# DRUM *and* CROAKER

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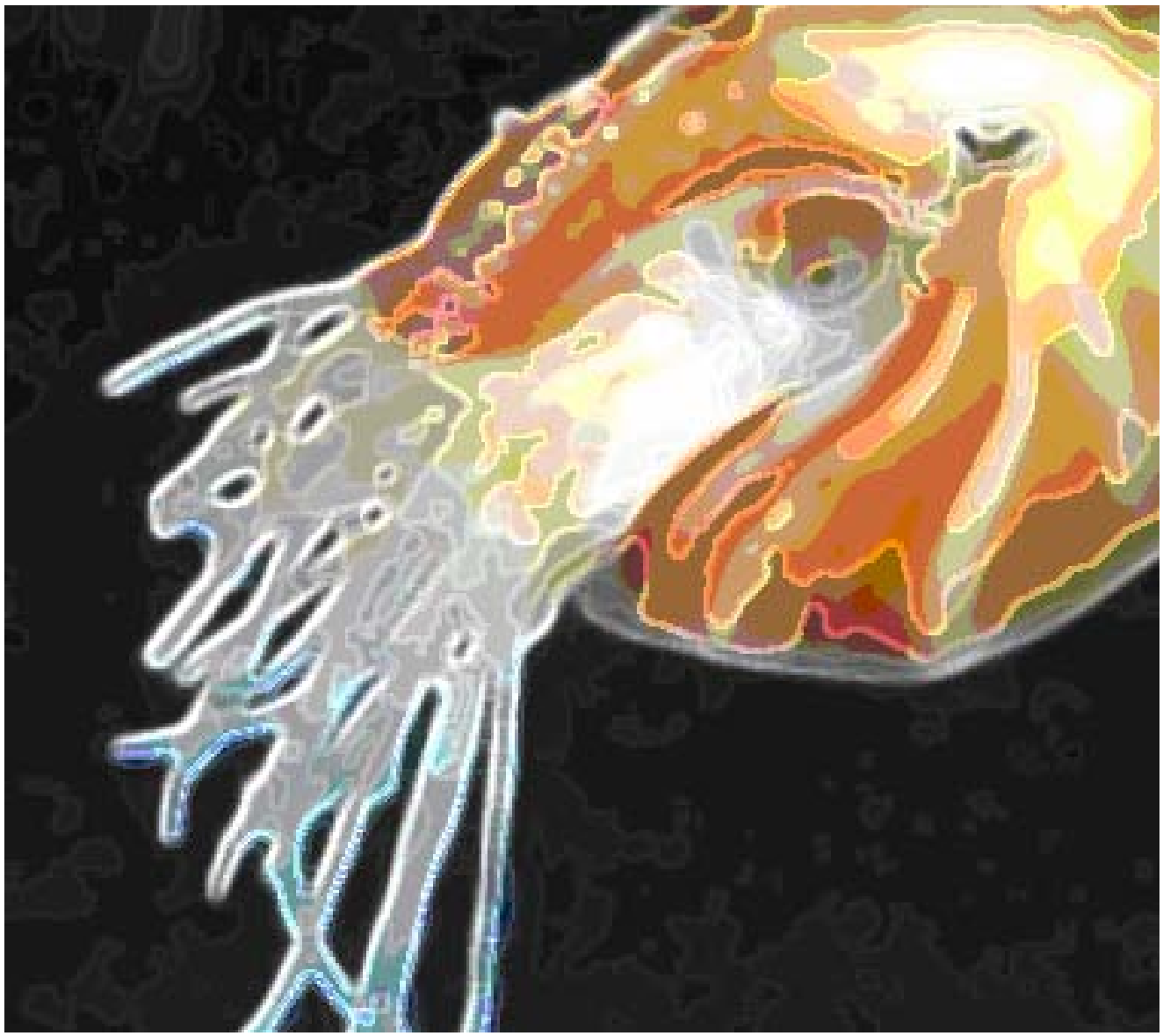

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*cover photo: cropped and posterized image from Rubin Fields' Nautilus article.*

## DRUM AND CROAKER 35 YEARS AGO

**Richard M. Segedi**

*(from the 1970 issues)*

### Artificial Coral Foods for Reef Fishes

W. Kymmerly Murphy  Sea World, San Diego

. . . we made five-pound blocks of fast-dry plaster of paris impregnated with such exotic ingredients as Purina Dog Chow, laying pellets, a liquid vitamin supplement, and an amino acid solution. Our parrot fish eagerly attacked this "artificial coral," biting off pieces of plaster and consuming both the plaster and the exposed foods. Many other types of fish were attracted to this food as well.

### Professional Aquarists Symposium, Ichs and Herps Meeting - New Orleans, March 1970

The discussion dwelt mainly on the future of the aquarium symposium. Should professional aquarists continue to meet in conjunction with the ASIH or should they meet with the American Association of Zoological Parks and Aquariums, or the Ecological Society, or should they form an association of their own and meet whenever they felt it would be convenient? Many felt that there was a need of some change - that the poor stepdaughter role should end and we should have more to say as to how, when and where we meet and the scheduling of events.

### The Application of Fluidics in the Aquarium

Louis Garibaldi  National Fisheries Center and Aquarium

A stream of fluid flowing close to a surface tends to be deflected toward the surface and under proper conditions touches it and attaches to the surface. When interacting streams are involved, one or more streams are used to influence or control the direction of flow of the power stream. Using these phenomena, a two-way valve can be made without any moving parts.

### Biology Laboratory at the Vancouver Public Aquarium

Sharon Proctor

A given biology class comes to the aquarium once during the school year. With a volunteer "docent" serving as instructor each student is handed a set of printed questions to be answered during his visit. The exercises concern evolutionary adaptations of seashore animals, and to answer the questions the students must examine living specimens.

Prior to the class visit, the teachers spend an evening at the Aquarium. This meeting enables the teachers to prepare their classes for the visit and to discuss answers to the questions back at the school.

# CLASSICAL CONDITIONING OF MYLIOBATIS CALIFORNICA

**Anita Baker, Aquarist**

**Oregon Coast Aquarium, Newport, Oregon**

California bat rays, *Myliobatis californica,* are housed in the Open Ocean exhibit at the Oregon Coast Aquarium in Newport, Oregon. This exhibit contains 875,000 gallons of water and has a 29'x24'x9' medical pool attached. Other elasmobranchs sharing this exhibit are broadnose sevengill sharks, *Notorhynchus cepedianus,* leopard sharks, *Triakis semifasciata,* spiny dogfish, *Squalis acanthias*, brown smoothhounds, *Mustelis henlei* and one soupfin shark, *Galeorhinus zyopterus.*

There are nineteen California bat rays in this exhibit which includes fifteen females and four males. Their weights range from eighty-four pounds (female) to twenty-four pounds (male). Prior to the conditioning procedure, the bat rays were handled for weights, flukes removal and medical treatment by catching each of them in large nets and transporting them to the medical pool. Moving the bat rays in this manner resulted in stress for the bat ray and increased shark activity in the tank.

The conditioning of the bat rays began with catching all nineteen of them and isolating them in the medical pool. Here they were introduced to classical conditioning techniques over a five week period. A light was placed inside a red bucket with white tape arranged in diagonal lines. The bucket illuminated like a Chinese lantern. This would become the signal for the bat rays to enter the medical pool. The light was placed in the tank prior to feeding and feeding occurred only around the light.

The rays were taught to maneuver through a gate by placing a simulated gate in the medical pool. The gate had a 9-foot opening which reproduced the width of the gate between the main exhibit and the medical pool. The light and food were placed on one side of the gate with the rays on the other. Eventually, the majority of the bat rays swam through the gate to the food.

The bat rays were then returned to the main pool for display. The following day the light was placed in the main pool beside the medical pool gate. Four of the bat rays responded after an hour and swam into the medical pool where they were immediately rewarded with food.

This procedure was continued for 10 days. By day ten, sixteen of the nineteen bat rays responded to the light and swam through the medical pool gate. Eventually, all nineteen bat rays did respond and came to the medical pool when the light was placed in the water. The light continues to be placed in the pool as often as possible to encourage all of the bat rays to enter the medical pool for feeding. The amount of time taken for the bat rays to respond has reduced to ½ an hour.

During the conditioning period there were only nineteen bat rays. We acquired one male and one female after the conditioning was complete. These two were conditioned in the same manner as the first nineteen and quickly learned to come to the light and enter the medical pool. Sometimes there are a few stragglers in the main exhibit who do not choose to respond the light that day. The main tank is fed five times a week and this is taken into consideration when some bat rays do not come to the medical pool. If medical baths are needed, the procedure runs over a period of days until all the bat rays respond and enter the medical pool.

The use of classical conditioning has significantly benefited the animals. Medical baths are now easier to complete and injured rays can be brought into the medical pool using the conditioning procedure. Here they are isolated from the sharks and their wounds are treated with betadine without causing additional stress to the animals. It also allowed monitoring of their feeding behavior. The wounds have since healed and the rays have been returned to the main exhibit pool with full bellies and a little rest and relaxation.

# THE USE OF A HYPERBARIC CHAMBER WITH FISH EXPOSED TO EXCEEDINGLY HIGH LEVELS OF DISSOLVED OXYGEN

**Jack Schneider, Curator and Amy Rollinson, Aquarist**

**The Maritime Aquarium, Norwalk, CT**

Most people have heard of an embolism, but may not be able to quite define what it means. It sounds like the dreaded Ebola virus. To SCUBA divers who break the surface too quickly from a deep dive and fish-keepers with waters supersaturated with dissolved oxygen, embolisms are even more dreaded and deadly - capable of killing within hours.

An embolism is a total or partial blockage of a blood vessel that impedes or stops blood flow. Embolisms can be life-threatening. For example, if a blood clot travels to the heart and blocks blood flow in the vessels supplying the heart muscles, the result could be a fatal heart attack. If this happens in the brain, the result could be a stroke (also called a "brain attack"). An embolism can also occur when bubbles are formed in the bloodstream. In humans, the disease is known as “decompression sickness,” or “the bends.” The latter are old-fashion names derived from the characteristic appearance of caisson workers that was similar to “Grecian bend,” a posture affected by the fashionable women of that time in the late 1800s.

For fishes, the most often cited cause occurs when an abnormal amount of air is dissolved under pressure in the water. This is known as super saturation. Supersaturated air moves from the water, through the gills of the fish and into the bloodstream. Much like a capped soda bottle, when the pressure is relieved, the excess air is released as bubbles both in the water and in the fish.

“Boulders” is a tank that is 1500 gallons of water mechanically filtered by a high rate, Hayward Sand Filter along with a fifteen-foot tower filled with bioballs covered in active bacteria to biologically filter the water. Also plumbed into the configuration is a chiller to cool the water to a crisp 45 degrees Fahrenheit.

Taken from a location in Long Island Sound, “Boulders” replicates an area 30 feet below off Penfield Reef Lighthouse just west of South Norwalk. Long pieces of kelp wave in between concrete boulders and rocks while fish like Pollock (*Pollachius virens*), Haddock (*Melanogrammus aeglefinus*), Atlantic Cod (*Gadus morhua*), Lumpfish (*Cyclopterus lumpus)*, ranging from 6’ to 18”, inhabit these cold waters. Hiding in between the rocks is an average size, blue lobster. Most of the fish in the tank came from fish hatcheries or from a surplus of animals from other aquariums. The fish in the tank had called “Boulders” its home for well over a year.

When a pump malfunctioned on this tank it began sucking air (venturi effect) and pumping it under pressure, essentially carbonating the water as it passed through the pressurized filtration pumps. As the water became supersaturated with oxygen and discharged from the confined, pressurized pipes into the open aquarium and the pressure was relieved, tiny bubbles

gradually formed in the water but not before the concentrated air passed into the fishes' tissues through their gills. With the pressure relieved, tiny bubbles inevitably formed within the fish.

One morning when doing a round of checks to see how the fish were doing, we came upon the horror of the "Boulders" tank with microbubbles strewn across the glass and a dozen fish lying dead on their sides on the bottom.

Now, all the fish in the tank that were still alive looked as if they had been through a popcorn popper. Their eyes were bulging and filled with tiny bubbles and their fins were tattered where bubbles had passed and ruptured, tearing tissue as they burst. The tank's skimmer box was cascading with water and whirling into the filter's intake. According to Stephen Spotte's Captive Saltwater Fishes: Science and Technology, acceptable levels of dissolved oxygen (D.O.) percent saturation in cold water tanks is 85-100% (page 77). Any reading of 125% or higher percent D.O. is considered a dangerous level to fish. With a calibrated YSI 85 D.O. meter, "Boulders" had a reading of 117% dissolved oxygen.

Although it was fairly obvious what the fish had died from, a necropsy was conducted on one of the Atlantic Cod fish. A clipping of the gill was placed onto a microscopic slide and under 25x magnification rows of bubbles filled the gill membrane. Upon cutting the fish from the anal vent and up, her body cavity was pale as well as most of the organs. Her swim bladder was an inflated, hard mass, which seemed to take up most of the body cavity.

Those animals still alive, which were about half of the animals in the tank, were on the verge of dying. All those tiny bubbles throughout their body, in their bloodstream were not going to go simply dissolve away on its own.

Knowing there was no way they were going to make it, the Curator of the Aquarium, Jack Schneider, decided not to just sit by and let these fish suffer, but instead to try an experiment in an attempt to save the lives of these fish.

For years it was known that the Norwalk Hospital had a hyperbaric (high pressure) chamber used to help relieve SCUBA divers of the bends and for other medical procedures. However, the idea that a hospital would be willing, or even able, to allow such a special piece of medical equipment to be used on fishes seemed to be unlikely and preposterous, but Jack was not resigned to seeing all of the fishes die.

Jack decided to take a chance and call the Hyperbaric Lab at Norwalk Hospital. Explaining the situation to the staff, and excepting to be cut short by the response, "*Are you crazy? We can't do that*," Eileen Curry, R.N., the Hyperbaric Medicine Center's Nurse Manager said, "*We want to help. Let's see what we can do.*"

Before Aquarium staff could begin to load the fish for transport, a few hospital delegates had to be consulted. In the meantime, feeling more optimistic and knowing nothing more than time could be lost, it was time to load up the fish and go. Within a few minutes and with the help from Aquarium Staff and interns, more than two-dozen fish and 50 gallons of salt water were transported in less than minutes. Altogether, an hour had passed since the initial call had been made, and legally it was agreed all was good to go.

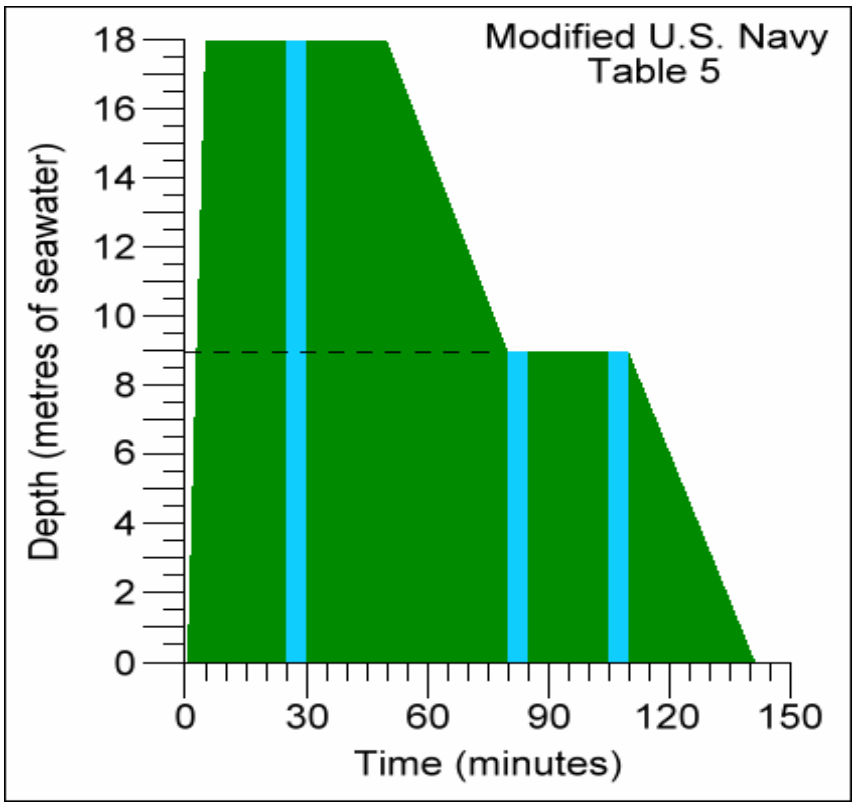
Upon entering the Emergency Room Ambulatory Care area with a hand truck with three different size tanks, nobody knew what to expect. But there they were—about a dozen people including nurses, technician, doctors, a photographer and head of public relations.

Eileen Curry and Ken Alba, the Hyperbaric Safety Director, had mentioned to us before our arrival that no metal could be in the chamber. It was confirmed that the ID tags inserted under the fishes' skin and read with a scanner to identify individual fish would not be problem. However, the transport tank we used to move the fish from "Boulders" to the Hospital would not fit into a 7' long X 33" diameter hyberbaric chamber. So instead, we moved all the fish and 20 gallons of seawater into a non-metal, shallow Rubbermaid tanks, covered it with a hospital sheet, taped with medical tape and cut out holes with surgical scissors. Through the holes we could monitor the fish but not to have to worry about them splashing or jumping out of the plastic container because once the chamber was running, there was no opening the door. Dr. Winters said that the symptoms and distress would disappear once the desired depth and pressure was achieved.

Ken and Patty Dennis used the pressurization schedule specified in the US Navy Treatment (Table 5 below) for treatment of mild gas bubble disease. They used 100% oxygen, but no air breaks, coupled with a pressure comparable to an ocean depth of 18 meters or about 60', and then gradually decreased the pressure to sea level in stages over nearly 2 ¼ hours. The process is represented diagrammatically below; dark shading indicates the period of time when the chamber contained pure oxygen, lighter shading indicates breaks when normal air would normally be introduced into the chamber.

As the pressure in the cylinder built, people passed in and out of the Emergency Room from other departments because they heard that the Aquarium had come to them. The fish that had been once swimming not too long ago were now slumped to the bottom, aligning their bodies along like packed sardines. It was as if they were "reliving" the initial feeling they had when the pump on the "Boulders" tank malfunctioned. Even though we were not aerating the water, we knew from experience in air-shipping fishes in a closed bag of oxygenated water that the fish could continue to breathe because of the 100% oxygen concentration within the chamber.

A visiting hyperbaric expert used math and physics to prove that at 60 ppm, the available oxygen in the air was more than sufficient to pass into the water and keep the fish alive. During the whole procedure we learned that either air, pure oxygen or other gases could have been bubbled into the water if needed.




Green: 100 % oxygen
Blue: Normal air
Source for the technical information. www.hyperchamber.com

All the extra reassurance from the Hospital staff was comforting and our time was passed with answering questions about what transpired to bring a large group of fish to a Hyperbaric chamber; however, we all were preoccupied with the fish - will they jump? Will they suffocate? Is the condition of the animals too far gone that they will die from this condition no matter what? Unless we were to terminate the procedure and risk reestablishing the gas bubble disease, we had come so far there was no turning back and nothing was left to do but to watch and hope.

As the pressure eased in the chamber, the fishes began to stir and slowly started swimming again, listing a little bit from side to side. Although the fish were showing colors of stress, the fact they were up and swimming was the first and most critical stage to recovery.

If anything positive could come out of the situation, it would have to be the strength of determination from everyone who helped these fish because they would have died otherwise. It is always best to try something, anything, than to just stand by and do nothing. A gamble was taken that day, and won; if it had not, the “Boulders” tank would be empty today.

It took a while for the fish to recuperate from their mishap with a malfunctioning pump and supersaturated fish tank, but all have resumed their old habitats and continue to live in the “Boulders” exhibit. Next time you visit, look for them!

**"LOOK MOM, FISH STICKS!"**
**WHEN GOOD EDUCATION GOES WRONG**

**Written by your fellow aquarists**
**Compiled by Brian Dorn, Assistant Curator**

**Albuquerque Aquarium**

We all know that one of the main purposes of public aquariums is to provide our public with a thorough education of all things aquatic and anything related to aquatics. We all 'know' our education programs are second to none, yet when we hear some of the comments our guests make in regards to our displays, animals etc., we have to wonder, "Are they listening at all?" I guess on a positive note we can see there is at least a lot of interest and attempted explanation for what many of us take for granted and have the privilege to work with on a daily basis. So keep up the great work and always remember, no question is a dumb question and no matter how many times you get the same question or comment, it's the FIRST time that patron has asked it or commented on it and deserves to be given your honest heartfelt answer or opinion. After all it's our public that keeps us employed and provides us with a never ending resource for our second job as stand-up comics. The following stories have been provided by your fellow fish heads around the country. So read, enjoy, laugh and learn. Have fun!

When I first moved to Oklahoma, before the aquarium was even under construction, we set up an exhibit at the State Fair to show the public what we were all about. We had touch tanks and a main exhibit full of Lookdowns (*Selene vomer*). Several fair-goers approached the tank, read the fish ID sign "Lookdown", and then looked at their feet. Some spent several minutes searching the area around the tank and periodically checking the sign to make sure they hadn't misread the instructions. Most shrugged their shoulders and left feeling like they had missed something. A few of the more inquisitive stopped to ask, "What kind of fish is that?"

John Money
Curator
Oklahoma Aquarium

Mommy, did that man go potty on himself? No honey, he works here!!!

Bob Snowden
Biologist II
The Aquarium at Moody Gardens
Galveston, TX

While at our Manatee exhibit, I heard a mother talking to her daughter saying "look honey that one is having a baby". The discussion went on for awhile. Finally I pulled the mother aside and told her that we only have males, and that the males frequently get excited. The mother quickly changed the subject with her daughter, and left.

Mike Brittsan
Curator Columbus Zoo and Aquarium

Two good jelly quotes from when I was at Newport Aquarium: Child looking at the Ctenophore exhibit: “Mom, these ones have motors!” Child looking at West Coast nettles: “Whoa! Look at the testicles on this one!”

Rich Terrell
Aquarist – Tropical Marine Gallery
Pittsburgh Zoo & PPG Aquarium

We have an 800 gallon with tank with some *Euphyllia*, some gobies, a couple labrids etc. that happens to be next to a graphic talking about open ocean marine mammals, and a woman was seen peering intently into the tank for a while, and eventually asked: "I can't seem to find the Narwhal in this tank, could someone point it out to me?"

Barrett Christie
Biologist II
The Aquarium at Moody Gardens

I used to work at the Dauphin Is. Sea Lab, and we had a reconstructed pygmy sperm whale skeleton hanging from the ceiling. One afternoon I was walking through the area and overheard a father say to his children "Pygmy sperm whale...that means its a boy."

Sheryl Crossley
Tennessee Aquarium

As to why a shark was swimming with it’s dorsal out of the water “Its how it breathes” and as to how it is safe for divers to be in a tank with Grey Nurse Sharks “ They have steel plates implanted in the roof of their mouth which they use to shock the sharks into submission”. The GNS had just taken a gulp of air and had an airpocket against the roof of it’s mouth. And when first sighting a seahorse “Oh my, are they real? I thought they were just a myth!”

And why do elderly people always point to places that you have missed when dive cleaning windows in large aquaria?

Paul Groves
Aquarist
Reef HQ Aquarium

I was just told yesterday that we band our penguins on the right wing so they don't fly away, and that the bands are used instead of cutting the tendon on the right wing. The reason they're banded on the right wing is that penguins are right wing dependent, and it wouldn't work if the band was on the left wing. Is it a full moon or something lately, or just the odds on coming across these folks has increased with the summer crowds?

Joe Yaiullo
Atlantis Marine World Aquarium, NY USA

I've lost count on how many times I've heard the Australian Lungfish referred to as Austrian Lungfish. Apparently there is some Bavarian stream dwelling subspecies. No doubt has a yodel-like mating call.

Another, is the read aloud description of the Red Sea species - Golden Jewel "Atheists"

But the closer needs a bit of description. Our GOP exhibit is a corner tank with two viewing windows. The windows are on the sides making up the corner. One individual, doing his best Foghorn Leghorn voice, decided to read aloud the graphic text to whomever might be within earshot. Standing in front of one window he says with distain "Humph, says here that the Octopus is the most intelligent of the invertebrates. Don't look to intelligent to me." At this point he walks around the corner to the other viewing window and says "oh, look there's another one".

Mark Rehling
Aquarium Biologist
Cleveland Metro Park Zoos

One morning I was standing above our pilings exhibit, straddling two of the pilings and trying to net out a dead fish. The security guard (who could be a long lost cousin of Barney Pfief) saw the net in the tank and came behind the scenes to investigate what was going on. He asked what I was doing and I told him I was trying to net out a dead fish. His response was "oh yeah, I saw it swim behind that rock." When I finally stopped laughing I told him I didn't realize that dead fish could swim. He didn't get it...

Missy Moorehouse
formerly of The Maritime Aquarium, Norwalk CT

Then there was the time I was walking past our Sarcastic Fringehead *(Neoclinus blanchardi*) display, and heard a visitor describing them as Sarcastic "FINGER"-heads..... Lysdexia, maybe?

Mark Ball
Aquarist
Birch Aquarium at Scripps

We had an 8ft x 4ft x 2ft tall tank which was being stored vertically, on its short side. The top of the aquarium had several routed out access holes, which of course were now on the side. A high ranking zoo official comes by and asks, "How is that supposed to hold water?"

We just set up a new Amazon exhibit and just added a couple of stingrays. A high-ranking zoo official asks, "So we are cycling this system with baking soda or something, right?"

We have keepers here at the zoo which are “relief”, which means that they cover for anyone who has called in sick or is on vacation. We had one working in aquatics one day. She looked at a pipefish in a seahorse/pipefish system and said, “Oh, they straighten out at night!”

While building a holding cage out of PVC pipe and plastic mesh when an employee stops by and asks, "what ya’ doin'?" I told him that I was building a holding cage for an off exhibit octopus. He then asked, “How is it supposed to hold water?”

There were several keepers interested in a zoo sponsored trip to our sister zoo in Venezuela. Some of the keepers have never traveled abroad before so the management thought it would be wise to inform us of the dangers of traveling to foreign countries. One of the things that we were told was that it is suggested that we wear our rubber boots in the forest to help protect us from Fer-de-lance. Later that day during a coffee break, one of the keepers asked, “How are our rubber boots going to protect us from the fertile ants?”

Then of course we have the ever popular, "flathead minnows" and "tubiflex worms"

And our best, to date anyhow: While renovating our octopus exhibit, we had a sign that read, ‘Animals Temporarily off Exhibit’. A fellow employee comes up and says, “Why would you have a sign that says ‘Animals Temporarily off Exhibit’? Instead you should have a sign that says ‘Octopus Temporarily off Exhibit’”! My response, “Well, ok, what is an animal then?” “An animal has fur and breathes air” was his response. “Ok, then is a bird an animal?” “Well, yeah, but an animal has legs and breathes air.” “So, I guess a snake is not an animal?” I replied. Realizing that he is painting himself in a corner he then says, “OK, then it should say ‘Aquatic animals off exhibit’!” “So for, say, the clouded leopards, should we have a sign that says ‘Terrestrial Animals Temporarily Off Exhibit’?” He looked at me totally puzzled and says, "No, they are not from outer Space." Bottom line.....stay away from zoos ;)

Nick Zarlinga
Aquarium Biologist
Cleveland Metroparks Zoo

Here’s a couple while I was still in Orlando:
Guests looking at a baby Clearnose Skate exhibit, “Look at all the baby manatees.”
We did figure out they were thinking these were Manta Ray babies; manta ray/manatee?
I guess it makes sense.

Guests watching a teenage bottle nose dolphin swimming by, “Oh dear that poor dolphin has a piece of pink coral sticking out of its belly.” After explaining the dolphin’s adolescent condition the subject was changed and several red faces swiftly walked away.

Brian Dorn
Albuquerque Aquarium

While working at Sea Arama Marineworld in the late 80's I had the following occur. Following a dive show in the main oceanarium I was standing in the public area answering questions as was our procedure. While in a wetsuit in a puddle of saltwater, I had a guy approach me and compliment us:
"That's the best movie I ever saw, is that one of those IMAX's?"

Greg Whittaker
Moody Gardens

Slow afternoon and I'm out in the public area. A family walks past me and heads into the darkened room that contains the flashlight fish exhibit. I teenage boy soon appears and walks over to me, "Where are the flashlights to see the flashlight fish?" he asks. He patiently listened to my explanation, thanked me and walk back into the room. After a few seconds of silence, there was a loud collective "Ooohhh". I ducked into the backup area before they got to the next exhibit, the seahorse exhibit.

Standing in our kelp forest tunnel exhibit. A little girl about 9 yrs old, points at a smooth hound shark swimming overhead and says, "Look daddy, a dogfish." To this, the father loudly replied, "No honey, that's a TIGERSHARK!!!" Not wanting to embarrass the father, I kept my mouth shut. The father takes the little girl's hand and leads her out of the tunnel. I see the little girl look back over her shoulder and mumble, "Sure looks like a dogfish to me."

Mark Lewin
Aquatic Biologist, formerly of Newport Aquarium, Newport KY

Here's another...
Young girl looking at pipefish: "Look mom, fish sticks!!"

Cheers
Sharyl

# SUN PEN: A USEFUL PENGUIN EXHIBIT ADDITION

**Pamela Schaller, Aquatic Biologist II**
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**Steinhart Aquarium, California Academy of Sciences**
**875 Howard Street, San Francisco, California 94103**

## Abstract

Penguins are social birds and benefit from being kept in visual or in vocal contact with each other (Beall & Branch, 2003; Ellis, 2003; Wallace & Walsh, 2003). They have internal biological clocks which cue breeding, molting, feeding, nest relief and resting (Cockrem, 1990; Cockrem, 1995; Davis, 1995; Davis & Renner, 2003, Wallace & Walsh, 2003). These internal clocks are influenced by exposure to external environmental factors, including day length (Cockrem, 1990; Cockrem, 1995; Davis, 1995; Davis & Renner, 2003, Wallace & Walsh, 2003) and light intensity (Cockrem, 1990, Moore-Ede *et al.*, 1982). In captive penguin colonies there are husbandry, medical or behavioral issues that require short term isolation/holding or involve rearranging internal clocks. The following manuscript describes the penguin sun pen, a multifunctional short term containment design built within an indoor penguin enclosure which includes the asset of natural lighting.

## Introduction

The AZA Penguin Husbandry Manual recommends four components of housing and enclosure, one of which is the "isolation area" (Beall & Branch, 2003). The isolation area is intended as a "separate area to house birds that need to be isolated for forced pairing, behavioral [issues], both parent and hand rearing of chicks, and non-contagious health problems" (Beall & Branch, 2003). Penguin sun pens address some of the isolation area intentions and offer additional valuable husbandry, health and photostimulation functions.

## Materials and Methods

From January, 2004 through May, 2004 we had the privilege to design and construct a new African penguin *Spheniscus demersus* exhibit and a new completely separate quarantine room. The exhibit consists of a 36,465 liter (9,633 gallon), 137 cm. (54 in.) deep saltwater pool and 30.5 square meter (100 ft.$^2$) fiberglass land space. In addition, the exhibit is completely enclosed with an active positive pressure HVAC system that keeps the filtered air at 19-20° Celsius (66-68° F) and has a total of 10 complete air changes per hour. The life support systems also include two foam fractionators [1] with ozone injection [2], a biotower [3], two high rate sand filters [4] and a chiller [5] that maintains the water between 11° and 17° Celsius (52-63° F).

The artificial lighting consists of metal halides [6], high output fluorescents [7] and 29 LED panels which simulate natural lighting colorations, including sunrises, sunsets, midday blue and twilight. The lighting is computer driven by Horizon software [8] and correlated with a 37° north latitude photoperiod. Lighting parameters as measured in the exhibit are: color temperature

varies from 4460 Kelvin to 5125 Kelvin; the visible light ranges from 50-300 fc and the ultraviolet light is from 75,000 µW/lumen to 95,000 µW/lumen.

Within the enclosed exhibit, there are behind-the-scenes husbandry areas that include food prep, sink, kennels, Dri-Dek [9] wash down station, wader rack, buckets, mops, brushes, siphons etc. It also includes two foam fractionators, Octopus unit [10] with probes for continuous water quality testing, ozone destruct unit [11], ozone gas monitor [12] and the biotower. All other life support systems are located separately outside of the exhibit.

The sun pen consists of a 203 cm long by 119 cm wide by 58 cm high (80 in. x 47 in. x 23 in.) redwood frame covered in black plastic mesh (Figure 1). The sun pen has 236 cm (93 in.) high black drapes that can be drawn closed to completely encircle the sun pen and a black drape that can be drawn to cover the window (Figure 2). The 140 cm long by 135 cm high (55 in. x 53 in.) window is facing southeast.

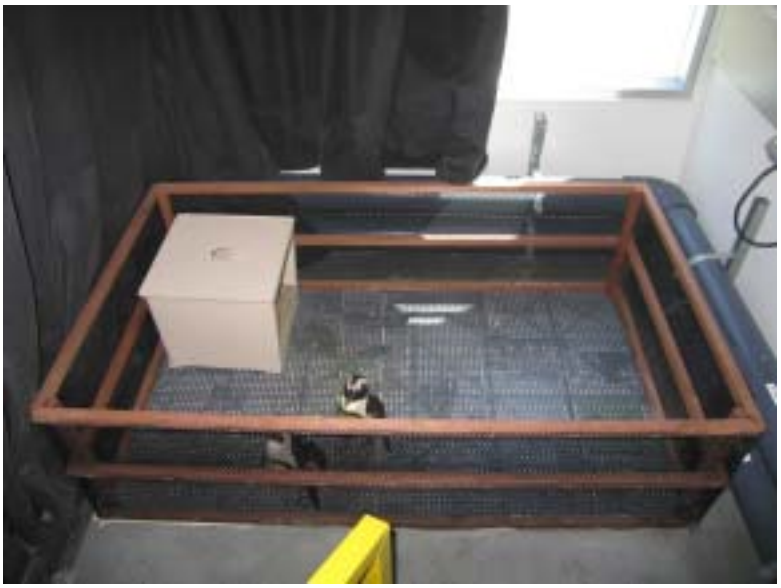

Figure 1: The penguin sun pen is within the controlled penguin enclosure but separated from the penguins on exhibit.

Within the sun pen, the floor is covered in newspaper. Over the newspaper is a layer of Dri-Dek which has been fitted to the floor space and can be easily removed for cleaning. There is also a 51 cm long by 51 cm wide by 45 cm high (20 in. x 20 in. x 17.5 in.) fiberglass nest box located in the space (Figure 3). The sun pen is not attached to the floor and can be lifted and completely removed from the enclosure if necessary. However, it is heavy enough to retain the genus *Spheniscus*. There is no pool or pool access in this sun pen.

**Discussion and recommendations**

There are many purposes for the penguin sun pen. Penguins requiring post-surgical care that cannot have access to a pool or to their enclosure are temporarily housed in this sun pen. Penguins suffering traumatic injury or lameness benefit from being enclosed in this small,

contained area. Penguins exhibiting molting difficulties, behavioral problems or reproductive issues that benefit from access to sunshine or environmental change also profit. During annual physicals, veterinary checks or minor exhibit repairs, penguins are temporarily housed in this easy-to-use environment. Finally, chick rearing can be performed in this space (Henry & Sirpenski, 2003).

Figure 2: Sun pen drapes can be pulled closed to completely surround the space for recuperating penguins.

Housing penguins in the sun pen include health, social and husbandry advantages. The penguins are relocated within their current enclosure without exposure to new fungal spores thereby reducing the chances of succumbing to Aspergillosis. Sun streaming into the penguin sun pen allows penguins to thermoregulate. Based on the angle of the sun, they walk into warmer spaces and conversely into cooler spaces. Penguins located within the same room in which they are usually housed hear identical environmental sounds. They will call to their mates and to other colony members and stay within auditory contact while recovering, during treatment and throughout provisional accommodation. Vocal communication is common behavior for penguins (Williams, 1995) and eases the stress of isolation (Wallace & Walsh, 2003). Most notably, biologists can observe the birds more frequently because they are transferred within their enclosure rather then being located in completely separated housing.

I recommend that any facility building a new indoor penguin exhibit or retrofitting a current exhibit put aside a comparable space with access to a window. Evaluation of window placement for maximum sun exposure and window material for less UV inhibition is important.

The penguin sun pen is a simple design, inexpensive to build and offers a safe, multifunctional location to temporarily place penguins. Due to location of the pen within the exhibit, it is not intended to completely replace isolation space and it does not offer appropriate quarantine space.

Figure 3: The nest box offers a place for penguins to retreat into and rest in for the night. The sun pen is wide enough to accommodate two nest boxes side by side.

"How can the penguin sun pen be improved," you ask? I reply "raise the frame off of the floor with plastic 2cm (0.8 in.) spacers and add the capacity to hose down the area with a floor drain."

**Acknowledgments**

Special thanks to Jeannie Lomma, Brian Whittier, Chris Tebbutt, Scott Moran, Tom Tucker and Ken Howell who allowed for functional spaces and creative developments for the biologists and for the birds.

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**Equipment Information**

[1] RK2 Systems, Inc. www.rk2.com 421A South Andreasen Drive, Escondido, California 92029, USA: each unit is 50.8 cm (20 in.) diameter

[2] RK2 Systems, Inc. www.rk2.com 421A South Andreasen Drive, Escondido, California 92029, USA: each ozone generator is capable of producing 4.5 grams of ozone per hour

[3] Water tanks.com www.watertanks.com P.O Box 340 Windsor, California, USA: plastic tank 122 cm (48 inch) diameter, 229 cm (90 in.) tall

[4] Neptune-Benson, www.neptunebenson.com One Bridal Avenue, P.O. Box 578, West Warwick, RI 02893-0578, USA: each filter is 107 cm (3.5 ft) in diameter and 122cm (4 ft) long

[5] Universal Marine Industries, www.umii.net , Advanced marine systems, 2790 Sunnyside road, Anmore, B.C., Canada: 15 ton

[6] Lithonia Lighting, www.lithonia.com P.O. Box A, Conyens, Georgia, 30012, USA : 250 watt Metal Halide TFL small flood, Mogul base with vertical socket

[7] Cooper Lighting, www.cooperlighting.com , 1121 Highway 74 South
Peachtree City, GA 30269, USA: 122cm (48 in.) Metalux Industrial/Vaportite

[8] Horizon Software Inc. www.mrpplus.com 40 Shuman Blvd. Suite 160, Naperville, Illinois 60563, USA

[9] Kendall Products www.dri-dek.com , P.O. Box 8656, Naples Florida 34101, USA

[10] Aquadyne, www.aquadyne.com 7343 “P” Ronson Road, San Diego, California, 92111, USA: Octopus 3000; two units each has three probes to test pH, Temperature and ORP, ORP parameters determine ozone generation

[11] Carus Chemical Co., www.caruschem.com , 1500 Eighth Street, P.O. Box 1500, LaSalle, Illinios 61301, USA: Carulite 200 Low Temperature Oxidation Catalyst

[12] Analytical Technology, Inc. www.analyticaltechnology.com , 6 Iron Bridge Drive, Collegeville, Pennsylvania 19426. USA: Gas Sens, Ozone gas monitor

# UNDERWATER TRAINING, FEEDING AND MEDICATON FOR CALIFORNIA BAT RAYS, *Myliobatis californica* IN LARGE COMMUNITY EXHIBITS

**Kevin Lewand, Senior Aquarist**

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## Abstract

California bat rays, *Myliobatis californica,* are exhibited in a variety of small, isolated displays at Monterey Bay Aquarium (MBA). Historically, displaying large rays in big exhibits such as the Monterey Habitats Tank (MBT) has been problematic because they were prone to developing heavy infestations of resident parasitic flukes (also termed trematodes or monogeneans). We developed a feeding protocol in which bat rays are trained to feed at a specific area within the display, which has allowed us to implement oral medication when necessary to eliminate monogeneans from the rays. Using this new protocol, we have been successful in exhibiting these graceful rays inside MBT.

## Introduction

Since the opening of the Aquarium in 1984, there have been many attempts to add large bat rays to MBT, one of the largest community exhibits (334,000 gallons) at MBA. However, after a period of time the rays would develop external flukes which were visible to the public and harmful to the rays. MBT is an open system that receives water indirectly from the ocean, thereby making treatments for flukes extremely difficult. After many attempts, the decision was made not to display large bat rays in community exhibits at MBA.

When I worked at Aquarium of the Bay, San Francisco (ABay), we had success feeding bat rays by hand via SCUBA. ABay has two large tanks that display bat rays. One tank (T1) is filled with near shore fishes such as rockfish, surfperch, kingfish, anchovies, etc. The other tank (T2) is filled with larger animals such as sevengill sharks, white sturgeon, leopard sharks, and big skates. In T2, there are greater than 20 large bat rays (DW > 100 cm), and they are fed via broadcast from the surface three times/week. There are too many animals to control individual diets, therefore we did not add vitamins to the food. The other tank, T1, contains 3 to 5 smaller bat rays (DW approximately 50–75 cm), but staff divers feed these rays underwater directly by hand. The diet is varied and includes squid, sardines, and smelt, and food is supplemented with Mazuri™ vitamins. Over time, the large bat rays in T2 become infected with flukes and their dorsal surfaces became a cloudy white, whereas the bat rays in T1 remained clean of external parasites and their dorsal surfaces remained a healthy, black color. We attribute this to a controlled diet plus the addition of vitamins. I submitted a proposal to the Curators at MBA to implement the same method to feed bat rays within MBT, with a few modifications.

**Collection**

Bat rays are very common in bay and coastal areas in the central coast of California (*i.e.* San Francisco Bay and Elkorn Slough, Monterey) especially in spring where parturition and mating occurs (Martin, 1988). These animals are caught easily using hook-and-line. They are brought back to the Aquarium and moved into quarantine tanks for treatment of ectoparasites.

**Feeding Method**

We started by adding two bat rays into MBT that were too big for our bat ray touch pool. Although these animals fed and acclimated to the touch pool, they did not acclimate to the new surroundings inside MBT comfortably enough for us to feed them underwater. They were spooked by divers and swam away into the rockwork and concrete walls which in many spots are covered with sharp calcareous material such as orange cup corals and spirorbis tube worms. The bay rays soon became abraded from the sharp material within the display and we decided to move them off exhibit.

Realizing that bat rays are not accustomed to divers, we decided to train them first in a large holding tank inside our quarantine area. We started with two smaller bat rays (DW 60-75 cm). First, we created a target for them to approach in order to be fed. Within a few weeks, they learned to touch the target with their snout to receive food. After they adjusted to the target, we added a diver to the tank so they could adjust to the loud sounds and bubbles created by divers prior to their introduction into the exhibit. Within a short amount of time (2-3 weeks), the bat rays acclimated to divers and began feeding from the target. After we felt the animals were strong enough to be moved, we gave them a prophylactic bath using praziquantal at 10 ppm for 3 hours and placed them directly on display. Once on display, we attempted to feed them via SCUBA. We approached the rays slowly so we would not spook them, and brought the food and target to them. After a period of time (1-2 weeks), the animals quickly began feeding from divers using the target, and we were able to create a specific feeding area within the exhibit (see figure 1). We fed them mostly prawns and squid plus vitamins (Mazuri™ shark and ray tablets). Their dorsal surface remained a healthy black color without any flukes for four months.

*Figure 1. Staff diver hand-feeds a bat ray that has been trained to approach a feeding target.*

We decided to try two very large, female bat rays (DW > 110 cm; weight > 30 kg). We collected these animals from San Francisco Bay, and they came into our facility infested with copepods, trematodes, and leeches. We removed most of the leeches by hand, and began treating them with praziquantal at 10 ppm for 3 hours, three times over two weeks. We continued to treat them with dylox at 65 ppm for 24 hours three times once every five days to remove copepods and leeches we could not remove by hand. After the treatments were completed, we began training them in the holding tank using the same method we used for the smaller bat rays. The bat rays quickly adjusted to the divers and began feeding from the target. After we felt the bat rays were ready, we moved them on exhibit. The large, female bat rays began feeding from divers in the same target area where we were feeding the smaller bat rays. Although all four of the bat rays were feeding well at the target in one specific area, flukes began to reappear on the large bat rays, plus they began to show white cloudiness on their dorsal surfaces. Usually, cloudiness on the skin results from excess mucus production and is a response to fighting off monogeneans (Noga, 1996). Soon thereafter, the smaller bat rays, which had been clean of external parasites for over 6 months began contracting flukes. After consultation with our Curators and staff veterinarian, we decided to try oral droncit/biltricide (praziquantel). We started at 9 mg/kg, three doses over a period of two weeks, every 4 days. We did not see any changes with flukes, so we increased the dosage to 30 mg/kg, three doses over a period of two weeks, every 4 days. After the first treatment, there was a noticeable decrease in the trematode load on all four bat rays. After the third treatment, the flukes were gone from the small bat rays, but there were still some on the larger bat rays. We decided to continue treatment at 30 mg/kg a few more times for the bat rays, and subsequently, most of the external parasites disappeared. To date, they still show some white cloudiness on their dorsal surfaces, but a healthy black has become the prominent color.

## Conclusion

All four of our bat rays are feeding directly at the target, at the same location every feeding event (Sundays and Wednesdays at approximately 2:00 p.m.). This consistent underwater feeding method at the same approximate time, plus the addition of oral vitamins and medication has allowed us to successfully display these amazing rays in a large community display. One male has been observed mating with the females, and we are hoping to see progeny in spring, 2006.


## Acknowledgements

The author would like to thank the Husbandry Staff at Aquarium of the Bay, San Francisco and the Elasmobrach Team of the Monterey Bay Aquarium for their support. I would like to acknowledge the assistance of Dr. Mike Murray and Jon Hoech for their clinical advice on medication, and Freya Smith, Ann Coleman, and Michelle Jeffries for their help with training and feeding. I want to thank Christina J. Slager and J. Manuel Ezcurra for the helpful comments and final edits. The photograph was taken by Randy Wilder.


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# TREATMENT OF A MUSCULO-SKELETAL INJURY IN A BROAD NOSE SEVEN GILL SHARK (*Notorynchus cepedianus*): BELLA'S REHABILITATION

**Dr Alex Hauler & Alison Edmunds.**

*The following paper describes the treatment of a shark, which suffered a debilitating musculoskeletal injury. Melbourne Aquarium (MAQ) in association with Dr Alex Hauler and Alison Edmunds used needle treatment and massage therapy techniques to return the shark to functional normality.*

Bella is an adult female Broad nosed seven gill shark, *Notorynchus cepedianus*. She was captured at Policeman's Point near Portsea and brought to the Melbourne Aquarium on the 14th of August, in 2001. Currently, Bella is approximately 2.6 meters in length and weighs about 85kg.

The Melbourne Aquarium sharks are routinely caught out for veterinary health checks. Sharks are caught from the 2.2 million litre oceanarium using a clear plastic tubular bag handled by divers who then bring the shark into a shallow holding pool adjacent to the main tank. On the 2nd of June 2004, Bella was caught out for a veterinary inspection. When brought through the entry gate to the holding pool, the shark turned and twisted inside the plastic capture bag. The shark's trunk was fully flexed around to the left, over extending the muscles down the right side of her body. The veterinary inspection was normal but upon release back into the oceanarium, the shark was seen to be lethargic and did take longer than the expected time to recover from the stress involved in being caught and assessed. After a catch-out it is normal for a Seven gill shark to have altered breathing for about 10 minutes but it is expected that their swimming behaviour during this time is normal. During the time when Bella's swimming seemed weak, the only male seven gill shark in the Oceanarium bit her several times, possibly an attempt to initiate mating, but it did not seem to be successful. Bella's unusual behaviour alerted curatorial staff to the fact that the shark may have sustained an injury and was therefore to be monitored closely.

Over the next few weeks, the curatorial staff watched as Bella's interest in feeding lessened and she seemed to lose weight. Her body curved to the right and she consistently swam on a fairly precise track with two right turns creating an oval swimming track next to one of the viewing tunnels. She would also stay low in the 7m deep section of the oceanarium (called the trench) swimming in a tight right hand circle, coming out of the trench only to begin the right hand track next to the tunnel again. She seemed unwilling and unable to turn left. Bella's right sided trunk musculature seemed to be in a permanently contracted state and she began to demonstrate very obvious right sided trunk muscle atrophy. The muscle mass running down the length of her right side, from the pectoral to the pelvic region had atrophied to approximately 60% of its original mass.

On Wednesday the 23rd of June, it was decided by staff that she required treatment for this condition. Over those several weeks of observation, Bella had not shown any improvement, she was progressively losing muscle mass and the restrictive shortening of the right abdominal

and trunk musculature led to scoliosis. This restricted Bella to swimming in a fairly tight clockwise circle.

Scoliosis describes a spine, which has single or multiple lateral curvatures. Scoliosis can be permanent and stable and this particular condition does not worsen. In these muscular injury states, the scoliosis is most commonly observed caudal to the pelvic girdle and does not prevent the shark from functioning. This can be seen in the adult female Grey Nurse shark (*Carcharhinus taurus*) at Mooloolaba Underwaterworld called 'Bentspine'. Alternatively, the scoliosis may be progressive and dramatically interfere with the functionality of the shark. As a rule, sharks with progressive scoliosis, travel along a degenerative pathway where the affected muscle masses become increasingly atrophied and lose their ability to extend. This is defined as a loss of mobility. This muscle shortening, in the presence of a cartilaginous skeleton very rapidly establishes alterations of spinal curvature. The loss of muscular function is so severe that swimming is substantially interfered with. Often the shark loses its feeding drive and death is a common end result. In Bella's case, she showed substantial muscle atrophy and an inability to fulfil functional tasks. However, there was no indication of a neurological deficit. Prior to her catch out and examination it was assumed that she had sustained a painfully restrictive injury that may or may not have had a muscular tear component. Musculoskeletal injury is associated with protective guarding which is a postural response that minimises the pain. This type of injury very rarely resolves with time or rest. The Melbourne Aquarium vet, Dr Rob Jones, recommended an assessment by Dr Alex Hauler (dogvetnet.com : Melbourne, Australia), a sports medicine veterinarian who specialises in greyhound racing injuries.

On Sunday the 27$^{th}$ of June, Dr Hauler conducted the first treatment of Bella. To lessen the stress of being caught and handled the maximum treatment time is 12 minutes. The treatment involved the palpatory detection and needling of spasmed muscle bundles. The needling of the spasmed muscle bundles allows the muscles around the pectoral and pelvic girdles on the right side of the shark's body to again lengthen. A 25 gauge needle is used to needle the subcutaneous fascia of the spasmed muscle bellies, with particular emphasis being given to the origins and insertions of the hypaxial and epaxial muscles which run along the full length of the body. The approach taken with Bella was essentially to assess by palpation and then to treat and assess the response. This method of treatment is routinely performed by Dr Hauler on many breeds of dog and especially the racing greyhound, where treatment responses are readily and accurately able to be measured. This needling treatment conforms to the physiology of muscular function and injury. The treatment response whether in the dog, fish, equine or human is observed to be the same - to cause the cessation of the muscular spasm and so allow the restoration of normal muscular mobility, which is lengthening. Successful treatment of this injury is dependant on the palpatory detection of the restricted muscles and even more importantly the palpatory detection of the specific area of muscle that requires needling to nullify the restrictive spasm. The functional response to the treatment is virtually immediate with an obvious improvement of mobility and the observation in the ensuing 10 to 14 days of regeneration of muscular mass. The chronicity of Bella's injury is demonstrated by the degree of muscular atrophy. These chronic muscle atrophy inducing injuries require a number of treatments where each treatment is followed by a muscle mass regeneration and it is this patient response that determines the number of treatments required to restore normal functionality.

Immediately after the first treatment Bella responded well by beginning to attempt to turn left. Her left turns were jerky and stiff, whereas her right turns curved sharply as she seemed to almost collapse into them. Her swimming pattern remained on the same right track although less frequently did she enter the much tighter right track in the trench. Occasionally upon reaching the acrylic window, Bella would begin to turn left but would often suddenly appear to change her mind and turn back to the right. Her dorsal fin curved over to the right side of her body. Target feeding was initiated, using trevally with an added Multi-vitamin and Vitamin C, to increase Bella's weight and health.

Each needle treatment was adapted to suit Bella's muscular appearances as it changed over the treatment course. Due to the positive response Bella showed to the first treatment, a second treatment was undertaken on Sunday the 4th of July. The response to the second treatment showed that her turns to the left were becoming easier and less laboured. Having begun a left turn she now seemed able to follow it through rather than suddenly turning back to the right. Bella's increasing ability to swim out of the right track showed that there was rehabilitation of the muscles down the right side. The muscles had not deteriorated any further but her right trunk muscles did need to continue to increase their mass.

On Sunday the 18th of July, a third treatment was given because Bella's dorsal fin still listed to the right side of the body. She still showed a body curvature to the right but with each treatment the curve became less obvious and the return of muscle mass was beginning to become noticeable and was approaching 80% of original size. Target feeding was finished as Bella had begun to request food regularly from divers. She was also able to negotiate and utilise other parts of the oceanarium. This was her normal swimming behaviour prior to sustaining her injury.

A fourth treatment occurred on Sunday 29th of August, because Bella's right pectoral region still showed a degree of muscle wastage. Upon examining the pectoral girdle there was an obvious muscular depression on the right side below the lateral line. After Dr Hauler's treatment of this particular area the depression all but disappeared and the spasm in the muscle was relieved. The muscles forward of the pectoral girdle responded well and seemed to have almost returned to their pre-injury state. There was still an observable muscle loss immediately above the right pelvic fin extending forward up the midline to the pectoral region. The lack of muscle in this area and the way the left side of the abdomen bowed out gave her the appearance of being unbalanced. However, her swim patterns around the tank were markedly improved, with regular periods of uninterrupted straight-line swimming.

Bella's fifth treatment was on Sunday the 7th of November. This treatment focused on the right pelvic region where this localized muscle mass had only 80% recovered. Following this treatment, Bella's body began to look much more balanced. Several weeks after treatment, Bella

was swimming around the entire oceanarium. She still had a variation in muscle definition from left to right sides and her dorsal fin still occasionally seemed to lean to the right.

Bella's response to treatment was impressive. From the very first treatment she no longer favoured a tight clockwise circle but could swim in a larger though still right handed circle and was seen attempting to turn left. With each treatment, her swimming behaviour progressed closer to that which it was prior to injury. The improvement which was seen after treatment seemed to plateau at about 2 weeks post treatment where no further improvement would be seen until the next treatment was applied. The total treatment and recovery time was over a four month period.

It is now January 2005 and Bella is just like any other broad nosed seven gill shark swimming around the oceanarium tank. She swims all around the tank in any direction. Upon a very close inspection, Bella has slightly less muscle development down the length of her right side, the right side muscle mass being approximately 95% of her pre-injury condition. Where a significant neuromuscular injury has occurred it is not unusual to be left with an area of functionally normal but marginally atrophied muscle at the completion of successful treatment. Bella's body is no longer bent, and her tail movements seem equal to the left and right during straight swimming, she is once again a functionally normal shark.

Senior Aquarist, Alison Edmunds, is learning Dr Hauler's techniques and under his supervision has since applied them to broad nosed seven gill shark pups. Prior to this research, when sharks sustained a spinal curve inducing musculoskeletal injury there was no treatment to offer them. The technique used on Bella was used to proactively treat a musculoskeletal injury that was behaving like an irreversible scoliosis. Injuries that have traditionally albeit erroneously been considered to be active muscular tears are in fact a neuromuscular response to over-extension of mechano-receptors.

Dr Hauler has applied these treatment formats to the canine population where the house pet or the greyhound can equally find itself in a circumstance of accidental over-reach of any limb or trunk muscle and hence exhibit a similar injury. This treatment format, which includes the observation of shark function, palpation, muscle lengthening and dry needling, is the application of practical physiology and is now being applied to injured sharks at the Melbourne Aquarium.

# RAW 2006

***In Conjunction With:***

**Sea Turtle Husbandry Symposium • AZA TAG Working Meetings**

**Schedule and details available soon at: http://www.rawconference.org/**

The Regional Aquatics Workshop (RAW) is the premier annual gathering of public aquarium professionals. The 20th Regional Aquatics Workshop (year 17) will be hosted by the Aquarium and Rainforest at Moody Gardens, in Galveston, Texas. **The main conference will take place from Tuesday, May 16th to Friday, May 19th**. As has been customary, the annual working meeting of all AZA aquatic conservation groups will take place the day before RAW on Monday May 15th. A Separate Sea Turtle Husbandry Symposium will be conveniently held immediately following RAW on May 20th and 21st. Early registration for RAW is available on the 14th.

Tentative Schedule:

- Sunday, May 14 - registration available; no formal events planned.
- Monday, May 15 - AZA TAG and CAP meetings in AM; AQIG meeting in PM; informal evening possible.
- Tuesday, May 16 - Intro RAW session; cephalopod session; tour of NRCC cephalopod labs; Galveston pub crawl in the evening.
- Wednesday, May 17 - RAW paper sessions in AM and PM; evening event at Moody Gardens, with silent auction.
- Thursday, May 18 - RAW paper sessions in AM; afternoon at Houston Zoo; evening at Houston Downtown Aquarium.
- Friday, May 19 - final RAW paper sessions in AM; Aquarist Olympics in PM at the beach.
- Saturday, May 20 - Sea Turtle Husbandry Symposium paper sessions at Moody Gardens.
- Saturday, May 21 - Sea Turtle Husbandry Symposium wet lab at NMFS in AM.

**CONTACTS / INFORMATION**

Our host for RAW 2006, and both the AZA and Sea Turtle Husbandry meetings that serve as bookends, will be Greg Whittaker gwhittaker@moodygardens.com and program tasks will be handled by Paula Kolvig pkolvig@moodygardens.com and Roy Drinnen rdrinnen@moodygardens.com.

Conference registration is $35 before April 1, and $50 thereafter. Registration for the Sea Turtle Symposium will be handled separately, with cost to be determined. Hotel information will be on the website soon, but rates are expected to be about $132 per night plus taxes (double occupancy). Round trip limo service from the airports is typically in the $50-60 range.

# INTERNATIONAL AQUARIUM FORUM.

**Paul Van den Sande, Executive Director E.U.A.C.**

**Eugeen Fahylaan 34, B-2100 Antwerp, Belgium**

At the Monaco meeting the idea of transforming the IAC into a recognised professional organisation was already introduced as can been seen from the declaration which stated that the IAC (International Aquarium Congress) should continue as a professional network for communication between the aquariums world-wide. The three committees, a) Conservation, b) Education, c) Commercial activities, will continue to work between the congresses.

The IAC steering committee met several times during the meeting and noticed that in fact little progress was made towards this end.

I feel that we reached a significant milestone in Monterey in our professional and collaborative development and that we had to structure the IAC to meet the needs and challenges that will face us in the coming years. The need for professional consensus, a forum for exchange and a common voice can no longer be ignored. It seemed to the steering committee that it was a more urgent than before that the participants seize the initiative and the respond to the mandate already given to us by the previous congress to consolidate our position and to formalise our movement.

A proposal to start such a forum was presented at the closing session of the 6$^{th}$ IAC and the participants approved by consensus the foundation of an International Aquarium Forum.

The declaration of the 6$^{th}$ IAC says that: Public Aquariums have a greater role than ever to play in advancing and promoting global conservation of aquatic environments. Aquariums must work to effect a significant transformation in human behavior to ensure a sustainable relationship with earth's natural ecosystems and the survival of our civilisation as we know it.

Towards this end, public aquariums worldwide should increase their efforts and should not only focus on nature but also on human activities that affect global aquatic ecosystems
Inspire, engage and empower our audiences to become better stewards of aquatic environments, with special focus on concrete actions that people can take in their everyday lives
Ensure our institutional management practices are sustainable both commercially and environmentally.

In order to be more effective in achieving these results and to ensure we can create the successful aquarium of the future, the creation of a new organisation, the International Aquarium Forum, was decided. Its mission is to actively promote communication among aquarium professionals worldwide for the advancement of conservation of global aquatic environments.
The steering committee of the International Aquarium Congresses will act as founding committee and I myself agreed to chair this committee.

The founding committee did not want this newly created organization to be heavily structured and wanted it to start as an informal organization similar to the original European Union of Aquarium Curators and we agreed to provide staff.

We are all aware of the fact that the aquarium landscape has evolved and the importance of communicating and transmitting messages to the visitor has become one of our major preoccupations .

The initial task consisted of a proposal to develop a mission statement which was agreed upon by the members of the founding committee and it reads: *To improve worldwide communication among public aquarium professionals in order to strengthen capacity building, promote sustainable practices and conserve global aquatic ecosystems.*

The goals of the IAF are to

- Provide the best possible environments in our aquariums ( both animals and public)
- Raise public awareness about the need for conservation
- Sustain, encourage and participate in global initiatives for species and habitat conservation
- Establish coordinated sustainable species programs and participate in captive breeding with special emphasis on threatened species
- Provide good guidance in planning and operating aquariums for sustainability
- Initiate and actively support educational endeavors both within its premises and outreach programs
- Welcome, support and conduct scientific research within its premises
- Promote technology and expertise exchange among aquariums
- Contribute to a free and open flow of information and communication with fellow aquarium personnel
- Assist fellow institutions in their efforts in the application of this mission statement.

Since the start a web site has been activated and can be consulted at www.intaquaforum.org. The site already features interactive buttons where you can find the addresses to the best of my knowledge from aquariums world-wide. You can also find the declarations of the different International Aquarium Congresses, the proceedings of the 5th and 6 th IAC and links to organisations dealing with conservation activities.

All participants of the 6IAC have been informed that the IAF web site has been activated and many positive reactions have been received. Other existing zoo and aquarium organizations will be notified within short time.

The IAF does not want to be involved in political actions or debates. We do not intend to lobby for standards, management procedures etc but would always like to be consulted and to advise when it comes to aquarium linked issues. We strive to have our own identity which can be a guarantee for the future of the profession.

It is clear that this new organization cannot work without the input of all aquariums world-wide. I therefore like to encourage you to both make use of it and to actively participate within it in order to pursue common professional goals.

For more information, please contact Paul Van den Sande at cyper@scarlet.be and consult the web site at www.intaquaforum.org.

# SEASONAL OBSERVATIONS AND POTENTIAL COLLECTIONS SITES OF FOUR LOCAL JELLIES SPECIES; *Aurelia labiata, Chrysaora fuscescens, Chrysaora colorata,* AND *Phacellophora camtschatica*

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**Monterey Bay Aquarium**

**Abstract:**

Between December 1996 and December 2001, Monterey Bay Aquarium logged jelly collection data from different areas in the Bay. The hypothesis of this project was that jelly species vary in abundance depending on the location and season. Four popular, local display species were chosen and their data analyzed to determine seasonal preferences, if any. The jellies *Aurelia labiata, Chrysaora fuscescens, Chrysaora colorata, and Phacellophora camtschatica* were chosen and the collection data was averaged for each area, per season. The results showed *C. colorata* and *P. camtschatica* were mainly observed during the summer, *C. fuscescens* in winter and fall, and *A.labiata* in the spring. The data tends to support the hypothesis that jelly abundance varies with season. The location of jellies was more variable. A secondary goal of this project was to map the collection areas. The bar graphs show the average number of each species collected, per season, from eight collection areas in Monterey Bay. The map was created as a tool for anyone seeking a good location and season to find these jellies.

**Introduction:**

At the Monterey Bay Aquarium there are several species of cnidarian and ctenophore on display. In the main exhibition, all species are local and collected as often as possible to keep the exhibit full. In addition, many institutions ask for animals or ask for information on when and where to collect them. For aquarists, constant boating activity is important to insure a healthy stock because it is never known exactly where or when gelatinous zooplankton will appear in the bay.

While there are few references for gelatinous zooplankton abundance and seasonality along the western United States, there are a few highlights to note. On the coast of Oregon and Southern Washington the dominant species of jelly collected in one study from May to August of 1981 was *Chrysaora fuscescens. Aurelia aurita and Phacellophora camtschatica* were collected in fewer numbers. As an aside, *C. fuscescen* densities were greater near shore (Shenker, 1981). In another study done by Suchman (2005), the months June and August of 2000 and 2002 showed *C. fuscescens* was most abundant. The study was done in the California current which flows at the southern edge of Oregon. Lastly, in 2001 *Aurelia labiata* was found in the spring on the central coast (Gershwin, 2001).

During the time frame of December 1996 and December 2001 many boating excursions happened in Monterey Bay. The log book from those excursions showed collection/observation areas, dates, species of jelly, and numbers collected. This project focused on only four jellies, *Auralia labiata, Chrysaora fuscescens, Chrysoara colorata,* and *Phacellophora camtschatica* (pictured below). It should be noted that it was assumed that the species of *Aurelia* collected locally was the "local" species and not any other cosmopolitan species. The data was broken down to show an average collection for each species, per season, per area. The collection areas included Carmel Bay, Cypress Point, Point Pinos, Chase Reef, Lovers Point, Monterey Bay Aquarium, Macabee Beach, and the Breakwater. The hypothesis of this project was that jellies vary in abundance depending on location and season. It is also this goal of this project to map the collection areas and show which areas had an abundance of each species.

*A. labiata*

*C, fuscescens*

*C. colorata*

*P. camtschatica*

This project could not have manifested without the log books from the Monterey Bay Aquarium. Dave Wrobel was a main contributor to these documents and it is much appreciated. Also, the staff at MBA was very supportive of my educational endeavors and they covered my responsibilities while in class. Lastly, the GIS professors from the Monterey Peninsula College GIS were very helpful and their tutoring was exceptionally helpful.

**Methods:**

Data Processing and Graphing

The collection data consisted of logged boating expeditions over the time frame of December 1996 until December of 2001. The person entering the data was an aquarist from MBA specializing in jelly culture. The expeditions occurred weekly, if weather permitted, and usually took several hours. All collections were done at random. Jelly data was taken where jellies were found. In conjunction with this, there were several entries that did not indicate a number, just a presents, and thus earned a numerical value of 1 for data processing. All the data was entered into Microsoft Excel where it was processed. Each species was sorted, and then all the data from each jelly was separated onto new excel sheets. These sheets represented each season of the year; winter, spring, summer and fall. Then location sites were extrapolated and an average was taken for 5 years, per site, per season. The chart-wizard in Excel was used to generate the graphs.

The collection sites consisted of areas of the bay defined by a landmark or known underwater dive site. These are areas commonly known by other aquarists and therefore good for return visits. However, the map created by this project shows collection sites from memory and as a best guess of their location. The boat usually resided in water no less than 25 feet and no more than 100 feet. The sites are Carmel Bay, Point Pinos, MBA, Macabee Beach, Cypress Point, Chase Reef, Lovers Point, and the Breakwater.

Map Building:

The map generated was a compellation of shape files downloaded from websites, borrowed from old projects and created using the ArcMap Edit tool. To begin, two files were downloaded to show the Monterey County coastline, and bathymetry of the bay. The first came from the CSUMB Seafloor Mapping Lab (http://seafloor.csumb.edu/index.html), and the second came from the Department of Fish and Game (www.gfd.ca.gov). To show the local cites and roads shape file were copied from a previous MPA and Shipwreck project. The county land mass file was downloaded from the instructor, via the server. The collections sites and landmarks associated with them were created in ArcMap.

Projection/Datum Transformation:

The projection chosen was California Teale Albers, North American Datum 1983. This projection was chosen because it is an earth-centered datum that utilizes latitude and longitude, which can be useful when on boats. The strengths of the projection are that it is good for direction and distance and is compatible with most state maps.

ArcCatalog Organization:

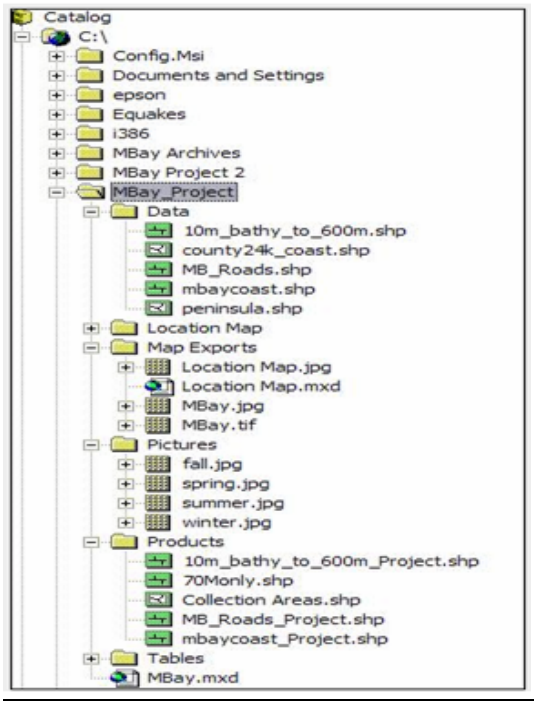
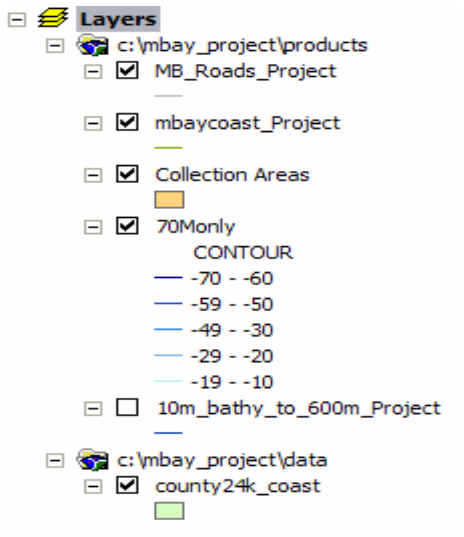



Table of Contents:




MB Roads Project:

To get local roads the file was copied from an older Shipwreck project. The Shipwreck folder was still on the hard drive and so it was just copied and pasted into the MBay data folder. Once there, it was checked in Microsoft Notepad for a .prj file. In ArcToolbox it was projected into Cal Teale Albers. The file was saved to the products folder and added to ArcMap.

Mbaycoast Project:

To get a map of the coastline, a web search was done and one was downloaded from CSUMB. Once in the site, the shape file was found under Data Library, Monterey Bay Region, Monterey Peninsula, All Sites, and Coastline. The file was high-lighted and saved in the Data folder in the Project folder. In explorer, open the file and it is in "zip" form. Right click the file and open Winzip (evaluation software) and choose extract to here.

The file was assigned the UTM projection, but the desired projection was California Teale Albers. According to the metadata, the datum assigned was the WGS 1984 and in explorer the file did have a .prj file. Therefore, it was projected using ArcToolbox, assigned NAD_1983_Cal_Teale_Albers and placed in the products folder. It was then added to ArcMap. The color was changed to a nice green.

Collection Areas:

For this file, polygons needed to be created. To do this the first thing that was to create a new shape file. In ArcCatalog, go to the products folder and hit new shape file. Name the new file "Collection Areas," select polygon as the feature type, and create it with the Cal Teale Albers 1983 projection. Once the new layer has popped up, open the attribute table and create a new field. The new field was titled "name," so as each polygon was built using the editor function it could be named and later labeled. Then, the editor function was utilized. The tool was double clicked and a box opened up. In editor, choose Start Editing from the drop down menu, the pencil, Create a new feature, and Collection Areas. Then go to the area on the map and click were and how big the polygon is desired. Once done, the sketch was finished from the right click menu. Once all the polygons are done, hit Save Edits. Before ending the editing, go to the attribute table and name all the polygons that were created. This can only be done while editing. Then hit Stop Editing.

10m_bathy_to_600m_project:

To get the bathymetry maps, go to the website, browse the types of files, and download. To download, go to 10 m, right click and save as. Save this to the project data folder. In explorer, it was also unzipped. The file was in California Teal Albers NAD 83. Once unzipped, the shape file was added to Arcmap and the zipped form can be deleted. This file was added to ArcMap.

70Monly:

Once in Arcmap, only 70 meters or less was desired. More was too much to look at. So, in Arcmap the bathymetry was selected, the select by attribute was chosen and "contour"<"-70" was applied. Because the integers were negative, the selection was opposite of the desired result. The file was right clicked and the selection was switched. The new file was saved as a data export file and a new layer.

To get contour colors the properties box was opened and the symbology was changed. The contour field was separated into 5 segments and the colors were graduated so the deeper colors represented deeper depths.

County24K_coast:

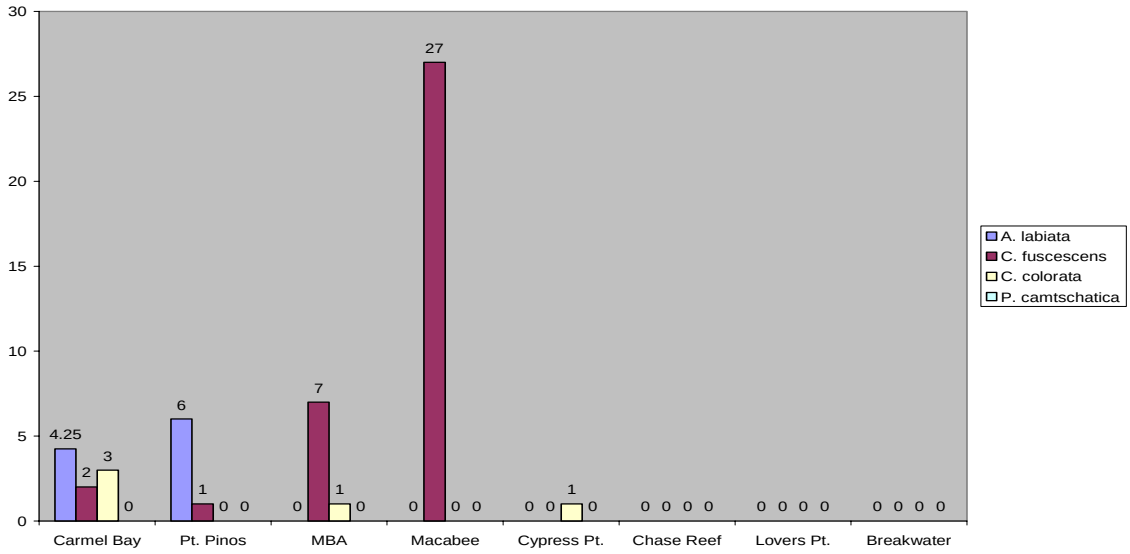
This file was downloaded from the server, via the instructor. The file was in an Albers projection with the NAD 83 datum. Nothing needed to be changed and it was added into Arcmap. The color was changed to a nice green.

**To Make Map Transportable:**

When the map is complete, go to file, hit Map Properties. Then select Data Source Options and Store Relative Path Names. Then save it as a JPEG, TIFF, and PDF.

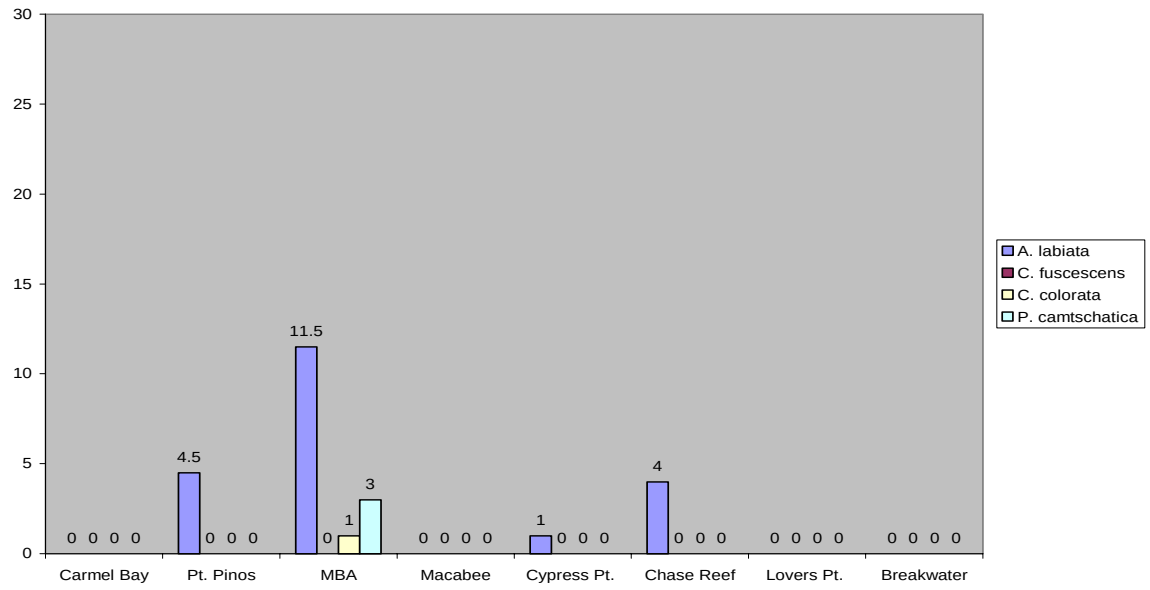
**Results:**

The results show for each season certain jellies were found in greater numbers than others. During the winter time, from December until March, the data shows *C. fuscescens* to be found at Macabee Beach, in front of the Monterey Bay Aquarium, in Carmel Bay, and near Pt. Pinos. The average collected was 27, 7, 2 and 1, respectively. *A. labiata* was collected at Point Pinos and Carmel Bay, with averages of 6 and 4.25. Also, *C. colorata* was collected in Carmel Bay with an average of 3, MBA with 1, and Cypress Point with 1.



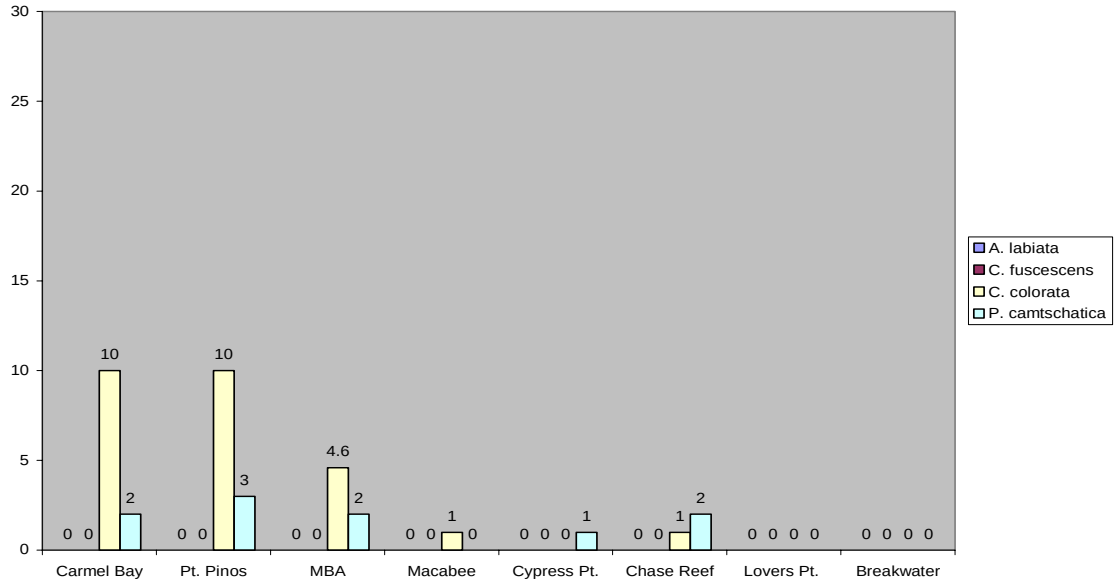

Graph 1. The average collection for the winter months.

During the spring season *Aurelia labiata* was the jelly colleted, on average, the most. At MBA 11.5 were collected. At Pt. Pinos 4.5 were collected. At Chase Reef 4 were collected. Lastly, at Cypress Point 1 was collected. At MBA, an average of 3 *P. camtschatica*, and 1 *C. colorata* were also collected.



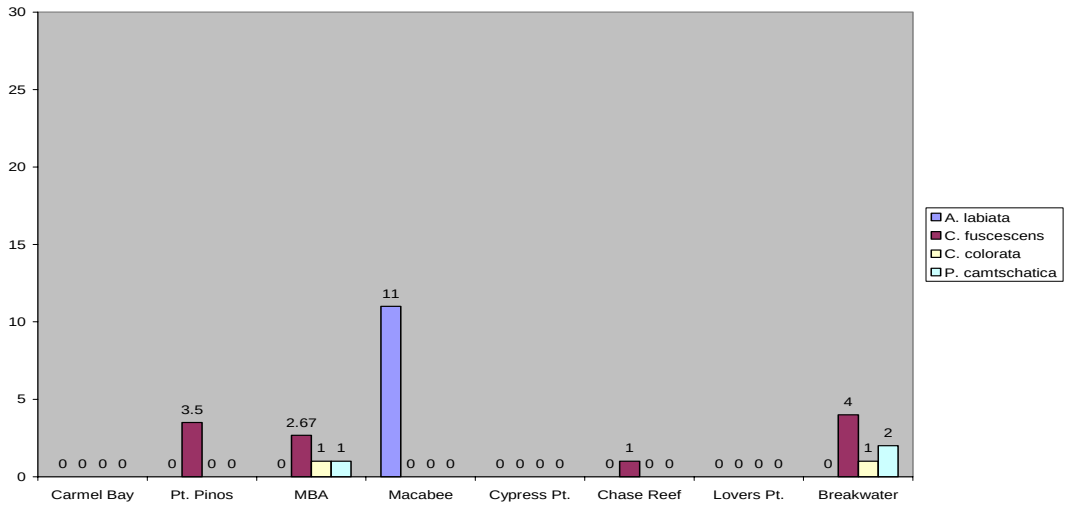

Graph 2. The average collection for the spring months.

For the summer months, *C. colorata* was the jelly most collected. In Carmel Bay and Point Pinos the average was 10. This jelly was also collected in front of MBA, Macabee beach, and at Chase Reef, with averages of 4.6, 1, and 1, respectively. The secondary jelly collected was *P. camtschatics* and it was found at several locations. These locations are Point Pinos, Carmel Bay, MBA, Chase Reef, and Macabee beach. The collection averages were 3, 2, 2, 2 and 1, respectively.




Graph 3. The average collection for the summer months.

The fall months showed a slightly different story than the other three seasons. All the jellies show an average according to the bar graph, but *C. fuscescens* seemed to show up most often. *A. labiata* had a collection average of 11 at Macabee beach. *C. fuscescens* was collected at the Breakwater, Point Pinos, MBA, and Chase Reef (4, 3.5, 2.67 and 1). *C. colorata* had a collection average of 1 at MBA and Breakwater. *P. camtschatica* had collection a average of 2 at the Breakwater and 1 at MBA..

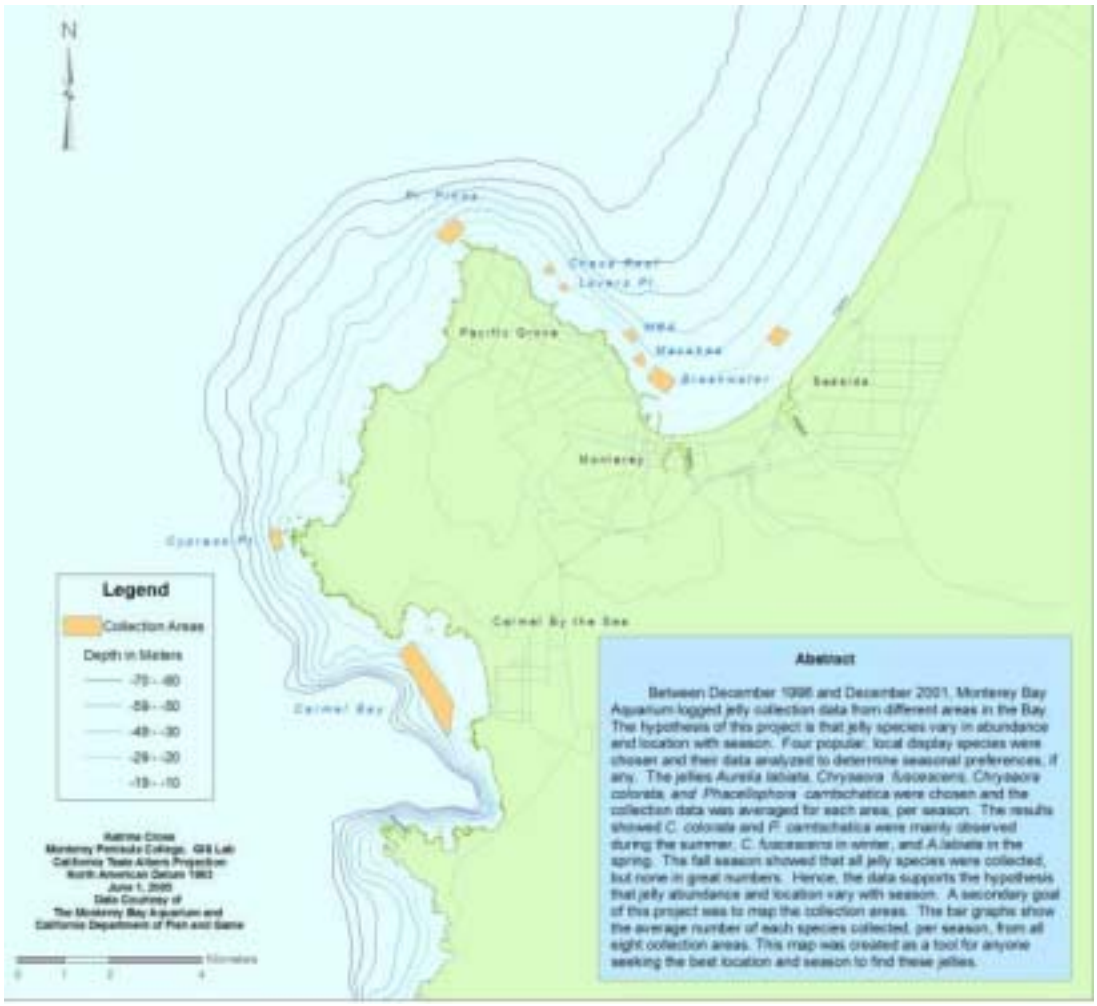



Graph 4. The average collection for the fall months.

**Discussion:**

In general, it can be inferred that certain jellies appear in Monterey Bay during certain seasons. *C. fuscescens* tends to show up in fall and winter, whereas *A. labiata* and *C. colorata* have appeared during the winter and spring months, respectively. *P. camtschatica* appeared during the summer months. Each species appeared at more sites during certain seasons. In the fall and winter, *C. fuscenscens* was present at 4 out of 8 sites. In the spring, *A.labiata* was present at 4 out of 8 sites. In the summer, *C. colorata* and *P. camtschatica* were present at 5 out of 7 sites. It is also noteworthy that all four were present during the fall months

To narrow the search down to a potential collection site, the bar graphs are useful. If *C. fuscescens* is desired, Macabee and MBA seem to be the best sites during the winter season. If *A. labiata* is desired they have shown up at MBA during the spring months. *C. colorata* has shown up in Carmel bay and Pt. Pinos during the summer months. *P. camtschatica* has also shown up in the summer, mainly at Carmel Bay and Pt. Pinos. As a caveat it should be noted that this study only shows where these jelly have been found. Many factors beyond the scope of this study influence their appearance, and therefore there is no “magic” combination to finding jellies.




Map 1. A map of Monterey and Carmel Bay with collections areas. The map is a copy of my final project poster and shows all collection area around the bay, including Carmel Bay.

There are several factors that shaped the results. First, the sampling technique was completely random. In fact there was no study in mind during the said timeline. A hypothesis was extrapolated, by a curious aquarist, from the logged data. Second, for each excursion not all areas were visited. Weather and time constraints dictated where the boat went. Third, certain jellies may have been targeted and therefore some observed but not documented. Fourth, water visibility could have inhibited seeing below the surface. Lastly, all observations and collections were made from the boat. There could have been more jellies subsurface.

If the study were to be done again there are a couple of things that could be done differently. It would be better to hit all the area during one excursion. It would be useful to look at coinciding water temperatures, during "normal" and El Nino years, and tidal phases. An El Nino event occurred in 1997-98, which means the water was warmer and plankton production reduced (Raskoff, 2001). It may also be useful to generate GPS points for accuracy. However,

with GPS points, the ocean is fluid and jellies are zooplankton moving with tidal currents and temperatures (we think). Statistical analysis would also add integrity to any observations. Hopefully these changes would make the data more substantial and a better story would surface.

Luckily, the budget for this project was minimal. The data taken was during the course of an aquarist doing his/her job over time. It did take many hours to enter data and generate graphs and maps. The focus was on four scyphozoan jellies, but the data encompassed many other species of cnidarian and ctenophore. The potential of the data was larger than the scope of this paper. Due to time constraints, only four jellies were focused on. Lastly, the most costly part of this was taking a class to learn ArcGIS and associated software.

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Photos by Dave Wrobel.

**Special Thanks:**
Special thanks go to my co-workers who covered for me, my friends who encouraged me and loved ones who supported my ideas.

# HATCHING OF *Nautilus pompilius* IN A CLOSED SYSTEM USING ARTIFICIAL SEAWATER

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## Abstract

Attempts at raising *Nautilus* in captivity have been ongoing for decades and although some advances in husbandry have been made, there is still more to be learned. Until recently, only coastal institutions have been able to breed and hatch *Nautilus* species using natural seawater. At the Henry Doorly Zoo's Scott Aquarium in Omaha, NE, two *Nautilus pompilius* have been successfully hatched using a closed system with artificial seawater and for the first time, one of the hatchings has been recorded on video.

## Introduction

*Nautilus* have been considered mysterious creatures since being encountered by people. Virtually unchanged by time,this living fossil holds many secrets for such a seemingly simplistic animal. There has been extensive research conducted on *Nautilus* species, ranging from the cold dark oxygen deficient depths at which the animals reside,to its chambered shell which provides the *Nautilus* with buoyancy to make its daily migration in the water column. Though there are still many facets of the *Nautilus* being explored, the hatching and propagation aspect is one that has been under the scope of scientists and aquarist alike for a long period of time with very little success.

An early attempt at hatching *Nautilus* occurred in 1985 when *Nautilus belauensis* embryos were produced at the Waikiki Aquarium observed by Bruce Carlson, Majorie Awai and John Arnold. A total of 14 embryos were maintained at an incubation of 21 degrees Celsius to 24 degrees Celsius. After four months of incubation and examining the development of some embryos, Carlson's group was able to extrapolate that it would require up to a 12 month incubation period to produce a hatchling (Carlson et al, 1992).

A few years later, the Kagoshima Aquarium in Japan, succeeded in being the first to hatch 3 *Nautilus belauensis* between December 27, 1988 and January 5, 1989. The report stated that the incubation tank was maintained at 25 degrees Celsius with an incubation time of 12 months, confirming Carlson's earlier conclusion. On October 27, 1990 the Waikiki Aquarium then succeeded in hatching 10 of 17 eggs with the remaining egg capsules being void of any embryos. It was reported that the hatching took place at night and was never witnessed. The incubation time at Waikiki ranged from 9.4 months to 13.7 months at 22 degrees Celsius. The life span of these animals after hatching ranged from 6 months to a little over a year.

At the Henry Doorly Zoo in Omaha, NE work has been ongoing to breed and hatch *Nautilus pompilius* for approximently 8 years. The first noted account of *Nautilus* eggs at this

institution occurred in 1998. Unfortunately, work had never been attempted before with *Nautilus* eggs at this institution and some referencing was required in order to make an informed decision on how to proceed.

**Materials and Methods**

Using a "hands off" approach, the first attempt at hatching *Nautilus pompilius* eggs was to leave them in the exhibit tank, wait and observe. After 7 months of patience with no success, it was decided to set up a system which would resemble Waikiki's incubation tank with the hope that this would produce results. This system consisted of a 55 gallon tank with black plastic wrapped all the way around it and colored gels on top off the tank to block out light. There were 2.5 inches of crushed marble on the bottom of the tank with a schedule 40 PVC spray bar around the top of the tank for circulation. The eggs would rest in pieces of airlift tubing to keep them upright. Henry Doorly Zoo is landlocked and access to natural sea water is not possible. The artificial sea water that is produced from a special mixture made at the zoo called 20 salt formula, has proven to work very well for fish and invertebrates and was thought to be adequate for hatching *Nautilus*. The temperature of the water was ambient, 23-25 degrees Celsius and would fluctuate only by a few degrees throughout the year.

After the first year and still not having a successful *Nautilus* hatching, the set up of the tank was changed by removing the black plastic,the plastic was replaced with black centra board and glued to the outside walls in case light was penetrating through the plastic with ill affects. Another change was to remove the eggs from the clear plastic pieces of airlift tubes and make small holders out of vexar to create circulation from all angles, not just the top and bottom (See Figure 1). With these changes, sporadic batches of eggs were produced over a period of 6 years but none yielded successful hatchings.

Again, it was time to try something new. The new system started with a circular tank that was 37 inches in diameter, 30 inches tall and held 110 gallons. Milk crates were placed on the bottom of the tank to support the floating filter bed. The bed consisted of egg crate fly screen and 2 inches of aragonite sand. An influent and effluent hole was drilled in the side of the incubation tank to place it on the same system as our *Nautilus* exhibit so that it would have similar chemistries, salinities and temperatures until all eggs were transferred from the exhibit to the tank (See figure 2). After the eggs have been transferred to the incubation system, the tank is then valved off from the main exhibit. All water changes thereafter are then done using Instant Ocean Sea Salt by Aquarium Systems. The room temperature was between 24.5-29 degrees Celsius during the summer months which would cause the tank to fluctuate between 23-27 degrees Celsius. The eggs received approximately 12 hours of fluorescent light daily and 12 hours of darkness.

In June 2005, one *Nautilus pompilius* embryo began to hatch out of its egg case, a process that took approximately 2 months (See Figure 3). The egg was closely monitored during this time and periodically handled to observe changes within the egg. On August 17, 2005 at 4:15pm, the first of 2 *Nautilus* eggs fully hatched. An attempt was made to feed frozen and live mysis after hatching but the hatchling was not interested in feeding at that time. The young *Nautilus* was then left alone for the remainder of the night. The next morning the old shrimp was removed and fresh frozen shrimp was offered directly to the animal which it accepted. The

*Nautilus* was then fed fresh frozen mysis shrimp twice a day for the first week. Upon the second week, new foods where introduced such as capelin, crab meat and silverside which it readily accepted.

On October 7, 2005, under the same environmental conditions, the second *Nautilus pompilius* hatched and for the first time was recorded on film by night vision camera.

**Discussion**

It has been quite an endeavor, trying to successfully hatch *Nautilus pompilius* in a closed system with artificial seawater. The process has been full of challenges. Some were expected, some were not. One challenge encountered was parasitism of the *Nautilus* eggs during incubation. Opportunistic worms0 were thought to be responsible for the demise of some eggs, which then resulted in the addition of six line wrasse and scarlet cleaner shrimp to the tank. Another variable that was not accounted for included the tank being in a location that would subject the system to temperatures swings. Temperature variations could be detrimental to the embryos resulting in their death.

One factor taken into consideration was limiting the amount of handling done to the embryos in order to avoid negative results from environmental stress or positional changes. Another factor was the use of phosphate remover to eliminate phosphate build up in the tank system which,if left in excess, could inhibit proper shell development.

One similarity,as noted by earlier work and reproduced here at Henry Doorly Zoo is the incubation time to hatching which was also about 12 months. Furthermore, it appears that the artificial sea water did not significantly change the incubation time required to hatch *Nautilus* and the significance of using natural seawater versus artificial seawater is unknown. However, one can speculate that an environment that most closely resembles a natural situation is best.

**Conclusion**

Over an eight year period, there has been some progress achieved at the Henry Doorly Zoo in the hatching of *Nautilus*, but now is the time to start continuing the efforts. The next step is to erect a propagation system in an attempt to determine the optimal environment for incubation. The goal would be an eighty percent hatch rate for each batch of *Nautilus* eggs by placing them through a series of tanks with varying environments coupled with perfect chemistry. There after, the goal will be placed on the longevity of the *Nautilus* in their simulated environment. The bar has been set with the length of time these animals have been kept alive after hatching by the Waikiki Aquarium. The goal is to now surpass that tremendous deed, and then distribute the information for others who are striving for the same objective. There are still other challenges with nutrition probably being the most important. Furthermore, to date no one has discovered the natural location of where the eggs are being laid.This raises the question as to how stable the *Nautilus* populations are in the wild. Perhaps hatching *Nautilus* in captivity on a consistent basis could one day play a vital role in future conservation efforts of *Nautilus* species.

**Figure 1.** Close up of incubation tank showing egg crates with vexar holders

**Figure 2.** Nautilus incubation tank

**Figure 3.** *Nautilus* hatching from egg case


**Figure 4.** *Nautilus* at 3 months post hatching

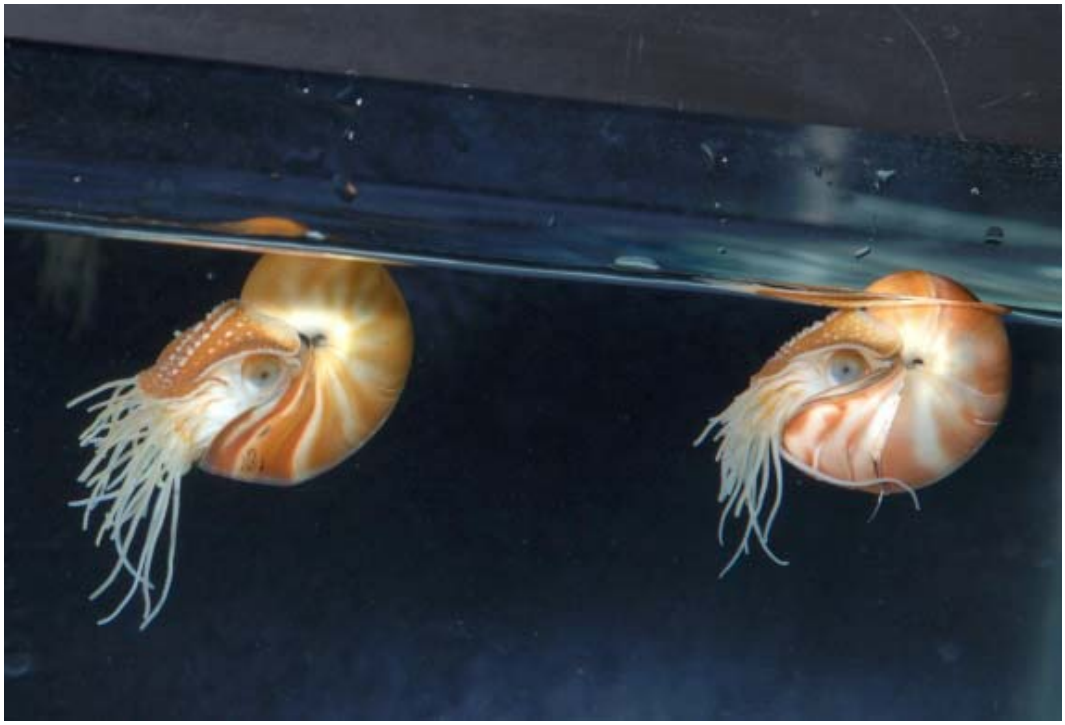

**Figure 5.** *Nautilus* at 3 months and 2 months post hatching

**Acknowledgements**

I would like to thank Dr. Lee Simmons, Director of Omaha's Henry Doorly Zoo for continued support and photography during this project along with Sean Putney, Animal Curator and the aquarium staff for all their support. I also wish to thank Dr. Eva Restis for editorial assistance.

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# CAPTIVE REPRODUCTION IN THE SARGASSUM FISH, *Histrio histrio*; WITH NOTES REGARDING ESTIMATED FECUNDITY

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Sporadic anecdotal reports of egg-production in the Sargassum fish, *Histrio histrio* (Lophiiformes: Antennariidae) are scattered throughout the literature of popular fish-keeping venues, though confirmation of viable eggs from these captive spawnings is absent. Little is known of the reproductive biology of the Antennariidae in general (Pietsch and Grobecker, 1987), and knowledge regarding the captive breeding of these specimens is virtually non-existent. It is known that *H. histrio* has complex and fascinating spawning behavior (Mosher, 1954); and that the buoyant, gelatinous egg rafts produced by the Antennariidae represent a radical departure in morphology from the eggs of all other teleosts (Pietsch and Grobecker, 1987).

The lone published report of successful captive reproduction in *H. histrio* is that of Mosher (1954). This early investigation was able to provide a wealth of information regarding egg raft morphology and early development, but was unsuccessful in rearing the eggs to postlarvae (Mosher, 1954). The eggs in Mosher's 1954 study died before metamorphosis into larvae having reached a maximum length of 1.6 mm. Further investigations have described the development of postlarvae from 1.9 mm to juveniles of approximately 2 cm based on wild-collected specimens (Adams, 1960). Adams noted in her 1960 work that the smallest specimens examined bore no resemblance to the largest specimens reared in captivity; thus it can be inferred that the period of development between 1.6 mm and 1.9 mm TL is one of significant morphological progression. This investigation was an attempt to contribute to the biology of *H. histrio*, as well as to establish preliminary husbandry requirements of juveniles and postlarvae of this unique and fascinating species.

A 24-hour old egg mass was received as a donation from a local hobbyist on 30 July 2005, and was placed in a 10 L container with seawater and gentle aeration. The container was kept at 80-85°F and 50% of the water was changed daily throughout the study. Immediately upon receipt of the mass the dimensions were recorded and 1 ml samples were taken and size recorded from several locations within the mass with a serological pipette to determine viability and egg density so that approximate fecundity could be estimated. Samples of the egg mass were pressed between two 50 x 80 mm glass slides to enable counting of viable eggs. Photomicrographs were taken daily using an Olympus BH-2 Microscope with a LW Scientific MiniVID Digital Ocular Camera at 100x magnification to document developmental progress. Copies of all images were contributed to Fishbase.org, and are available online or by contacting the author.

At day 2 of development the mass was measured as being approximately 10 cm in width and 1 m long. The eggs were determined to be approximately 500 microns in diameter using the gradations of an improved Neubauer counting chamber. The eggs showed rather rapid

development, with notochords being visible by the 6th day of development as evident in figure 1. By the 7th day yolk sacs were a prominent feature of all the larvae, and the beginnings of tails and fins were emerging (fig. 1). Unfortunately the larvae died between days 7 and 8 due to a protozoan infection within the egg mass, halting further documentation of development.

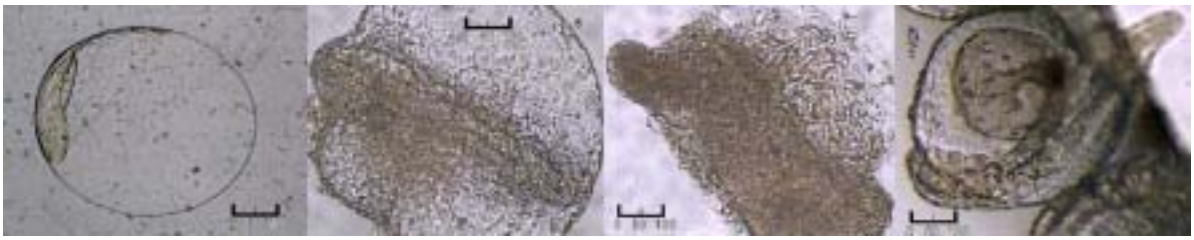

Figure 1. Photomicrographs of *Histrio histrio* eggs taken at 100x magnification. From left to right: development at 24 hours post-fertilization (HPF), development at 96 HPF, development at 120 HPF, development at 144 HPF. Scale bar is 100 microns.

From the initial samples of egg mass taken on day 2 of development, the density of eggs within the raft was found to range between 58-162 eggs per cubic centimeter. Assuming that the raft is roughly cylindrical we can extrapolate a total egg count of approximately $1.52x10^5$ to $4.24x10^5$. It must be stressed that this estimate is highly preliminary, and further study of the density and distribution of eggs from rafts of multiple specimens will be necessary to determine fecundity of this species with any certainty.

In summary, while this effort was not successful in rearing *Histrio histrio* in captivity, it was successful in providing the first estimates of fecundity for this species, and further documenting the early life history. Additional study is needed to conclusively determine the fecundity of this animal, to determine mortality rates of larvae, postlarvae, and juveniles, and to establish the husbandry practices and appropriate foods for larvae and postlarvae.

**Acknowledgements:**

The author wishes to thank Mr. Dale H. Jolly for his kind donation of Histrio histrio egg rafts to the aquarium, as well as for his careful observation and accounts of spawning behavior in his specimens. Thanks to Mr. Roy Drinnen of the Aquarium at Moody Gardens for his assistance and insights into this effort. Thanks also to Mr. Josh Frey of Landry's Downtown Aquarium Houston, and Mr. David Mahlman of the Florida Aquarium for their help in the initial research and suggestions regarding husbandry.

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# AN EVALUATION OF THE AQUARIUM SCIENCE PROGRAM AT OREGON COAST COMMUNITY COLLEGE

**Catherine Ellis, Curator/Fish and Invertebrates**

**Mystic Aquarium & Institute for Exploration, Mystic, CT**

I was fortunate enough to be asked to participate in a review panel of the Oregon Coast Community College's Aquarium Science program in November 2004. In addition to myself, there were three other Aquarium professionals with me, and two professionals from Aquaculture and the wholesale/retail ornamental trade. This was a unique experience for me as I have not served on a panel such as this before. This was a great opportunity to meet young people who have as much passion as I did at their age, and who have the drive to achieve their goals.

I did not know what to expect from this program and its students, even though I had heard Bruce talk about it for several years prior to its inception. I have to admit that I was a little worried about the success of the program due to the fact that it was being offered through a community college, and not through a four-year college or university. I was so very impressed; however, at the quality of the program that I quickly realized this was not your ordinary community college. The curriculum is impressive, encompassing and challenging, and geared exactly towards the issues that we face every day in our profession. In fact, I felt that these students would come out of this program much better prepared for a career over an ordinary marine science or biology degree student. In addition, several of the students who were brave enough to try a new program had already earned a four-year degree from another educational institution, and realized that they needed more hands-on experience and training. I applaud their willingness to venture into a new program, and commend them on their decision to look for further successes in this program.

The National Visiting Committee arrived for the weekend from all over the country to meet the staff of the Aquarium Science program the evening before meeting the students. Their gracious hospitality and fine food was a welcome respite from a full day of traveling. The next day we had the opportunity to meet the students and observe both a classroom session and laboratory session at the renowned Hatfield Marine Science Center, where the students were able to apply the classroom theory to practical application. Watching the students put together small foam fractionators was impressive from the standpoint that they had already learned how to use some plumbing skills and also had the understanding of how the fractionators work chemically in an aquarium. We then went to the Oregon Coast Aquarium, where we met some of the staff and were able to see where the students were doing some of their practical internships. The staff had nothing but good things to say about the students and the skills and talents that they each brought to the areas in which they worked.

I would say the best experience was performing "mock job interviews" with a small representation of the students, and getting to explore their backgrounds and abilities. We interviewed both first and second year students. Our goal was to examine their expertise, and determine if they could be viable candidates for a position within our business or institution. We were all very impressed with their skill sets and their understanding of water chemistry and

system design. We all felt that the second year students were well prepared to enter the work force in the overall aquarium industry. We wrapped up the interview portion of our visit with a review by the students of the program overall, and what they felt would be helpful in enhancing the program for future students.

Life Support Systems students experience a wide range of activities that support the design and construction of aquarium life support systems. The anticipated graduation date for the students pictured here is Spring 2006. Each will serve an 11 week, 40 hours per week internship prior to graduation.

The highlight of the trip, however, was attending the fundraiser for the OCCC, the *Oyster Cloyster*, held annually at the Oregon Coast Aquarium. This is a wonderful event that specializes in one of the local delicacies (oysters) that are prepared in a myriad of ways by many different restaurants and caterers from the surrounding area. The local micro-brewery even made a special brew in honor of the occasion! This event raises money that goes directly towards the Aquarium Science Program, and has been an ever-increasingly successful event. Many of the students were there to show support for their program, and to help describe the program to the event's attendees.

I strongly urge all of you to support and promote this program to your colleagues and within your institutions, as well as to students who are looking for these types of opportunities. This program offers us all the chance to benefit from prospective personnel who are ready, able and trained to take on the responsibilities of caring for captive aquatic environments. These students must participate in an internship at the end of their second year, which provides us all with the opportunity to test and hone their skills at our own facilities. I would also encourage you to consider allocating time and travel expenses to participate in future reviews of the Aquarium Science Program. This is a wonderful opportunity to meet future aquarists that may someday be working in our facilities, and to remember what it was that pushed us into the field, and more importantly, what keeps us here.

# RAW 2005 ABSTRACTS
# Regional Aquatics Workshop, June 20 - 23
# Cabrillo Marine Aquarium and Aquarium of the Pacific

Hard copies compiled by 2005 co-organizer: Perry Hampton
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Edited, supplemented, and matched to actual presentation schedule by Pete Mohan
**petemohan@aol.com**

## Monday, June 20
### *Pre-RAW AZA Conservation Group Meetings*

For complete minutes of all AZA TAG meetings, and copies of any materials distributed, please contact Doug Warmolts (MFTAG), Melissa Salmon (FFTAG), Steve Bailey (LVSSP), or Mike Brittsan (AITAG, CRCAP)

### *AZA Focus Topics*

**A Look Behind the Curtain at AZA's Conservation Endowment Fund**
Ruth Allard, AZA
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Our various Taxon Advisory Groups (TAGs) and other AZA conservation groups may apply for CEF funding to support research in our areas of interest. How can we maximize our chances to receive funding? Statistics are provided on how aquatic proposals have fared over the years, and recommendations on proposal content and structure are provided. *(editor)*

**Strategic Planning: Working Smarter?**
**(Introducing the AQIG)**
Pete Mohan, Akron Zoo
PJMohan@akronzoo.org

Over the past couple of years, RAW attendees and AZA conservation committee members have been discussing ways to maximize our use of time. Our relatively small leadership groups are interested in prioritizing and combining our efforts. Those in attendance at this presentation unanimously voted to support the "AQIG option", which involves spinning all common efforts off from the existing TAGs (Marine Fishes, Freshwater Fishes, Aquatic Invertebrates) and CAP (Coral Reefs). TAGs would continue focusing on RCPs, SSP(s), and taxon-specific goals for conservation, animal welfare, and Husbandry. The new Aquatic Interest

Group (AQIG) could combine all TAG and CAP efforts on legislation, communication, general health issues (such as Mycobacteria), ZIMS, acquisition/vendor issues, pet trade, emerging issues ( such as Aquatic Nuisance Species), training, liasons with other groups, and general husbandry/exhibit issues. *(editor)*

## Tuesday, June 21
## *General Interest*

### The Effect of Supplemental Nutrition on the Growth of *Acropora Cervicornis* in a Captive Study.

R. Sean Coats, The Florida Aquarium
scoats@flaquarium.org

In observations at The Florida Aquarium, the growth of staghorn coral (*Acropora cervicornis)* was not comparable to growth found in the wild. It was suspected that some type of supplemental nutrition might be the key to increase the growth rate in captivity. An experiment was devised that used twenty fragments of *A.cervicornis*; half would be given additional food sources, while the other half would serve as the control group. All of the study corals were kept in the same water and same light regime. Concentrated brine shrimp nauplii (*Artemia sp.*), enriched with Selco® for 24hrs were used as the supplemental nutritional item. Each set of corals were placed in separate acrylic boxes during the feeding periods. Bi-weekly, *Artemia* was injected into one box and both boxes were allowed to remain in place for one hour. Once a week all fragments were removed from the system and buoyant weights were taken. The study lasted for one year. The observed growth and buoyant weights indicate a significant difference between the two sets, with the supplemented group growing 2.67 times ($p < .05$) the rate of the control group. This indicates that optimum growth within our facility will not be achieved without this supplemental nutrition and leads us to theorize that in-situ hermatypic corals, even though they contain zooxanthellae, may get a significant part of their nutrition from heterotrophic activities.

### Exhibiting Tridacnid Clams in an Open Display Design

J. Charles Delbeek and Norton Chan, Waikiki Aquarium
nchan@hawaii.edu

The Waikiki Aquarium recently opened a new outdoor exhibit featuring five species of aquacultured tridacnid clam*: Tridacna crocea, T. gigas, T. maxima, T. squamosa and Hippopus hippopus*. This unique exhibit features a continuous overflow design coupled with reverse flow and circulation lines. The top down viewing offered by this design exhibits these clams in a new and unique way that allows their brilliant colors to be easily viewed from above. The presentation will include a discussion of what worked and what didn't work in the initial design, and what changes were made as a result.

**Oh the Pressure!**
**Preliminary Results of a Hyperbaric Chamber for Deep-Water Fish**
Jeff Landesman, Cabrillo Marine Aquarium
jlandesman@rap.lacity.org

Collecting fish from deep water is problematic. Rapid ascent results in uncontrolled gas expansion, especially in the swim bladder and eyes. Excessive gas can be released from the swim bladder with hypodermic needles, however gas expansion in eyes and bloodstream, possibly resulting in embolism, can only be treated with a recompression chamber. A portable pressurized chamber has been used with some success.

**Development and Execution of New England Aquarium's New Stellwagen Bank Exhibit**
Brian Nelson, New England Aquarium
bnelson@neaq.org
Tony Davi, Underwater Adventures Aquarium
tdavi@minnesotaaquarium.com

Based on previous experiences with the NMSF - Flower Gardens Sanctuary folks, New England Aquarium staff developed and executed exhibit renovations of our Cold Marine Gallery in conjunction with and funded by the NMSF - Stellwagen Bank Sanctuary. We will briefly examine how we developed the partnership with our local sanctuary, got institutional buy-in, designed, built and collected for the new 4000 gallon Stellwagen boulder reef tank, the 'centerpiece' of the renovations.

**The Evolution of the Perfect Predators**
Jose I. Castro, NOAA/Mote Marine Laboratory
jcastro@mote.org

The earliest sharks known lived in the Devonian period some 400 million years ago. These animals had already evolved as pelagic predators. Over the eons sharks have evolved into the perfect predators. They have evolved superb senses that allow them to detect prey in the absence of light, smell, sound, etc. They have evolved a skin that allows them to glide through the water stealthily to their prey. They have replaceable teeth that allow them to have a sharp dentition at all times. Their dentition allows them to attack prey larger than themselves. They have an efficient buoyancy mechanism that reduces the energy spent in swimming. Today's sharks are the product of over 400 million years of evolutionary processes that continue to improve their efficiency as predators.

**Ocean Adventure – The Little Aquarium that Could…**

Greg Whittaker, The Aquarium at Moody Gardens
gwhittaker@moodygardens.com
Jeffery Archer, UNDP/GEF Environmental Specialist – Korea

Ocean Adventure is a tourist destination located at Camayan Wharf in the ex-US Naval Base of Subic Bay in the Philippines. The first and only open water Marine Park in Southeast Asia went through a 4-month concept design phase into an aggressive one-year construction phase and was completed for less than $2.5M U.S for physical facilities. In September 2001 the park opened its 14-acre complex on Camayan wharf with nearly 800 linear feet of open water net pens in Ilanin bay and a backdrop of undisturbed Rainforest. Ocean Adventure receives nearly 250,000 guests per year and supports an array of community based education programs as well as active conservation and rehabilitation efforts for local marine and terrestrial wildlife in its own Wildlife Rescue and Rehabilitation Center added in the last two years.

The aquarium facilities include an aquarium building, numerous open-water lagoon pens containing animals such as rehabilitating sea turtles, breeding sharks and stingrays and large pelagic and reef fishes, as well as semi-aquatic reptile exhibits in an open-air terrestrial area.

The aquarium building at Ocean Adventure is 3000 $ft^2$ (280$m^2$), with 700 $ft^2$ (65$m^2$) of enclosed, air-conditioned public gallery, showcasing 20,000 total gallons in 10 displays ranging from 150 gallons to 2200 gallons utilizing re-circulated natural seawater systems. The exhibit path follows the freshwater progression from rainforest through mangroves and grass bed estuaries to reef and open water environments. The aquarium houses an impressive collection of over 100 species (400 specimens) within its diverse habitats, actively educating the parks visitors on the Philippines' marine resources. With a total construction budget of only $200,000 U.S. and the extremely demanding design and construction deadline, this aquarium project required both experienced knowledge and innovation from a team of professional biologists, architects, project coordinators and local construction resources. This small aquarium with its regional focus, direct access to professional laboratories and animal rescue facilities, and its situation in a conservation hot-spot is ideal to serve as an overseas partner to progressive AZA facilities looking for in-situ conservation programs with ex-pat oversight.

**Update on the Progress of the Pygmy Sunfish Conservation Project**

Jennifer Rawlings, Riverbanks Zoo
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The Pygmy Sunfish Conservation Project (*Elassoma spp*.) has been identified as a priority in the AZA FFTAG Regional Collection Plan as a component of the Five-Year Action Plan. Established by Riverbanks Zoo (Aquarium) in 1999, the project has experienced progress towards its goals in the last several years. These goals are:

1) to establish self-sustaining populations of the three rare species at Riverbanks and other AZA institutions,

2) to collaborate with university scientists to catalog genetic material,
3) to work in conjunction with southeastern states' natural resources departments to facilitate release of captive bred animals back into areas of their traditional range,
4) and to develop an M.O.U. in partnership with federal agencies to establish pygmy sunfishes on federally protected land.

To meet the goal of working with other AZA institutions, breeding groups of pygmies have been sent to several of the thirteen interested institutions, as identified by the FFTAG space survey. These include Tulsa Zoo, Dallas Aquarium at Fair Park, and The North Carolina Aquarium at Roanoke.

During the first few years of the Project, Dr. Joseph Quattro of the University of South Carolina has contributed to the cataloging of DNA of all captive held pygmy sunfishes. Dr. Quattro is now focusing on other research, but Michael Sandel of the University of Alabama is now working to complete a phylogenetic analysis of the Elassomatidae.

Progress has also been made toward the goal of partnering with government agencies. Riverbanks has recently joined with the U.S. Department of the Army to sample populations of *E. okatie* found on Fort Gordon Army base in Georgia. An M.O.U. has been drafted and is currently under review. Riverbanks will establish and maintain breeding populations from these samples for the purpose of reintroduction of captive bred fish to areas of Fort Gordon that had previously been destroyed but are currently being restored to habitat suitable for wildlife. This species is listed as critically imperiled by the state of Georgia, so reintroductions at Fort Gordon are of particular importance to the preservation of wild populations of that state.

## Traveling Turtle has Things to Teach Us

Pam Lyons Gromen, Newport Aquarium
plyons@newportaquarium.com

The launch of AZA's Wonders of Water campaign has brought ocean conservation issues to the forefront of our industry, and each member institution has been asked to create programming to generate awareness and a call to action about the serious topics relating to the health of our oceans. Inland institutions, even those with saltwater exhibits, are challenged with connecting their visitors to the ocean in a meaningful way that compels them to become involved in ocean conservation. Teachers in particular have realized the futility of teaching about remote areas such as the rainforests as the students feel so disconnected from the topic, they eventually tune out what they perceive as a hopeless situation that they can do little to remedy. Newport Aquarium has developed a conservation program that we feel has potential to generate personal connections from inland schools to the oceans. In 2003, Newport Aquarium partnered with the Marine Turtle Research Group, North Carolina Wildlife Resources Commission and Seaturtle.org on a project that follows loggerhead sea turtles in the Western Atlantic. Researchers tag nesting female loggerheads from Bald Head Island with satellite transmitters in order to document migratory and feeding behaviors, which may provide clues as to why this population appears to be declining. In 2004 we also tagged Fisher, a nine-year-old, sub-adult male loggerhead that had been in captivity since hatching. Tagged turtles are monitored via an

innovative, state-of the art web site, www.seaturtle.org. The first two years of our study have provided groundbreaking data for the research team while the tracking pages on the web site provide a real-time connection between ocean science and classrooms.

**Hey! Where Did All the Water Go?**
**Observations on Extended Aerial Exposure Tolerance in Indo-Pacific Corals**

Rich Terrell, Pittsburgh Zoo & PPG Aquarium
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In March, 2005, one of the PPG Aquarium's Indo-Pacific reef exhibits was found drained to within 6 inches of the false bottom. The root cause of the problem was the LSS design of the system. All of the live corals above this depth were left exposed for an unknown period of time overnight. Most of the stony corals that were exposed suffered damage ranging from partial coenosteum tissue loss to total colony mortality. Soft corals were stressed but, overall, undamaged. The presentation will focus on observations of the effects of the event on the different genera of coral on exhibit, possible causes for the differences observed, and solutions for the prevention of future problems.

**Aquatic Animal Enrichment at Moody Gardens**

Jenni Lewis and Bob Snowden, The Aquarium at Moody Gardens
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bcsnowd@msn.com

Moody Gardens is a rather diverse facility in that it houses a 1 acre rainforest and a 1.5 million gallon aquarium facility. In May of 2004 the rainforest opened a mammal exhibit. Part of the crucial care of these mammals was the requirement of daily enrichment. This got our Training and Enrichment Coordinator, Diane Olsen, thinking. She came up with a great idea to incorporate all of the animals, including fish, into the enrichment program. Biologists from the aquarium and rainforest were brought together in groups to brainstorm ideas and choose animals to be enriched. The enrichment was designed to encourage and reward the animals to use and display natural behaviors in their captive environments. In order to accomplish these enrichment goals, we were tasked with designing devices, either complex or simple, to aid in enrichment and to stimulate the desired behaviors. Some of the aquatic animals that were enriched were cownose rays, brown-banded and white-spotted bamboo sharks, ratfish, and loggerhead and Kemp's Ridley sea turtles. This presentation will highlight the cownose ray enrichment and touch on the enrichment with some of the other aquatic animals.

**Conditioning and Enrichment at Shark Reef at Mandalay Bay**

Hugh Purgley & Monica Brazel, Shark Reef at Mandalay Bay
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mbrazel@mrgmail.com

Conditioning and enrichment of mammals has been widely utilized as successful techniques in the husbandry of zoo collections for years. Recently, these techniques are becoming widely used for reptiles and fishes. At Shark Reef, we are conditioning several species of animals with the goal of providing less stressful methods in dealing with various husbandry and medical procedures. We are also using enrichment to enhance our animals' natural behaviors and provide a stimulating environment. The conditioning of our elasmobranchs, sea turtles (*Chelonia mydas*), golden crocodiles (*Crocodylus porosus* x *siamensis*), and Asian water monitor (V*aranus salvator*) has proven to be extremely helpful in managing difficult species interactions and in routine medical procedures, greatly reducing stress to the animals and staff.

**Does this Fish Look Fat in this Tank?**

Debbie Crain, Bass Pro Shops
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One of the main challenges we face as an aquarist is the perception of the health of the animals we house. Management's perceptions can sometimes be manifested by their concern of the weight of individual animal relative for that species. Are we feeding enough to meet the needs of this fish and allowing continued growth of this individual? It is common to house several individuals of the same species and similar size in an exhibit. It is vital to positively identify an individual fish in a given population to follow the animal from acquisition to disposition. Passive Injected Transponders (PIT) tagging of individuals will take out the guess work when monitoring health of specific animals. By monitoring individual fish we can then use the length-to-weight condition factor to show in a qualitative way that the fish is sustaining a necessary weight. The power point will show one method used for PIT tagging fish and a formula for calculating optimum weight for different species.

**The Tennessee Aquarium's "Ocean Journey" expansion overview.**

Kathlina Alford, Tennessee Aquarium
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In the spring of 2002 the Tennessee Aquarium began planning for an expansion to compliment its existing River Journey building. The new Tennessee Aquarium Ocean Journey building, which opened April 2005, features a tropical cove, invertebrate gallery and a 600,000 gallon artificial reef tank focusing on the Flower Gardens National Marine Sanctuary. Here is a look at some of the happenings from ground breaking to completion.

**Display of a Captive White Shark, *Carcharodon carcharias*, at the Monterey Bay Aquarium: Step One - Add Shark and Stir Evenly with Public and Media.**

Manny Ezcurra, Monterey Bay Aquarium
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The display of a young of the year white shark at the Monterey Bay Aquarium for 198 days was the culmination of a three year, $1.2 million dollar project. The juvenile shark was incidentally captured in a commercial gill net on August 20th 2004. An ocean pen was used to house the shark for 25 days in order to let it recover from the stress of capture and to insure that it was feeding. On September 14th 2004 the shark was transported to Monterey. While on display, from September 15th 2004 until March 30th 2005, in the 1.2 million gallon Outer Bay exhibit the juvenile white shark fed at an average daily ration of 1.58 % BW/day ± 1.44 (S.D.) or 30.3 Kcal/kg/day ± 33.5 (S.D.). The captive white shark grew at 2–3 times the estimated rate of growth in the wild, adding 43 cm in total length and gaining 45.4 kg in mass. The white shark was released on March 31st 2005 and data from an attached archival satellite tag determined that the shark survived the release.

**Behavioral Cues for Catalyzing Cleaning Behavior in The Scarlet Cleaner Shrimp *Lysmata amboinensis***

Bob G. Snowden, The Aquarium at Moody Gardens
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The cleaner shrimp, *Lysmata amboinensis*, is native to the Indo-Pacific and is a much misunderstood cleaner species despite how common it is in the marine aquarium trade. They are sequential hermaphrodites that spawn immediately following ecdysis. This species of shrimp lives a life of mutualistic symbiosis with numerous species of fish and is known for cleaning ectoparasites off of their bodies and oral cavities. In this study, the cleaner shrimp, *L. amboinensis*, will be studied with various species of living fish of different colors and shapes as well as dummy fish with progressively changing markings. The dummy fish will also be introduced with scents on them. The goal is to accurately determine what the catalyst for the cleaning behavior is in this species of shrimp. The study will be conducted in 4 different test aquariums with at least 10 different individual shrimp in, at least, pairs and a few shrimp will be placed into control settings.

Questions to Answer:

1. Is the behavior initiated, or, is cleaning duration lengthened by the addition of chemoreception to the dummy fish?
2. Is the cleaning behavior initiated by visual or behavioral cues?
3. Which is more relied upon for cleaning to commence visual cues or chemoreception?
4. What species work best with this shrimp for demonstrating symbiosis?

**Changing the Feeding Regime in a Multi-Species Open-Ocean Tank by Means of Target Training Pelagic Sharks**

Michaël Laterveer, Rotterdam Zoo, Rotterdam, The Netherlands
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The open-ocean tank in Rotterdam Zoo contains 92 animals of 19 different species, including 2 species of sea turtle and 5 Elasmobranch species. Initially one central feeding station was used to feed the wide diversity of animals. But after two years problems such as food competition, chasing and biting necessitated a different approach, as well as the need for monitoring individual food intake of the animals.

Three different tools were used to change the feeding regime in the open-ocean tank. First, a research into differences of swimming and feeding behaviour of the animals in the open-ocean tank resulted in a definition of four different feeding groups. Second, a literature study was carried out to determine the nutritional needs per species. Third, special target training for the pelagic sharks enabled controlled feeding for individual animals. The sharks were divided into two groups: (1) four blacknose sharks (*Carcharhinus acronotus)* and (2) three sandbar sharks (*Carcharhinus plumbeus)* together with two blacktip sharks (*Carcharhinus limbatus).* At the end of the training period the blacknose sharks, blacktip sharks and sandbar sharks showed an average of 90%, 91% and 80% correct target hits. By training the sharks, the problems during feeding decreased by 80%.

The success of the conducted target training of pelagic sharks will be used to discuss further possibilities for shark research in public aquaria.

## Wednesday, June 22
## *Aquaculture / Propagation / General Interest*

**The Marine Fish Breeding Records;**
**A Tool for Monitoring Captive Breeding of Marine Fish**

Michaël Laterveer, Rotterdam Zoo, Rotterdam, The Netherlands
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The Marine Fish Breeding Records (MFBR) is a database containing data on the worldwide breeding efforts of marine fish. It may be the most comprehensive source of information about marine fish culture today, covering 575 species of which 211 are recorded to be bred to the juvenile stage and beyond. This number is in sharp contrast with the results which are published recently in the UNEP World Conservation Monitoring Centre Report on the Global Trade in Marine Ornamental Species (2003), which only mentions 69 fish species in correlation to captive breeding.

The collected data of the MFBR originates from various sources including questionnaires of the EUAC (2000 & 2004), the AZA (marine fish TAG survey, 1995), Internet and popular as well as special literature.

The MFBR gives a review on a number of parameters, such as references to persons and institutes, fish species, stage of development obtained in captivity and food used during the initial larval stages. In the database four different interest groups are distinguished: research institutes, private sector, aquaculture and public zoo's and aquaria, giving insight in the contribution of the various parties.

Graphs will be shown of the most recent information covered in the database. Furthermore, the benefits, availability and future prospects of the MFBR will be discussed, as well as possibilities for international co-operation.

**Exploration of the Deep Reef Slope Off of Manado, Indonesia in Search of Coelacanths.**

Forrest A., Young, Dynasty Marine Associates, Inc.
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A three week long expedition to Manado was conducted in April of 2005. A multinational consortium consisting of participants from Aquamarine Fukushima, Dynasty Marine Associates, Inc., the Monterey Bay Aquarium and LIPI (Indonesia Fisheries Institute) surveyed likely undersea habitats by both deep technical diving and ROV.

Many new species of deep reef slope fishes and invertebrates have been discovered, filmed and collected. Each dive by the diving team and the ROV team was filmed. The report will include video of the diving operation, images of the new species and a discussion of the results of the search.

**Temperature Effects on Prey Availability and Survival and Growth of Copper Rockfish Larvae, Sebastes caurinus**

Thom Gilbert, Hatfield Marine Science Center-Oregon State University
thomgilbert@hotmail.com

Temperature shock effects SS-rotifer, L-rotifer, and *Artemia* swimming activity and mobility. Live prey were cultured at 20° C and tested for handling and temperature shock when transferred to 10, 14, 18, and 20° C. Prey were sampled over 48 hours in 10 L buckets from four levels in the water column. Results showed all prey to undergo transfer and handling shock with varying recovery times. *Artemia* recovered within two hours from 10° C and 60 % of L-rotifers returned to the water column after 48 hours but SS-rotifers showed severe mortality at 10° C. Temperature effects on live prey were studied as to aid in static copper rockfish larval culture. Copper rockfish larvae were cultured at three temperatures (10,14,18° C) to study optimal temperature for growth and survival. Water changes and live prey feedings were performed every other day and *Isochrysis galbana* was used to green the water. Rotifers were fed from day 1-12 and new hatched Artemia from day 7 until day 16 completion. Results showed survival of

>40% for 10 and 14° C but <15% for 18° C. Optimal growth occurred at 14° C were standard length, notochord depth, and anus depth larval measurements showed to be significantly different from 10 and 18° C.

## ***Medical***

### A Real Hole in the Wall" A Case Study of a *Nautilus pompilius.*

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This case study focuses on a *Nautilus pompilius* at the Smithsonian's National Zoological Park that lived briefly with a hole in its shell. On January 29, 2004 a thumbnail size hole exposing living tissue was identified on a Nautilus at the Invertebrate Exhibit. This Exhibit highlights lesser known invertebrates as feature attractions. Did this nautilus shell hole expose the body cavity to the salt water environment? What type tissue was exposed? How should a hole in the shell wall be treated? Will a hole in the shell heal? What considerations should be weighed, and how heavily, when evaluating tank interior surfaces and individual animal shell markings? This Nautilus died on February 15, 2005 after mesmerizing visitors for almost five years. It lived two and a half weeks with its shell hole. This case generated questions, things of interest, and discussion among colleagues.

### Dinoflagellates and Marine Head and Lateral Line Erosion

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Marine Head and Lateral Line Erosion (MHLLE) was found affecting fish in the Coral Reef Tunnel exhibit at the Newport Aquarium in Newport, Kentucky. While investigating the link between a vitamin A and C deficiency in the diet and MHLLE, an unidentified dinoflagellate was found. The dinoflagellate exists in association with a marine sponge, protista and other invertebrates and has proven difficult to isolate. The dinoflagellate forms cysts and is resilient to known disease treatments. The experiment conducted at Northern Kentucky University (NKU) consisted of 3 control saltwater tanks (containing 1 healthy brown sailfin tangs, *Zebrasoma scopas*) and 5 experimental saltwater tanks (containing 1 healthy *Z. scopas* and the dinoflagellate). Visual assessments using a 35 – millimeter camera were used to determine the progression of the disease, while a compound microscope was used to determine if the dinoflagellate was present. In addition, skin scrapes of all the fish were conducted to determine if the dinoflagellate was parasitic. Dry red marine algae (their diet during the experiment) was compared to the dry green marine algae (their diet at the Newport Aquarium) to determine if the dinoflagellate was present in the food. While the dry red marine algae fed in this experiment did not contain the dinoflagellate, the dry green marine algae used as a comparison did. This suggests a possible way for the dinoflagellate to enter into an enclosed aquarium system. All of the *Z. scopas* exposed to the dinoflagellate did exhibit signs of MHLLE. Early scanning electron photomicrographs have been obtained, but an exact identification of the dinoflagellate has yet to be made. Due to the lack of dinoflagellates found in the skin scrapes,

we suggest the release of a toxin by the dinoflagellate and not a parasitic dinoflagellate was the cause of MHLLE. However, water samples that were taken from the tanks are still being analyzed for the presence of a toxin. The results thus far suggest there is a link between the dinoflagellate and MHLLE; however the exact mechanism is still uncertain and the species of dinoflagellate has yet to be determine, the experiment is on going.

**Formaldehyde Trends in Water**

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37% Formaldehyde was monitored by a series of experiments with the purpose of revealing the duration the chemical remains within a closed system of water. The experiments ranged from uncycled fresh and salt water systems dosed with formaldehyde once to cycled systems containing fresh and saltwater fish that were dosed a series of times. Each individual experiment documented the concentration changes of 37% Formaldehyde within the water environment over a period of time.

**Preliminary Case Reports of Two Suspected Neoplasms from Fishes of the Family Acanthuridae**

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This report documents two suspected cases of tumors in different species of captive surgeonfishes. Accounts of neoplasia in fishes of the Acanthuridae, and of many families of reef fishes in general, are largely absent from the literature. At present it is unclear whether this absence reflects a lower incidence of neoplasia or a lack of tumor research within these taxa. In the first case two suspected neoplasms of unknown etiology were discovered upon necropsy in a blue tang surgeonfish, *Acanthurus coeruleus*. The larger of the two masses was found embedded in the epaxial musculature 15mm anterior of the caudal peduncle on the right side of the fish. The growth was approximately spherical with a diameter of 20mm, and had a mass of 3.167g. The second growth was similarly embedded in the epaxial musculature along the lateral line 35mm anterior to the caudal peduncle; it measured 8 x 9mm, and had a mass of 0.597g. In the second case a spotted unicornfish, *Naso brevirostris*, was noted as being emaciated and having incredibly rapid opercular ventilations. Upon examination of the anesthetized living specimen a large, vascularized mass of apparent esophageal origin was observed to be obstructing the esophagus and extruding both opercula. Upon necropsy it was noted that the mass blocking the esophagus was significantly smaller than had been previously observed, and that the two bottom gill arches had an unusual growth covering the gill rakers and filaments. The remnants of the esophageal growth that was removed measured 30 x 10 x 10mm and had a mass of 1.811g. The diagnoses of both these cases remain presumptive pending histological analysis of the excised masses. Fixed and preserved tissue specimens from both fishes were donated to the collection of the National Cancer Institute's Registry of Tumors in Lower Animals. It is hoped that this account and other similar contributions will help elucidate the incidence of tumors in reef fishes and other less researched taxa.

## *General Interest*

### Agonistic Displays and Sound Production in the Humphead Maori Wrasse (*Cheilinus undulatus)*

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The humphead Maori wrasse (*Cheilinus undulatus*) is a popular display animal in public aquariums throughout the world. Its sheer size, color and activity level make it an icon for aquariums and conservation efforts. Relatively little is known about the *C. undulatus* the largest wrasse species and largest coral reef fish in the world. Found throughout the tropical reefs of the Indian and western Pacific Oceans, the humphead is highly valued as a food fish, particularly in Southeast Asia. With stocks of this species in severe decline, studies of *C. undulatus* behavior are increasingly difficult to undertake. As a collaboration between Shedd Aquarium and the Fish Division at the Field Museum of Natural History we studied agonistic behavior and sound production in this species

As part of agonistic displays, many fish are able to produce sound through the use of pharyngeal jaws or swim bladder. By showing a large humphead puppet to a terminal male *C. undulatus*, agonistic displays including rapid swimming motions, fin displays and avoidance maneuvers were documented on video. Two definitive sounds from the humphead were recorded via hydrophone and analyzed. Recordings of sound production in the *C. undulatus* at the Shedd Aquarium are a first for not just the humphead, but in any known behavioral context for the entire wrasse family.

### Bluewater Diving for Gelatinous Plankton: The Thrills and Chills

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The Waikiki Aquarium is the only aquarium in North America situated in the tropical Pacific. This affords us access to pelagic planktonic animals rarely seen or even displayed in public aquaria. A joint collecting trip with researchers from the Kewalo Marine Lab (KML), Honolulu, Hawaii, provided an opportunity for collecting pelagic animals for the Waikiki Aquarium for R&D purposes, with the long-term goal of creating exhibits of gelatinous animals rarely attempted before. The University of Hawaii dive safety program oversees all diving done at UH auspices; therefore some training would be needed. This required the learning of dive protocols and techniques for bluewater diving, and the subsequent collecting ins-and-outs of gelatinous animals. A short video of a collecting trip will be presented followed by a discussion of what we have learned so far.

**A Preliminary Comparison of Buoyant Weighing vs. Weighting in Air as Methods for Measuring Coral Growth**

Carrie Pratt, Columbus Zoo & Aquarium
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Commonly used methods for measuring coral growth include the buoyant weighing technique, density band analysis and photographic documentation of linear expansion. These methods are time consuming, require expensive equipment and in the case of density band analysis are destructive. This study aimed to compare the buoyant weighing technique versus simply weighing coral fragments in air on a balance. Weights of fragments of three species of Scleractinian corals (n=15 for each species) were taken during the course of the study using these two methods. A positive correlation ($R^2$>0.95) was found between the two methods. This study suggests that when applicable weighing corals in air could be a useable method for monitoring coral growth. Knowledge of coral growth, not only in linear expansion, but in increased biomass is an important factor in determining coral health and as a measure of proper coral husbandry.

## Thursday, June 23
## *General Interest*

**How Can Future Public Aquariums Contribute to Coral Reef Conservation? Some Thoughts on the Feasiblity of Coral Breeding Programs to Manage In- and Ex-Situ Populations**

Dirk Petersen, Rotterdam Zoo / University of Essen, Inst. of Ecology, Dep. of Hydrobiology,
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Coral reefs, which represent the most diverse marine ecosystem are in decline. Currently the popularity to display live coral exhibits in today's aquariums is mainly used to raise public awareness. What else can be done to support coral reef conservation? The World Zoo Conservation Strategy describes the role of zoos and aquariums in global conservation and gives various examples how zoos have contributed to preserve endangered species from extinction. Improved techniques in coral husbandry and captive sexual reproduction on the one hand and increasing knowledge in coral population genetics and reef ecology on the other hand might offer new tools for coral reef restoration, population management and breeding programs. Public aquariums might get a great opportunity for future conservation, which would also mean a great responsibility. So far at least 15 scleractinian coral species have reproduced in public aquariums, in the case of *Favia fragum* at Rotterdam Zoo, a full life cycle was generated leading to F2 and (potentially to) F3 generations. When applying latest advances in coral breeding in a larger scale more species will be captive bred in near future. This leads us to new topics like the importanceof cross- and inbreeding in the long term management of ex situ populations. Can we bring the tools together? Is there a limit when looking at the complex and diverse reproductive ecology in corals? What has the future in store?

**The Trials and Tribulations of a Temporary Jelly Gallery Gone Crazy**
**– or –**
**Converting a Gallery of Wild Jellies to One of Cultured Specimens.**

Michael Howard, Aquarium of the Pacific
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On June 16, 2000, the Aquarium of the Pacific opened one of the largest and most diverse temporary jelly galleries in the U.S. In the first three years of the gallery's existence, 12 to 14 displays were kept stocked primarily with locally captured animals and non-local purchased specimens. Recent efforts have been made to become more self-sufficient in "Jellyland", thereby saving 10s of thousands of dollars annually. Over the past two years, many tricks have been learned by chance, from failure, and through perseverance (i.e. by generating infinite inquiries and attempting countless trials). Five years after the opening, the gallery is still flowing and has transformed into an important, crowd pleasing, semi-permanent display. Here is our story.

## ***Conservation***

**Coochi Coochi Coo:**
**Cabrillo Marine Aquarium's new aquatic nursery**

Mike Schaadt, Cabrillo Marine Aquarium
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Going to the nursery of any hospital and plastering your face up against the glass while you coo at the babies is a favorite pastime for young and old alike. Cabrillo Marine Aquarium (CMA) opened its Aquatic Nursery so visitors can do just that, coo at the babies. A theme of aquaculture is displayed throughout the exhibit highlighting the reasons for aquaculture and environmental implications. With CMA's regional focus on southern California sealife, the Nursery provides a peek at sea jelly ephyrae, blue banded goby larvae, juvenile pipefish and Pacific seahorses, abalone veligers, garibaldi embryos, grunion eggs, red rock shrimp colonies, and juvenile giant seabass, just to name a few.

**"ZIMS: Where Are We Now? Reflections from the Fish-Heads."**

Tim Carpenter, Seattle Aquarium
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Melissa R. Hartley-Salmon, Riverbanks Zoo
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Since the advent of the Zoological Information Management System (ZIMS) currently being developed by ISIS, many in the aquarium community have been cautiously optimistic. Over the past year, there have been several opportunities for aquarium management to be a part of the development process. Through online consultation of "Business Use Cases" and phone communication to the participation of "Subject Matter Experts" at data standards meetings, aquarium representation has been heard. This presentation will review where the development process stands, how to participate in the process, and what the aquarium community should expect to see in ZIMS once completed and online in the next year.

**Aquarium Science Program at Oregon Coast Community College**

David Beran, Oregon Coast Community College
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The Aquarium Science Program, a program designed specifically to train individuals for the aquarium profession, at the Oregon Coast Community College is preparing to graduate its first cohort of AQS students. These students are currently participating in their three-month internships and will receive an Associates of Applied Science degree in Aquarium Science this spring as they enter into the aquarium industry job force. The graduates and current students in the AQS program reflect the diversity of community colleges. Student profiles will be shared with conference attendees.

Along with the graduation of the program's first students, this past year has also brought about significant developments within the AQS program. These include the adoption of a one-year certificate available to students with previous college experience, an articulation agreement with Oregon State University, and the planning of a dedicated Aquarium Science educational facility scheduled to open in 2008.

**Conservation Efforts of Threatened Rockfish Species at the Oregon Coast Aquarium**

Kevin Clifford, Oregon Coast Aquarium
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This project at the Oregon Coast Aquarium is focusing on the conservation of yelloweye rockfish a threatened species. The work that we are doing will also be applicable to other species found off our coast. Over fishing has caused a drastic decline in the populations of rockfish from California to Alaska.

It is said that if all fishing were stopped today then it would take about 100 years for the rockfish populations to return to their original numbers. At the Oregon Coast Aquarium we are looking at ways to improve the populations of rockfish, but our focus is on yelloweye rockfish. The yelloweye rockfish live to over 100 years and they are slow to mature. Yelloweyes reach maturity at about twenty years of age. For these reasons we are focusing our efforts on these animals.

There are several phases to the yelloweye rockfish program at the Oregon Coast Aquarium. The first phase was to PIT tag all of our yelloweyes so that we will be able to track there life history at the aquarium. This will enable us to collect data on individual animals. Will be able to track individuals as they are treated for medical problems, determine their sex, determine which females mate more often and who provide the most number of viable offspring. When the animals were captured for tagging they were also weighed, lengths were taken, and tissue samples were collected. A phase of this project is to be able to collect and ship larvae to other research facilities for growth studies and one day for possible release. Another phase of this project is to develop an efficient way of collecting the larvae, a gravid yelloweye can release up to 2.5 million larvae. Lastly we would like to release larvae into the wild. These animals would have a fighting chance to survive to adult hood. Since, fishing is an important part of the culture of Newport we want to get the local fishermen involved with this part of the project. There will be disease issues that we will have to deal with if we are going to be release captive born animals back into the wild. I would also like to raise the rockfish larvae at the Oregon Coast Aquarium, but currently we do not have the staff or the infrastructure in place to take on such an intense project.

## Race to Save the Dace

Cindy Lee, Toronto Zoo
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The Toronto Zoo has been working on projects with native species at risk. One such fish is the redside dace (*Clinstomus elongatus*). Found in Canada, in the lower Great Lakes drainage basin, the species occurs within the most populous region in Canada. After working for over a decade on habitat rehabilitation and community outreach, Toronto Zoo has undertaken a large project to construct a fish way on the Zoo property. Working with a local volunteer organization, Ontario Streams, the provincial Ministry of Natural Resources and federal partners the project constructed a 1km fish way around an 20 m. in-stream obstacle that had blocked passage of aquatic species for close to 3 decades. New landscaping and hydrological engineering techniques were used to replace the tradition fish ladder structures of the 1970's. The presentation will highlight several reconstruction sites and show the working fish way.

**Reef Protection International (RPI) educates the public about the marine aquarium trade and promotes consumer behavior that enhances coral reef conservation.**

Drew Weiner, Reef Protection International
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RPI is currently developing a pocket "Reef Guide" for marine aquarium hobbyists. Modeled after successful seafood guides like the Monterey Bay Aquarium "Seafood Watch" guide, RPI aims to provide consumers with general information about the marine ornamentals trade and detail clear buying choices (avoid and recommend) that will contribute to coral reef conservation.

RPI Director Drew Weiner will discuss the "Reef Guide" campaign, highlighting details of the ranking methodology used to categorize fish for the "Keep It Wild" (avoid) and "Bring it Home" (recommend) lists and the role RAW member aquariums may play in the successful execution of this coral reef conservation program.

**An Innovative Life Support System to Create Dynamic Ecosystems**

Michaël Laterveer[1], Peter Henkemans[2], Rene H. Wijffels[3] and Ronald Osinga[3]
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The culture and display in captivity of sensitive organisms such as corals and sponges requires more than a reliable and stable life support system. Many sessile lower invertebrates form an integrate part of the marine ecosystem. For example the display of a coral reef habitat, with life key species like stony corals, requires a closed captive ecosystem which allows biological cycles to be completed within the system.

In contrast to traditional life support systems the DYnamic MIneral COntrol technology (DYMICO) does not use chemical or mechanical filtration to maintain a high water quality. In combination with specially designed plankton friendly pumps the system creates captive ecosystems. The DYMICO system controls the organic and inorganic composition of the water in a natural way which enables it to react automatically to variations in bio-load.

Three experimental 1000 litre DYMICO systems were installed at Wageningen University, The Netherlands. The Food and Bioprocess Engineering Group of the Wageningen University carries out bioprocess technology research focused on sponges. Four 3000 to 6000 litre systems were installed at Rotterdam Zoo as research tanks for the culture of stony corals and sponges and holding tanks for sensitive marine organisms.

The suitability of the DYMICO system for the culture and display of lower invertebrates will be reviewed. The general use for aquaculture and public aquaria in terms of financial as well as time investment will be discussed.

**Advances in Captive Coral Breeding – Results of Three Years Research at Rotterdam Zoo**

Dirk Petersen[1, 2], Michaël Laterveer[1], Helmut Schuhmacher[2].
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Successful coral breeding does not only depend on the stimulation of gamete and larvae production, but also on larvae settlement and rearing of primary polyps to adult corals. We examined (1) the influence of artificial moonlight and temperature on the reproduction of the Caribbean reefbuilding corals *Favia fragum* and *Agaricia humilis* in a closed system, (2) settlement behaviour of released larvae depending on substrate condition and light, and (3) early survival and growth rates of juveniles in relation to different light sources. We will compare laboratory results with reproductive events of both species taken place in a 30 $m^3$ live coral exhibit to discuss species specific limitations.

## ***POSTER ABSTRACTS***

**Aquarium & Aquaculture Science of Saddleback College, California**

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The Aquarium and Aquaculture Science Program at Saddleback College is the first accredited program in the State of California's Community College System and was officially approved May 2004. The program was lauded by the State Chancellor's Office for its effort in taking a bold, new direction in merging two specialized areas of aquatic animal husbandry for a premier vocational program.

Accomplishments of the program originate from the successful launch of a 'grassroots' pilot class in 1998, *but more importantly*, from the network of professionals and collaborators that were forged during the curriculum process. Members of the AAS Advisory Board are directors, curators and managers of local public aquariums, corporate aquarium and aquaculture industries, research institutes and four-year universities. Representatives from these venues provide expert guidance for on-going curriculum development and program evaluation. Continued success is mandated by formative and summative evaluations of the program for which the college must provide to the Chancellor's Office every two years.

Classroom instruction integrates traditional and innovations of advance technology of computer projection system with internet capability to streamline and increase student learning outcomes. The lab facility for the Aquarium/Aquaculture is approximately 4,350 square feet, a renovated Greenhouse and adjoining patio, circulates over 2,200 gallons of seawater in several stand-alone aquariums and recirculating systems and supports a working class size of up to 25 students at a time. Students engage in a variety of hands-on activities from water quality, animal care, life support, health and disease, and captive ecology focusing with potential reproductive success. Complementing and strengthening our campus instruction are specialized workshops,

work-site tours, lectures and internship opportunities which occur within our region. These are; Aquarium of the Pacific at Long Beach, Birch Aquarium of Scripps in San Diego, the Cabrillo Marine Aquarium in San Pedro, the Ocean Institute of Dana Point, Hubbs-Sea World Research Institute, Sea World of San Diego and many other businesses too numerous to mention.

The program combines core areas of technical knowledge and skills to marshal the desired talents of today and future workforce needs to meet the challenges of conserving and managing our world's aquatic resources in an environmentally and ecologically friendly way. Saddleback College's current enrollment exceeds 25,000 students and links education with economic growth and vitality.

## A preliminary Study on How Divers Affect the Swimming Behavior of Captive Sharks

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Most major aquariums have strict diver training protocols in place to protect both the sharks and the divers entering any exhibit containing these animals. While diving has been occurring in the Open Seas tank at the Oregon Coast Aquarium since its opening in 2000, there has never been a critical study done to look at the behavior patterns of the individual sharks while divers are in the water. This study seeks to answer questions about how the presence of divers affects the swimming patterns of two of the larger sevengill sharks inhabiting the tank. Ethograms were used to plot the position of each shark on a horizontal and vertical axis. Quantitative measurements were also taken on the number of turns each shark made, as well as how many times the sharks swam up the walls or under the tunnel. These observations were taken in short, sequential intervals, before the divers entered the water, while the divers were in the water, and after the divers had exited the water. It was hypothesized that the swim patterns of the sharks would change markedly while the divers were in the water and then return to a baseline state once the divers were gone. So far results are sparse but there seems to be a strong correlation between the presence of divers and the shark's utilization of different zones in the water column. There is also some evidence of more frequent turning while divers are in the tank. If further analysis shows a higher frequency of turning, this information will be critical in assessing whether or not divers are contributing to increased energy demands by the sharks.

## ALTERNATIVE AQUARIUM FOODS

**Tony Moore, Aquarium Curator,**

**The Mirage**

One of the things common to all aquarists, regardless of what kind of animals they care for, is the need for variety in what is feed to their animals. Since a varied diet is important to the husbandry of most all animals, aquarists are constantly on the hunt for something new and different to try with their aquatic animals. And in recent years, this search has intensified with the use of many food items as a means of "animal enrichment". In this light, I recently conducted a small survey on the Aquatic Information list server and Aquatic Interest Group list server for feedback on what unusual food items different facilities use. The replies were interesting due to the fact that the majority of the items were used for freshwater animals. While not meant to be a scientific survey of nutritional value, hopefully this list will give some ideas for adding variety to aquarium animals diets.

### ***Fresh Water***

| Plant Material | | Animal (live, frozen) |
|---|---|---|
| - alfalfa pellets | - melons (various) | - chicks (frozen) |
| - apple | - nectarines | - daphnia (live) |
| - banana | - nuts (various) | - earthworms |
| - beans (fresh green) | - oatmeal | - freshwater amphipods (live) |
| - cabbage | - oranges | - fuzzy mice (live) |
| - carrot | - peas | - macrobrachium shrimp (live) |
| - cereal (cheerios, ezekiel) | - pears | - meal worms |
| - chard | - peach | - mussels |
| - cherries | - plums | - panagrellus (microworm) |
| - cherry tomatoes | - potato | - paramecia |
| - chick peas | - satsumas (mandarin) | - prawns (frozen) |
| - corn (on cob and off) | - sea lettuce | - shrimps (various) |
| - courgette (zucchini) | - spinach | - whelks |
| - cucumber | - strawberries | - winkles |
| - garlic (whole, liquefied) | - sunflower seeds | |
| - grapes | - sweet corn | |
| - green pepper | - sweet pea (seed) | |
| - greens | - sweet potato | |
| - kiwi | - tangerine | |
| - langoustines | - tomato | |

### ***Marine***

| Plant Material | Animal |
|---|---|
| - algae paste (inverts) | - artemia nauplii |
| - cheerios | - blood worms |
| - collard greens | - boiled egg |
| - kale | - cockle |
| - mustard greens | - cuttlefish |
| - parsley | |