristi Fazioli, Dee Allen, and James Throson in June 2019.

In 1987, I started a 33-year adventure of volunteering and doing what I have always dreamed about, working with marine mammals. I first started by finding Earthwatch, an organization that helps pool labor to help assist in research around the world. Looking through the pages there were many options that I could have chosen. I chose working with a small group, at the time called DBRI (Dolphin Biology Research Institute). Their corporate headquarters just happened to be out of Siesta Key, Florida. This would be my one and only chance to do what I have always wanted to do. Work with dolphins. One small issue - it was the same time as my high school graduation. Life-changing decision needed to be made. I would have to miss finals and not walk for graduation. Most of my teachers had told me they were not sure I was making the right decision. It was so important to me that I skipped my high school graduation to be part of working with DBRI. I was accepted into the small program. After 33 years of working with DBRI, I say to them: best decision I could have ever made. Best part about being a volunteer is you are able to provide help with all of what I perceive the fun stuff - from being ballast on a boat to help the lift of dolphins out of the water for weighing, to learning how to fix holes in nets and everything in between. As a volunteer there is no job too small or too large. I am always more than happy to help with whatever is needed - scraping barnacles off the bottom of boats, building a net trailer, assembling a scaffolding tower on the end of a dock to study boat disturbance, and my favorite job, holding dolphin flukes. I very much like the physicality of the processes that have been put in place.

I have valued seeing the building of the infrastructure and the struggles to create a team of the best of the best to extract the best scientific work possible. Dr. Wells and his core team have carried out a remarkable vision of long-term instruction for the future of marine biology around the world. I have personally been able to witness students start as undergraduates and work their way up to grad students and then earning their doctorates. I have with great excitement seen them starting their own projects with the tools that Dr. Wells and his core team have constructed, nurtured, and applied over the 50 years of research. He has handed down traditions of excellence. Through his willingness to share he has set processes in motion that will shape research for the foreseeable future.

One of the best parts about being a volunteer so long was that I also was able to talk my parents into, after retiring, moving to Florida and volunteering at Mote. Then my father began working for Dr. Wells and the Chicago Zoological Society as Operations Manager. I truly loved being able to spend many years working side by side with my father in doing something we both cared very deeply about. Making a difference in our own ways. Also making so many lifelong friends. I so much enjoyed volunteering for Dr. Wells and his top-notch team I have just moved down to Florida in hopes of doing much, much more.

Jeff Stover helps Peter Tyack suction cup a digital archival tag to F259 shortly before she was released in June 2019.

Products

Professional Activities Summary: November 2019 through October 2020

One accepted measure of the productivity of a research and conservation 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 are available through our website (sarasotadolphin.org) or they can be obtained upon request, as electronic pdf files. It should be noted that the pandemic precluded most in-person presentations after March 2020, leading us to add a category for virtual presentations.

Published Peer-Reviewed Journal Articles and Book Chapters

Andrews, R. D., R. W. Baird, J. Calambokidis, C. E. C. Goertz, F. M. D. Gulland, M. P. Heide-Jørgensen, S. K. Hooker, M. Johnson, B. Mate, Y. Mitani, D. P. Nowacek, K. Owen, L. T. Quakenbush, S. Raverty, J. Robbins, G. S. Schorr, O. V. Shpak, F. I. Townsend, Jr., M. Uhart, R. S. Wells and A. N. Zerbini. 2019. Best practice guidelines for cetacean tagging. Journal of Cetacean Research and Management 20:27-66. https://doi.org/10.47536/jcrm.v20i1.237

Barratclough, A., R. S. Wells, L. H. Schwacke, T. K. Rowles, F. M. Gomez, D. A. Fauquier, J. C. Sweeney, F. I. Townsend, L. J. Hansen, E. S. Zolman, B. C. Balmer and C. R. Smith. 2019. Health assessments of common bottlenose dolphins (*Tursiops truncatus*): Past, present, and potential conservation applications. Frontiers in Veterinary Science 6:444. https://doi.org/10.3389/fvets.2019.00444

Brewster, L.R., B.V. Cahill, M.N. Burton, C. Dougan, J.S. Herr, L.I. Norton, S.A. McGuire, M. Pico, E. Urban-Gedamke, K. Bassos-Hull, J.P. Tyminski, R.E. Hueter, B.M. Wetherbee, M. Shivji, N. Burnie and M.J. Ajemian. 2020. First insights into the vertical habitat use of the whitespotted eagle ray *Aetobatus narinari* revealed by pop-up satellite archival tags. Journal of Fish Biology. https://doi.org/10.1111/jfb.14560

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Galligan, T. M., A. S. P. Boggs, B. C. Balmer, T. Rowles, C. Smith, F. Townsend, R. S. Wells, E. S. Zolman and L. H. Schwacke. 2019. Blubber steroid hormone profiles as indicators of physiological state in free-ranging common bottlenose dolphins (*Tursiops truncatus*). Comparative Biochemistry and Physiology - Part A: Molecular & Integrative Physiology, 239: 110583. https://doi.org/10.1016/j.cbpa.2019.110583

Greenfield, M. R., K. A. McHugh, R. S. Wells and D.I. Rubenstein. 2020. Anthropogenic injuries disrupt social associations of common bottlenose dolphins (*Tursiops truncatus*) in Sarasota Bay, Florida. Marine Mammal Science. https://doi.org/10.1111/mms.12729

Hart, L., M. Dziobak, E. Pisarski, E. Wirth and R. S. Wells. 2020. Sentinels of synthetics – a comparison of phthalate exposure between common bottlenose dolphins (*Tursiops truncatus*) and human reference populations. PLOS ONE 15 (10): e0240506. https://doi.org/10.1371/journal.pone.0240506

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Morin, P., F. Archer, C. Avila, J. Balacco, Y. Bukham, W. Chow, O. Fedrigo, G. Formenti, J. Fronczek, A. Fungtammasan, F. Gulland, B. Haase, M-P. Heide-Jorgensen, M. Houck, K. Howe, A. Misuraca, J. Mountcastle, W. Musser, S. Paez, S. Pelan, A. Phillippy, A. Rhie, J. Robinson, L. Rojas-Bracho, T. Rowles, O. Ryder, C. Smith, S. Stevenson, B. Taylor, J. Teilmann, J. Torrance, R. Wells, A. Westgate and E. D. Jarvis. 2020. Reference genome and demographic history of the most endangered marine mammal, the vaquita. Molecular Ecology. https://doi.org/10.1111/1755-0998.13284

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Robles-Malagamba, M., M. T. Walsh, M. Shamim Ahasan, P. Thompson, R. S. Wells, C. Jobin, A. A. Fodor, K. Winglee and T. B. Waltzek. 2020. Characterization of the bacterial microbiome among free-ranging bottlenose dolphins (*Tursiops truncatus*). Heliyon 6: 1-10. e03944. https://doi.org/10.1016/j.heliyon.2020.e03944

Ronje, E. I., H. R. Whitehead, K. Barry, S. Piwetz, J. Struve, V. Lecours, L. P. Garrison, R. S. Wells, K. D. Mullin. 2020. Abundance of common bottlenose dolphins (*Tursiops truncatus*) in three discrete estuaries of the Northwestern Gulf of Mexico: Implications for a metapopulation. Gulf and Caribbean Research 31(1): 18-34. https://doi.org/10.18785/gcr.3101.09

Rycyk, A. M., R. B. Tyson Moore, R. S. Wells, K. A. McHugh, E. J. Berens McCabe and D. A. Mann. 2020. Passive acoustic listening stations (PALS) show rapid onset of ecological effects of harmful algal blooms in real time. Scientific Reports 10: 17863. https://doi.org/10.1038/s41598-020-74647-z

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Tyson-Moore, R. B., D. C. Douglas, H. H. Nollens, L. Croft and R. S. Wells. 2020. Post-release monitoring of a stranded and rehabilitated short-finned pilot whale (*Globicephala macrorhynchus*) reveals current-assisted travel. Aquatic Mammals 46(2): 200-214. https://doi.org/10.1578/AM.46.2.2020.200

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Manuscripts In Press or Accepted for Publication

Dunn, C., D. Claridge, D. Herzing, C. Volker, K. Melillo-Sweeting, R. S. Wells, T. Turner and K. O'Sullivan. Accepted. Satellite-linked telemetry study of a rehabilitated and released Atlantic spotted dolphin (*Stenella frontalis*) in The Bahamas provides insights into broader ranging patterns and conservation needs. Aquatic Mammals.

Herrman, J., J. S. Morey, R. Takeshita, S. De Guise, R. S. Wells, W. McFee, T. Speakman, F. Townsend, C. R. Smith, T. Rowles and L. Schwacke. Accepted. Age determination of common bottlenose dolphins (*Tursiops truncatus*) using dental radiography pulp:tooth area ratio measurements. PLOS ONE.

Humble, E., J. Hosegood, R. Ogden, M. de Bruyn, S. Creer, G. Stevens, M. Abudaya, K. Bassos-Hull, R. Bonfil, D. Fernando, A. Foote, H. Hipperson, R. Jabado, J. Kaden, M. Moazzam, L. Peel, S. Pollett, A. Ponzo, M. Poortvliet, J. Salah, H. Senn, J. Stewart, S. Wintner and G. Carvalho. In press. Phylogenomics and species delimitation for effective conservation of manta and devil rays. Molecular Ecology.

Presentations at Professional Meetings

Allen, J. B., R. B. Tyson Moore, D. Blount, C. Cush, J. Holmberg, J. Parham, J. Thompson, K. Urian and R. S. Wells. 2019. Experimental evaluation of two computer-assisted dorsal fin identification systems. World Marine Mammal Conference, 9-12 December 2019, Barcelona, Spain. (speed talk)

Allen, J. B. and R. B. Tyson Moore. 2019. CurvRank background, testing, implementation. Rise of the Machines - Applications of automated systems for matching dorsal fins: current status and future directions. Workshop at the World Marine Mammal Conference, 8 December 2019,

Barcelona, Spain (oral presentation)
Bassos-Hull, K. B. 2019. Ray research for conservation. Workshop presentation at the Manta Ray Symposium, Georgia Aquarium, Atlanta, GA. 04 November 2019.
Bassos-Hull, K. B., K. A. Wilkinson, S. McBride-Kebert, J. B. Allen, A. A. Barleycorn, V. Lovko and R. S. Wells. 2019. Evaluating bottlenose dolphin distribution patterns in response to harmful algal blooms and hypoxic events in a west coast Florida estuary. World Marine Mammal Conference, 9-12 December 2019, Barcelona, Spain. (poster)
Berens McCabe, E. J., S. McBride-Kebert, K. McHugh, C. Toms, A. Barleycorn, J. Allen and R. S. Wells. 2019. Bottlenose dolphin, Tursiops truncatus, predator – prey responses to a red tide harmful algal bloom. World Marine Mammal Conference, 9-12 December 2019, Barcelona, Spain. (poster)
Casoli, M., M. Johnson, F. H. Jensen, V. M. Janik, L. S. Sayigh, K. A McHugh, R. S. Wells and P. L. Tyack. 2019. Parameterizing dolphin behaviour with animal-attached tags to study acoustic communication. World Marine Mammal Conference, 9-12 December 2019, Barcelona, Spain. (oral presentation)
Cush, C. C. 2019. Gulf of Mexico Dolphin Identification System (GoMDIS). Rise of the Machines - Applications of automated systems for matching dorsal fins: current status and future directions. Workshop at the World Marine Mammal Conference, 8 December 2019, Barcelona, Spain (oral presentation)
Cush, C. C., S. McBride-Kebert, R. S. Wells, J. Adams, E. Fujioka and K. Urian. 2019. Gulf of Mexico Dolphin Identification System (GoMDIS) - A collaborative program to better define bottlenose dolphin (*Tursiops truncatus*) movements. World Marine Mammal Conference, 9-12 December 2019, Barcelona, Spain. (poster)
DeGuise, S., M. Levin, L. Jasperse, E. Gebhard, J. Herrman, C. Smith, F. Townsend, R. Wells, B. Balmer, E. Zolman, T. Rowles and L. Schwacke. 2019. Changes in bottlenose dolphin immune functions associated with the Deepwater Horizon Oil Spill in the Northern Gulf of Mexico, a recurrence? World Marine Mammal Conference, 9-12 December 2019, Barcelona, Spain. (oral presentation)
De Guise, S., M. Levin, L. Jasperse, J. Herrman, R. Wells, R. Takeshita, T. Marques and L. Schwacke. 2020. Changes in bottlenose dolphin immune functions associated with the *Deepwater Horizon* Oil Spill in the Northern Gulf of Mexico, a recurrence? 2020 Gulf of Mexico Oil Spill and Ecosystem Science Conference, 3-6 February 2020, Tampa, FL (poster)
Dunn, C., D., Claridge, D. Herzing, C. Volker, K. Melillo-Sweeting, R. S. Wells, T. Turner and K. O'Sullivan. 2019. Satellite-linked telemetry study of a rehabilitated and released Atlantic spotted dolphin in The Bahamas provides insights into broader ranging patterns and conservation needs. World Marine Mammal Conference, 9-12 December 2019, Barcelona, Spain. (poster)
Dziobak, M., R. S. Wells, E. Pisarski, E. Wirth and L. B. Hart. 2019. Sex, age, and hormone correlates of phthalate exposure among common bottlenose dolphins (*Tursiops truncatus*) from Sarasota Bay, FL. World Marine Mammal Conference, 9-12 December 2019, Barcelona, Spain. (poster)
Fellner, W., R. S. Wells and M. A. Stamper. 2019. Presence of rake marks in common bottlenose dolphins (*Tursiops truncatus*) across age and sex classes: What's normal? World Marine Mammal Conference, 9-12 December 2019, Barcelona, Spain. (poster)
Gomez, F., K. Colegrove, S. Huston, A. Hsu, B. Linnehan, W. Musser, R. Takeshita, C. Harms, T. Rowles, E. Zolman, B. Balmer, F. Townsend, R. Wells, L. Schwacke, E. Jensen and C. Smith. 2019. Assessment of sublethal cardiac injury in bottlenose dolphins (*Tursiops truncatus*) in the Gulf of Mexico following exposure to Deepwater Horizon oil-associated chemicals. World Marine Mammal Conference, 9-12 December 2019, Barcelona, Spain. (speed talk)
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Hazelkorn, R. A., R. S. Wells, Z. A. Siders, R. DeLynn and G. N. Lovewell. 2019. Examining physical maturity in known common bottlenose dolphins of Sarasota Bay, Florida. World Marine Mammal Conference, 9-12 December 2019, Barcelona, Spain. (poster)
Hooper, L., N. Boucquey, K. McHugh, R. Tyson Moore and M. Fuentes. 2019. Eco-tour boat compliance to NOAA Marine Mammal Viewing Guidelines in Naples, Florida. World Marine Mammal Conference, 9-12 December 2019, Barcelona, Spain. (poster)
Jensen, F. H., K. A. McHugh, R. S. Wells, J. Sweeney, R. Stone, P. L. Tyack and A. Fahlman. 2019. Adaptations of biosonar behavior to a deep-diving lifestyle in offshore bottlenose dolphins. World Marine Mammal Conference, 9-12 December 2019, Barcelona, Spain. (oral presentation)
Jordan, D., K. A. Wilkinson, K. A. McHugh and R. S. Wells. 2020. Exploring shark and dolphin interaction frequency over time. Mote Marine Laboratory NSF REU Poster Session, 06 August 2020, Sarasota, FL.
Lettrich, M., M. J. Asaro, D. L. Borggaard, D. M. Dick, R. B. Griffis, J. A. Litz, C. D. Orphanides, D. L. Palka, M. S. Soldevilla, B. Balmer, S. Chavez, D. Cholewiak, D. Claridge, R. Y. Ewing, K. Fazioli, D. Fertl, E. Fougeres, D. Gannon, L. Garrison, J. Gilbert, A. Gorgone, A. Hohn, S. Horstman, B. Josephson, R. D. Kenney, J. Kiszka, K. Maze-Foley, W. McFee, K. Mullin, K. Murray, D. E. Pendleton, J. Robbins, J. Roberts, G. Rodriguez-Ferrar, E. I. Ronje, P. E. Rosel, T. Speakman, J. E. Stanistreet, T. Stevens, M. Stolen, R. Tyson Moore, N. Vollmer, R. Wells, H. R. Whitehead and A. Whitt. 2019. The climate vulnerability of U. S. marine mammal stocks in the western North Atlantic, Gulf of Mexico and Caribbean. World Marine Mammal Conference, 9-12 December 2019, Barcelona, Spain. (invited plenary presentation)
McBride-Kebert, S. and C. Toms. 2019. Bottlenose dolphin, *Tursiops truncatus*, seasonal distribution and behavioral response to a freshwater flood in Pensacola Bay, Florida. World Marine Mammal Conference, 9-12 December 2019, Barcelona, Spain. (speed talk)
McHugh, K. A., K. Bassos-Hull, R. Tyson Moore, D. Mann, G. Lovewell, J. Isaac-Lowry, S. Alessi and R. S. Wells. 2019. Turning the tide: Addressing increasing adverse human-dolphin interactions through complementary research and outreach approaches. World Marine Mammal Conference, 9-12 December 2019, Barcelona, Spain. (poster)
Morey, J. S., B. C. Balmer, E. S. Zolman, R. A. Takeshita, T. K. Rowles, C. R. Smith, R. S. Wells and L.H. Schwacke. 2020. Transcriptomic analyses of bottlenose dolphin blood and skin to identify additional biomarkers and pathways to inform cetacean health assessment. 2020 Gulf of Mexico Oil Spill and Ecosystem Science Conference, 3-6 February 2020, Tampa, FL (poster)
Powell, J., D. Duffield, J. Kaufman, R. Wells and W. McFee. 2019. Clinical assessment of bone density in the common bottlenose dolphin, *Tursiops truncatus*. World Marine Mammal Conference, 9-12 December 2019, Barcelona, Spain. (poster)
Sayigh, L. S., A. Rozas, R. Wells and V. Janik. 2019. Mother-offspring and sibling whistle comparisons in bottlenose dolphins. World Marine Mammal Conference, 9-12 December 2019, Barcelona, Spain. (oral presentation)
Schwacke, L., L. Thomas, C. Smith, G. Bossart, L. Burt, S. DeGuise, F. Gomez, M. Mazzoil, J. Morey, T. Rowles, E. Stolen, F. Townsend and R. Wells. 2019. Veterinary Expert System for Outcome Prediction (VESOP): A Bayesian model to predict changes in cetacean population vital rates from measures of individual health. World Marine Mammal Conference, 9-12 December 2019, Barcelona, Spain. (oral presentation)
Schwacke, L., C. Smith, F. Gomez, T. Rowles, R. Wells, E. Zolman, T. Speakman, J. Herrman, R. Takeshita and L. Thomas. 2020. Health trends for bottlenose dolphins in the 8 years following the Deepwater Horizon oil spill: Evidence for lack of resilience. 2020 Gulf of Mexico Oil Spill and Ecosystem Science Conference, 3-6 February 2020, Tampa, FL
Smith, C., F. Gomez, M. Ivančić, W. Musser, A. Barratclough, J. Meegan, S. M. Waitt, A. Cárdenas Llerenas, E. D. Jensen, T. Rowles, V. Cendejas, E. Zolman, B. Balmer, T. Speakman, B. Quigley, F. Townsend, R. Wells and L. Schwacke. 2019. New diagnostic techniques to characterize fetal, placental, and maternal health in bottlenose dolphins following the Deepwater Horizon Oil Spill. World Marine Mammal Conference, 9-12 December 2019, Barcelona, Spain. (speed talk)
Takeshita, R., B. Balmer, E. Zolman, L. Thomas, T. Rowles, R. Wells and L. Schwacke. 2019. Behavioral responses of common bottlenose dolphins (*Tursiops truncatus*) to changes in salinity within the Barataria Basin in Louisiana. World Marine Mammal Conference, 9-12 December 2019, Barcelona, Spain. (speed talk)
Takeshita, R., B. Balmer, E. Zolman, L. Thomas, T. Rowles, R. Wells, F. Gomez, C. Smith and L. Schwacke. 2020. Health and behavioral responses of common bottlenose dolphins (*Tursiops truncatus*) in low salinity waters within the Barataria Basin in Louisiana. 2020 Gulf of Mexico

Oil Spill and Ecosystem Science Conference, 3-6 February 2020, Tampa, FL (poster)

Toms, C., T. Stone and T. Och. 2019. Visual assessments of skin lesions on free-ranging bottlenose dolphins (*Tursiops truncatus*): Reliability and utility of quantitative tools. World Marine Mammal Conference, 9-12 December 2019, Barcelona, Spain. (speed talk)

Tyson Moore, R. B. 2019. Testing the performance of photo-ID systems. Rise of the Machines - Applications of automated systems for matching dorsal fins: current status and future directions. Workshop at the World Marine Mammal Conference, 8 December 2019, Barcelona, Spain (oral presentation)

Tyson Moore, R., D. Douglas, H. Nollens, L. Croft and R. S. Wells. 2019. Post-release monitoring of a stranded and rehabilitated pilot whale (*Globicephala macrorhynchus*). World Marine Mammal Conference, 9-12 December 2019, Barcelona, Spain. (poster)

Wells, R. S., K. A. McHugh, E. J. Berens McCabe, J. B. Allen, A. A. Barleycorn, S. McBride-Kebert, C. Toms, Reny Tyson Moore, K. A. Wilkinson, C. Cush, K. Bassos-Hull, G. N. Lovewell, S. Rossman, D. Mann, L. K. Schwarz and A. Rycyk. 2019. Bottlenose dolphins and red tide harmful algal blooms: Are patterns of dolphin responses emerging from repeated events? World Marine Mammal Conference, 9-12 December 2019, Barcelona, Spain. (oral presentation)

Wells, R. S., M. Cremer, L. Berninsone and P. Bordino. 2019. *Pontoporia* sociality. Workshop on Sociality in Riverine, Lagoon-living, and Coastal Cetaceans: Conservation Implications. World Marine Mammal Conference, 8 December 2019, Barcelona, Spain. (oral presentation)

Wells, R. S. 2020. Update on ATN-related Sarasota Dolphin Research Program activities. Animal Telemetry Network Steering Group Meeting, Silver Spring, MD 8 January 2020.

Wells, R. S. 2020. The Chicago Zoological Society's Sarasota Dolphin Research Program: Now in our 50th year of conducting the world's longest-running study of a wild dolphin population. Clearwater Marine Aquarium Stranding Conference, Clearwater, FL. 11 January 2020.

Wells, R. S., K. A. McHugh, E. J. Berens McCabe, J. B. Allen, A. A. Barleycorn, C. Toms, R. Tyson Moore, K. A. Wilkinson, C. Cush, K. Bassos-Hull, G. N. Lovewell, S. Rossman and D. Mann. 2020. Bottlenose dolphins and red tide harmful algal blooms: Are patterns of dolphin responses emerging from repeated events? 2020 Gulf of Mexico Oil Spill and Ecosystem Science Conference, 3-6 February 2020, Tampa, FL (poster)

Wilkinson, K. A., K. A. McHugh, R. S. Wells, W. E. Pine, III, R. R. Borkhataria and R. E. Hueter. 2019. I get by with a little help from my friends: Understanding bottlenose dolphin social affiliations in response to shark-inflicted injury. World Marine Mammal Conference, 9-12 December 2019, Barcelona, Spain. (poster)

Zimmer, W., M. Casoli, V. Janik, F. H. Jensen, K. McHugh, P. Tyack, R. Wells and L. Sayigh. 2019. Clear movement responses by bottlenose dolphins to whistle playbacks. World Marine Mammal Conference, 9-12 December 2019, Barcelona, Spain. (poster)

Public, University, School Lectures

Bassos-Hull, K. 2019. Connecting for conservation: Research on marine rays in Gulf of Mexico, Atlantic Ocean and Caribbean Sea. Workshop presentation for Sharks and Rays Endless Oceans Adult Learners Class at Mote Marine Laboratory, Sarasota, FL. 14 Oct 2019.

Bassos-Hull, K. 2020. Tracking marine wildlife in Sarasota Bay (and beyond) using sound. Presentation to members at the monthly Boaters Breakfast at the Sarasota Yacht Club, Sarasota, FL. 01 Feb 2020.

Bassos-Hull, K. 2020. Marine debris impacts on Florida's marine megafauna. Presentation to Mote high school intern group (City Island cleanup event) at Mote Marine Laboratory, Sarasota, FL. 08 Feb 2020.

Bassos-Hull, K. 2020. Tracking marine wildlife in Sarasota Bay (and beyond) using sound. Presentation to Sarasota Yacht Club youth group, Sarasota, FL. 03 Mar 2020.

Bassos-Hull, K. 2020. Connecting for Conservation: Research on Dolphins and Marine Rays in the Gulf of Mexico, Atlantic Ocean and Caribbean Sea. Presentation to Dr. Linae Boehme's marine biology class (St. Pete College) at Mote Marine Laboratory, Sarasota, FL. 05 Mar 2020.

McHugh, K. A. 2019. Sarasota dolphins and red tide. Chapter BM, Philanthropic Educational Organization, Siesta Key, FL. 14 Nov 2019.

McHugh, K. A. and G. Lovewell. 2020. Help Protect Our Wildlife. Sarasota County Beaches & Water Access staff presentation, South County, Nokomis Beach Plaza. 14 Jan 2020.

McHugh, K. A. and G. Lovewell. 2020. Help Protect Our Wildlife. Sarasota County Beaches & Water Access staff presentation, North County, Turtle Beach Pavilion. 16 Jan 2020.

Sayigh, L. S. 2020. Dolphin communication: fact and fiction. University of Southern California's Otolaryngology and Hearing & Communication Neuroscience Seminar Series. Jan 2020.

Wells, R. S. 2020. Insights into the lives of Sarasota Bay's bottlenose dolphins, from 50 years of research. Mote Marine Laboratory Special Lecture Series, Sarasota, FL. 20 Jan 2020.

Wells, R. S. 2020. Insights into the lives of Sarasota Bay's bottlenose dolphins, from 50 years of research. Mote Marine Science Course, Sarasota, FL. 19 Feb 2020.

Wells, R. S. 2020. Insights into the lives of Sarasota Bay's bottlenose dolphins, from 50 years of research. Longbeach Village Association, Longboat Key, FL. 4 Mar 2020.

Virtual Presentations

Allen, J. B. 2020. Bringing the Zoo to You: Sarasota Dolphin Research Program. Facebook Live presentation, Brookfield Zoo. 8 Jun 2020. https://www.youtube.com/watch?v=TH_xSHWj--8

Bassos-Hull, K. and K. Wilkinson. 2019. Mote SEA Show High Tech Tides. 19 Nov 2019. https://www.youtube.com/watch?v=u311X_3Kffw

Bassos-Hull, K. and K. Wilkinson. 2019. Sci Girls - High Tech Tides. Broadcast premier on PBS Sci Girls, Season 5 Episode 1. 12 Dec 2019. https://www.youtube.com/watch?v=NlbbNd8lmlA

Bassos-Hull, K., R. Hueter and V. Hagan. 2020. SRAD (Shark and Ray Awareness Day) - Livestream AZA event from Mote Marine Laboratory. 14 Jul 2020. https://www.youtube.com/watch?v=aDgX2GmWzp8 (from 50:01-1:03:55)

Bassos-Hull, K. 2020. Connecting for conservation: Research on marine rays in Gulf of Mexico, Atlantic Ocean and Caribbean Sea. Zoom presentation for Mote High School Advanced Research Program Interns. 09 Sep 2020.

McHugh, K. A. 2020. Dolphins: Our coastal neighbors. Zoom presentation to Manatee Master Naturalist Chapter. 8 June 2020.

McHugh, K. A. and A. Rycyk. 2020. Estuary soundscapes: Sarasota Passive Acoustic Listening Stations network. Deep Dives Facebook Live presentation/interview by Sarasota Bay Estuary Program. 23 June 2020. https://www.youtube.com/watch?v=yu4bzowTP2g

SDRP. 2020. Virtual celebration of the 50th anniversary of the Sarasota Dolphin Research Program. Includes video contributions from 25 long-term colleagues and collaborators from around the world, as well as summaries and updates by CZS-SDRP staff. 03 Oct 2020. https://vimeo.com/frontpageprod/download/464727198/74e1a913bc

Toms, C. 2020. Filling the gaps: Common bottlenose dolphin population dynamics, structure and connectivity within the Florida Panhandle. University Programs Seminar Series, Dauphin Island Sea Lab. 30 Oct 2020.

Tyson-Moore, R. B. 2020. Listening to our PALS: Long-term passive acoustic monitoring stations (PALS) provide insights into the underwater soundscape of a coastal environment. Long-Term Animal Research Seminar Series, Duke University. 27 Oct 2020. https://www.youtube.com/watch?v=L0dJUMWGGf8

Wells, R. S. 2020. Celebrating 50 years of dolphin research in Sarasota Bay. Deep Dives Facebook Live presentation/interview by Sarasota Bay Estuary Program. 28 May 20. https://www.youtube.com/watch?v=7-pDU0I2zCA

Wells, R. S. 2020. Dolphin Edition. Friday Q&A, Facebook Live presentation/interview by Scientist in Every Florida School and Community Scholars Initiative, University of Florida. 29 May 2020. https://www.facebook.com/SarasotaDolphins/videos/859206404574318/

Wells, R. S. 2020. Where do Bermuda's dolphins go? One Minute Ocean, Global Diving Research, Inc. 21 June 20. https://www.youtube.com/watch?v=AZ3oDlwdRv8

Wells, R. S. 2020. Factors influencing wild bottlenose dolphin health and survival. SEAVET, U. of Florida, College of Veterinary Medicine, Gainesville, FL. 24 Jun 2020

Wells, R. S. 2020. EOC 204: Dr. Randall Wells shares his porpoise. Eyes on Conservation Podcast. Wild Lens. 15 July 2020. http://wildlensinc.org/randallwells/

Wells, R. S. 2020. Behavior of marine mammals. Hampshire College. 22 Oct 2020.

Program Operations

As the lab turns...

Krystan Wilkinson, Chicago Zoological Society's Sarasota Dolphin Research Program

Lab meetings gone virtual over Zoom during the pandemic.

Like the rest of the world, CZS-SDRP staff have been livin' their best lives "quarantine style" as the pandemic has persisted throughout 2020. From virtual game nights to virtual happy hours, we have made our social lives creative and kept our work lives productive.

In February, CZS-SDRP research assistant and GoMDIS curator, Carolyn Cush, and her family moved back to the Tampa Bay area from California. While the pandemic has still kept us physically apart, it is wonderful having the Cush family nearby once again.

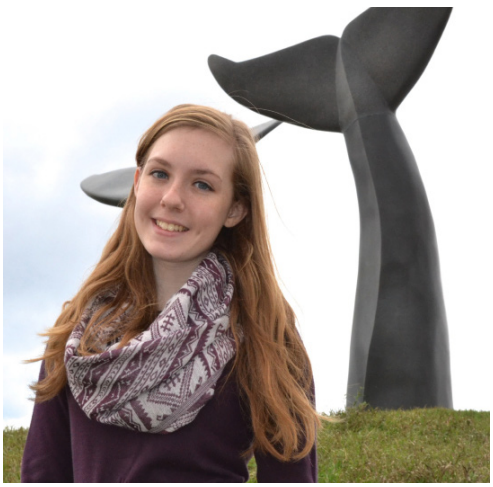
Congratulations to Theresa for successfully completing her comprehensive exams, receiving a distinguished NSF Fellowship Award, and for being elected to the Board of the Society for Marine Mammalogy!

This year, I received the inaugural William R. and Lenore Mote Early Academic Career Fellowship from Mote Scientific Foundation (an entity separate from Mote Marine Laboratory). This award will help support my collaborative research assessing the ranging patterns and diet of coastal sharks in relation to the resident Sarasota dolphin community.

The challenges of 2020 haven't kept University of California, Santa Cruz, and CZS-SDRP graduate student, Theresa-Anne Tatom-Naecker, down! This year, not only did Theresa pass her doctoral comprehensive exams, but she also received the prestigious National Science Foundation (NSF) Graduate Research Fellowship to continue her dissertation research on fatty acids and bottlenose dolphin diets. To find out more about Theresa's research, see her article on previous pages of this NnN edition. Additionally, Theresa was elected to the Board of the Society for Marine Mammalogy – the world's largest marine mammal organization – as one of two Student Members-at-Large. Theresa will focus on improving the support provided to student members through a variety of initiatives and engaging students from under-represented geographic regions. Theresa extends the long tradition of CZS-SDRP involvement in the Society.

This year, we welcomed former CZS-SDRP intern, Kylee DiMaggio, to our team as a graduate student with the University of Florida. She is co-advised by Dr. Madan Oli and program director, Randy Wells. Kylee's master's thesis research will examine the influence of human-dolphin interactions by comparing reproductive success and survivability of dolphin calves between females that exhibit natural foraging strategies and those that exhibit human-conditioned foraging strategies (i.e., patrolling or stealing fish from fishing gear).

DBRI president and long-time volunteer Ralph Piland, and long-time volunteer Jeff Stover (featured in this issue), have recently moved to the Sarasota area with their families – we look forward to increasing our interactions with these tremendously helpful members of our extended SDRP family.



Welcome to the team, Kylee DiMaggio!

Program Operations

Chicago Zoological Society Staff

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Aaron Barleycorn, BS, Field Coordinator
Elizabeth Berens McCabe, MS, Research Associate
Jonathan Crossman, BA, Research Assistant
Carolyn Cush, BS, Research Assistant
Allison Honaker, MPS, Research Assistant
Katie McHugh, PhD, Staff Scientist
Christina Toms, PhD, Research Associate
Reny Tyson Moore, PhD, Staff Scientist
Randall Wells, PhD, Program Director
Krystan Wilkinson, PhD, Postdoctoral Scientist

Affiliated Mote Marine Laboratory Staff

Kim Bassos-Hull, MS, Research Associate

Dolphin Biology Research Institute Officers

Ralph Piland, President
Blair Irvine, PhD, Vice President
Michael Scott, PhD, Secretary
Randall Wells, PhD, Treasurer

Interns and Post-Graduate Trainees

Jessica Barrios (Venezuela)
Olivia Boeberitz
Amy Cabeceiras
Elayna Daniels
Letícia Magpali Estevão (Brazil)
Devin Jordan (NSF-REU)
Meredith MacQueeney
Isabella Michal
Cecilia Mould
Kera Pasquerilla
Britney Pepper
Colin Perkins-Taylor
Kaelyn Shirley
Julia Wolfe

Local and Returning Volunteers

Dee Allen
Andrew Barba
Perfecto Barba
René Byrskov (Denmark)
Heather Daszkiewicz
Michael Duranko
Amy Evers
Kristi Fazioli
Mark Fishman
Sondra Fox
Ramsey Frangie
John Hamilton
Jeff Hollway
Renee Jones
Maria Kast-Ondraczek
Linda Kern
Cathy Marine
Caryl Mason
Charlie Mericle
Nigel Mould
Lizzy Pluta
Aya Robinson
Stefanie Rossnagle
Bryan Spaulding
Jeff Stover
Frank Szydlowski
James Thorson
Bill Tiffan
Robyn Trainor
Kristyn Waterwash
Martha Wells
Nick Williams

CZS-SDRP interns during January prey sampling left to right: Letícia Magpali Estevão, Amy Cabeceiras, Meredith MacQueeney, Jessica Barrios.

Krystan Wilkinson and Jonathan Crossman during monthly population monitoring survey in Sarasota Bay.

CZS-SDRP interns left to right: Kaelyn Shirley, Elayna Daniels, Devin Jordan, Britney Pepper, Julia Wolfe, Isabella Michal.

Jason Allen and Colin Perkins-Taylor during a monthly population monitoring survey in Longboat Pass.

Opportunities for You to Help Dolphin Research and Conservation

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 approximately $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 fascinating creatures. For more information on how you can help, please contact Cindy Zeigler, Chief Advancement Officer, at (708) 688-8263.

Special Thanks

The Chicago Zoological Society is honored to recognize the following donors and funding organizations for their generous contributions from October 1, 2019 – October 15, 2020 to its Sarasota Dolphin Research Program through donations, research grants, and/or contracts.

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Dr. Randy and Martha Wells
Cindy and Bill Zeigler

SDRP welcomes equipment donations in addition to funds

Donations, including boats, computers, cameras, and vehicles, greatly help with our efforts, and can be made to Dolphin Biology Research Institute (dba Sarasota Dolphin Research Program). DBRI is a Sarasota-based 501{c}3 not-for-profit organization, incorporated in 1982, and dedicated to continuing our research and conservation of dolphins and their habitat. For more information on how you can help, please contact Randall Wells at (941) 374-0449.

Dolphin Biology Research Institute would like to thank the following contributors for their cash or in-kind donations of $100 or more over the past year, through October 2020:

Anonymous
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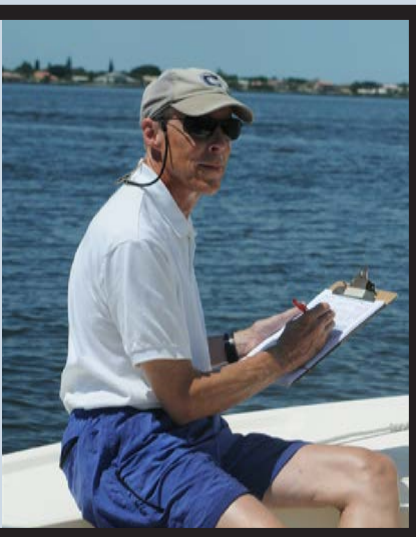

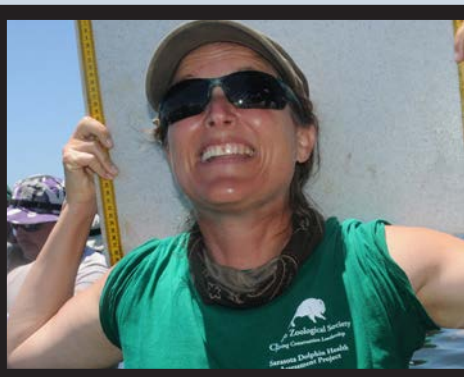

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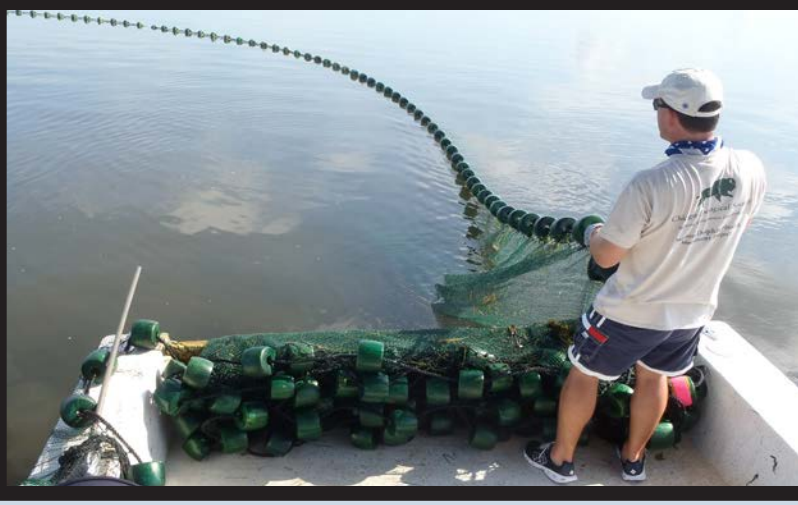

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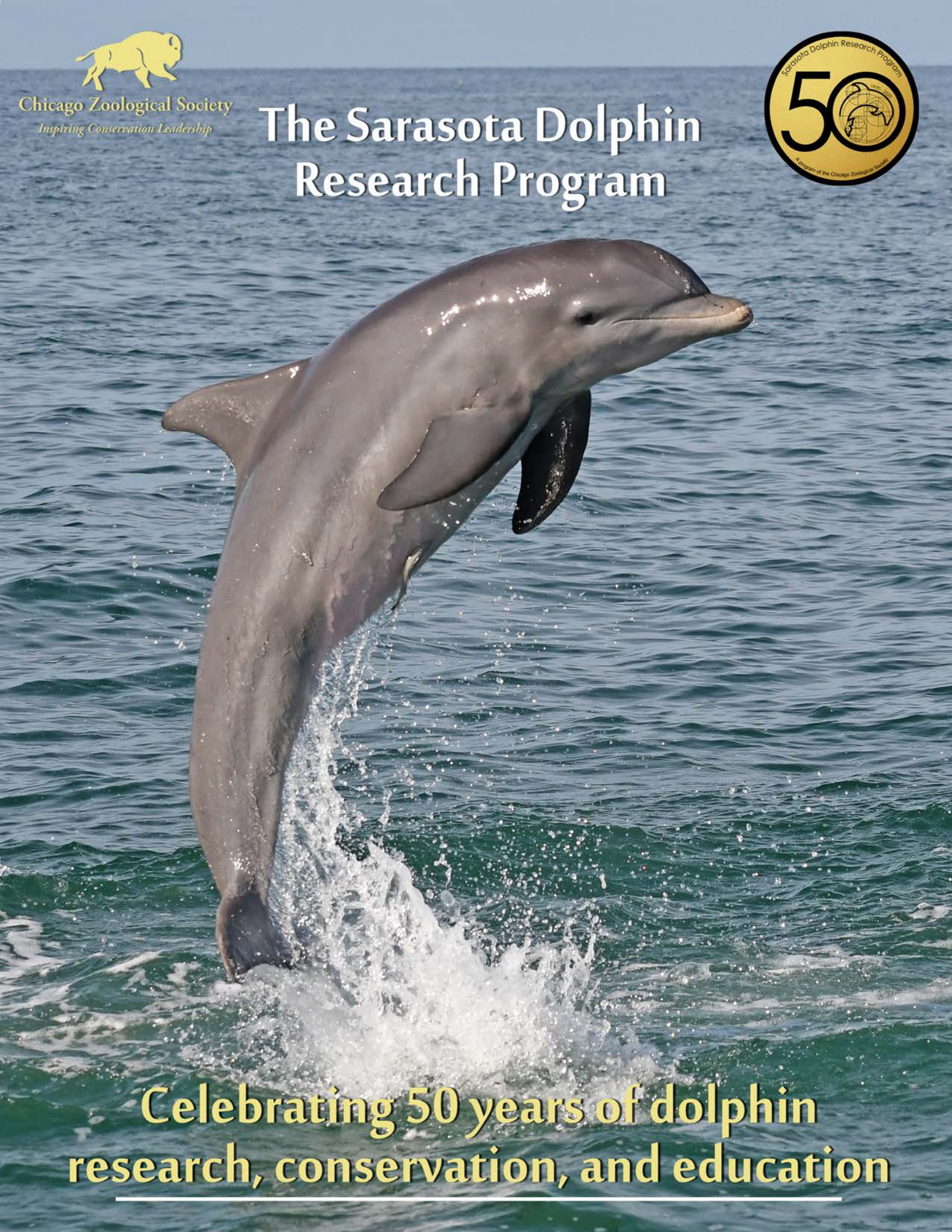

Celebrating 50 years of dolphin research, conservation, and education