DRUM *and* CROAKER

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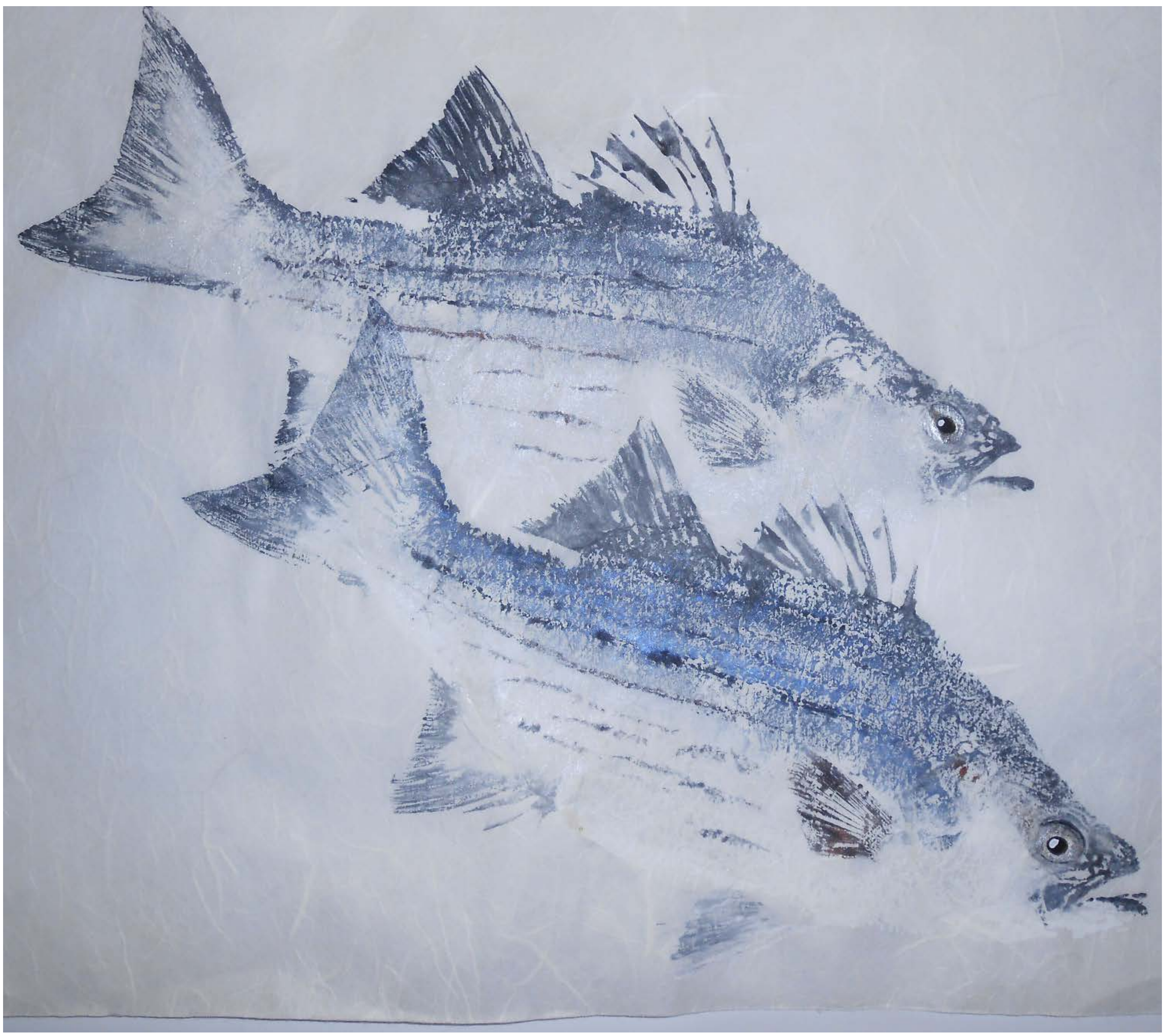

TABLE OF CONTENTS
Volume 49, 2018

Cover Art: "White Bass." Gyotaku print by Bruce Koike.

Interior Line Art: Craig Phillips, D&C 1968.

DRUM AND CROAKER ~50 YEARS AGO
Richard M. Segedi

Excerpts from 1968, Edited by Craig Phillips, Assistant Curator, National Fisheries Center and Aquarium, Washington, D.C.

VANCOUVER KILLER WHALES

Murray Newman's whales received nation-wide attention in a filmed news spot on Walter Cronkite's evening news coverage the 25th of April.

ORINOCO AND BIMINI

Bill Braker, Director, and Don Zumwalt, Curator, of the Shedd Aquarium returned in mid-April from a collecting trip to the Cinarnco River, a tributary of the Orinoco, about 350 miles south of Caracas, Venezuela. About 600 fresh water fish of 35 species were shipped home. During the last half of May these travelers planned to be in Bimini.

NEW ENGLAND AQUARIUM

The New England Aquarium Corporation is an independent, non-profit organization created in 1958 to establish a public aquarium in the Metropolitan Boston area. Construction is presently well-advanced at a site on Central Wharf on Boston's waterfront. The aquarium is scheduled to open this fall.

PUBLIC AQUARIUMS IN JAPAN

Richard M. Segedi, Curator, Cleveland Aquarium

One of the most striking differences between the aquariums of Japan and those of this country is the general attitude of the visitors. Most Japanese aquariums have open pools and/or open tanks which are accessible to the visiting public. Yet coins, papers and other trash are not to be seen in the displays. In one aquarium (Yase) there is a tank on a stand in the public area, with the top completely uncovered and unwatched, containing several specimens of Pterois. In another (Suma), the electric eel demonstration equipment, as well as the eel's tank, is out on a table in the public area. Japanese aquarium visitors also spend much more time in observing individual displays. They read all labels and watch the display specimens intently.

FROM BILL FLYNN, CURATOR OF THE PITTSBURGH AQUAZOO

Our new Aquarium, scheduled to open on July 4, 1967 but delayed by strikes in the construction industry, opened its doors on October 1, 1967. From that date until March 1, 1968, we have had over 125,000 paid visitors at $1.00 for adults and 25¢ for children under 16.

SAFETY

Persons responsible for aquarium operations should be alert to accidents and safety hazards which are unique to their activities. Recently, an employee of the National Aquarium was severely burned on the hands while holding calcium chloride during the preparation of artificial sea water. The accident was serious enough to result in tine lost from the employee's job.

TONIC IMMOBILITY IN THE PADDLEFISH, *Polyodon spathula* (POLYODONTIDAE)

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Abstract

Within public aquaria, there has been an ongoing search for improved capture and restraint techniques to be utilized with large and/or sensitive aquatic ectotherms. While a vast majority of these improvements have been focused on the marine megafauna most commonly kept in the aquarium environment, the authors found a significant lack of information regarding improved capture and restraint techniques for large freshwater teleosts and other fishes. Tonic immobility (TI) is a common technique employed by field researchers and aquarists to manually restrain elasmobranchs in order to facilitate routine husbandry and veterinary care. This paper serves to demonstrate the use of TI in a small group of Paddlefish, *Polyodon spathula,* in order to aid in transport, gavage feeding, and the administration of oral antihelminthic drugs. In two trials, over 74 animals were handled and placed into dorsal recumbency with the anterior end placed slightly below the posterior end. Time from moment of capture to induction of TI was measured and found to be 8.4±2.3 seconds. TI was not found to be sustainable for long periods of time (>90s) in this group of animals, however, it was still found to be a viable method for short-term immobilization, allowing the authors and veterinary staff ample time for several routine veterinary procedures.

Introduction

Paddlefish, *Polyodon spathula* (Acipenseriformes: Polyodontidae), are a primitive fish species that was once widely distributed through central North America (Jennings and Zigler, 2009) though populations have declined significantly throughout the 20th century (Bettoli *et al*., 2009). In response to the decline of the wild fishery, much attention has been focused on understanding the life history of the species, especially as it pertains to reproduction in efforts to bolster wild stocks through aquaculture. To date, most of the published studies on the species have focused on nutrition, growth, or fecundity; as such there is a paucity of data on the behavior of the species except where it pertains to reproduction or feeding.

Polyodontid fishes are phylogenetically most closely related to the sturgeons. However, these fishes share some similarities with the elasmobranchs both morphologically and anatomically. Externally the scaleless epidermis and heterocercal caudal fin of the paddlefishes bear a striking gross resemblance to that of sharks, but the similarities are more than skin deep, as polyodontid fishes also possess a cartilaginous skeletal structure and a spiral colon. The similarities between the Acipenseriformes and elasmobranchs are unsurprising as both evolved early in the fossil record and have remained relatively unchanged for millions of years (Choudhury and Dick, 1998).

Table 1. Some references to elasmobranch tonic immobility responses from the literature.

Species	Common	Induction (s)	Duraton (s)	Reference
Cephaloscyllium ventriosum	Swellshark	36	75-91	Henningsen 1994
Mustelus canis	Dusky Smoothhound	n/s	n/s	Whitman et al., 1986
Triakis semifasciata	Leopard Shark	28	37	Henningsen 1994
Carcharhinus amblyrhynchos	Grey Reef Shark	n/s	n/s	McKibben et al., 1986
Carcharhinus galapagensis	Galapagos Shark	n/s	n/s	Lowe et al., 2006
Carcharhinus leucas	Bull Shark	n/s	n/s	Werry et al., 2011
Carcharhinus melanopterus	Blacktip Reef Shark	25	67-121	Henningsen 1994
Carcharhinus melanopterus	Blacktip Reef Shark	n/s	n/s	Davie et al., 1993
Carcharhinus perezi	Caribbean Reef Shark	30	210-338	Henningsen 1994
Carcharhinus perezi	Caribbean Reef Shark	n/s	n/s	Garla et al., 2006
Galeocerdo cuvier	Tiger Shark	n/s	n/s	Holland et al., 1999
Negaprion brevirostris	Lemon Shark	n/s	100-600	Watsky and Gruber, 1990
Negaprion brevirostris	Lemon Shark	n/s	n/s	Sundstrom and Gruber, 2002
Rhizoprionodon terraenovae	Atlantic Sharpnose Shark	n/s	n/s	Gurshin and Szedlmayer, 2004
Triaenodon obesus	Whitetip Reef Shark	21	165-189	Henningsen 1994
Sphyrna lewini	Scalloped Hammerhead	n/s	n/s	Young et al., 2002
Sphyrna tiburo	Bonnethead	n/s	n/s	Smith and Curran, 2017
Pristis microdon	Freshwater Sawfish	n/s	n/s	Whitty et al., 2009
Rhinobatis productus	Shovelnose Guitarfish	17	126-139	Henningsen 1994
Urobatis halleri	California Round Ray	43	52	Henningsen 1994
Rhinoptera bonasus	Cownose Ray	18	181-229	Henningsen 1994
Raja eglanteria	Clearnose Skate	46	29-41	Henningsen 1994
Dasyatis americana	Southern Stingray	24	82-210	Henningsen 1994

In most vertebrates, tonic immobility (TI) is known primarily as a catatonic response to extreme stress which is exhibited after the subject has passed the fight or flight response and been captured and restrained (Brooks *et al*., 2011). Nearly all taxa of vertebrates have been shown to exhibit some form of TI response including humans (Gallup 1977), sea turtles (Rusli *et al*., 2016), and is particularly well documented in chickens (Gilman et al., 1950) and other fowl. In sharks, the TI response has been found to be effective when specimens can be rapidly restrained and inverted into dorsal recumbency (Gruber, 1980; Watsky and Gruber, 1990).

Practical application of TI allows handling of wild sharks for research purposes, as the procedure immobilizes animals quickly and safely for tagging or blood collection and is even suitable for minimally invasive surgical procedures (Stamper, 2007; Kessel and Hussey, 2015). This practice has obvious implications for husbandry of captive animals as well and has been described from a number of shark and ray species in public aquaria (Henningsen, 1994). An incomplete list of elasmobranch species exhibiting a strong TI response is summarized in Table 1.

Methods

Fifty-Three *P. spathula* specimens were permanently housed in a 53,000 L exhibit measuring 14.6 x 5.2 m with a depth of 1.2 m. Water temperature is maintained between 21-23°C and the pH 7.8-8.0. The animals were broadcast fed 3-4x daily 1-1.3 kg of chopped superba krill, pacifica krill, freshwater Mysis, bloodworms, and/or fish roe. In addition to the *P. spathula*, approximately 60 yellow perch (*Perca flavescens*), two common carp (*Cyprinus carpio*), and a smallmouth buffalo (*Ictiobus bubalus*) resided in the display.

In the initial trial, over 60 specimens of *P. spathula* were handled during transport from Missouri to Arizona and during gavage feeding using standard TI methodology for elasmobranchs. Animals were inverted and placed in TI both submerged and in air over 400 times total. See Figure 1 for illustration of handling techniques used to induce *P. spathula* into TI.

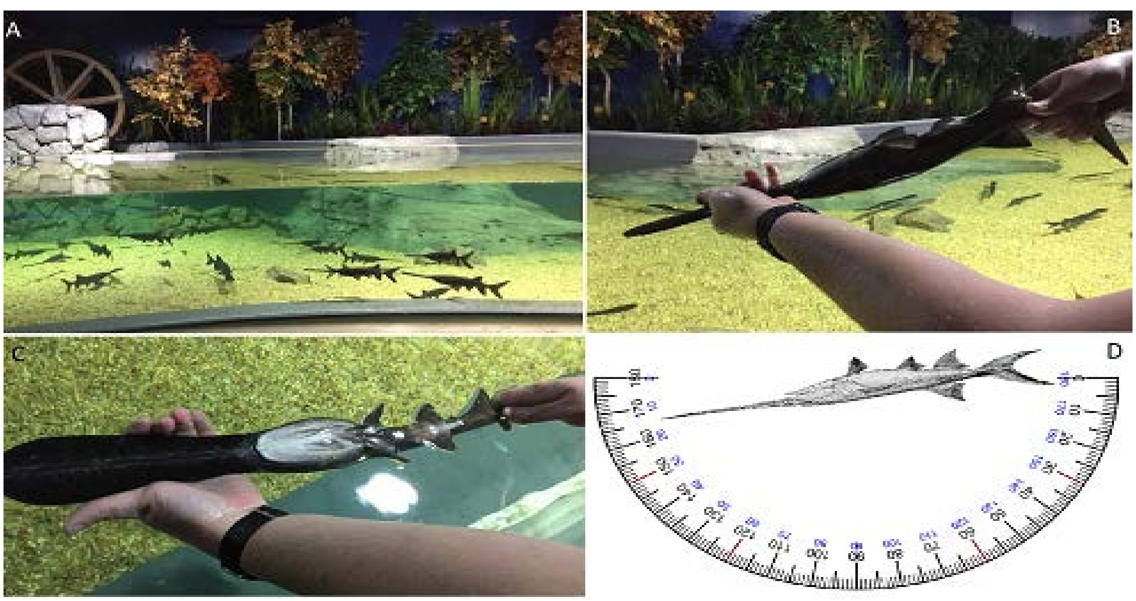

Figure 1. Induction of tonic immobility (TI) in the paddlefish, *Polyodon spathula*. 1a. Paddlefish Exhibit at OdySea Aquarium featuring 53 juvenile specimens. 1b. & 1c. *P. spathula* in TI. 1d. appropriate positioning for rapid induction of TI- animal is in dorsal recumbency with the anterior end lowered approximately 15-20°. Though not shown here, the authors recommend wearing latex or nitrile gloves when handling paddlefish to avoid dermal lesions.

In a second, more controlled, experiment, 14 specimens of *P. spathula* from the exhibit at OdySea were captured by hand, grasping the rostrum and the caudal peduncle. Nitrile gloves were employed to minimize damage to the animals (epidermal lesions) from handling. The animals were immediately inverted into dorsal recumbency while submerged, with the anterior end lowered slightly (15-20°) below the posterior. Induction of TI was considered to be achieved when the animal became motionless, ceased struggling, and entered into a deep pattern of rhythmic ventilation as evidenced by opercular movements.

Results

All specimens of *P. spathula* in the initial trial showed a strong TI response which could be rapidly induced and sustained for short-term handling during transport and gavage feeding. This technique proved quite effective at minimizing damage to the rostrum when transferring animals between quarantine and exhibits during the opening of the aquarium, as well as for collection of blood and gavage feeding of both antihelminthic medications and supplemental nutrition.

During the controlled experiment, mean induction time was found to be 8.4±2.3 seconds with a range of 5.3-12.6 seconds. TI was not found to be sustainable for extended periods, with most specimens spontaneously reviving (even when still inverted) in approximately 30-90 seconds.

Table 2. Tonic immobility induction time in *Polyodon spathula*.

Species	Common	Induction (s)
Polyodon spathula	Paddlefish	8.4
Polyodon spathula	Paddlefish	12.6
Polyodon spathula	Paddlefish	6.4
Polyodon spathula	Paddlefish	8.2
Polyodon spathula	Paddlefish	10.7
Polyodon spathula	Paddlefish	7.3
Polyodon spathula	Paddlefish	5.3
Polyodon spathula	Paddlefish	6.9
Polyodon spathula	Paddlefish	10.7
Polyodon spathula	Paddlefish	7.7
Polyodon spathula	Paddlefish	6.7
Polyodon spathula	Paddlefish	10.4
Polyodon spathula	Paddlefish	10.5
Polyodon spathula	Paddlefish	5.5

Discussion

To the knowledge of the authors this report serves as the first documented intentional induction of TI in *P. spathula*. The use of TI in elasmobranch husbandry as popularized by Henningensen (1994) has been of tremendous benefit to aquarists worldwide in reducing animal stress and furthering the highest standards of husbandry. This technique as applied to polyodontid fishes (and perhaps Acipenseriform fishes as a whole) holds great promise in husbandry applications due to the inherent proclivities of paddlefish husbandry. The authors have found *P. spathula* to be especially sensitive to bruises, blisters, and other dermal lesions even with careful handling and the use of nitrile gloves. In captivity, this species struggles to adapt to artificial feeding and paddlefish energy reserves are presumably much lower than other freshwater species. Therefore, any reduction in stress or potential for secondary infections/dermatitis are beneficial in the husbandry of this species.

During this study, the use of TI has been very beneficial in restraining animals for blood collection, administration of IM injections, gavage feeding of underweight animals, and especially in the *per os* administration of antihelminthic medications. Over 13 species of endoparasitic metazoans are known to infect *P. spathula*, including five trematodes, three cestodes, and five nematodes (Hoffman, 1999). Upon acquisition, nearly all of the paddlefishes in the current study were infected with *Hysterothylacium cf. dollfusi* and/or *Contracaecum cf. spiculigerum* (Nematoda), and a significant amount also had concurrent infections of *Marsipometra spp.* (Cestoda). The parasite burden of new animals coupled with both the stress of transport and the fact that juveniles are frequently acquired add to the overall physiological burden which can have profound effects on the ability of the animals to thrive in a public aquarium. This technique also reduces stress and opportunity for injury during handling, allowing for administration of routine deworming medications (e.g. fenbendazole 25mg/kg, pyrantel pamoate 10mg/kg, praziquantel 50mg/kg). Additionally, the tranquil response of *P. spathula* during TI allows for rapid measurements to be taken so that antihelminthic dosages may be more precisely calculated for each individual animal rather than making assumptions for a population; this is critical with certain drugs such as fenbendazole, which has been implicated in toxicosis in certain fishes (Myers *et al.*, 2007) reptiles (Alvarado *et al.*, 2001; Neiffer *et al.*, 2005) and birds (Howard *et al*., 2002; Bonar *et al*., 2003).

The exact mechanism of the TI response in *P. spathula* (or other fishes) is not known with certainty. It is well-documented that the response varies significantly between species, with not all elasmobranchs exhibiting a strong-enough response for the purposes of husbandry, surgery, or handling (Henningsen, 1990). Paddlefish seem to display a strong TI response which is induced rapidly, but when being restrained manually does not persist for much longer than approximately 90 seconds in most cases. This stands in stark contrast to some elasmobranch species (e.g. *Negaprion brevirostris*) which exhibit a strong TI response, some of which can remain immobilized in dorsal recumbency for 10-30 min (Watsky and Gruber, 1990) and up to 180 min (Brooks *et al*., 2011).

While deliberately-induced TI is not documented in *P. spathula*, a similar stress response in hatchery specimens has been observed. It has been documented that when paddlefish are transported a curious (self-induced) inverted stress response is common in the species:

> *"…they float belly up moving infrequently and they have weak operculation. They appear to be in a state of extreme physiologic stress; however plasma levels of stress indicators increase less in paddlefish than for most teleosts…paddlefish survive surprisingly well despite this behavior and their poor capacity to operculate by branchial pumping…fish recover and swim normally with some stimulation…"* (Mims *et al*., 2009)

Published studies have documented some of the physiological consequences of TI in elasmobranchs. Davie *et al.* (1993) report that heart rate and blood pressure are depressed in blacktip reef sharks, *Carcharhinus melanopterus,* when inverted and placed in TI. In extreme-duration TI in lemon sharks, *N. brevirostris*, Brooks *et al*. (2011) found significant physiological changes including decreased blood pH and bicarbonate levels and increased CO_2, lactate, Mg, and Na concentrations. These changes are characteristic of stress and could indicate the onset of acidosis, which is often fatal in elasmobranchs due to their unique physiology (Smith *et al*., 2004). It is not yet known if similar physiological changes are occurring in paddlefish or what the maximum safe duration of TI might be for the species. Though questions remain to be answered, the application of TI in this species provides a useful tool in handling an otherwise delicate and fascinating species of fish.

Acknowledgements

The authors would like to thank fellow tankmen Lyssa Torres and Johnny May who aided with this investigation and the entire Animal Care and Conservation staff at OdySea Aquarium. Thanks to Lori A. Elliott for critical review of the manuscript. Also thanks to one of the original gangstas of ichthyology, Johann Julius Walbaum; who, when he wasn't describing the paddlefish or great barracuda, was the first to recognize that wearing gloves during surgery could prevent infection. *De piscibus, scientiam.*

Literature Cited

Alvarado, T.P., M.M. Garner, K. Gamble, G.P. Levens, J.I. Raymond, & R. Nordhausen. 2001. Fenbendazole Overdose in Four Fea's Vipers (*Azemiops feae*). Proceeding of the American Association of Zoo Veterinarians. 58: 28-29.

Bettoli, P.W., J.A. Kerns, & G.D. Scholten. 2009. Status of Paddlefish in the United States. In Paukert, C.P. and G.D. Scholten (eds.) Paddlefish Management, Propagation, and Conservation in the 21st Century. American Fisheries Society. 443p.

Bonar, C.J., A.H. Lewandowski, & J. Schaul. 2003. Suspected Fenbendazole Toxicosis in 2 Vulture Species (*Gyps africanus*,*Torgos tracheliotus*) and Marabou Storks (*Leptoptilos crumeniferus*). Journal of Avian Medicine and Surgery. 17(1): 16-19.

Brooks, E.J., K.A. Sloman, S. Liss, L. Hassan-Hassanein, A.J. Danylchuk, S.J. Cooke, J.W. Mandelman, G.B. Skomal, D.W. Sims, & C.D. Suski. 2011. The stress physiology of extended duration tonic immobility in the juvenile lemon shark, *Negaprion brevirostris* (Poey 1868). Journal of Experimental Marine Biology and Ecology. 409(1-2): 351-360.

Choudhury A. & T.A. Dick. 1998. The Historical Biogeography of Sturgeons (Osteichthyes: Acipenseridae): A Synthesis of Phylogenetics, Palaeontology, and Palaeogeography. Journal of Biogeography. 25(4): 623-640.

Davie, P.S., C.E. Franklin, & G.C. Grigg. 1993. Blood pressure and heart rate during tonic immobility in the black tipped reef shark *Carcharhinus melanoptera* [sic]. Fish Physiology and Biochemistry. 12(2): 95-100.

Gallup, G.G. 1977. Tonic immobility: the role of fear and predation. The Psychological Record, 27: 41.

Garla, R.C., D.D. Chapman, B.M. Wetherbee, & M. Shivji. 2006. Movement patterns of young Caribbean reef sharks, Carcharhinus perezi, at Fernando Noronha Archipeligo, Brazil: the potential of marine protected areas for conservation of a nursery ground. Marine Biology. 149: 189-199.

Gilman, T.T., F.L. Marcuse, & A.U. Moore. 1950. Animal hypnosis: a study in the induction of tonic immobility in chickens. Journal of Comparative and Physiological Psychology, 43(2): 99.

Gruber, S.H. 1980. Keeping Sharks in Captivity. Journal of Aquariculture. 1: 6-14.

Gurshin, C.W.D. & S.T. Szedlmayer. Short-term survival and movements of Atlantic sharpnose sharks captured by hook-and-line in the north-east Gulf of Mexico. Journal of Fish Biology. 65: 973-986.

Hoffman, G.L. Parasites of North American Freshwater Fishes, 2nd ed. Cornell University Press. 539p.

Holland, K.N., B.M. Wetherbee, C.G. Lowe, & C.G. Meyer. 1999. Movements of tiger sharks (*Galeocerdo cuvier*) in coastal Hawaiian Waters. Marine Biology. 134: 665-673.

Howard, L.L., R. Papendick, I.H. Stalis, & J.L. Allen. 2002. Fenbendazole ad Albendazole Toxicity in Pidgeons and Doves. Journal of Avian Medicine and Surgery. 16(3): 203-210.

Jennings, C.A. & S.J. Zigler. 2009. Biology and Life History of Paddlefish in North America: An Update. In Paukert, C.P. and G.D. Scholten (eds.) Paddlefish Management, Propagation, and Conservation in the 21st Century. American Fisheries Society. 443p.

Kessel S.T. & N.E. Hussey. 2015. Tonic immobility as an anaesthetic for elasmobranchs during surgical implantation procedures. Canadian Journal of Fisheries and Aquatic Sciences. 72(9): 1287-1291.

Lowe, C.G., B.M. Wetherbee, & C.G. Meyer. 2006. Using Acoustic Telemetry Monitoring Techniques to Quantify Movement Patterns and Site Fidelity of Sharks and Giant Trevally Around French Frigate Shoals and Midway Atoll. Atoll Research Bulletin. 543: 281-303.

Mims, S.D., R.J. Onders, & W.L. Shelton. 2009. Propagation and Culture of Paddlefish. In Paukert, C.P. and G.D. Scholten (eds.) Paddlefish Management, Propagation, and Conservation in the 21st Century. American Fisheries Society. 443p.

Myers, G.E., M.M. Garner, M.T. Barrie, C.E. Yach, & G.L. Pribyl. 2007. Fenbendazole and Albendazole Toxicity in Sharks. Proceedings of the American Association of Zoo Veterinarians. 64:64-65.

Neiffer, D.L., D. Lydick, K. Burks, & D. Doherty. 2005. Hematologic and Plasma Biochemical Changes Associated with Fenbendazole Administration in Hermann's Tortises (*Testudo hermanni*). Journal of Zoo and Wildlife Medicine. 36(4): 661-672.

Rusli, M.U., N.C. Wu, & D.T. Booth. 2016. Tonic Immobility in Newly Emerged Sea Turtle Hatchlings. Chelonian Conservation and Biology. 15(1): 143-147

Smith, D.T. & M.C. Curran. 2017. Movement Patterns of *Sphyrna tiburo* (Bonnethead Shark) in a Shallow Tidal Creek System. Southeastern Naturalist. 16(2): 297-316.

Smith, M.F.L., A. Marshall, J.P. Correia, & J. Rupp. 2004. Elasmobranch Transport Techniques and Equipment. In Smith, M.F.L., D. Warmolts, D. Thoney, & R. Heuter (eds.). Elasmobranch Husbandry Manual: Captive Care of Sharks, Rays, and their Relatives. Ohio Biological Survey. 589p.

Stamper, M.A. Elasmobranchs (Sharks, Rays, and Skates). In West, G., D. Heard, & N. Caulkett (eds.) 2007. Zoo Animal and Wildlife Immobilization and Anesthesia. Blackwell Publishing. 656p.

Sundstrom, L. F. & S.H. Gruber. 2002. Effects of capture and transmitter attachments on the swimming speed of large juvenile lemon sharks in the wild. Journal of Fish Biology. 61: 834-838.

Watsky, M.A. & S.H. Gruber. 1990. Induction and duration of tonic immobility in the lemon shark, *Negaprion brevirostris*. Fish Physiology and Biochemistry. 8(3): 207-210.

Werry, J.M. & S.Y. Lee. 2011. A multi-faceted approach for quantifying the estuarine-nearshore transition in the life cycle of the bull shark, *Carcharhinus leucas*. Marine and Freshwater Research. 62(12): 1421-1431.

Whitman, P.A., J.A. Marshall, & E.C. Keller. 1986. Tonic Immobility in the Smooth Dogfish Shark, Mustelus canis (Pices, Carcharhinidae). Copeia. 1986(3): 829-832.

Whitty, J.M., D.L. Morgan, S.C. Powell, D.C. Thorburn, & S.J. Beatty. 2009. Ontogenetic depth partitioning by juvenile freshwater sawfish (*Pristis microdon*: Pristidae) in a riverine environment. Marine and Freshwater Research. 60: 306-316.

Young, F.A., S.M. Kajiura, G.J. Visser, J.P.S. Correia, & M.F.L. Smith. 2002. Notes on the Long-term Transport of the Scalloped Hammerhead Shark (*Sphyrna lewini*). Zoo Biology 21: 243-251.

PUBLIC AQUARIUMS IN THE 21ST CENTURY – WHAT'S NEXT?

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Based on an article first published in Broom, D. & Carr, N. editors (in press). Animal Welfare and Tourism. Center for Agriculture and Biosciences International. For details please go to: https://www.cabi.org/bookshop/book/9781786391858

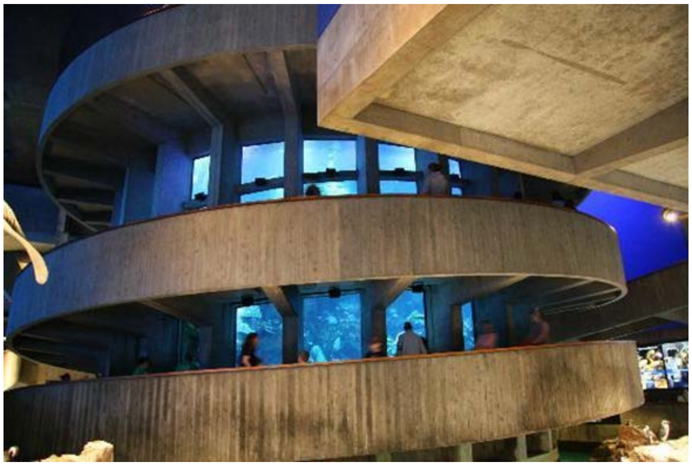
"…because I am anxious for zoos to go on and prosper and do better and more valuable work, not dwindle and become extinct because of their inertia and public criticism." Gerald Durrell, in *The Stationary Ark* (1976).

"The United Nations Strategic Plan for Biodiversity 2011–2020 is a key initiative…to halt and eventually reverse the loss of biodiversity. The very first target of this plan states that 'by 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.' Zoos and aquariums worldwide, attracting more than 700 million visits every year, could potentially make a positive contribution to this target." Moss, Jensen & Gusset (2014) in *Conservation Biology* 29, 537-544.

Public aquariums: their first 150 years

The Age of Enlightenment emerged from the centuries-long Age of Exploration and developed into the Industrial Revolution, and Charles Darwin's *Origin of Species* was published in 1859. The 18th and 19th Centuries were a time of tremendous curiosity about science and nature, and major zoological institutions were established around the world, including the first public aquarium (at the London Zoo in England in 1853). Over the next several decades, a tidal wave of (then) novel aquariums swept across Western Europe, North America and Japan, many displaying creatures which had never been seen before by the public. These aquariums were popular attractions, with an underlying assumption or practice of scientific research and public education. Significant facilities – even by today's standards – opened in large cities across Europe and North America. Then, around the middle of the 20th Century, there was an escalating concern over the undeniable impact of humans on nature and wild places, which led to much needed environmental legislation in some countries, and the first "Earth Day" in 1970. At the same time there was the start of a new global wave of aquariums, arguably led by the New England Aquarium in Boston MA in 1969, and driven by the increasing concerns for the environment, and empirical data on aquatic animal care, new methods for large tank construction and glazing, high quality dry synthetic sea water mixes, and improved closed life support and filtration systems. Suddenly (almost) any aquatic species could be displayed, and often far from the ocean. Public aquariums were also found to play a significant role in the economic development of derelict waterfront property and similar abandoned urban environments.

Some aquariums, it appeared, could be funded through debt financing, although those that could successfully service a sizable construction loan – and continue to operate in the black – proved to be few and far between. By the 1980's zoos had recognized that there was an urgent need for them to play a more active role in conservation and to safeguard the supply of animals for their displays, initially through managed breeding programs of threatened species, as well as through partnerships with conservation organizations and by promoting behavioral change to their guests. Aquariums were a little slower to adopt a conservation focus, although by the end of the 20th Century they too were promoting a triumvirate mission of overlapping roles: scientific research, public education and conservation. And the many faces of sustainability, from “green” construction methods to sustainable operations, became a priority for all. But is this enough to justify the continued display of wild animals in human care, and (in some instances) to continue to remove them from their natural, if beleaguered and rapidly shrinking, natural habitats?


The New England Aquarium started a new wave of aquariums in 1969.

2000 and a new millennium

The start of the 21st Century has proved to be a challenging time for aquariums and zoos, certainly in North America and Europe. There was increasing evidence to show that a wide range of animal species (and not just so-called “higher” vertebrates) are, in fact, sentient creatures, able to suffer pain and feel emotions. They have lives beyond, and far more complex than, the hard-wired automatons that they were considered to be just a few years previously. With renewed vigor, proponents of animal rights and anti-captivity extremists questioned the need for aquariums and zoos, questioned their underlying motives, and questioned if they were actually achieving all of the impacts they claimed. The widely publicized film *Blackfish* captured the zeitgeist of the time, and aquariums and zoos were forced to reflect on their achievements, against a background of disturbing and increasing biodiversity loss and the Sixth Mass Extinction, and disappointing results from some of the vaunted captive breeding programs of the previous 40 years or so. All of this at a time when aquarium displays had effectively stalled-out, with no significant novel display ideas for many years (noting that bigger was no longer novel or even news worthy). Indeed, some became jaded about aquarium offerings, well aware that they were now able to experience the world on a computer, a high definition TV, a hand held device or a VR head set, all without leaving their home. The Age of Humans had arrived.

A future for public aquariums: creating relevance and leading by example

Public aquariums can range from small coastal facilities of one or two thousand square meters which serve a predominantly local audience of a few tens of thousands each year, to major tourist attractions of tens of thousands of square meters with an annual attendance in the millions…and everything in between. Jellies to cetaceans, and octopus to sharks and living corals, can all be found thriving in public aquariums today. While most public aquariums are “not-for-profit” in their governance, recent years has seen a surge in for-profit aquariums, blurring the distinction between a solely mission focus and meeting the requirements of private owners and share-holders. Aquariums are as diverse as the animals they display and the people they attract. To be successful in the long term, however, it is vital that each aquarium has a strong sense of identity and is aware of how its scale and programs fit into, serve and can be supported by the local community. One size/type does not fit/suit all locations, and what works in London England or Baltimore MD, may or may not work in Charleston SC, or Orlando FL.

Public aquariums must put animal welfare (wellness) first. Each animal must thrive, and must be seen to thrive, in their display, and aquariums must be seen to respect their animals. A 2015 survey by the Association of Zoos and Aquariums (AZA) in North America found that messages which promoted an aquarium’s role in marine animal rescue, education of children, scientific research, and high quality animal care resonated with the American people. The visiting public may perceive the animals’ need differently, even inaccurately (e.g. size of display needed by some species), and aquariums must be prepared to be sensitive to these perceptions rather than fight them. The euthanasia of an animal at the end of its life span, when its quality of life has declined to a level deemed inappropriate by the attending veterinarian, is understood by most people. Euthanasia of surplus and otherwise healthy animals which result from, for example, overly successful breeding programs is not appropriate, and management plans should prevent this whenever possible. The feeding of live vertebrate food items should be discontinued to the greatest extent possible, and never form any kind of public exhibition. Similarly, the necropsy of deceased animals can provide valuable scientific information (much like autopsy examinations of humans), and should only be carried out before an audience which understands the value and importance. Above all aquariums must be completely transparent regarding their animal care programs, and the welfare and conservation implications of how and from where they obtain their display animals. They must also have well documented “care for life” plans in place for all the species in their care (which include behavioral enrichment programs, wherever relevant). Accreditation to respected professional organizations should be a requirement, and minimum governmental standards reviewed to ensure that they allow the animals to thrive in human care. In this regard, veterinarians will continue to play an increasing and vital role and must partner with the aquarium’s curatorial team to ensure that the wellness needs of all the animals are met.

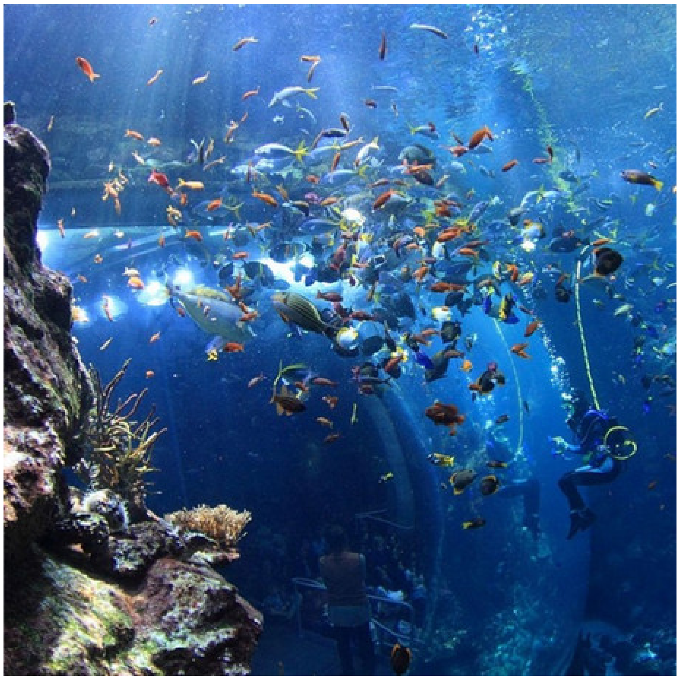
Aquarium visitors seek experiences which are fun, engaging and relevant to them, and which explain what they can do in their daily lives to help conserve wild places. Therefore, aquariums must *attract*, *intrigue*, *engage* and ultimately *involve* their guests in critical thinking and hands-on learning, and inspire conservation action with the ultimate goal of demonstrating positive behavioral change. However, information needs to be provided in the form of a hierarchical menu so that each guest can pick their learning level and style, and this means that significant resources have to be devoted to formative and summative exhibit and education program evaluations, far more than is commonplace in aquariums and zoos at the moment. In addition, rather than simply adding technology to the guest experience (which may be unavoidable at existing facilities), new facilities need to seamlessly blend live exhibits with digital technologies and mechanical interactives while greatly increasing opportunities for animal-staff-guest interactions, the latter of which can be especially impactful. Significant new exhibit species may not be forthcoming (or needed), but innovative ways to tell stories that resonate with the guests can be found, perhaps learning from the renaissance of children’s museums that is occurring, at least in North America.

Aquarium detractors – even supporters – are becoming increasingly suspicious of unsubstantiated claims and institutional hyperbole. Credibility and consistency are both key and must be assured throughout all of the communication channels, including social media, and the *Ocean Literacy Framework* is a very useful tool for creating educational content. Education programming requires a broad, well-articulated education and engagement strategy, with close working relations between the education, marketing and curatorial teams, so as to establish learning goals and outcomes, and a balance between substance, style and the institution's brand. Content and information must be accurate and presented in a fun, engaging and meaningful way, and under the direction of staff qualified and experienced in all that informal science learning has to offer.


Aquariums should appeal to people of all ages.

To be more impactful, communication programs need to be less species-centric, less reliant on the easy option of unconnected, head-line grabbing "fun facts", and more focused on story-telling about human relationships with – and reliance on – the natural world. Why should they care? Focusing on habitats as special places, and the issues they face, will create relevance and solidify what the visitor can do to protect them. Losing a species is unforgivable; losing a habitat and all the animals that call it home is a tragedy. Exhibits on the Amazon rain forest, Indo-Pacific coral reefs, or great white sharks, for example, may be popular and even drive attendance (at least for a while), but they too must be presented in a fashion that demonstrates relevance to the visitor and develops support for local issues. In the 1960's Rachel Carson captured the essence of the modern aquarium experience: *"If facts are the seeds that later produce knowledge and wisdom, then the emotions and the senses are the fertile soil in which the seeds must grow"*. Since humans are a social and emotional species, and prone to nostalgia (all of which drives their learning and sometimes less-than-logical decision-making), spending time in a natural setting that evokes memories has a special meaning for most.

Many aquariums display *hundreds* of species of animals, far more than are actually needed for each to fulfill their scientific research, education and conservation goals. Curators need to rigorously justify each species before its acquisition, highlight the essential benefits that each species brings to the display, and their ability to provide the care which enables the species to thrive in the aquarium. Biodiversity for the sake of biodiversity must be discouraged, and collection planning must be approached from the perspective of "how much is – really – enough" to achieve the display's goals. The species count of most collections could be reduced by one third without impacting their mission or attendance goals. That is the same sized collection in terms of the number of individual animals (biomass), but just fewer species. Preference should be given to hardy, interesting species from captive bred sources, managed fisheries and/or truly sustainable wild sources, especially if the sustainable harvest has local socio-economic benefits, effectively creating the "sustainable aquarium". Obtaining animals from the wild in a sustainable fashion, with those animals then thriving in human care, is a cause for celebration. Public aquariums should encourage the ornamental aquarium trade to move more proactively towards aquaculture and genuine sustainable use programs in the wild, noting that the legal trade in exotic birds, reptiles and amphibians as pets is now sustained almost entirely from captive bred sources.



Aquariums should determine how much biodiversity is needed to achieve their conservation goals

Scientific research on novel display species must still occur, however, but with specific goals and desired outcomes: why *that* species? Is there a clear benefit to the species in the wild or its natural habitat? Even more research is needed on the methods to breed and rear important display species, and more partnerships – and resources – are required to rear display animals on a commercial scale, as is now happening, for example, in Florida and Hawaii. Public aquariums should critically review their role and results to date in the captive breeding of endangered fish species. Pragmatic decisions need to be made regarding the choice of species and the likely tangible *in situ* outcomes through long-term, institutional commitments and partnerships.

Aquariums must become much more aware of and reduce the energy footprint and environmental impact of their initial construction and subsequent operations, especially water usage and the energy needed for lighting and life support, and promote their corporate responsibility through their marketing and public relations activities. Leading by example is – now – a cost of doing business, which extends to the merchandise sold in the gift shop, the food and beverages sold in the café, the foods fed to the animals on display, and even apply to employee behaviors, such as how the aquarium staff commute to work each day.

Aquariums must become centers of excellence, not only for science education in general, but also to promote the role of females and especially minorities in science and conservation. Indeed, the aquarists and aquarium curators of today and tomorrow need to be far more than "just" experts in animal care. They must also be able to interact with the public and media, speak passionately and with credibility on current aquatic conservation issues, and work and argue persuasively in a diverse, team-based environment. The now popular "70:20:10" approach to learning and development is particularly pertinent to staff growth in the public aquarium industry, where collegial support and inter-facility sharing is commonplace. However, methods need to be developed to record this experiential learning, so that the staff may receive recognition, and so the learnings can be shared further afield. Since the spark that leads to engagement in science and the environment can occur at any age, aquariums also need to continue to focus on diverse audiences from early learning to life-long learning, so as to fan the spark into a flame, whenever it may occur. There needs to be a pipeline, an attainable career path, for the middle school student who is perhaps disinterested in science to become an aquarist, a curator and more.

There are some well documented, successful aquarium and zoo conservation programs, but the global impact of these efforts has not been enough. Aquariums must sharpen their focus on participating in and encouraging impactful conservation action. For some, acting individually or as a part of a larger consortium, advocating for policy presents an important opportunity. Some US aquariums worked with other conservation groups to ban shark finning, and in 2016 a group of AZA member institutions enlisted their guests to lobby the US government to increase marine protect areas. Aquariums must continue to think global, but do more by acting with local relevance (engaging with schools, colleges, NGO's, and state and federal education and *in situ* conservation programs). Since what has been done thus far is not working, or not working fast enough, non-traditional partnerships must be sought. Membership of NGO conservation organizations pales in comparison to the annual global aquarium- and zoo-going audience of nearly one billion, and, for example the congregations of faith-based groups, many of whom provide spiritual guidance, education and health care in areas where biodiversity loss is at its greatest. Can common ground be found with non-traditional partners regarding stewardship of Planet Earth? After all, conservation is not about mourning what has been lost, but rather celebrating what can still be saved, and aquariums need to seek out any and all that will help them do more, faster. The stark reality is that the natural world and the biodiversity that safeguards the quality of life for humans are shrinking fast. Yet one in ten people on the planet visit an aquarium or zoo every year. If aquariums and zoos are conservation organizations, they must do more. What if that army of aquarium- and zoo-goers could be engaged and motivated to make a difference and to transform conservation within a generation, stabilizing conditions for the benefit of all?

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CA/December 10th 2017

Selected Bibliography

Ardoin, N. M. & Heimlich, J. E. 2013. Views from the field: conservation educators' and practitioners' perceptions of education as a strategy for achieving conservation outcomes. *Journal of Environmental Education* 44, 97-115.

Brown, C. 2015. Fish intelligence, sentience and ethics. *Animal Cognition* 18, 1-17.

Brunner, B. 2005. *The Ocean at Home*, 143 pp. Princeton Architectural Press.

Carr, N. & Cohen, S. 2015. Public face of zoos: images of entertainment, education and conservation. *Anthrozoos* 24, 175-189.

Ceballos, G. *et al*. 2015. Accelerated modern human-induced mass species losses: entering the sixth mass extinction. *Sci. Adv. 1.e1400253* (on-line).

Dick, G. & Gussett, M., editors. 2010. *Building a Future for Wildlife*, 215 pp. www.waza.org.

Durrell, G. 1976. *The Stationary Ark*, 157 pp. Collins.

Fa, J. E. *et al*. 2014. Zoos have yet to unveil their full conservation potential. *Animal Conservation* 17, 97-100.

Falk, J & Dierking, L. 2010. The 95 percent solution. *American Scientist*, 98, 486-493.

Fraser, J & Sickler, J. 2008. *Why Zoos and Aquariums Matter*, 87 pp. www.aza.org.

Frost, W. editor. 2011. *Zoos and Tourism*, 262 pp. Channel View.

Fuller, S. 2011. *Economic Impact of Spending for Construction and Operations by AZA-Accredited Zoos and Aquarium*, 20 pp. www.aza.org.

Gusset, M. & Dick, G. 2011. The global reach of zoos and aquariums in visitor numbers and conservation expenditures. *Zoo Biology* 30, 566-569.

Kajewski, K. & Mardsen, V. 2013. *Demystifying 70:20:10*. DeakinPrime, 20 pp.

Lees, C. M. & Wilcken, J. 2009. Sustaining the Ark: the challenges faced by zoos in maintaining viable populations. *International Zoo Yearbook* 43, 6-18.

Marino, L. *et al*. 2010. Do zoos and aquariums promote attitude change in visitors? A critical evaluation of the American Zoo and Aquarium study. *Society and Animals* 18, 126-138.

Miller, B. *et al*. 2004. Evaluating the conservation mission of zoos, aquariums, botanical gardens and natural history museums. *Conservation Biology* 18, 1-8.

Moss, A. *et al*. 2015. Evaluating the contribution of zoos and aquariums to Aichi Biodiversity Target 1. *Conservation Biology* 29, 537-544.

Rabb, G. B. & Saunders, C. D. 2005. The future of zoos and aquariums: conservation and caring. *International Zoo Yearbook* 39, 1-26.

Roe, K. *et al*. 2014. The role of zoos in modern society – a comparison of zoos' reported priorities and what visitors believe they should be. *Anthrozoos* 27, 520-541

Ripple, W. J. et al. 2016. Saving the world's terrestrial megafauna. *Bioscience* 66, 807-812.

Safina, C. 2016. *Beyond Words*, 480 pp. Henry Holt.

Schubel, J. R. *et al*. 2009. Environmental literacy through the lens of aquarium ocean literacy efforts. In *Free-choice Learning and the Environment*, edited by Falk *et al*., pp. 123-137. Altamira.

Taylor, L. 1995. *Aquariums: Windows to Nature*, 168 pp. Prentice Hall.

Tlusty, M. *et al*. 2013. Opportunities for public aquariums to increase the sustainability of the aquatic animal trade. *Zoo Biology* 32, 1-12.

Wilson, E. O. 2016. *Half-Earth*, 259 pp. Norton.

Wulf, A. 2015. *The Invention of Nature*, 473 pp. John Murray.

SUCCESSFUL TREATMENT OF CHRONIC SWIM BLADDER DISTENSION IN A Leather Bass (*Dermatolepis dermatolepis*) AT THE BIRCH AQUARIUM

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Introduction

This is a case report describing the successful treatment of chronic swim bladder distension resulting in positive buoyancy in a Leather Bass, *Dermatolepis dermatolepis*, at the Birch Aquarium at Scripps. After attempting several standard treatments without success, we applied a more aggressive treatment therapy which resulted in resolution of positive buoyancy and allowed for the animal to be displayed. This case is important due to the limited amount of published information regarding treatment of this common disease syndrome in aquarium fish.

Case History

A Leather Bass, *Dermatolepis dermatolepis*, was brought into Birch's population in 2012 and housed in a 10,000 gallon, multi-species Mexican-Pacific exhibit. Occasionally, it would show signs of swim bladder distention; the fish would become positively buoyant and sit near the surface of the water, constantly, struggling to swim downward. These episodes always seemed to resolve after a few days without treatment. In February 2016, the Leather Bass showed the same signs of swim bladder disease as previously displayed. However, the positive buoyancy was unresolved and resulted in the development of dorsal ulcerative lesions due to prolonged exposure to air. The fish was transferred into our hospital area for closer observation and treatment. Due to the lesions and positive buoyancy, a 10-day consecutive oxolinic acid (38 mg/gal) bath series followed by 7 doses of oral enrofloxacin (10 mg/kg) given every other day, was the treatment administered. After completion of this treatment, the fish remained buoyant, so an intramuscular (IM) injection of acetazolamide (3 mg/kg) was given. The Leather Bass responded to this treatment well; the positive buoyancy issue resolved. On March 31, 2016, after a few weeks of normal, neutral controlled buoyancy the fish returned to exhibit.

In September 2016, the Leather Bass was observed to be positively buoyant again with ulcerative lesions along its dorsal ridge and was removed from the exhibit back into the hospital area for treatment and observation. Immediately after this move, the exhibit from which it came was discovered to have a parasite outbreak: *Amyloodinium ocellatum*. We performed diagnostic tests, including a gill clip and skin scrape, to ensure the Leather Bass was not also affected. The Leather Bass showed no signs of a parasitic infection. Prophylactically, we lowered the salinity to 22ppt for 5 days, concluding with a 4-minute freshwater bath to treat any parasites unobserved. The salinity was then returned to normal ambient (35 ppt). During this time, we also treated for the swim bladder disease. On September 17, we performed a percutaneous gas aspiration of the swim bladder. A 200 mg/L dose of MS-222 (Tricaine) was used to anesthetize the fish before a 22-gauge needle and 10 mL syringe was used to aspirate 20 mL of gas from the swim bladder. Initially this reduced the positive buoyancy, but the results did not last long.

On September 22, five days after the initial gas aspiration procedure, the positive buoyancy worsened, with the Leather Bass able only to swim on its side. Therefore, another round of treatments was initiated, including another percutaneous aspiration and a dose of enrofloxacin. 150 mg/L MS-222 anesthetic was used: the previous dose of 200 mg/L MS-222 resulted in the Leather Bass's inability to orient properly. Aspiration was again performed using a 22-gauge needle, but this time we allowed the gas to escape into the outside environment directly without the use of a syringe. With needle inserted, the aspirated area was held under water and escaping air was seen as bubbles escaping from the hub. The entire aspiration procedure lasted 8 minutes, with continuous gentle pressure applied to the swim bladder around the needle in order to expel as much air as possible. When no more air could be expressed from the swim bladder, the needle was removed and one injection of enrofloxacin (10 mg/kg) was given IM prior to recovering the animal. This procedure made the Leather Bass extremely negatively buoyant, demonstrated upon recovery by the animal sinking straight to the bottom of the tank and remaining in the lower third of the water column for several days. Despite this more aggressive approach to treatment, the Leather Bass was observed a few days later becoming increasingly buoyant again. On October 4, a whole-body radiograph was performed to look for any air outside of the swim bladder which may explain such a rapid increase of buoyancy; however, no gas was seen in the body cavity apart from inside a well-demarcated swim bladder (see Figure 1).

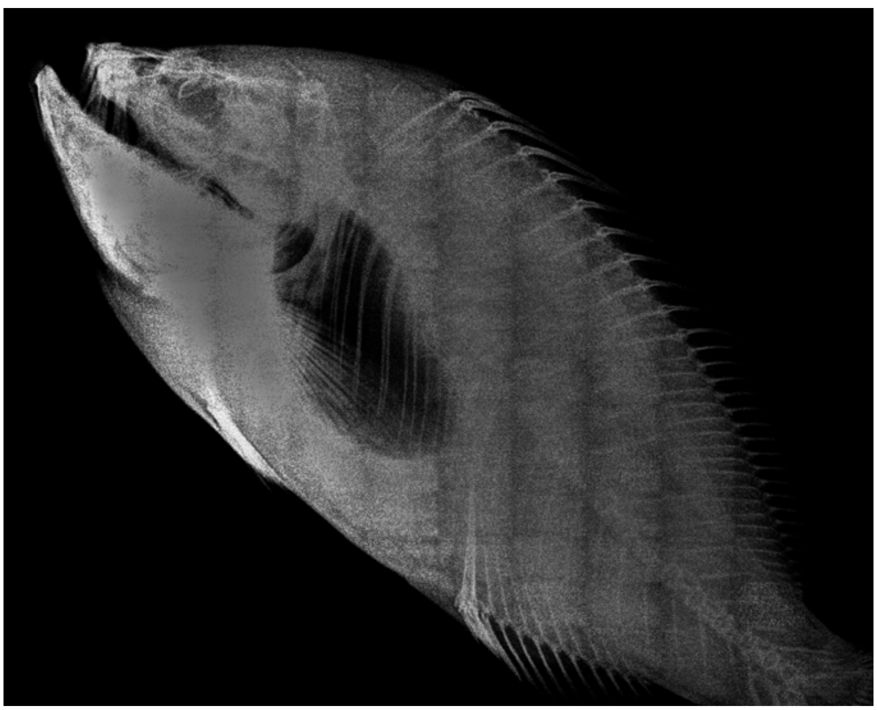


Figure 1. Whole-body radiograph of a Leather Bass, *Dermatolepis dermatolepis*, with chronic swim bladder disease. Note the gas (black area) present in the distended swim bladder. No free gas was seen elsewhere in the body cavity.

During October and November the leather bass was kept in the hospital area for observation of any recurring symptoms. In December 2016 the Leather Bass was again positively buoyant with red, ulcerative and sloughing lesions on both sides of the dorsal ridge. Treatment via percutaneous aspiration was again performed, using a similar method as the previous procedure in September. Afterwards, the Leather Bass swam easily to the bottom of the tank and seemed to manage its buoyancy for a while without further intervention. In early February 2017, the Leather Bass was more positively buoyant than ever, and the red, sloughing lesions recurred along the dorsal ridge. Due to the escalating appearance of clinical signs and failure of treatments to adequately maintain neutral buoyancy, we decided to use an even more aggressive approach: percutaneous aspiration of air followed by injection of medication directly into the swim bladder. On February 8th the fish was anesthetized with 150 mg/L of MS-222, and, using a needle attached to a 3-way stopcock hooked up to a large syringe (Figure 2A), 180 mL of gas was aspirated from its swim bladder. Once the aspiration was complete, we used the second syringe port on the stopcock to inject medication directly into the swim bladder without having to move the needle (Figure 2B). Three different drugs were chosen for this injection: enrofloxacin (10 mg/kg), dexamethasone (2 mg/kg) and acetazolamide (3 mg/kg).

Immediately after the procedure, the Leather Bass was negatively buoyant at the bottom of the tank. The next day, expecting to see a negatively buoyant Leather Bass, we instead found a positively buoyant fish in the morning. We were wary of administering more drugs into the swim bladder so soon after such an aggressive procedure, thus we simply aspirated gas from the swim bladder again and gave another dose of enrofloxacin (10 mg/kg) IM.

Two weeks later, it was observed that the Leather Bass would have a few days of positive buoyancy and then seemed to regulate for a day and continue on this pattern. Due to the aggressive nature of the procedure and multiple episodes of undergoing anesthesia, we decided to allow the Leather Bass to recover. Oral antibiotics (enrofloxacin, 10 mg/kg) were started for 3 days, but discontinued after the animal became anorexic. A few weeks later, the Leather Bass began resumed feeding so oral enrofloxacin treatment was again initiated, for a course of 13 consecutive days.

Figure 2A. 3-way Stopcock connected to 20 mL syringe and a needle. Note the blue valve points in the direction that is currently closed. In the figure above, the stopcock is closed to the syringe side. Another port, perpendicular to the needle and syringe, allows for the addition of another syringe for application or medication or aspiration of air/fluid.

Figure 2B. Aspiration of the distended swim bladder of a Leather Bass, *Dermatolepis dermatolepis,* using a 3-way stopcock connected to a 20mL syringe.

Two months after the first aggressive procedure, the Leather Bass was still positively buoyant with red, sloughing lesions on the dorsal ridge due to prolonged skin exposure to the air. The fish struggled to keep itself under the water surface, and we often observed it resting upside down inside a 12" PVC pipe at the bottom of the tank in order to stay submerged. We took advantage of another anesthesia event in order to ultrasound the swim bladder (see Figure 3) for any signs of a mass or fluid inside that might explain the chronic clinical signs of distension and positive buoyancy. In addition, we tried to perform a swim bladder "wash", similar to a bronchial wash in which we would inject a small amount of sterile saline into the swim bladder and aspirate it back out for bacterial culture.

So, once again, on April 25 2017, we anesthetized the Leather Bass with 150 mg/l of MS-222. The ultrasound revealed nothing noteworthy. 200 mL of gas was aspirated out of the swim bladder, then, using the 3-way stopcock, we injected 5 mL of sterile saline into the swim bladder, massaged the area with gloved hands, but unfortunately had no luck aspirating any saline for bacterial culture. For weeks after, the Leather Bass was neutrally buoyant and seemed to be regulating his position in the water column very well. But by mid-May, the Leather Bass had once again built up gas and was becoming increasingly buoyant. So we went back to the drawing board and re-evaluated all the treatment we had done and looked at how well the Leather Bass did after each one and it seemed the more intense procedures showed the best results. It was decided to try injecting another round of medications into the swim bladder again. The longer lasting antibiotic, ceftazidime was used in place of enrofloxacin. We increased the sterile saline injected from 5mL to 20 mL to increase the chance of getting a bacteriological sample. We also increased the acetazolamide dosage from 3 mg/kg to 5 mg/kg, since the previous doses of 3 mg/kg were ineffective. On May 24th, we used 150 mg/l MS-222 to anesthetize the Leather Bass. Using a 3-way stopcock we injected 20 mL of sterile saline into the swim bladder and aspirated a sample for testing, injected ceftazidime (25mg/kg), dexamethasone (2 mg/kg), and acetazolamide (5 mg/kg) into the swim bladder. Additionally, we aspirated 420 mL of gas from the swim bladder. After the procedure, we administered oral ibuprofen (10 mg/kg) in the food for 5 doses for some pain management. The swim bladder wash sample was sent out for bacterial culture and sensitivity, but results came back with no bacterial growth.

Finally, we appeared to be successful with this last procedure. However in the beginning of June, one of the Leather Bass' eyes began to bulge out and become opaque. In hopes of catching this issue early, we treated the area locally, injecting dexamethasone (2 mg/kg) subcutaneously in the periorbital region, and applied Polyox bandage (composed of misoprostol 0.0024%/ phenytoin 2%) directly onto the cornea. A vitamin C (12.5mg/kg) injection was also given to help with healing. After a few weeks, the Leather Bass was back to normal with good control of buoyancy and a normal eye. We held the Leather Bass for a month in the hospital area to confirm that all issues had resolved, and then re-introduced it into a different Mexican- Pacific exhibit on October 7th 2017. As of the date of submission of this article, the Leather Bass is still on display and regulating buoyancy well. (See Figure 4)

Figure 3. Using an ultrasound on the swim bladder of a Leather Bass with chronic swim bladder distension.

Discussion

Dermatolepis dermatolepis are classified as groupers, of the Family Serranidae, Subfamily Epinephelinae. This means that, in terms of swim bladder anatomy, they are physoclists. Physoclist fish do not have a pneumatic duct that connects the swim bladder to the digestive tract, and all gas exchange occurs between the swim bladder and the circulating blood via special structures in the swim bladder wall (Fange, 1983). This becomes important when choosing treatment options for physoclist fish with swim bladder distension, since some of the treatments used for physostomes (fish with a pneumatic duct), such as increased fiber in the diet, will not work.

Swim bladder distension is a generic descriptor for a clinical sign that could arise from a number of different diseases. Any number of etiologies can cause swim bladder distension, including environment (gas supersaturation), inflammation, or infection (bacterial, viral, fungal, parasitic) (Roberts, 2012). Potential treatments are aimed at these differential diagnoses, and can include changing environmental parameters (such as water temperature and/or dissolved oxygen levels), or application of medications such as antibiotics, anti-inflammatory agents, or acetazolamide.

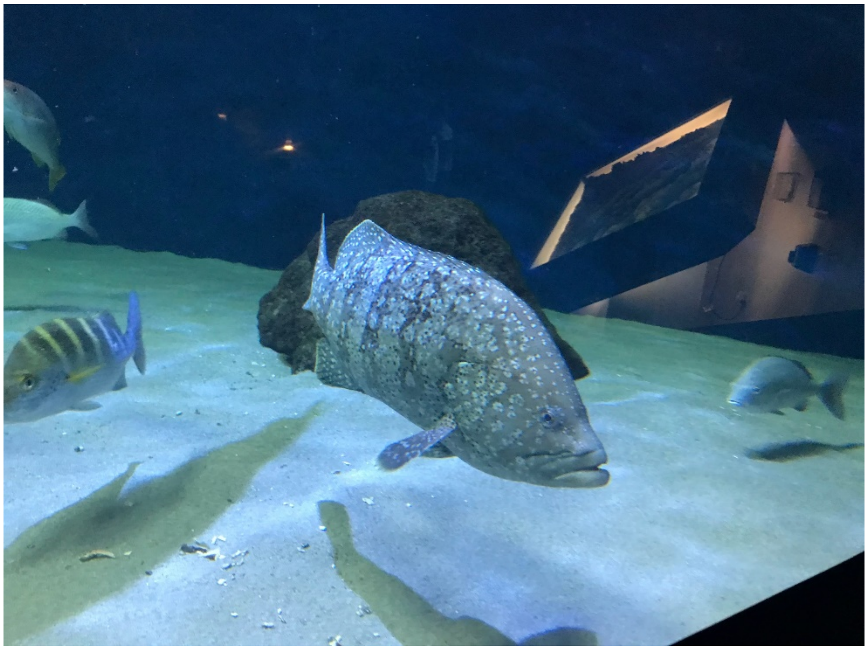


Figure 4. Leather Bass on display regulating buoyancy well.

Acetazolamide is a carbonic anhydrase inhibitor commonly used as a treatment for swim bladder distension and for gas-supersaturation in general. Carbonic anhydrase is an enzyme found in abundance on red blood cells and in other organs, such as lungs, that reversibly converts carbon dioxide and water to bicarbonate and hydrogen ions, which is important for the transport of carbon dioxide and for maintaining acid-base homeostasis (Kleinman et al., 1967). Acetazolamide blocks this enzyme's function, causing multiple downstream effects such as producing a metabolic acidosis and inhibiting peripheral chemoreceptors (Leaf and Goldfarb, 2007). In humans, it is a commonly used treatment for acute mountain sickness (Leaf and Goldfarb, 2007). In fish medicine, acetazolamide is a commonly used drug for the treatment of gas-supersaturation and buoyancy issues. This usage is based on anecdotal efficacy, since the mechanism of action of this drug in fish is still not explicitly clear. Carbonic anhydrase is present in the gills of teleost fish and also has been found in the air bladder of bowfish (Gervais and Tufts, 1998), so there is evidence to support that acetazolamide could potentially have an effect directly on the respiratory organs.

For this case, we started with minimally invasive standard treatments such as acetazolamide and antibiotics, which at first seemed to resolve the clinical signs. However, as the case progressed, the clinical signs worsened despite treatment. Therefore, we increased the aggressiveness of the therapies, culminating in the two final procedures of aspirating large amounts of gas from the swim bladder followed by injection of medications directly into the swim bladder. We chose a combination of drugs in the hopes that they would target all potential causes of this chronic case. The antibiotic (either enrofloxacin or ceftazidime) was chosen in case there was an infection present in the swim bladder. Initially we chose enrofloxacin not only for its antibiotic properties but also for its high pH. We hoped that the alkaline quality of the liquid might "kill" some of the cells in the vascular portion of the swim bladder responsible for gas exchange, in the hopes that this would lessen the about of gas exchange that occurred in the swim bladder, and thus lessening the chance of a return to positive buoyancy. However, enrofloxacin has a higher dosing frequency in fish compared with ceftazidime (Carpenter, 2013). So, when the enrofloxacin treatment was not effective for the first treatment, we decided to switch to ceftazidime for the second treatment. The second drug, dexamethasone, was chosen for its anti-inflammatory properties. The third drug, acetazolamide, was chosen based on anecdotal efficacy in treating gas-supersaturation and buoyancy-related issues.

One tool that made the treatment of this case much easier was the 3-way stopcock. This made it possible for us to do multiple things, such as aspirate air, give medications, and apply sterile saline, while only sticking the swim bladder once. Reduced number of needle sticks lessens the risk of introducing bacteria or other infectious agents into the swim bladder via the skin. Of course, there are other risks to performing such a procedure. Not only is there a risk of iatrogenic infection, discussed above, via the needle stick directly into the swim bladder, but tissue damage to the swim bladder and skin can also result. Another potential risk of this procedure is coelomitis. This could result if the needle was improperly placed (i.e. not in the swim bladder but in the coelom itself) or if leakage of medication occurred after the fact. The risk of an improperly placed needle was greatly reduced in this present case because we used the 3-way stopcock. By placing the needle into the swim bladder while full, we could confirm proper placement by aspirating air out, then, without moving the needle, apply medications using the second port on the 3-way stopcock.

We learned many things during the journey of managing this chronic case of swim bladder distension. The first is that this Leather Bass is a survivor and put up with more procedures, needle sticks, anesthesia events and imaging techniques than we had thought possible. Second, we learned that just because you do not know what is causing a certain disease or condition does not mean you cannot successfully treat it. To this day, we are not sure if this was caused by an infectious, inflammatory, or a gas supersaturation problem. Even though the bacterial culture came back negative, we cannot completely rule out the possibility of a bacterial infection causing these clinical signs, especially, when it seemed the issue resolved immediately after we switched to ceftazidime as a treatment. The final lesson, which is vital in long chronic cases such as these, is do not give up! We kept trying different treatments and thinking outside the box. We also asked for help, and received especially useful advice from Dr. Colin McDermott (currently at Mount Laurel Animal Hospital in New Jersey). Our goal for sharing this story is that others may benefit from the advice we received and the lessons we learned from the successful management of this case.

Acknowledgements

The authors would like to thank Leslee Matsushige, Ryan Shaeffer and Sean Bruce of the Birch Aquarium husbandry staff, Latisha Moody and Kent Osborn of the UC San Diego veterinary staff, and Dr. Colin McDermott for their valuable advice and help with the management of this case.

References

Carpenter, JW. 2013. Exotic Animal Formulary, 4th ed. St. Louis (MO), Elsevier.

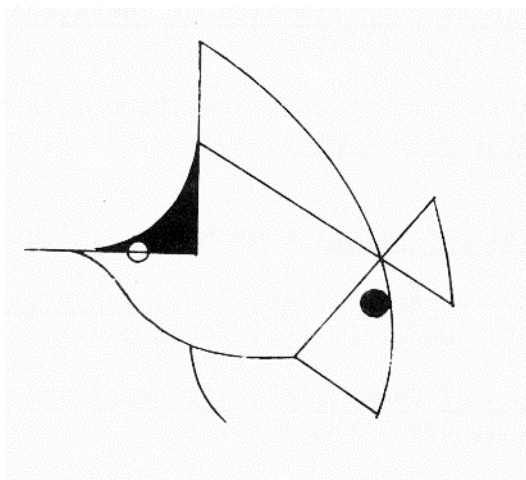
Fange R. 1983. Gas exchange in the fish swim bladder. Rev Physiol Biochem Pharmacol, 97:112-158.

Roberts, RJ. 2012. Fish Pathology, 4th ed. Ames (IA), Wiley-Blackwell.

Gervais MR, Tufts BL. 1998. Evidence for membrane-bound carbonic anhydrase in the air bladder of bowfin (Amia calva), a primitive air-breathing fish. J Exp Bio. 201: 2205-2212.

Kleinman LI, Petering HG, Sutherland JM. 1967. Blood Carbonic Anhydrase Activity and Zinc Concentration in Infants with Respiratory-Distress Syndrome. N Engl J Med; 277:1157-1161

Leaf DE, Goldfarb DS. 2007. Mechanisms of action of acetazolamide in the prophylaxis and treatment of acute mountain sickness. J Appl Physiol 102(4):1313-22.



BIOLOGICAL CONTROL FOR HYDROIDS IN A SUB-TROPICAL EXHIBIT

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In May 2016; the Steinhart Aquarium premiered its Twilight Zone exhibit. The gallery features fish and invertebrates found in the "twilight" or mesophotic zone, which is 50-150m in depth. To simulate the natural environment, the exhibits are dimly lit and range in temperature from 20-22°c.

Due to the low light levels, the corals found at this depth are azooxanthellate, or non-photosynthetic, and must feed on plankton. One of the exhibits with the heaviest invertebrate load highlights a pair of *Sacura speciosa* anthias as well as a number of corals including *Cirrhipathes spp., Antipathes spp., Stichopathes spp., Tubaestrea spp., T. micrantha, Dendrophyllia spp., Menella spp., Siphonogorgia spp., Acanthogorgia spp.,* and *Junceella spp.* In order to provide a regular source of plankton throughout the day, both to provide nutrition as well as encourage polyp extension for aesthetic purposes, the tank utilizes an autofeeder system that doses a mixture of newly hatched artemia, 48-hour old artemia that has been enriched, live rotifers and phytoplankton, plus a mixture of other commercially available planktonic feeds.

Like many exhibits that require heavy feeding, we have our share of pests that thrive on the high food density. Aiptasia anemones and colonial hydroids are the most common. The anemones are controlled manually, but the hydroids were more difficult to remove due to the small size of the individuals. As an aquarist, I try to opt for biological pest control because it means less work for me. However, the majority of organisms regularly used for control are found in tropical temperatures above 23°c or temperate below 18°c. The 20-22°c temperature of this exhibit lies right at the outer limits of these ranges.

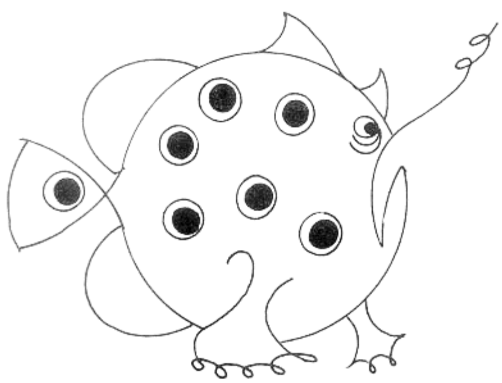
Having worked with temperate biotopes, I was familiar with using jeweled top snails, *Calliostoma annulatum*, for hydroid control. This species is usually associated with kelp beds and not readily available. A related species, the blue top snail, *C. ligatum,* has been used regularly for hydroid control in Steinhart's crinoid and sand dollar exhibits, which are also heavily fed.

C. ligatum are regularly collected by aquarists at local tidepools. Since intertidal animals often have a higher tolerance for temperature swings, in order to survive low tide events, I wondered if these snails would be able to survive long term at 22°c. Being locally collected and not purchased and shipped is an added bonus.

In order to ease the transition to a life at warmer temps, the exhibit was lowered to 20°c. Two snails were drip acclimated and added to the exhibit overflows, which were heavily colonized with hydroids. 24 hours later, tracks through the colonies were observed. Within a week, the two snails had completely eradicated all trace of hydroids. Unfortunately, they had no effect on aiptasia. Having established that the snails would predate on the hydroids, 12 additional were acclimated and added to the exhibit. Within a month, most of the hydroids which had spread across the tank's various surfaces were gone. The only remaining patches were those that had grown onto the corals or their skeletons, presumably because the snails were unable to access them. These patches were fairly easy to remove manually as they were fewer and more contained. A year later, the snails have kept the exhibit mostly hydroid free and have survived well with only one addition of another 12 individuals during that period.

There are a couple of things to consider when using *C. ligatum* for hydroid control. First, when using an intertidal species, they will often hug the water line. The exhibit that I am using them in does have an artificial backdrop that leaves a small gap between the top of the tank and the backdrop above the water. I have found individuals that have gotten stuck in that space and died. Second, this species is not an obligate feeder, they are scavenging omnivores with a preference for hydroids and bryzoans. Though my current population has been well behaved, I have observed this species predating on orange cup corals, *Balanophyllia spp.* Another Steinhart individual has been found predating on feather stars, *Florometra serratissima.* So your mileage may vary.

Photo by Margarita Upton



General Information for RAW 2018

For more details about Registration see the RAW 2018 website: http://rawconference.org/

Host Institution: The Florida Aquarium, Tampa, FL, USA

Conference Hotel: Embassy Suites by Hilton Tampa Downtown Convention Center
513 South Florida Avenue, Tampa, Florida 33602 USA
Telephone: +1-813-769-8300
Book your RAW 2018 Reservation on http://rawconference.org/ under Travel & Lodging
Rates: from $219.00 USD/Night 2 Double Beds Nonsmoking or 1 King Bed Nonsmoking

When: May 14-18th

- May 11-12th AZA SAFE Shark Workshop May 11-12th
- May 13th TAG Prep Day
- May 14th TAG Report Day & Professional Development Workshops
- May 15th-18th General Sessions

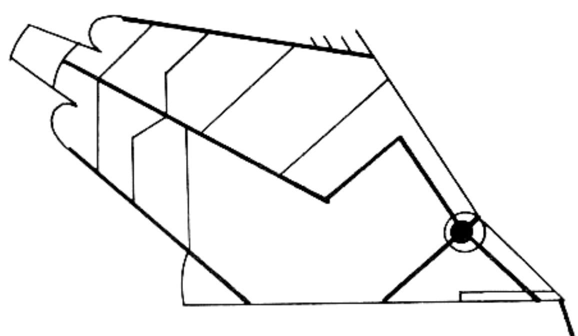
Registration: Before March 31st, 2018 11pm (America/New York)

$100 + $5.86 Fee	Full Conference Registration (includes Tuesday, Wednesday, and Thursday evening events)
$500 + $0 Fee	Commercial Affiliate Registration (includes Tuesday, Wednesday, Thursday evening events)
$50 + $2.06 Fee	Additional Ice Breaker Ticket - Tues May 15th (Required if bringing a guest who is not registered for the conference)
$100.00 + $3.81 Fee	Professional Development Workshop: Leading When You Aren't In Charge - Monday May 14th
$200.00 + $7.31 Fee	Animal Behavior Workshop - Monday May 14th

Airport & Transportation Options:
Tampa is located on the West coast of Florida. The city can be accessed by the Tampa International Airport (TIA), St. Petersburg-Clearwater International Airport (PIE), or Orlando International Airport (MCO).

Transportation between Embassy Suites by Hilton Tampa Downtown Convention Center and airports.

Airport	Distance	Estimated Travel Time	Estimated taxi fare
TIA	8 miles	15 minutes	$15 USD
PIE	17 miles	25 minutes	$27 USD
MCO	87 miles	1 hour 25 minutes	$135 USD



Wicked RAWesome (RAW 2017) ABSTRACTS
Regional Aquatics Workshop, May 8-12.
New England Aquarium, Boston MA

AZA Aquatic TAG reporting meetings were held May 8th.

Tuesday, May 9th
Session 1: Research and Conservation 1
Moderator: Mark Smith

Welcome and Introduction:
Mark Smith, New England Aquarium

Sponsor: Tenji

Keynote Speaker:
Research and Aquaria
John Mandelman, New England Aquarium

Conservation and Aquaria: Panel
Les Kaufman, Boston University; Hap Fatzinger, NC Aquarium at Pine Knoll Shores; Joe Yaiullo, Long Island Aquarium; Mike O'Neill, New England Aquarium

Session 2: Research and Conservation 2
Moderator: Sandy Trautwein

Sponsor: Aqua Logic

Working as a Global Conservation Network: Linking with the International Union for Conservation of Nature (IUCN)

Kira Mileham, Kent Carpenter, and Rob Bullock
Association of Zoos and Aquariums, Old Dominion University – IUCN Global Marine Species Assessment, and The Deep Aquarium, UK
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Business as usual is no longer an option. The aquarium community is facing a huge challenge to protect the species we care for; of the nearly 80,000 species assessed on the IUCN Red List of Threatened Species, almost 30% are threatened with extinction. Conservation efforts continue to be surpassed by the pressures on biodiversity, especially in the aquatic realms. Aquariums are critical players in protecting species in the wild, utilizing funds, expertise, facilities and public profiles to drive conservation efforts within their organizations and in the field. However, in the face of so many challenges, we need to collaborate strategically, combining our differing strengths and resources. To do this, many aquariums are strengthening relationships with the IUCN Species Survival Commission. These relationships focus on collaboration for Red List Assessments, conservation planning, and global networking to play a more integrated and global role alongside the world's largest conservation network.

A Roadmap to Using CITES Successfully? The Recent Listing of Nautiluses

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In 2016, nautiluses (Family Nautilidae) were adopted into Appendix II of the Convention on International Trade in Endangered Species (CITES). The listing requires countries to provide non-detrimental findings (NDFs) showing that export of the species does not affect wild populations. However, there are no standard methods for how countries determine the NDFs. Often, a consequence of increased regulation is illegal trade. Simply placing a species on CITES does not guarantee its survival, as countless examples show. Thus, it is paramount that all stakeholders involved in the successful CITES proposal continue to expand on work already done. In reality, the success of CITES might be better gauged by how long a species remains on CITES. As education, awareness, and management plans improve, thereby increasing populations, a species would no longer meet the requirements for CITES and should be de-listed, resulting in a success! The road to de-list nautiluses starts now.

Aquarium Roles in the Conservation of Marine Biodiversity - How Our Daily Practices Can Help Save Aquatic Species in Real World Applications

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The outlook of marine ecosystems is bleak; overfishing, by-catch, coastal development and climate change are among the biggest threats to marine biodiversity. Corals, marine mammals and sea turtles are among the groups with highest threat of extinction. This project assessed the number of threatened aquatic species in the Species360 ZIMS database network in comparison to the IUCN's Red List. The results indicate the wealth of species and knowledge curated by the aquarium community can be crucial to support projects such as assisting propagation of new coral colonies, the provision of samples for biomarkers to identify illegal products, and determining the limits of captive breeding of species that are laundered under false pretenses through international markets. As aquariums continue to focus efforts on captive breeding and species conservation work, the importance of record keeping and sharing information for captive animals becomes increasingly relevant for conservation work well beyond the walls of our facilities.

DNA to Discoveries with Ocean Genome Legacy:
A DNA Bank for Research and Marine Conservation

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The Ocean Genome Legacy Center (OGL) is a non-profit genome bank that preserves marine DNA samples and makes them widely available to scientists around the world. Marine organisms contain a wealth of information hidden in their DNA about their unique adaptations, vulnerabilities, interactions, and history. The DNA also contains information about cell growth and replication, which is similar across the tree of life. OGL works with aquariums and other contributors to collect DNA from marine species and then distributes the DNA to researchers working in medicine, biotechnology, and conservation. A recent result of these cross-disciplinary collaborations involves the analysis of DNA from a diverse group of species, including fish, to investigate the development of diseases and how they can be diagnosed and treated. Projects such as these highlight the importance of exploring, preserving, and conserving the vast biodiversity contained within our oceans.

Sponsor: Aquatic Equipment and Design, Inc.

Session 3: Research and Conservation 3
Moderator: John Hoech

Sponsor: Kessil

The Altruistic Genie: Aquariums in the 21st Century

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Public aquaria aspire to be centers for research, conservation, and education, as well as models for sustainability. In this endeavor public aquaria inspire their visitors through representation of marine and freshwater ecosystems, displaying a wide variety of aquatic organisms. To remain effective and relevant aquaria must: (1) Set an example of sustainability; (2) Continue to optimize industry best practice; (3) Increase pure and applied research activities; (4) Increase conservation activities, esp. in situ; (5) Advance well-researched and practical advocacy; and (6) Augment up-to-date and effective education. Aquaria must actively advance each of these domains, more coherently police industry best practice, better connect their visitors to the wild spaces they represent, and work together to more effectively communicate their value to the environment and society. The New England Aquarium alone presents over 850 different species. When selecting species for exhibition, it is critical to consider the following: justifiable rationales for acquiring a species; available infrastructure and operational capacity; animal husbandry capacity and animal welfare implications; a long-term deaccession plan; and sustainable sources for chosen display animals. The New England Aquarium addresses these demands through a structured planning process, using a set of Strategic Program Criteria and an Exhibition Species Selection Flowchart, implemented through a sustainable collection committee. One mechanism employed at the Aquarium to improve collection sustainability is the strategic breeding and rearing of fish species highly demanded within the industry, yet rarely (or not yet) bred in human care. Examples include the blue chromis (*Chromis cyanea*), lookdowns (*Selene vomer*) and the smallmouth grunt (*Haemulon chrysargyreum*). In addition to careful stewardship of its living collection, the New England Aquarium regularly reviews its animal food sources to ensure sustainable practice is employed.

The Gulf Stream Orphan Project: Creating a Citizen Science Network to Learn More about Wayward Tropical Species

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Each summer, the Gulf Stream is responsible for transporting tropical fish, larvae, and eggs north to the coast of New England. Many, if not all, will fail to survive their first New England winter as water temperatures drop below the tolerance of these Caribbean species. For decades, marine research institutions, universities, aquariums, divers, and hobbyists have known about this seasonal phenomenon and have independently collected data and specimens but the transmission of data has been largely anecdotal. The goal of the GSO project is to build a comprehensive data set with contributions from researchers and citizen scientists to better understand the phenomenon of Gulf Stream Orphans and their environmental impact. In addition to abundance and distribution, Gulf Stream Orphan sightings may be useful in gauging climate change and environmental perturbations in the northwest Atlantic.

FCTC-The Florida Conservation and Technology Center: Bringing Together Partners for a Better Tomorrow

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FCTC is a partnership between Private Corporation, Tampa Electric Company, government, Florida Fish and Wildlife Conservation Commission (FWC), and not-for-profit, The Florida Aquarium (FLAQ). Their goal is to create educational and environmental resources for our state and community.

With support from the State of Florida, these institutions have been able to create and implement a 5-year plan to start Phase I. The site encompasses a 400-acre strip of land on Tampa Bay. With coral research facilities (FLAQ) and an environmental education building (FWC) running, we are also months away from accepting our first patient in our sea turtle rehabilitation center (FLAQ).

FCTC is off to a great start conserving our Blue Planet, teaching about and researching our Florida shores. We house full time biologists and host visiting scientists and 100's of school children each year. Expansion plans include fish stock enhancement and shark research tanks.

Take a Walk on the Wild Side: The Role of Aquariums and Zoos as "Storefronts" for Science and Conservation Related to the Collection of Aquarium Fish

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For decades, the global trade in freshwater fishes for home aquariums has provided livelihoods for rural people, often serving as the economic base in regions of critical biological importance. There is also evidence that these fisheries drive environmental protectionism and help maintain vital ecosystem services. However, the social and environmental benefits from these fisheries are threatened by many external factors. Public aquariums and zoos have a unique opportunity to not only educate visitors about these fisheries, but also foster environmental outcomes by exhibiting fish which showcase examples of fishery-driven social and environmental benefits. Research conducted by New Knowledge reveals opportunities for future exhibits, messaging, and educational programming that inspire passion for science and conservation action. In addition, new avenues of research by the recently launched sub-group of the IUCN's Freshwater Fish Specialist Group aim to better identify and catalogue case studies of fisheries which result in socioeconomic and environmental benefits.

Sponsor: Dynasty Marine

Session 4: Research and Conservation 4
Moderator: Amy Slagoski

Sponsor: 121 Animal Handling Products

Sustainable Aquatic Collections - Closing the Loop on Exhibit Species

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We recently finished a 3-year IMLS funded project to teach aquarists to rear the fish that spawn on exhibit. We created a small turn-key modular larval rearing system (MoLaRS), and held workshops to train aquarists on using the MoLaRS, along with techniques for how to grow appropriate foods for the larvae. In total, we worked with eggs and larvae from 84 species that could be reared to a size where they could be positively identified. Of these, 4,926 individuals of 61 species were placed back onto exhibit at participating public aquariums. This project increases the ability of zoos and aquariums to rear their own exhibit marine fish, reducing the need to collect fish from the wild. It also adds greatly to the basic scientific knowledge of early life histories of fish, and creates additional exhibit opportunities in showcasing the full life history of marine fish.

Project Coral – Captive Broadcast Coral Reproductive Research and Larval Rearing Techniques at the Horniman Museum & Gardens

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Project Coral is a multiyear research project focusing on coral reproduction and climate change. In environmentally controlled research systems at the museum a number of experiments, in collaboration with our partners are being conducted. There are many targets over the years, ultimately leading to understanding the role that genomics and proteomics plays on coral reproduction. In December 2015 synchronous spawning was successfully induced in our Australia research system enabling 6 genetic crosses of *Acropora tenuis* & 2 genetic crosses of *Acropora millepora* through in-vitro fertilization, producing 176 new juvenile colonies (1-year-old). In March 2016 the second synchronous spawning event was induced in our Singapore research system, resulting in 2 genetic crosses of *Acropora hyacinthus* producing 43 settled new colonies.

Inducing broadcast coral spawning in captivity is a new frontier in coral conservation that may open a whole new area of coral reef research and reef restoration potential.

Spawn 'till You Die: Captive Rearing of Kokanee Salmon and Arctic Grayling

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Thymallus arcticus (Arctic grayling) and *Oncorhynchus nerka* (Kokanee salmon) are local Colorado species housed at the Downtown Aquarium. In years past, Aquarium biologists would collect wild specimens with the help of Colorado Parks and Wildlife on an annual basis. However, we decided we would like to do this sustainably. With the aid of Colorado Parks and Wildlife who graciously provided the eggs, we decided to try hatching and raising these species in-house to create a more sustainable population. To do so, we constructed and set up a cold water hatch system capable of hatching and raising both species. We first started with Kokanee salmon which hatch in three months, followed by Arctic grayling, which hatch in approximately 20 days, and had success with both species. Similarities between them include treatments for fungal growth prior to hatching. Major differences between raising these species include hatch time, temperature and egg size.

Movement and Habitat Use of Mature Female Sand Tiger Sharks (C*archarias taurus*) in North Carolina Coastal Waters

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The North Carolina coast serves as a migration route for *Carcharias taurus*, but some degree of residency may exist. Aggregations of *C. taurus* have been observed with coordinated seasonal reproductive movements with birthing grounds loosely defined in southern coastal waters.

For this study, mature female sand tiger sharks will be tagged and tracked using acoustic telemetry to explore habitat utilization, residency time and to quantify movement patterns along the NC coast and define essential fish habitats in the Cape Fear. Identifying critical habitats inform conservation management decisions for the protection of future generations of sand tiger sharks in the wild. Partnered with the NC Aquariums and SEZARC, comparative reproductive research will be conducted alongside this study to provide baseline data for sustainable collections in aquaria.

Data collection began in 2016 and continues into 2017 as part of the primary investigator's thesis. Preliminary findings may be available at time of conference.

Sponsor: Pecan Grove Solutions LLC

Wednesday, May 10th

Session 5: Culturing 1

Moderator: Barbara Bailey

Welcome: Barbara Bailey, New England Aquarium

Sponsor: McRoberts
Sponsor: Animal Professionals

Zoo Babies, Aquaculture Efforts at OHDZA, with an Emphasis on the First-Ever Rearing of the Stocky Anthias, *Pseudanthias hypselosoma*

Timothy Morrissey
Omaha's Henry Doorly Zoo and Aquarium
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This presentation focuses on building and maintaining a successful larval rearing system at Omaha's Henry Doorly Zoo and Aquarium. Techniques were established for live food culture, egg collection, and larval rearing. CO2 injection was found to be key in culturing microalgae. Once the algae methods were established and repeatable, copepod cultures were ramped up. Most broodstock fish are on exhibit so egg collection techniques had to be modified for each exhibit and/or species. The larval rearing methods were then adapted to each species with the highlight being the first captive raised Stocky Anthias. We now culture 3 species of microalgae, 2 species of copepods, rotifers, and have raised 7 species of tropical teleost fish totaling over 200 fish and more than 100 of those back on exhibit. This talk will go into detail in explaining the process of starting from scratch and building a successful larval rearing system.

Hormone Induced Spawning of the Atlantic Lookdown, *Selene vomer*

Andrew L Rhyne, Barbara Bailey, Kathy Tuxbury, Monika Schmuck, Joseph Szczebak
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There has been a surge of interest in the production of marine fish for display in public aquaria. In order to develop aquacultured displayed specimens, reliable sources of embryos must be developed. While some species spawn on exhibit, many species of marine fish do not volitionally spawn in captivity. Here we demonstrate the successful induced volitional spawning of the Atlantic Lookdown, *Selene vomer*.

A mature population of *S. vomer* broodstock (two males, eight females) were transferred from exhibit to New England Aquarium's offsite holding facility in Quincy, MA. Broodstock were cannulated to determine gender and gonadal development then transferred to a 6,000 L recirculating seawater system designed specifically for the conditioning and spawning pelagic fish. Females were implanted with the slow release GnRHa hormone implant OvaPlant (Syndel) and spawning ensued 36 hours post injection. The single spawning event resulted in the production of over 2,600 juvenile fish, which reached a marketable size of 3-4" by 60 days post hatch.

Spawning Behavior and Early Development of the Flashlight fish, *Photoblepharon palpebratum*

Audrey Santos, Paula Carlson, Daryl Richardson
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Minimal information has been published regarding the life history of members in the *Anomalopidae* family. Captive rearing records of *Photoblepharon palpebratum* are not readily available. The first egg release was observed in March 2016 in the Palau exhibit at the Dallas World Aquarium, which mainly houses flashlight fish. By October 2016, the flashlight fish began spawning regularly. The exhibit is on a reverse light cycle and the fish spawn in the dark. Spawning behaviors are observed daily and digitally recorded. Flashlight fish reproduce via paired external fertilization. Fertilized eggs are harvested almost daily from the exhibit. After two days the eggs hatch into simple bodied larvae. Different larval rearing attempts have documented seven days development post hatch. Recent changes to the larval rearing setup demonstrated that increasing temperature allows for better mouth development. Continued efforts to evaluate effects of temperature and food preference will hopefully allow for successful larval rearing.

Methods, Mishaps, and Successes of Rearing the Blue Chromis

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Chromis cyanea, the Caribbean Blue Chromis, is a dynamic and desirable addition of color and movement to many public aquaria exhibits across the country, including the New England Aquarium (NEAq) in Boston, Massachusetts. At any given time, our largest exhibit, the Giant Ocean Tank, will hold a school of up to 100 Blue Chromis. When the NEAq initiated an official larval rearing program to expand on their sustainability efforts, the focus was decidedly on a key exhibit species, the Blue Chromis. Early in 2015, the Aquarium acquired a small school of 20 wild-caught Blue Chromis to serve as the broodstock population. Over the course of the next year, the broodstock were groomed, nests were collected, and larval rearing methods were trialed. This presentation will detail the methods, mishaps, and successes of rearing the Blue Chromis, from broodstock care to larval rearing techniques to quarantine and exhibit introduction.

Sponsor: U.S. Mysids

Session 6: Culturing 2
Moderator: Jennifer Rawlings

Sponsor: Cairns Marine

Hungry, Hungry Rhizostomes:
Successful Rhizostome Culture Strategies at National Aquarium

Matt Wade
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Jellies are highly popular in public aquaria, but the availability of Rhizostomes can be challenging. Though some species have been successfully cultured in aquariums, specific culturing information is difficult to obtain and replicate. National Aquarium staff successfully cultured *Mastigias papua* and *Phyllorhiza punctata* following multiple failures, by modifying advice from multiple colleagues. Strobilation is now controlled by transferring polyps between our exhibit and culture lab, which are supplied by seawater of different chemical make-ups. Ephyrae developed best in successive enclosures: transferred from evaporating dishes to pseudokreisels to modified boxes to bullnose exhibits. Optimal growth and activity were observed using metal halide lighting at PAR levels exceeding 500 µmol m^{-2} sec^{-1}. Feeds consisted of a slow *Artemia* nauplii drip supplemented, as medusae developed, with live rotifers, Reef Nutrition R.O.E. and Piscene Energetics *Calanus finmarchicus*. Compiling and communicating these lessons learned in this format will be instructive to future Rhizostome culturists.

When it snows in Florida: Methods for the Successful Mass Culture of Moon Jellies (*Aurelia sp.*) at the Florida Aquarium.

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There are a number of factors that limit a facilities ability to culture any species of jelly and each case is different. Forcing strobilation on a schedule, harvesting ephyra, feeding ephyra, and then raising the jellies to a size that is displayable all take time, space, and energy. The Florida Aquarium has created a culture system and husbandry protocols which have allowed for the successful strobilation of moon jellies (*Aurelia sp*) every 6 months for the last 3 years. The current culture system and husbandry protocols not only allow the ability to raise the jellies to a displayable size for stocking a 700 gallon exhibit but to also routinely surplus them by the thousands at multiple life stages while keeping a significant number of individuals on reserve as a healthy backup population and for feed out to other species of jellies.

The Cuboid Invasion – Part 1: Sweating the Small Stuff

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In November 2016, juvenile box jellyfish (Phylum Cnidaria; Class Cubozoa) began appearing in an 80L reef scorpionfish exhibit at National Aquarium. As cubozoans are considered highly venomous, a modified handling protocol was immediately implemented along with relevant staff education for both safety and biosecurity. With two tentacles present in its juvenile stage, rather than the typical four, this cubozoan resembles only one other cubozoan for which the life history is known: *Carybdea marsupialis* from Puerto Rico. However, some morphological differences exist between the juvenile box jellyfish from National Aquarium and Puerto Rico. Therefore, in collaboration with the Smithsonian National Museum of Natural History, DNA molecular analysis was conducted at the Laboratories of Analytical Biology to determine species identity. The resulting molecular barcode was used to develop markers to facilitate environmental-DNA (eDNA) detection of this cubozoan in National Aquarium's salt water habitats where their presence might pose a safety threat.

Attach of The Clones: Asexual Re-aggregation of *Pocillopora damicornis*

Chelsea S Wolke, Norton T Chan, David A Gulko, Stephen P Ranson, Laura Del Rio Torres
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Hawaiian corals average 1 cm of growth per year, which is amongst the slowest rates worldwide. As a result, it takes these corals longer to achieve reproductive sizes and requires significantly longer recovery periods after environmental perturbations. At Hawaii's Division of Aquatic Resources' Coral Restoration Nursery, *Pocillopora damicornis* frequently releases asexual planula which have been successfully collected, settled, and re-aggregated in a controlled environment to produce larger, mature colonies at rates faster than they occur in the wild. The resulting colonies provide an in-house supply of source material for reef mitigation projects, having the ability to improve reef restoration techniques by providing further insight for increasing growth rates via assays on replicate corals with no impact to wild source colonies. Our ability to grow coral, in addition to developing and implementing transplantation techniques without harvesting existing wild colonies, helps to maintain our natural reef's ecological value.

Sponsor: Tracks Software

Session 7: Culturing 3
Moderator: Hap Fatzinger

Sponsor: Quality Marine

Improvise, Adapt, Overcome: Larval Success with Minimal Resources

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Marine ornamental aquaculture is a necessary area of growth within our industry but individual institutions may experience staff, knowledge, or resource bottlenecks that make larval fish culture seem prohibitive. Through industry surveys, time logging, and endless trial and error, the fish propagation team at Moody Gardens has identified ways to resolve these bottlenecks through decision trees, project growth resources, and partnership opportunities with other facilities. Our hope is for biologists to use these resources at their home institution to initiate small-scale larval culture that can help convince management to invest in larger scale activities.

Chill out! It's just *Nannochloropsis.*

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Nannochloropsis spp. is a common microalgae grown for live food culture at aquariums because of its availability and simple culturing process. *Nannochloropsis spp.* provides critical nutrition for rotifers, invertebrates, and various larval species. Although simple to culture, microalgae cultures encounter challenges. Attempting to eliminate ciliate contamination in one the cultures at the Aquarium Science Program facility, we discovered that *Nannochloropsis oculta* can successfully rebound from prolonged freezing. After freezing batches for 24 hours, three days, one week, and one month cultures successfully restarted. These intriguing results offer the potential for new exploration in the field of microalgae culture, such as, the ability to eliminate biological contaminants, store batches, and easily ship stock.

Octopus bimacu…wait, which one am I trying to rear again? Who cares- it's an octo project! But really, it was *bimaculatus*.

Artie Ahr
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Attempts were made at rearing *O. bimaculatus* paralarvae. Settlement is low due to high mortality rates as these require adequate nutrition and upwelling. This project utilized different tank designs with the same feeding schedules. The tanks were stocked with copepods and progressively different sized foods were introduced. Settlement was not achieved, however presettlement behaviors were observed. The longest living paralarvae lived for at least 28 days in tank design "A", 19 days in tank design "B", and up to 47 days in tank design C. Survivorship rates were as follows for tank design A: Day 7: 43.8% Day 14: 24.7% Day 21: 5.5% Day 28: .06% This surpasses the previous DPH success of 6 recorded by Ambrose in 1983. Octopuses were collected on exhibit under natural hatching as well as hatched artificially in a manifold with no significant difference in survivorship. From our results, it seems that the pseudokreisel was the best set up for the paralarvae, and additional work should be done on exploring these techniques

The missing INK - Innovations to Cuttlefish and Squid Husbandry

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We shall have no better conditions in the future if we are satisfied with all those which we have at present – Thomas Edison. Aquariums have been keeping squid and cuttlefish for decades without significant evolution in species diversity and husbandry methods. Our industry knows relatively very little about cephalopods compared to other commonly displayed freshwater and marine organisms. In order to continue advancing our knowledge of cephalopods in aquaria, we need to continually investigate ways to optimize cephalopod husbandry. Areas to be improved upon are feeding methods, artificial incubation, maximizing reproduction, *in vitro* fertilization, and transfer methods. Cephalopods are a rapidly emerging model organism for numerous objectives, not only for public display but also biomedical applications, neural research, soft robotics, behavior studies, and genomics, to name a few. This makes it increasingly important to better understand this group of animals and promote their longevity and culture in aquaria over time.

Sponsor: Omega Sea

Session 8: Husbandry
Moderator: Doug Warmolts

Sponsor: Blue Corner

Using Electricity to Bridge Temperate Sharks during Positive Reinforcement Training

Mark Murray
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Current training of elasmobranchs consists mainly of classical conditioning. Adding a bridge to elasmobranch training could greatly increase the number of learned behaviors. This method would allow many different species of sharks, skates, and rays to be easily trained to load into a stretcher in a matter of weeks or months rather than months or years. Normally a neutral stimulus such as a target is paired with a biological stiumulus. Positive reinforcement training can be difficult to accomplish with marine organisms because sound travels faster underwater. Therefore, all individuals hear an auditory bridge, such as a clicker, simultaneously. Eugenie Clark pioneered shark training by training a lemon shark to push a target, which would cause a submerged bell to ring, and receive food. Unfortunately, this is only effective if you are trying to train a few individuals, instead of training multiple animals in a single tank. By producing a localized non-auditory cue specific individuals were bridged in an environment with 49 individuals of four temperate species: Leopard Sharks, *Triakis semifasciata*, Pacific Spiny Dogfish, *Squalus suckleyi*, Broadnose Sevengill Sharks, *Notorynchus cepedianus*, and Soupfin Sharks, *Galeorhinus galeus*. By using a light as a bridge during training sessions, visual and electrical stimuli are simultaneously provided. This has increased the response and targeting from these sharks.

"To Catch a Pristid" …or How Many Aquarists Does it Take to Lift a 375 lb. Sawfish?

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At Shedd Aquarium, a surgical intervention to remove a rapidly growing papilloma necessitated the need to capture, handle and provide support for a 13.5-foot (4.1 meter) 375lb (170 kg) green sawfish (*Pristis zijsron).* Although a variety of methods exist to successfully catch and handle adult sawfish, special considerations regarding habitat infrastructure, potential risks to staff and animal, along with the quantity of staff and specialized equipment needed, had to be realized before a safe and successful procedure could be achieved.

Increasingly, more facilities may face similar challenges when managing large sawfish. With ongoing husbandry advancements and more frequent handling for addressing medical issues, providing advanced preventative veterinary care may be required. Shedd Aquarium will present the challenges we faced in our facility, and the methods and procedures used to overcome them.

The Use of Physiotherapy in Aquatic Animals

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Physiotherapy is a relatively new discipline in the animal field. It involves the treatment of disease or injury by physical means such as massage, heat treatment and exercise. The potential uses across species (with some species-specific modifications) is vast and a valuable resource in rehabilitating both captive and rescued animals. There is therefore potential in using this form of treatment for rehabilitating time to be reduced, or rescued animals previously deemed unreleasable to be suitable for return to the wild. The possible applications and benefits of utilizing this form of therapy in wildlife cases were assessed through treatment of a Port Jackson Shark, Flatback Sea Turtle, Green Sea Turtle, Little Penguin and an Eastern Water Dragon that were considered to be suitable candidates.

Each animal had a different form of trauma and their quality of life was impacted. The physiotherapy protocol was altered to suit each case. All but the dragon made a full recovery. The dragon recovered partially but the suspected neural damage prevented further recuperation.

Effects of 2-Phenoxyethanol $C_6H_{10}O_2$ as a Means of Humane Euthanasia for Three Common Aquarium Tropical Teleosts; Bicolor Damsel *Stegastes partitus*, Bluehead Wrasse *Thalassoma bifasciatum* and French Grunt *Haemulon flavolineatum* in a Captive Environment.

Erika Pinney
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The three teleosts chosen for this study are commonly seen species at many public aquariums worldwide, and are the focus species for this study. Subjects (*N=20/species*) were administered a given amount of 2-Phenoxyethanol for a 20-minute maximum induction period. The objective of this study was to create an ideal dosage for these listed species that would ensure virtually no suffering/discomfort during euthanasia based on observations of respiration changes and response to external stimuli. Dosage of this medication ranged from .04 ml L^{-1}- 2 ml L^{-1} to determine an efficient and effective amount of medication. After the three species were researched; it can be suggested that a concentration of 1.2ml L^{-1} for humane euthanasia on smaller warm water marine teleosts in an exposure time of twenty minutes.

Sponsor: Reef Brite

Thursday, May 11th
Session 9: Personnel
Moderator: Steve Bailey

Welcome: Steve Bailey, New England Aquarium

Sponsor: Aqua-Tech Co.

Developing a Professional Team: Ideas from the Aquarium of the Pacific

Sandy Trautwein
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The long-term success of any aquarium depends on the professional health of its staff. Participation in exhibit development, operational improvements, and future planning are all important for professional growth, but are often led by senior management. Staying engaged in daily responsibilities can also be difficult for aquarists, as the job can be repetitive and physically demanding. Over the past several years the Aquarium of the Pacific has implemented several outlets for increasing aquarist professional growth while also integrating aquarists in departmental development. By creating these opportunities, the Aquarium of the Pacific hopes to contribute to each aquarist's personal growth while also helping staff to cultivate an atmosphere of respect and inclusion in which each employee can feel a sense of pride and professionalism in his or her work. This presentation will review these opportunities and present some ideas for developing a professional team.

Byting back:
How Well-Architected Digital Husbandry Practices Can Alleviate Operational Challenges

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SEA LIFE Aquariums throughout the U.S. have moved towards incorporating more advanced record-keeping techniques for animal collection tracking. Husbandry staff, educators, and a programmer (called the digital alchemist) have collaborated to create an open, web-based record keeping software called Biota. Five of eight SEA LIFE sites have moved towards integrating this new technology into their facilities. This integrates technologies that mix back-of-house data with educational content to create engaging and informative interactive features. Biota's animal inventory system automatically updates touch screens, mobile apps, and training materials. Husbandry staff can easily record feeding logs, animal observations, maintenance records, and dive logs. Guest interactions with the touch screens are recorded to gauge interest for upcoming displays. Future projects include the use of ethograms to track animal behavior and joint medical records between all SEA LIFE U.S. sites. Therefore, all of the data is harvested in one accessible and secure program.

Occupational Diving and How it Impacts Your Facility

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Occupational diving within the zoo and aquarium industry differs greatly from recreational diving. Occupational diving encompasses underwater diving with compressed air (SCUBA or surface supplied) during employment. The activities are mandated by Federal OSHA regulations and the task dictates the standard that is followed. Diving scope includes tasks associated with exhibit husbandry, such as cleaning tanks and feeding animals, inspecting and maintaining life support and treating and capturing animals. Also included are dive equipment considerations and sanitation, volunteer management, guest immersion programs, VIP/Media, special events, and managing reciprocity requests for staff. The goal of a well-managed occupational dive program is to safely and efficiently perform tasks underwater while facilitating institutional diving needs. In this way, Husbandry and the Dive Safety Team can better understand and assist one another in their respective jobs.

Preparing for the Unexpected: How One "Garden Variety Storm" Made Us Rethink our Disaster Preparedness

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On July 6th, 2016, a storm system rolled through Columbus, lasting only about 5 minutes. While the rest of the zoo went about operating as normal, two large aquarium buildings lost all power and back- up power. A transformer box had taken a direct lightening hit. What followed when power was restored was the quick realization that everything that was on before the storm, was now electrically compromised. Everything from pumps, IT equipment and radio chargers were essentially fried. The cost for this lightning strike totaled over $56,000 and took several weeks to repair. In this presentation, I will talk about what we learned from this unexpected event. Topics will include building aquariums for unexpected disaster, and the importance of fostering relationships with nearby institutions. I will discuss the need for disaster preparedness beyond the exercises required by AZA, and what that looks like for an aquarium.

Fires happen!!… How prepared are you?

Katy Duke
The Deep
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On the 10th August 2016 at 11.30am there was an electrical fire at The Deep. It took out our 16-year-old mature coral exhibit and engulfed the aquarium in smoke. The actions taken on the day by the Husbandry team were exemplary and have since been documented in an action plan should the worst ever happen again. The plan provides every detail of what to do and when, from communication with the fire brigade to preparing penguin transport containers. A fire evacuation grab bag has also been put together providing useful items for staff to start emergency preparations once they have left the building. The following days after the fire also threw up unexpected problems including the failure of our main exhibit life support system PLC. As a result, the fire has triggered a range of upgrades and modifications throughout the building to help prevent such events in future.

Sponsor: Fritz Aquatics

Session 10: AZA Sharks
Moderator: Beth Firchau

Sponsor: RK2 Systems

Sandra Elvin, Assoc. of Zoos and Aquariums
Jim Wharton, Seattle Aquarium

Sponsor: Hayward Flow Control

Session 11: LSS
Moderator: Andy Aiken

Sponsor: Asahi/America

Effect of Supplemental Phosphorus and Organic Carbon on Nitrification during Cycling

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Chemical cycling of new LSS through the use of ammonium salts or urea is standard practice in the aquarium industry. These nitrogen sources have long been used to facilitate growth of ammonia oxidizing bacteria (AOB) and nitrite oxidizing bacteria (NOB) in biofilters, though the process has its limitations. Cycling of nitrite typically is typically more problematic than ammonia as NOB communities develop more slowly than AOB and must compete for space in biofilms. Though the cycling process promotes chemoautotrophic nitrification most species of NOB are facultative organoautotrophs, and as such can utilize organic compounds as the electron donor in nitrification. Supplementation of organic carbon (e.g. sugar/ethanol) in addition to carbonates or bicarbonates has been found to enable NOB to more rapidly oxidize nitrite concentrations during cycling. Additionally, the supplementation of phosphorus (as phosphoric acid) has been used in aquaculture for years to similar effect to ameliorate “phosphate block” in cycling.

Aquarium Monitoring and Controls on a Budget: A Technology Based Approach for Creating Stable Environments

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In recent years, aquarium controls have evolved considerably. There are now affordable monitoring and control systems, originally designed for the hobbyist industry, which are robust, easy to build and program and prime for incorporating into certain portions of the public aquarium sector. These systems are ideal for monitoring and controlling smaller displays that often are not part of an institution's larger Building Management System (BMS), but nevertheless house important and valuable specimens. They provide piece-of-mind, help prevent and warn of catastrophes before it's too late, as well as create a more stable environment for the system's inhabitants.

These powerful systems allow aquarists to monitor and control a diverse range of inputs and outputs. They are cloud based and the end user can get real---time data and have remote control anywhere from any web---based device as long as they have Internet connection.

"Pumps - the Heart of Aquatic Installations"

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In modern public aquariums we often find a lot of chances to reduce the electrical power consumption and thus the carbon footprint. Old installations, bad planning or the need to change several installations lead to a mismatch of needed flow and head pressure versus pump performance.

We will talk a little bit about the do´s and don´ts of plumbing, explain differences in flow when piping wrong, the correct matching of pump to exhibit and sustainability issues.

Plastic Fantastic? Taking up the Challenge of Going #OneLess

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If marine conservation is truly important then why is it such a low priority for most people and bottom of the political agenda? Is the conservation community failing in selling the conservation message? Do public aquariums see conservation primarily in terms of supporting overseas projects and breeding programs? The #OneLess campaign is exploring how aquariums and other organization might adopt different ways to engage people in marine conservation, leading to changes in behavior and a more sustainable relationship with the ocean. Developed by the Zoological Society of London and partners, the #OneLess campaign aims to reduce the number of single use plastic water bottles, one of the highest sources of marine litter, by promoting alternative refillable bottles. The Deep have taken on this challenge. This case study documents the process of going #OneLess and how other aquariums might get involved in a wave of positive change for the ocean!

Sponsor: Abyzz

Session 12: Exhibits
Moderator: Marie Collins

Sponsor: See Clear

"Forests Underwater by Takashi Amano"
Maintenance of a 160 m3 Nature Aquarium at Oceanário de Lisboa

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In 2015, Oceanário de Lisboa opened its new temporary exhibition - "Forests Underwater by Takashi Amano" - giving its visitors the opportunity to see the world's largest nature aquarium. If the construction and assembly of an aquarium this big posted a great challenge, its maintenance is no different. Given the size of the tank, most of the techniques and tools used to keep this exhibit had to be up scaled. This presentation focuses mainly on the aspects related to the maintenance of the aquarium, namely the daily routines of cleaning, water quality management and supplements needed, algae and pest control but also special adapted routines of plant maintenance and trimming.

Here, we intend to demonstrate the main challenges involved in the maintenance of this aquarium but also to alert to different methods adopted in order to ensure a natural aspect in this type of aquaria.

9,000 Pounds of Acrylic and Water Suspended 15 feet in the Air, Add Over 200 Fish and a Scissor Lift and You Get……. Fish Globes!?

Johnny May
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Long before the opening of the OdySea Aquarium in Scottsdale, Arizona the founder of the aquarium envisioned an exhibit seen nowhere else in the world. The "Aqualobby", as it is appropriately named, is home to nine acrylic globes suspended between ten and fifteen feet above aquarium guest. Approximately thirty fish call each of the globes home. From vision, to design, to construction, and daily care, this presentation will cover the initial LSS design of these systems and some of the challenges encountered with this industry first.

The Rapid Design Process (RDP) in Aquatic Exhibits: a Designer's Perspective

Ed Seidel and Bob Bacigal
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We created the Rapid Design Process (RDP) in response to project teams' needs for more comprehensive project documentation earlier in the process. Based on the traditional design charrette, the RDP is an ultra-compressed concept design process. It produces enough critical documentation for teams to analyze, assess and approve a project - enabling an institution to move on to fundraising.

Hook, Line, and Sinker: Reeling in Guests and Staff with Engaging Uses of Data

Misha Body and Tony Niemann
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Emerging technologies are often meant to standardize and streamline data entry and reporting, but technology can also be used to share the invaluable and engaging experiences of our staff with our guests.

This year, we gave a human touch to Big Data to engage staff and guests alike. Information bandwidth, interdepartmental communications, and the variety of our populations were challenges of this project, but our solution uses the data staff members already create, streamlines the content approval process, and automatically updates content based on population management information. This information is shared on a public-facing iPad in an easily navigable design that our increasingly connected guests can operate.

In the end, we tap into our data in a way that gives guests a new view of our collection while also providing an opportunity to highlight staff and their exciting observations and notes without adding to workflows.

Friday, May 12th

Session 13: Medical 1

Moderator: Kathy Tuxbury

Welcome: Steve Spina, New England Aquarium

Sponsor: CBT Architects - Blueway Vision
(Eric Krauss, COO/CFO New England Aquarium)

Applying Vertebrate Concepts to Invertebrates for Long-Term Health and Conservation

Meghan Holst
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Facilities operating under the Association of Zoos and Aquariums (AZA) guidelines meet specific standards on physiological, nutritional and environmental needs for vertebrate animal husbandry. However, expanding these standards for invertebrates is still underdeveloped. While AZA is gradually increasing the production of invertebrate manuals, it is important that aquariums advance this effort by more thoroughly assessing invertebrate health and behavior. The Oregon Coast Aquarium has recently increased evaluation of invertebrate health in *Macrocheira kaempferi, Enteroctopus dofleini, Pisaster ochraceus*, and *Patiria miniata* via blood analysis and behavioral matrices. This novel data creates baselines of behavior and blood chemistry that aids in more definitive etiology for outbreaks (e.g. Sea Star Wasting Syndrome), provides unbiased understanding of invertebrate behavior (e.g. octopus senescence), and allows for comprehensive evaluation of husbandry practices. Data collected under this study provides templates and discussion for AZA facilities to take necessary steps towards improved invertebrate husbandry and conservation.

Stress and its Effects on Fish (including Mycobacteria)

Dr. Robert Jones
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Fish welfare is an increasingly important subject. We need to understand what it is and why it is so important to be concerned about the welfare of the fish under our care. Fish experience stress for a variety of reasons. What is stress? What are the factors that cause stress? We will examine the physiologic basis of the stress response in fish. Fish that are under stress become immunocompromised (via the HPI axis) which is then a major contributor to disease and death in aquatic animals. Stress leads to an increased incidence in Mycobacteria.

Characterization of microbial communities in cold-stunned Kemp's ridley sea turtles (*Lepidochelys kempii*) through rehabilitation

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Microbial communities play a role in the health of animals, including across disease states and immunocompromised conditions. Characterizing these communities, or the microbiome, is important to understanding the effects of captive environments and exposure to antibiotic therapy. This study evaluates the changes in the oral and cloacal microbiome of cold-stunned, or hypothermic, Kemp's ridley sea turtles (*Lepidochelys kempii*) during rehabilitation at the New England Aquarium (NEAq). Twenty-six stranded turtles had oral and cloacal swabs collected up to five time points from admission at NEAq to convalescence. High-throughput sequencing of the 16S rRNA gene revealed alterations in the microbial community as a result of the rehabilitation setting as well as from antibiotic therapies. This study not only provided the first characterization of microbial communities in the Kemp's ridley sea turtle, but also highlights the effects of a captive environment and drug exposure on wild animals.

Building a Horseshoe Crab Health Crystal Ball: Tracking *Limulus polyphemus* Hemolymph Cell Counts and Chemistry Profiles from Acquisition through Managed Care

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As part of a commitment to improve the health of horseshoe crabs (*Limulus polyphemus*) under managed care, techniques were developed to monitor cell counts and hemolymph chemistry values. Hemolymph was analyzed from 22 horseshoe crabs obtained from Delaware Bay and subsequently maintained at the National Aquarium in Baltimore. Hemocyte counts and 23 biochemical parameters were measured in hemolymph samples collected at multiple time points; acquisition, exiting quarantine, and subsequent 4-6 month intervals. Changes through time were observed in hemocyte numbers, electrolytes, lipase, and triglycerides. In addition to monitoring cell counts and chemistry values over time, data collected from study crabs that died provide an opportunity to evaluate differences between sick and presumed healthy animals and identify potential key health indicators, like copper, protein, and glucose. As reference data for this species is limited, the results should help in assessing horseshoe crab health as well as evaluating responses to husbandry changes.

Collection, handling and initial captive husbandry of *Sphyrna lewini* (scalloped hammerhead shark) from Queensland, Australia

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Hammerhead sharks are the world's most recognizable shark family; their head shape is unmistakable. Only a few species of hammerheads have been successfully displayed in aquaria and in recent years *Sphyrna lewini*, a CITES Appendix II listed species, has proven to be a species that can thrive in aquaria and enhance exhibits with their uniqueness and popularity. Adult *S. lewini* are capable of being collected and introduced for display but sub-adult specimens are better candidates for transportation and acclimation, and in-turn, most adaptable to new and existing aquarium habitats. Because hammerhead shark populations are threatened and declining globally, they should only be sourced from fisheries with strong management practices and demonstrably robust, sustainable populations, like the Great Barrier Reef Marine Park. The method in which *S. lewini* are collected is unique, requiring specific collection gear, handling and treatment. Successful initial captive husbandry of *S. lewini* includes excellent water quality, minimal prophylaxis, a varied and extensive diet, as well as a relatively large holding aquarium size. Although fast growing as juveniles, the average time in holding prior to being strong and sizable enough to transport is 2-4 months; their initial collection method and husbandry being

paramount to success. *S. lewini* have only been displayed in aquaria for a relatively short time, recent 5-10 years, and in only a small number of aquaria, so mature groups have not yet been achieved. Given hammerheads' global wild population status, their protection via strong fisheries management must be supported. It is important for public aquaria to continue working with *S. lewini* into the future to advance husbandry knowledge, create stable, mature populations in aquariums and lead to captive breeding success.

Session 14: Medical 2
Moderator: Mike Terrell

Chloroquine Phosphate and Praziquantel as a Means to Eradicate *Decacoytle floridana* in Spotted Eagle Rays.

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In an effort to maintain life expectancy and animal health in a managed care environment for spotted eagle rays (*Aetobatus narinari*), a new approach for treating a common monogenean, *Decacoytle floridana*, was implemented. Praziquantel and chloroquine phosphate have both been used in marine systems for a variety of parasites. By utilizing these two chemical treatments in tandem, the eradication of the target monogeneans was apparently achieved. The positive results achieved with this method can lead to improved health conditions of managed spotted eagle ray collections in the future.

Effects of Intramuscular Alfaxalone in Permit (*Trachinotus falcatus*) and Schoolmaster Snapper (*Lutjanus apodus*)

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Alfaxalone is a synthetic neuroactive steroid, progesterone analog, which binds receptors of the inhibitory neurotransmitter gamma-aminobutyric acid in the central nervous system to induce muscle relaxation, sedation and anesthesia. The drug is FDA-approved for intravenous use in dogs and cats and has been studied in a variety of species including birds, reptiles, amphibians, crustaceans, and freshwater fish. The effects of alfaxalone administered intramuscularly in two marine teleost species, permits and schoolmaster snappers, were studied. Alfaxalone was administered IM to permits at 5 mg/kg, 7 mg/kg and 10 mg/kg doses and to schoolmasters at a 5 mg/kg dose. Response to stimuli and opercular rates were measured every five minutes. The majority of permits and schoolmasters experienced mild, smooth sedation at the 5 mg/kg dose. All permits experienced prolonged excitement phases and durations of effect at the 7 and 10 mg/kg doses, which are thus not recommended in permits and similar species.

"The Aquarium of the Pacific experiments with acid, a large scale sterilization procedure"

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Spirorbid worms are tiny species of polychaete worms that are ubiquitous among marine aquarium displays. In exhibits housing gelatinous zooplankton, spirorbids can cause damage to the animals' fragile bodies. This past year the Aquarium of the Pacific decided to eradicate spirorbid worms in a large jelly system using a new method involving hydrochloric acid. By running hydrochloric acid through the life support system and pipes of the Northern jellies system staff members were able to eradicate 100 percent of the population. Since completing this treatment, staff members have experimented with hydrochloric acid on common aquarium surfaces in order to determine if it can be used on fish exhibits containing artificial rocks, algae, acrylic, etc. This poster will display the results from these experiments.

Necropsy Techniques

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The Aquarium Vet
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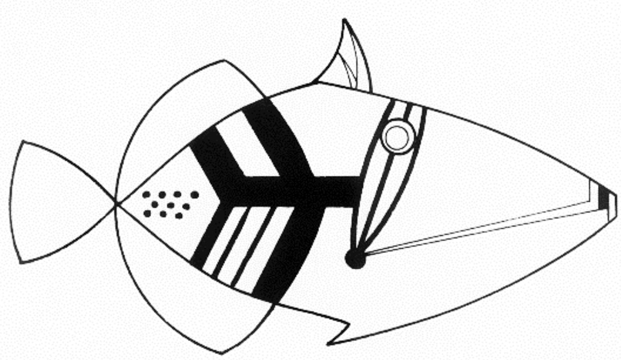
A good necropsy technique is an essential tool in any successful aquarist's toolkit. A well- developed and consistent necropsy technique will assist in making many diagnoses (it is one of the six steps in making a diagnosis). We will go through an entire necropsy procedure and also look at the value of wet preparations (both external and internal).



A BRIEF GUIDE TO AUTHORS

Updated 2018

This guide is intended for those not accustomed to using a "Guide to Authors", as provided by more formal periodicals. Historically only about 5% of *D&C* authors get this correct ☺. Please help me out folks!

As always, typical Drum & Croaker articles are not peer reviewed and content will not be edited, other than to correct obvious errors, clarify translations, modify incorrect or cumbersome formatting, or delete superfluous material. Other types of contributions (announcements, etc.) may be edited to meet space limitations.

The approximate deadline for submissions is December 15th. As has always been the case, materials in *Drum and Croaker* may be reproduced unless otherwise specified. Please credit *Drum and Croaker* and the contributor. I expect and assume that all submissions to D&C (papers, photographs, etc.) have been authorized by all original authors or co-authors, do not infringe on any copyright or prior publication agreements, and have successfully completed any internal review process required by your institution.

Submit articles via email as a Microsoft Word document (or a file that can be opened in Word). **My E-mail address is petemohan55@gmail.com.**

All Articles Must Adhere to the Following Basic Format:

- Use Times New Roman 12-point font throughout (except figure and table legends as noted below).
- A4 users please reformat to 8 ½ x 11-inch documents (North American "letter").
- Keep the resolution of photographs LOW. High resolution photos make the PDF file huge and are compressed anyway.
- **Format the title section with the line spacing set on 1.5 lines (not another method) and using centered, boldface font. Only the title should be CAPITALIZED (except italicized *Scientific namesii*).**
- Double-space after your "institution name" to begin the body of your text. It should look like this:

USE OF DUCT TAPE IN THE HUSBANDRY OF *Genus species* AT FISHLAND

Jill Fishhead, Senior Aquarist jfishhead@fishstinking.com

Fishland of South Dakota, 1 Stinking Desert Highway, Badlands, SD, USA

Continued….

Text Format

Headings and text should look like this heading and paragraph. Use single spacing with 1” (2.54 cm) margins on ALL sides. Please indent 0.5 inch (1.3 cm) at the beginning of each paragraph and leave a space between paragraphs. Justify the text (see toolbar options and note how pretty the right margin of this paragraph lines up!). Section headings should be in bold (as above) at the left margin.

Figure Legends

Please use the following format:

Figure 1. Legends should appear under the photo or graph in this format in 10-point font, aligned with the sides of the image or figure (center or justify). Photographs should be pasted into the document in the proper location by the author. All photos MUST be formatted as low-resolution files, no ‘larger’ than approximately 300 – 500 KB. I may reduce the size (appearance on the page) of figures and photographs to save space. Photos, tables, and figures not referred to in the text may be omitted for the same reason.

Table Legends

Table legends go above the table. Otherwise, formatting is as above for figures.

Other Things I Whine About

- Please don’t use Paragraph formatting to add space above or below lines. I have to remove all of these. Start with a single-spaced Word template.
- Use the “enter” key for all spaces (“carriage return” for those who remember typewriters with a slidey thing on top).
- If you submit a table, put the data IN an actual table. Don’t use the space bar or tabs to “line up stuff.” This formatting can be lost if I have to change margins.
- Use the “tab” key to set your 0.5” indent at the start of each paragraph. It’s likely your default. Don’t use the space bar.
- Use bullets or numbers to make lists. It is easier to reformat these later if needed.

Short Contributions (“Ichthyological Notes”)

These include any articles, observations, or points of interest that are about a page or less in length. A brief bold faced and capitalized title should be centered, the body text should be formatted as above, and **author and affiliation should be placed at the end of the piece** with the left end of each bolded line right of the center of the page. Reformatting that must be done by the editor may reduce a shorter “main” article to a note, or may bump a note up to main article status.

Reviews, abstracts, translations (with proper permissions) and bibliographies are welcome. Humor, apocrypha, and serious technical articles are equally appreciated.

END