

HEALTH MANAGEMENT | HUSBANDRY | ANIMAL WELFARE | DIVERSITY |
CORALS | CONSERVATION | SUSTAINABLE COLLECTIONS



RAW 2022

THE PLAN

THE AQUARIUM AT MOODY GARDENS

FEBRUARY 20-24

Thank you RAW Program Committee

Moody Gardens would like to acknowledge the hard work that the RAW Program Committee put in to create such a great assembly of sessions in a very short amount of time. From inception to completion this RAW 2022 has taken just under 6 months to put together. We could not host this without the assistance of the RAW Advisory Committee and our long-time commercial sponsors. We also wouldn't have had such a professional slate of presentations and panels without the Program Committee.

Thank you Julianne Steers for leading this effort and thank you Beth Firchau, Allan Marshall, Pete Mohan, Mark Schick, Jay Hemdal David Madison, Michael Daniel, Dee Murphy, Jennifer Rawlings, Rebecca Leitner and Bridgette SanMarco for your work on this great program.

RAW 2022 ABSTRACTS
The Regional Aquatics Workshop, February 20-24.
Moody Gardens, Galveston, TX USA.

AZA Aquatic TAG Steering Committee Meetings – February 20th.

Monday, February 21st
Welcome and TAG Meetings

RAW Welcome, Ground Rules, etc.

State of the Industry
Moderator: Beth Firchau

MFTAG Reporting Meeting
Paula Carlson et al.

FFTAG Reporting Meeting
Greg Whittaker et al.

AITAG Meeting
Brian Nelson et al.

Tuesday, February 22nd
Session 1: Health Management

An Oldie but a Goodie – Phenoxyethanol in Elasmobranchs
Dr Robert Jones, rob@theaquariumvet.com
The Aquarium Vet, PO Box 2327, Moorabbin, Victoria, Australia.

Phenoxyethanol has been used as a fish anaesthetic for many years. In the past three to four years, The Aquarium Vet team have used it in multiple elasmobranch species, including some large animals up to 300 kilograms. We have used it to assist with handling and preparation for transports, as well as for sedation for minor procedures and surgery. The results have been excellent with a very smooth induction as well as recovery. Doses range from 0.15 ml/L up to 0.30 ml/L and our protocol will be presented.

Stella the Sandtiger: No Bones About It

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Mississippi Aquarium

A sub-adult female sand tiger shark (*Carcharias taurus*), housed at Mississippi Aquarium, presented with scoliosis and kyphosis shortly after being introduced to the main 300,000-gallon habitat. The curvature, partnered with a severe decrease in appetite, resulted in a veterinary examination that indicated that the individual had a vertebral luxation. In a groundbreaking surgery, the luxation was stabilized by placing bilateral plates and screws.

After the surgery, aquarists used physical therapy, environmental obstacles, and a curated training plan, with the goal of improving the chances of a successful reintroduction to the main habitat with varying success. Aquarists were able to determine that tracking the trends of her consumption rate combined with changes to her swim pattern showed a correlation between the shark's assumed level of comfort/discomfort pre- and post-surgery.

Unfortunately, one month after reintroduction, the sand tiger shark presented with worsened spinal curvature, leading to a second spinal surgery. The second surgery required more invasive procedures including removing a piece of cartilage and placing larger plates. Post operatively the shark rested on the bottom with intermittent periods of swimming short distances. She became severely acidotic and was euthanized due to lack of response to emergency therapy.

Despite the outcome, the knowledge gained from both surgeries and the specific care required afterward provided information that may be useful to veterinarians and aquarists caring for elasmobranchs in other zoos and aquariums.

Investigation into Lymphoid Neoplasia in the Southern Stingray, *Hypanus americanus*.

Melissa C. Morrow, mmorrow@mysticaquarium.org

Mystic Aquarium

The presence of Lymphoid Neoplasia in elasmobranchs is a rare occurrence with a varied range of symptoms, making the diagnosis of this disease hard to confirm. At Wonders of Wildlife National Museum and Aquarium in Springfield, MO there is a 7 year old Southern Stingray "Wilma" that has been diagnosed with Lymphoid Neoplasia with vascular invasion.

Symptoms first arose on May 19, 2019 as a small strip of tumors along the left side of her midline. Over the course of 6 months her symptoms progressed to large tumors covering the majority of her dorsal side and the ventral side of her tail. Following the progression of her symptoms, a skin scrape and abscess swab culture were performed leading to the diagnosis and treatment for *Vibrio alginolyticus* and *Photobacterium damsela* infections. Upon the seemingly ineffectiveness of that treatment, a skin biopsy was administered and submitted to Fishhead Labs, LLC who confirmed the diagnosis of Lymphoid Neoplasia with vascular invasion on September 27, 2019. With this diagnosis, The Wonders of Wildlife facility decided to perform a trial treatment of Prednisone and Lomustine Chemotherapy. The treatment was administered for 4 months, and ostensibly had success. The external tumors presumably went into remission and the stingray was placed back on exhibit June 23, 2020.

Hilo's Story: Providing Intensive Neonatal Care to a Spotted Eagle Ray Pup

Amanda Vaughan, Amanda.M.Crook@Disney.com

Epcot's *The Seas with Nemo and Friends*, Walt Disney World Resort

In December of 2019, a spotted eagle ray pup was born into the 5.7-million-gallon Main Environment at Disney's The Seas. Upon initial examination, the pup appeared externally healthy, in great body condition, and was displaying expected behaviors for growth and development. It was isolated to a pup habitat for one-on-one feeding opportunities, where aquarists observed positive signs of foraging behavior begin. After a few days of witnessing small amounts of consumption from the pup, all foraging behavior unexpectedly ceased. A plan for intervention was made between Animal Husbandry, Management, and Health teams. Bloodwork revealed a high white blood cell count, so twice-a-day tube feedings were administered, in addition to antibiotic therapy. Despite our team's best efforts to sustain the pup, visible loss of body condition continued, prompting modification of the current strategy. Because the ray's health had reached a point of extreme delicacy and our treatment plan needed to be highly aggressive, several factors to balance animal handling with animal health were required. A careful approach that took into account the animal's caloric needs, repetitive exposure to capture and anesthesia, necessary medical treatments, and overall neonate development was designed. After a month of intensive intervention, the pup began to eat without assistance and a training plan was devised. Throughout the process, our team gained several invaluable learnings for critical neonate care, including a greater understanding of digestive time and nutritional needs, best-practices for repetitive handling and anesthesia exposure, lesser-used treatment methods, and highlighting of inter-team communication and camaraderie.

Tuesday, February 22nd

Session 2: Health Management 2

Completion of a Successful CT Scan on a Cownose Ray (*Rhinoptera bonasus*)

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Epcot's *The Seas with Nemo and Friends*, Walt Disney World Resort

At Disney's The Seas, a CT scan was planned for a cownose ray (*Rhinoptera bonasus*) who exhibited chronic spinning behavior. Several previous diagnostics and treatments had been administered, but were unremarkable in findings and behavioral improvement from the animal, hence the decision to proceed with a more invasive procedure. To complete the scan successfully, several caveats would need to be problem-solved, including: transport to an alternate facility, minimization of stressors on the animal, appropriate maintenance of all blood parameters during extended dry-dock time, design of equipment to adequately ventilate the ray while dry-docked, methodology to keep hospital equipment dry and free of salt, and collaboration of care efforts between teams that were unfamiliar working together. In order to best prepare, the Animal Husbandry Team spent time at the hospital facility to understand the building layout and transport path, space restrictions for storage of seawater and aquatic holding tanks, and dimension requirements to fit the animal into the CT machine. In turn, the Animal Health Team familiarized themselves with necessary husbandry equipment and ran through multiple practice runs with aquarium staff to mitigate unforeseen kinks in the plan. After the conclusion of extensive preparatory efforts, the scan was scheduled and all pre-established goals were completed, resulting in a successful procedure. Veterinarians were able to obtain quality images of the ray's brain, spine, and tail base, and we have opened up the door to use CT imagery as a diagnostic tool for our elasmobranch collection in the future, thus increasing animal welfare.

**New Methods for Restraint and Treatment of *Uronema marinum*
in Red Lionfish (*Pterois volitans*)**

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The Aquarium at Moody Gardens

A new method was needed to treat a systemic *Uronema* infection in Lionfish (*Pterois volitans*). Late diagnoses due to an atypical presentation commanded a radical treatment protocol. A drug cocktail of Panacur, Praziquantal, Enrofloxacin, Ponazuril and Vitamin B12, given orally with food was used to combat the infection. To facilitate this new treatment protocol, a new method of restraint needed to be created as well. A woven neoprene mat was used to wrap the fish and keep the venomous spines contained. Combined with neoprene glove, the method was effective and safe. This approach provided for keeper and fish safety while minimizing stress and sedation time. We believe that this method can be used by other institutions to facilitate animals handling safety.

**Towards Understanding Microbial Degradation of Chloroquine
in Large Saltwater Systems**

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(<https://www.sciencedirect.com/science/article/pii/S0048969721056096>)

Circulating saltwater aquariums hosting marine animals contain a wide range of microorganisms, which have strong implications on promoting animal health. In this study, we investigated the degradation of chloroquine phosphate, an anti-parasitic bath pharmaceutical used in saltwater quarantine and exhibition systems, and attributed the reduction in drug concentration to microbial degradation of chloroquine associated with pipeline microbial communities. To advance our knowledge on chloroquine degradation in aquatic systems, we conducted microbial and chemical analyses on three tropical saltwater systems. Our findings show that aquarium microbiome composition is shaped by sampling location (i.e., tank water and pipeline; PERMANOVA $R^2 = 0.09992$, $p = 0.0134$), chloroquine dosing (PERMANOVA $R^2 = 0.05700$, $p = 0.0030$), and whether the aquarium is occupied by marine animals (PERMANOVA $R^2 = 0.07019$, $p = 0.0009$). Several microbial taxa belonging to the phyla *Actinobacteria*, *Bacteroidetes*, *Chloroflexi*, and *Proteobacteria*, along with functional genes related to pathways such as phenylethylamine degradation and denitrification, appeared to have differential (relative) abundance between samples where chloroquine degradation was observed and those without degradation (Benjamini-Hochberg adjusted p -value < 0.05). Together, these results provide practical mitigation options to prevent or delay the development of chloroquine-degrading microbial communities in saltwater aquariums. Our results further demonstrate the need to improve our understanding of the interactions between nitrogen availability and microbial activity in saltwater systems.

**Quarantining Before It Was Cool:
Ecological Approaches in Coral Health Management**

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Hawaii Coral Restoration Nursery, Hawaii Division of Aquatic Resources

Investigation into successful methods in coral restoration has become a progressively important area of focus in the aquatic community. Disruptions to the natural reef system, caused by climate change and anthropogenic activity, has led to increased bleaching events and susceptibility of coral to global large-scale die-off. Subsequently, growing numbers of government-funded agencies, public aquariums, and NGO's are attempting to mitigate this loss through coral restoration. In Hawaii specifically, restoration poses unique challenges due to high levels of endemism and the growth rate of Hawaiian corals—the slowest worldwide. At the Hawaii Division of Aquatic Resources' Coral Restoration Nursery, staff is continually exploring different methods of treatment for various coral maladies. Unlike disease treatment in aquariums, the team must consider the long-term effects that a medication (such as an antibiotic) could have on the ecosystem post-outplant. As all corals coming into the nursery are intended for re-introduction into the wild, treatment regimens must be selected based on a risk assessment for both the facility and future reef outplant site. Following a pervasive cyanobacterial outbreak at the nursery, staff qualitatively determined the treatment success rate for several colonies of *Porites lobata* with hydrogen peroxide. Treatment efficacy varied by colony genotype, tank conditions, severity of initial outbreak, treatment concentrations, and time exposed to the hydrogen peroxide. Within the scope of coral conservation and ecology, this technique, as well as other less-invasive methods that utilize simple tools to address coral health concerns, are further presented and discussed.

Tuesday, February 22nd
Session 3: Husbandry Techniques

Was this Swamp Always Here?

Or

Shouldn't that Water be in a Tank?

J. Chris Emmet, jemmet@ucsd.edu

Birch Aquarium

Around 1:30am on November 26, 2021, one of the primary supply lines at Birch Aquarium catastrophically failed. Approximately 30,000 gallons of seawater were then pumped out of the system, before pumps shut down, leaving roughly one third of the facility's systems without flow, including the 70,000-gallon Kelp Forest tank. Once the reservoir was emptied, the Kelp Forest tank began to backsiphon, losing an additional 30,000 gallons. Staff were onsite within 30 minutes of the failure being discovered, and began responding to the situation, including emergency replumbs & rerouting of water, as well as isolating & identifying where the failure occurred.

Through coordination & teamwork between Birch Aquarium husbandry and facilities staff, as well as support from Scripps Institute of Oceanography facilities, systems were stabilized & bypassed, contractors were brought in, and the line was repaired and the system successfully recommissioned 20 hours from the initial response. Despite interruptions in flow, there was not a single fish mortality, highlighting the importance of a prompt response.

This presentation will discuss how the response proceeded, and how the lessons learned and steps taken can be generalized and applied to other facilities. A major line failure is a "worst case scenario," and staff being prepared for such an event can streamline and smooth the response to such a stressful and time-critical situation.

**Population Management and Introduction Techniques of Aquacultured Fishes
In the New England Aquarium's Giant Ocean Tank**

Lindsay M. Phenix, lphenix@neaq.org
New England Aquarium, Boston, MA

Since 2008, the New England Aquarium has been developing an expansive larval fishes program that has successfully reared 13 different teleost species to adulthood. This program has helped to advance self-sustaining animal populations and has allowed schooling species to reach great abundance within exhibits. One benefactor of these achievements in aquaculture has been the 200,000 gallon multi-taxa Giant Ocean Tank (GOT), with a total population comprised of more than 50% aquacultured individuals. While many challenges can be faced during the larval rearing process, special considerations must be taken into account once these animals reach exhibits. Introduction, and furthermore population management, have presented their own unique trials and tribulations, often due to behavioral and developmental difference from their wild counterparts. Here we will examine the introduction and management techniques used for the smallmouth grunt (*Haemulon chrysargyreum*) and lookdown (*Selene vomer*) populations within the GOT.

**Holistic Husbandry Management of a Population of 0.5 Blackblotched Rays
(*Taeniura meyeni*)**

Amanda Vaughan, Amanda.M.Crook@Disney.com
Epcot's *The Seas with Nemo and Friends*, Walt Disney World Resort

Epcot's *The Seas* 5.7-million-gallon Main Environment is home to five female Blackblotch rays (*T. meyeni*). As our Blackblotched population has increased due to in-house reproduction, we have witnessed the establishment of a perceived 'social hierarchy', as well a variety of social interactions, both aggressive and passive in nature. For this reason, as well as the species' demanding needs for appropriate behavioral training, aquarist experience, tight diet management, and adequate housing, our team continues to evolve our strategy for overall Blackblotched ray husbandry. As of 2021, all five rays consistently participate in surface stretcher training, have a strategy for appropriate social groupings within sessions, take place in a 'behavioral wellness' monitoring tool that assesses their welfare on a daily basis, and have recently completed voluntary captures for physical examinations and barb grooming. As we work to achieve unprecedented animal welfare and staff safety while managing such large elasmobranchs, aquarists make ongoing assessments to streamline feeding and management procedures that uphold 'manners' in a species that can easily become overbearing due to their overall size and outgoing behavior. Through these changes, our team has accomplished more consistent feeding participation from all animals, better understanding of their expected behavior during times of high social aggression, and improved techniques in handling 250+ kilogram animals. We continue to strive for more, with the population currently progressing on voluntary blood and ultrasound behaviors and our team continuing to discern patterns in socialization and feeding trends and how they may relate to overall animal health.

Tuesday, February 22nd
Session 4: Husbandry Techniques (continued)

**Hammering out Hammerhead Husbandry:
Lessons Learned in the Husbandry of *Sphyrna lewini*, and Designing a New Exhibit to Specifically Meet Their
Unique Requirements**

Melissa Bishop and Tyler Rankin
Point Defiance Zoo and Aquarium, 5400 N Pearl St, Tacoma, WA, 98407, USA

In 2018 the Point Defiance Zoo and Aquarium opened the new Pacific Seas Aquarium with the largest display being a 280,000-gallon Sea of Cortez exhibit specifically designed to showcase Scalloped Hammerhead sharks (*Sphyrna lewini*). After one year of growing the animals out, that exhibit successfully opened in 2018 with 0.4.0 animals on display for the public. Scalloped hammerheads are known to be a more difficult species to keep in public aquariums. Many challenges were met and much was learned through the process that will be shared. Also to be shared is compiled husbandry information acquired through the years by facilities that have previously tried to keep this species, as well as others who are currently successful. Some of our challenges included managing the complex social dynamics of female scalloped hammerhead sharks. This contributed to two mortalities while still in holding. Those social dynamics continue to be a challenge today. Also to be shared are transport techniques, feeding strategies, and prophylactic quarantine treatments.

Bonnethead Shark (*Sphyrna tiburo*) Rearing, Days 1 – 425

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Species that were commonly wild caught can no longer be relied upon for collections that aim to be more sustainable in the future. Bonnethead Sharks (*Sphyrna tiburo*), which in 2019 changed in IUCN status from Least Concern to Endangered due to decreasing population size, are notoriously difficult to rear and care for when born in captivity. In February 2020, 6 bonnethead sharks were born at Shedd Aquarium creating an ideal case study of how to successfully rear this species in captivity. Not only were all 6 bonnethead sharks able to survive well past their 1st birthday, they were also handled every other week (27 catchup days) for checkups using tonic immobility (4 minute mean handling time) giving the aquatic community a large data set of biometrics on this species and an example of how this once thought 'delicate' species can in fact be handled in a manner congruent with practices of modern aquarium husbandry. Data collected includes weights, lengths, daily food intake including supplements and plant fiber to mimic recent indications of omnivory in this species, liver size, and bloodwork including lactate levels (lactate mean = 1.93mmol/L +/-0.88mmol/L; 125 samples) which we believe to be a key aspect of success. The data collected can be disseminated to other facilities for future rearing of this endangered species and limit the need for wild collection.

**Use of Animal Training in the Capture and Transport
of Great Hammerhead Sharks, *Sphyrna mokarran***

Melissa Paynter
Georgia Aquarium

This presentation discusses the ongoing training of Great Hammerhead Sharks, *Sphyrna mokarran*, and the use of this training in the capture and transport of this species. Using a moving target, aquarists were able to guide the sharks throughout the habitat, and ultimately allow them to participate in their own husbandry by voluntarily swimming into their transport stretcher. In addition to this, this training program was able to provide mental and physical stimulation, customized nutrition, administration of oral medications and supplements, and reduction of handling stress. These behaviors transferred with the sharks when they were moved throughout the different systems they have been housed in and the training program continues to this day.

Large Elasmobranch Management: A Collaboration

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(305)-743-2247; ²Georgia Aquarium, Inc., ³Florida Aquarium, ⁴Georgia Aquarium,

New public aquarium facilities have opened over the last several decades specifically designed to showcase large elasmobranchs. Guest feedback indicates an expectation to be engaged with larger and in some cases unique megafauna in larger, complex habitats. The focus on guest experience has influenced design parameters and challenged zoological professionals to achieve a higher level of successful care with large sharks and rays.

A partnership commenced in 2017 between Georgia Aquarium and Dynasty Marine Associates to successfully collect, acclimate, and transport several species of larger elasmobranchs for a new, conservation-oriented shark habitat that opened in 2020. A fundamental goal of the new presentation was to transform the mindset of the guest. Many people have a fear of sharks, but once they conclude their experience that fear is transformed into a feeling of appreciation and advocacy. Though several different species were procured for this display, notable advances in husbandry techniques were developed for *Sphyrna mokarran* and *Galeocerdo cuvier*. The three years of research and development throughout this process has led to a better understanding of the initial and long-term care needed for these species. Some of these advances were achieved in relatively brief periods of time while others required a longer, more detailed process. As other facilities around the world consider displaying these particular species, our shared experiences might prove beneficial as we continue to work to advance the best practices of husbandry care for these sharks.

Wednesday, February 23rd

Session 5: Welfare General Session

On The Use of Statistical Modeling in Making Data Informed Husbandry Decisions R You Ready!?

Chad L. Widmer, PhD, chad.widmer@pdza.org

Point Defiance Zoo and Aquarium

In 2018 the new Pacific Seas Aquarium at Point Defiance Zoo and Aquarium opened which includes a 280,000-gallon exhibit featuring scalloped hammerhead sharks, green sea turtles and spotted eagle rays. Soon after opening the Elasmobranch team began noticing negative behavioral issues in the shark collection that were on track to lead to poor husbandry outcomes. One hammerhead shark was chronically rubbing against the front window causing mechanical damage to its cephalofoil whilst another had developed a *Fusarium* sp. fungal infection which is very often fatal. Before the situation worsened, the team wanted to better understand and mitigate the factors driving these negative outcomes. Fortunately, the team had been collecting behavioral data from the time the sharks were introduced which enabled robust statistical analysis. Significant factors affecting shark behavior were identified using generalized linear models. Based on model predictions changes were made that led to positive behavioral outcomes for the collection of hammerhead sharks. Ongoing data collection has enabled the team to statistically address and make data informed husbandry decisions as new issues have arisen.

Don't Blow It Up: Improving Welfare Through Small-Scale, In-House Actions

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North Carolina Aquarium on Roanoke Island,

Aquatic animal welfare is an increasingly vital aspect of aquarium science, but significant challenges may occur in modifying existing habitats and infrastructure in the name of animal welfare. These modifications can be both time consuming and cost prohibitive. The need for upgrades and improvements is a never-ceasing reality of modern public aquariums. However, small and seemingly insignificant changes within an environment can provide perceptible improvement, without breaking the bank, when executed thoughtfully and purposefully.

The Stingray Touch Habitat at the North Carolina Aquarium on Roanoke Island, constructed in 2000, was increasingly displaying the need for improvement based on documented animal welfare assessments. Although no immediate welfare concerns were identified, the scores were steadily presenting lower values than other similar habitats. At the end of 2019 and into the beginning of the COVID-19 pandemic of 2020, monetary resources were limited. Creativity and resourcefulness became key to addressing these animal welfare problems within the given financial and labor limitations. By making several changes over the span of 12-18 months, we were able to measurably improve animal welfare, aesthetics, and functionality within one of our most popular attractions.

Behavioral and Physiological Metrics of Sensory Decline and Welfare in Senescent

Giant Pacific octopus, *Enteroctopus dofleini*

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¹Aquarium of the Bay, ²San Francisco State University,

Senescent octopuses experience extreme physical decline over a period of days, weeks, or months before eventual death. Despite widely known, predictable declines in octopus health in the post-reproductive stage, evaluations of welfare and humane endpoints are not standardized, in part because little is known about sensory and neural degeneration in the terminal phase. This study measured changes in behavioral response to nociceptive stimuli over the course of senescence in giant Pacific octopus (GPO), *Enteroctopus dofleini*, held in public aquariums in the USA (N=9) using von Frey filaments. Post-euthanasia, tissue was collected from arm tips (N=8), neural and epithelial cell death was quantified and compared with arm biopsies of healthy, pre-reproductive (n=2) GPOs. Behavioral data showed a significant difference in threshold mechanosensory and nociceptive response between pre- and post-senescent stages (significant values $p < 0.05$). Cell density declined significantly between healthy and senescent GPOs for axial ganglion neurons ($p < 0.0001$) and epithelial cells at the sucker edge ($p = 0.0016$) tissues. There was a non-significant but clear trend in epithelial tissue death on the dorsal arm ($p = 0.0657$). Our results indicate a pronounced increase in sensitivity to touch at the early stages of senescence, followed by a precipitous decline as GPOs near death. Additionally, declines in cellular density between healthy and perimortem GPOs suggests the loss of sensitivity seen in peri-mortem behavioral assays may be explained by overall loss of neural and epithelial sensory cells. Our data provide new insight into the physiology underlying senescence-induced behavioral changes in octopuses.

Panel Discussion: Animal Welfare

Moderator: Allen McDowell

Wednesday, February 23rd
Session 6: Staff Diversity

Panel Discussion: Increasing and Retaining Minority Professionals in Aquarium Careers

Moderators: Jennie Janssen, Meghan Holst, and George Brandy

ALLY Workshop during lunch break

Wednesday, February 23rd
Session 7: Corals

Florida Coral Rescue

Tanya Ramsey¹ and Beth Firchau²

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Since 2014, the Florida Reef Tract (FRT) has been battling a disease called Stoney Coral Tissue Loss Disease (SCTLD). Over 20 species of reef building corals, including Endangered Species Act listed corals, are susceptible to the disease, often resulting in whole colony loss. Some species experience up to 100% mortality at individual sites. Since November 2018, the Association of Zoos and Aquariums (AZA) has partnered with the Florida Fish and Wildlife Conservation Commission and other agencies to create land-based nurseries for FRT corals in need of rescue from the advancing disease. To date nearly 2000 corals have been removed from the FRT and are being maintained at AZA facilities. Some of the coral species never been held in human care and much is being learned through the work of AZA coral aquarists. New relationships and networks have been created impacting how zoos and aquariums are viewed as partners for conservation.

Partnering in Coral Restoration

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Aquarium Encounters of the Florida Keys and its sister company, Dynasty Marine Associates, have recently begun working with a local not-for-profit company called Reef Renewal USA to help them develop a community-based coral reef restoration program in the Florida Keys. Although the Reef Renewal USA “brand” is relatively new, the management team are some of the key people who pioneered coral reef restoration in Florida. This new endeavor is blending the talents and resources of a passionate team of people from all three companies to launch a bold and innovative approach to coral reef restoration. A key component of this new approach is to fully train and engage the local community in the program so that a sense of ownership is developed. Local and out of town volunteers will be able to participate in everything from land based coral fragging programs to outplanting and reef maintenance programs taking place throughout the Florida Keys.

This program is working with over twenty species of corals, many of which have never been grown commercially or used for reef restoration programs. New, cutting-edge techniques for growing and outplanting these corals are being developed and implemented by this group of entrepreneurs, with the goal of being able to restore more reefs with more corals at a substantially better value than today’s current average.

Expedition Colombia: Coral Reef Restoration in South America

Barrett L. Christie and David M. Hudson, Ph.D.
The Maritime Aquarium at Norwalk

The reefs of Colombia are among the most degraded in the occidental world, with an estimated 1% of historical coral cover left intact amid warming seas, sedimentation, dynamite fishing, freshwater influx, and improper wastewater discharge. In 2019 the Maritime Aquarium undertook a 6 week expedition to Colombia to engage local stakeholders in jellyfish propagation, sea turtle conservation, and coral reef restoration. Alongside staff from the Parque Nacional Natural Corales del Rosario y San Bernardo, the Ocenario Islas del Rosario, Acuario de Rodadero, and the Universidad del Magdalena, Maritime biologists documented the first-ever recorded wild spawning of two *Acropora* species within the Marine Protected Area, and likely the first for the country. Over 100,000 eggs were collected from staghorn coral, *Acropora cervicornis*, and larviculture techniques were taught to locals to improve their understanding of sexual coral propagation techniques, resulting in thousands of coral recruits being generated for reef restoration and ongoing research projects intended to raise the standard of reef restoration in the region. Doing conservation work in remote locations such as South America has many inherent challenges to overcome, but also great potential for high-impact conservancy.

Wednesday, February 23rd **Session 8: Conservation**

Nautilus Conservation in the 22nd Century: Where Do We Go from Here?

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In November 2021, the Save the Nautilus organization celebrated its 10th anniversary! Over that decade, we have collaborated with universities, governments, communities, and non-governmental organizations to address some big knowledge gaps in our understanding of nautilus to support conservation efforts. That led to local, national, and international regulations of nautilus to curb their population decline because of unregulated fishing practices. However, there are plenty of examples of species that have been regulated under various agreements, but conservation efforts are not successful. The best/worst example of this is *Phocoena sinus*, the vaquita, and *Totoaba macdonaldi*, the totoaba, whose populations are still in decline even though both species have been listed on Appendix I of the Convention on International Trade in Endangered Species since the 1970's. With these stopgap measures now in place, we can continue investigating aspects of the natural history of nautilus that remain a mystery, such as reproduction, diet, sedimentation, life span, species relatedness, and the role nautilus play in their deep-sea habitat. Successful conservation does not happen on paper. Successful conservation is a result of collaboration of a diverse group of stakeholders, education and opportunity at all levels, and a commitment to improving outcomes that benefit the species and people. As the 22nd Century creeps closer and closer, the goal should be to see nautilus disappear, not from the wild, but from endangered species lists and that is what we aim to work towards.

A New Species of Nautilus from Fiji: Collection, Husbandry and Education (2020)

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The Fijian Islands are home to a population of nautilus that are geographically isolated from all other nautilus. This geographic isolation suggests, then, that the nautilus of Fiji may also be genetically distinct from other nautilus and represent a new species. After the 2017 CITES legislation to regulate nautilus exports, a five-year project was started in Fiji to support *in situ* and *ex situ* conservation efforts. As part of this plan, additional partners and stakeholders were brought to the table to continue population surveys, provide training/education to local students, and refine nautilus husbandry. With the strong likelihood of the Fijian nautilus being their own distinct species, it is imperative to have a management plan in place to ensure they receive effective stewardship. The successful use of this model in Fiji can also then be applied to other nautilus range states throughout the Pacific to promote education and conservation. These initial efforts have already led to the description of new species of nautilus in Vanuatu and American Samoa leading to additional questions surrounding the differences of their natural history, husbandry considerations, and outreach possibilities.

Making the Stars Align: Why Aquariums Are Key Players in The Recovery of the Critically Endangered Sunflower Sea Star (*Pycnopodia helianthoides*).

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University of Florida

The sunflower star, *Pycnopodia helianthoides*, is a keystone predator of sub-tidal kelp and rocky reef ecosystems from Alaska, USA to Baja, Mexico. They shape the benthic communities they inhabit, preying primarily on bivalves and other echinoderms. Starting in 2013, a sea star wasting event (SSW) was observed in twenty-two Asteroidea species along the Pacific coast, acutely affecting *P. helianthoides*, reducing the population by ninety percent. The most extreme loss was seen in the southern portion of their range, and *Pycnopodia* are now considered extirpated from California and Oregon. *P. helianthoides* was listed as critically endangered across its entire range by the International Union of Concerned Scientists (IUCN) in August, 2020. One of the IUCN action items listed starting a captive rearing program for *P. helianthoides* reintroduction, as it is unlikely sea stars will be able to naturally recruit to coastal waters where population densities are too low. Researchers at the University of Washington Friday Harbor Labs have shown initial success for the closed loop aquaculture of this species. Reintroducing *P. helianthoides* could provide one solution to maintaining resilient kelp ecosystems by reestablishing this keystone predator. Results from a survey sent through the aquatic info listserv in September 2021, identified aquariums that are uniquely poised as collaborators in this new conservation initiative, with four Aquariums holding valuable genetic broodstock from wild populations that no longer exist. Further investigation identified facilities with appropriate aquaculture resources and staff expertise to begin formal discussions to promote this species as an AZA SAFE candidate.

RAW Business Meeting

Thursday, February 24th
Session 9: Morning Buzz (short presentations)

The Kraken Curriculum – A New Professional Development Tool

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Professional development for aquarists, LSS operators, divers, and water quality technicians doesn't just have to happen once a year at RAW; it can happen every day right at your home institution. Professional development (PD) can require substantial investments of time, but as staff become more knowledgeable and proficient, such investments in time pay large dividends. Surveys of continuing education among aquarium professionals (n=150) indicate that 28% complete no PD on an annual basis, and the majority (>50%) do less than 10h/y (mean 13h/y), though time spent pursuing PD on personal time was significantly higher (32h/y). The first-year costs of onboarding, training, and inefficiencies associated with bringing on a new employee are significant, and at Maritime Aquarium that has been calculated to reach nearly \$14,000 per staff member. Given these costs of training and developing new staff, efforts spent on in-house professional development can actually save resources and time if they lead to better staff retention and proficiency. Adding to the variety of resources available to managers to build an in-house professional development program, the Kraken Curriculum has been created from existing content on AnimalProfessional.com with links to supplemental materials, all curated by topic to lead individuals or groups through industry knowledge on animal husbandry, life support systems, water quality, veterinary care, collection planning, and more. Organizing existing content in this way allows for learning to occur from a breadth of perspectives, while also allowing industry knowledge gaps to be elucidated and filled through future presentations.

Different Brains Different Voices

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The Aquarium at Moody Gardens

With a staff with wide ranging experiences, the differing personalities and backgrounds communication can be a challenge. How can staff leaders effectively convey information to staff in the most effective manner? Moody Gardens has begun a pilot program using the on-line personality test "16 Personalities" to identify different personality types and to teach staff what make their coworkers "tick". This allows the staff to understand their coworkers better and avoid conflict that comes with miscommunication.

Sharing the Wealth: Senior Biologist Presentations at Moody Gardens

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The Aquarium at Moody Gardens

At the Aquarium at Moody Gardens, the aquarium husbandry staff has a variety of backgrounds and experience. Senior biologist staff are given the opportunity to give short presentations on a husbandry topic of their choice during weekly fish staff meetings. This not only makes sure that industry and institutional-specific information is communicated clearly and standardized for all aquarium staff, but also allows senior staff a way to deepen their knowledge and pass on their experience. In this talk I will highlight some of the presentations senior staff have given and future plans for this initiative.

Chondrocensus 2022: Building and Streamlining Collaborative Capacity

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¹National Aquarium, ²Zier Niemann Consulting

The AZA SAFE Sharks and Rays International Census of Chondrichthyans in Human Care (aka the ChondroCensus), which launched in 2019 at www.sharksandraysproject.com as a reboot of the American Elasmobranch Society's International Elasmobranch Census, has grown to contain 274 unique species from 235 facilities across 54 countries world-wide as of November 2021. To make this collection of data a truly useful tool for engaging in meaningful, strategic, and collaborative chondrichthyan conservation, stakeholder Teams can complete a survey providing basic husbandry info and add their organizational accrediting body. These data can then be searched by region, organizational accrediting body, genus or species, sex, and the surveyed husbandry criteria. In addition to streamlining periodic reporting required by organizational accrediting bodies, these new features will also anonymously connect stakeholders with each other and with the research community to advance husbandry practices and facilitate collaborative chondrichthyan conservation efforts. Teams always remain anonymous and thus maintain control over their data, as search results are only shown as the number of Teams per ChondroCensus Region. Thus, each stakeholder facility's Team Coordinator holds the critical role of whether their Team chooses to respond to any requests for connection or information, thereby identifying themselves as stakeholders of the species a search query pertains to.

A Sea Turtle Wetsuit as a Therapeutic for Buoyancy Issues

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The Living Coast Discovery Center

A short time after closing our doors due to COVID, our rescued Loggerhead Sea Turtle experienced sudden changes in her buoyancy negatively impacting her quality of life. With limited resources, funding and time, our team quickly exhausted traditional medical options to remedy the issue. We began to explore other methods to manually achieve neutral buoyancy and in a collaborative effort with O'Neill Wetsuits, a custom wetsuit was developed to allow for targeted weight adjustments. With all in person meetings restricted by the pandemic, measurements, prototypes and data were all exchanged back and forth virtually and through the post with a final product developed at the end of 2020. After several trials, the novel use of weighted wetsuit therapy was used to correct the problem, improving the sea turtles long term ability to swim, eat, and breathe.

Thursday, February 24th
Session 10: Husbandry Techniques 2

Thrash of the Titans: Stretcher Training *Arapaima gigas*
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John G. Shedd Aquarium

Back in 2019, the question was posed: “How can we move three 6-foot long *Arapaima gigas* out of a 16,500-gallon exhibit?” The best place to start was with stretcher training using a 121 Animal Handling Flexible Shark Sling. However, these animals had never before had any type of training.

I began to station train all three arapaima by offering food only when they came up to a certain spot. They picked up on the station quickly, so I introduced a target, which two of the three took to immediately. At this point I decided to bring in a second person to help with training sessions, separating them into groups – the two that followed a target, the one that didn’t. Once this was accomplished, the stretcher was introduced.

The stretcher was largely met with hesitation, but after several months of training, I had success and got one of them to regularly swim into the it! However, multiple instances of the arapaima panicking while in the stretcher caused them to lose all of their momentum.

Then the pandemic hit, forcing us to take a step back in the stretcher training due to staffing. I reassessed our strategy, had one trainer per arapaima, and introduced a light as a “bridge” during training, all without the stretcher. I redesigned the stretcher and have been working at getting one of them to swim into the stretcher, with the plan to slowly work on getting them comfortable enough to lift them safely out of the exhibit.

Stickin’ It to the Sturgeon: Training for Diver Safety and Animal Welfare
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Wonders of Wildlife

Being both primitive and endangered, sturgeon of all species have long been a popular choice for freshwater exhibit displays. An often large bodied animal that is not known for its shyness around human divers, this leads to concerns of safety during routine maintenance as well as questioning what is the best method to administer nutrition and supplementation on the individual level. The industry’s rotation of primary care takers turns old training plans into over conditioning and a new approach must be developed to attain appropriate behavioral goals.

At Wonders of Wildlife (WOW), a training plan was implemented in our 100,000-gallon native community exhibit. The species involved with the training are White Sturgeon (*Acipenser transmontanus*) and Lake Sturgeon (*Acipenser fulvescens*). Two divers enter the exhibit with a long PVC Tee, soft pouch, and an aqua maraca (audible bridge). This method uses operant conditioning as well as synchronized teamwork to ensure diver safety while not compromising animal welfare and providing appropriate enrichment. Animals are gently diverted from performing previous unwanted behaviors and are rewarded at the execution of safe practices. The result of this operant style training has led to less frenzied animals, correctly managed nutrient intake, and a routine enrichment program.

Culturing the Flower Hat Jelly

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Mote Marine Laboratory

The flower hat jelly, *Olindias formosus* (Hydrozoa: Olindiidae), is a popular display species in public aquariums. Advancements in reproducing this species are highly sought after due to limited availability of wild specimens and limited culturing success. At the National Aquarium, several colonies of *O. formosus* hydroids were successfully settled in static bins at 16-24°C 4 weeks post-in vitro fertilization. Optimal temperature for hydroid growth was found to be 24°C, and medusae development was induced at 16°C. Initial attempts at rearing newly liberated medusae in flow-through bins on a diet of *Artemia* nauplii and rotifers yielded behaviors of food capture and active rejection of food. Observation of a novel luring behavior led to the realization that larval fish are a key food source for this species. Newly liberated medusa were housed in flow-through bins and fed larval fish from a 500,000 gallon Caribbean exhibit. As the medusa grew, larger fish were introduced to their diet increasing their growth exponentially. Using these techniques National Aquarium was able to complete the life cycle of *O. formosus* for the first time in captivity.

Culturing Live *Americamysis bahia* in an Existing System: Saving Money One Shrimp at a Time

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Mysid shrimp, *Americamysis bahia*, are small crustaceans used in the aquarium industry as a specialized food item for sea dragons, seahorses, pipefish and cephalopods. They provide a high protein diet that has led to increased growth rates in several aquaculture species. Many institutions dedicate financial resources to ordering live mysids to support high maintenance and specialized species. The New England Aquarium has directed this expense into trialing and developing an in-house culture using a low-cost, low-maintenance, small foot print design utilizing an existing system. This culture will serve to put money back into the aquarium and increase our sustainability. Controlling the culture conditions of our live foods gives us more control over what we are adding to our tanks and feeding our fishes, leading to a more successful and viable collection.

Thursday, February 24th

Session 11: Husbandry Techniques 2 (continued)

Something to Shellibrate: Refining Husbandry for Successful Springsnail Propagation

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Arizona Center for Nature Conservation/Phoenix Zoo

Hydrobiid snails are very small, gill-breathing mollusks inhabiting freshwater seeps, streams, and springs. Twelve species of Hydrobiid springsnails in the genus *Pyrgulopsis* are native to Arizona, with all considered Species of Greatest Conservation Need. At the Arizona Center for Nature Conservation/ Phoenix Zoo (ACNC), we work in partnership with Arizona Game and Fish Department (AZGFD) and U.S. Fish and Wildlife Service (USFWS) to establish *ex situ* conservation programs. The goal of these programs is to successfully create breeding populations of springsnails that will produce offspring for future augmentation and repatriation of wild sites. We have housed four different *Pyrgulopsis* species since 2008, including one endangered and one threatened species under the ESA. Over the years we have refined tank design, life support, and water chemistry to improve our husbandry, which has led to increased reproductive success. Recently, we have successfully reproduced Huachuca springsnails (*P. thompsoni*) and observed emergence of juveniles year-round. In this species, we have also observed exponential population growth, temporal activity patterns, and habitat preferences. We aim to apply the knowledge gained from our success with *P. thompsoni* to the recently acquired, threatened San Bernardino springsnail (*P. bernardina*), which is known to exist at a single spring in the U.S and two sites in Mexico.

Nurse Sharks Anyone? D.I.Y. Long Distance Shark Transport

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Point Defiance Zoo & Aquarium

The transportation of sharks across multiple states in excess of 2300 miles is not groundbreaking. However, executing the coordination, fabrication, and transportation itself completely from within an organization can be a significant and sometimes impossible undertaking for many facilities. In the fall of 2021, Point Defiance Zoo & Aquarium completed a sixty hour transport of six adult nurse sharks across six states, all supported by in-house efforts and expertise. Information regarding the construction of transport containers out of plywood, coordination of mobilization logistics, including emergency support from aquarium colleagues, and remote water quality monitoring will be among the items discussed. Not to mention, in the midst of a global pandemic, why would anyone do such a thing, and who in the world would be willing to take one, no six, for the team? All that and more will be discussed in an effort to share knowledge, lessons learned, and a good old fashioned shark transport story for the industry archives.

Growth and Feeding Strategies in the Husbandry of *Mola mola*

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The Ocean sunfish (*Mola mola*) is an enigmatic species, with many aspects of its biology and life cycle still requiring further investigation and understanding. Its nutritional requirements are a central topic of interest, as feeding strategies are key to ensure good husbandry practices. Fine tuning their diet regime should promote captive specimens' overall condition and growth. There are different management methods being applied from various institutions over the world and while some maintain a consistent percent BW per day ration, others apply an adjusted percentage according to the animal's development. Across institutions, BW percentages offered daily, vary from 5-6% at early stages to less than 1% for over 100Kg animals, distributed in one to six meals per day. Combining data from wild sunfish diet research and food consumption rates collected from captive animals we present key factors to define a feeding regime specific for this species. Institutions must not assume that one rule fits it all as there are important factors to consider. Aquarium systems, rearing parameters, animal's condition, and metabolism also impact the feeding regime and thus, must be evaluated continuously to apply the best practices to enhance longevity of these spectacular animals on display.

Culture and Display of the Ctenophore, *Beroe cucumis*

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Aquarium of the Pacific

With approximately 200 described species of ctenophores, representation at public aquariums in the United States is usually contained to one or two species. With their light reflecting comb rows and alien like bodies, ctenophores make for dramatic jelly displays. Ctenophores from the genus *Beroe* are particularly fascinating specimens. With a large mouth and ovoid shape, they look like nothing else normally displayed as a "jelly". Due to their specialized diet of other ctenophores, they are a challenging species to work with and not very common. The species *Beroe cucumis* has a global distribution and specializes on cydippid and lobate ctenophores as prey. Using cultured *Mnemiopsis leidyi* as a food source, the Aquarium of the Pacific has been able to learn techniques for the successful culture and display of this species.

Thursday, February 24th
Session 12: Sustainable Collections

Aquatic Sustainability the Next Steps

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The AZA Aquatic Collections Sustainability Committee has been actively developing new tools, resources and recommendations for how we can improve the sustainability of our aquatic exhibits. Each facility is unique and have different needs and access to resources. Decision management is the first step to ensuring animal populations are not only sourced appropriately, but that welfare, longevity, reproduction potential and facility expertise are considered.

The focus of this talk will be on collection planning with an emphasis on options to increase sustainability in our aquariums and zoos through the Larval Programs Distribution Model with supporting Sustainability Fund. This presentation will overview the teams within the ACSC, the areas of work, and how these efforts need the input and support of the RAW community.

Endangered Fish, on Sale Cheap in the Back of a Denny's

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Aquarium at the Boardwalk

Lots of interesting and aquarium-suitable species have been collected and bred by dedicated aquarium hobbyists. As a freshwater fish extinction crisis looms, many of these species have become endangered or extinct in the wild, and now only exist in the hands of private breeders, often far from their native range. While many species are commercially viable and can be found at big box pet stores, many more are not, and have been remarkably well curated for decades in the hands of relatively few hobbyists. These hobbyists are loosely organized into breeding groups and clubs that focus on killifish, livebearers, and cichlids. However, in recent years these clubs are mostly trending downward. Their leaders and members are aging, and the fish they curate are at risk of becoming extinct in the hobby. Public aquariums don't historically engage this group very well, despite our missions of preserving species, and the low difficulty level of propagating many of these fish. I'll provide my recent experiences with learning about and raising some of these fish, and how rewarding it's been engaging killifish and livebearer clubs.

Using Data for Sustainable Collection Planning and Conservation

Sandy Trautwein, Ph.D., Director of Aquatic Conservation and Product Management

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Species360

Recent data on the most financially successful aquariums indicates that being good at your mission is more important than ever². As the role of public aquariums continues to evolve, aquariums are seeking mission-based opportunities to promote their contributions to sustainability, animal rescue, and conservation. This presentation will review how data can help the aquarium community transform animal records into powerful tools to help promote our collective achievements and positive impact on the world.

²"Future Aquarium Trends" webinar hosted by Species360; data provided by Impacts Experience.

The Coral Reef Aquarium Fisheries Campaign: Year in Review

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The Coral Reef Aquarium Fisheries Campaign

In 2021, The Coral Reef Aquarium Fisheries Campaign took a comprehensive approach toward its goal of empowering sustainable coral reef aquarium fisheries that support biodiversity conservation, healthy coral reefs, and the livelihoods of fishers, traders, and others who depend on them across the global value chain. On advancing policy, the Campaign completed an analysis of the regulatory landscape for marine aquarium fish fisheries in the State of Florida, outlining a comparatively robust regulatory framework. Accordingly, trends in catch data have remained largely stable or on the incline over time. The Campaign also works to upgrade the value chain of aquarium fishes. On this front, we've identified genes in fishes that respond to cyanide exposure in clownfish, guiding us to target the enzymes they produce in developing a field test. Meanwhile, Mystic Aquarium volunteers completed a nationwide canvass of ~3,200 marine aquarium businesses that we can engage to understand the U.S. trade and help them achieve environmental and economic sustainability in business operations. The Marine Science Magnet High School innovated a new educational experience for their kids while they pivoted to a hybrid model in the midst of the pandemic, sending lab kits...that is, aquarium kits...to students' homes to learn aquarium & aquaculture science. And finally, on the aquaculture R&D front, we've published a peer-reviewed research article to help aquaculturists increase aquaculture capacity for the royal gramma, one of the most popular marine aquarium fishes in the U.S. Come see us and find out what's in store for 2022!