

# the Shellcracker



FLORIDA CHAPTER OF THE AMERICAN FISHERIES SOCIETY

<http://www.sdafs.org/flafs>

**April, 2013**

## *President's Message:*

Hello Florida Chapter members! Our 33<sup>rd</sup> Annual meeting came and went, and I think overall it was a great meeting. We missed a few of the regular faces we've seen around the fire for quite some time due to some illnesses and other family matters, but we also got a chance to see some old faces that we haven't seen in a while and some brand new ones too. As usual, the quality of work that was presented by both students and professionals was excellent. There were 50 total presentations, which included 35 oral presentations and 15 posters. Congratulations to all the award winners (please see page 3) and thanks to all the judges and moderators that helped make the meeting run smoothly!

The symposium 'Long-term monitoring: designs, problems, and results' on Wednesday morning provided us with a lot of useful and interesting information on a wide variety of LTM programs that occur throughout Florida. Dan Gwinn (University of Florida) got us kicked off in the right direction speaking in broad terms about the diversity of LTM programs, how they are set up, and why they take place. We then had seven presenters (Mark Hoyer – UF/Florida LAKEWATCH, Howard Jelks – USGS/SESC, Kenneth Keene – NOAA/NMFS, Bob McMichael – FWC/FWRI, Bill Pine – UF, Eric Sawyers – FWC/FWRI, Joel Trexler – FIU) discuss in detail the different LTM programs they are involved with. I received numerous comments during and after the meeting about how well the symposium went. Those comments came because of the quality of the presentations we heard from the symposium speakers, and I want to let each one of you know that we all appreciate you taking the time and making the effort to participate. Some of you have never been to a Florida Chapter meeting and others haven't been in a while. Hopefully, this opened up doors for more communication and collaboration and we'll get to see you at more Chapter meetings in future years.

This brings up a point I'd like to make about communication. Out of all the people I asked to participate in the symposium, I only had one person decline. All it took was a phone call or two to get in touch with the right person or to get a suggestion about who the right person was. That's how easy it was to get people involved. Some of them I never met and some I know well, but starting that communication with an actual voice, I think was key to their support. We live in a day where email is used all the time and a lot of time is necessary, but it is also convenient. Sometimes it means a lot more to pick up the phone or stop by and see somebody to congratulate them, recognize them, make a request, or make a suggestion.

At our business meeting this year, we voted to place a bid to host the 2017 AFS Meeting in Tampa. The bid will be submitted in July with a formal presentation made by our Chapter at the Little Rock, Arkansas meeting in September 2013. After hosting the 2011 Southern Division Meeting, we know that these meetings require a lot of support and commitment from our Chapter members. We had volunteers sign up to fill quite a few positions to help out with the meeting, but we still need to fill a few more and can always use extra support. Two positions we are looking for include a Fundraising Chair and a Publicity and Meeting Relations Chair. If you are interested in getting involved in any capacity, please get in contact with Kerry Flaherty [Kerry.Flaherty@myfwc.com](mailto:Kerry.Flaherty@myfwc.com) or myself [Travis.Tuten@myfwc.com](mailto:Travis.Tuten@myfwc.com).

Finally, I'd like to recognize an individual who has done a whole lot of work over the years and is ready to pass on the torch. Bob Wattendorf has been the Florida Chapter's webmaster since 1997-98. There weren't any dinosaurs left then, but a few of you may have just got away from using slide rules. Bob built and managed our website to date and has always been quick to respond if there were any requests for additions to the website. He's handing it over to Eric Sawyers (FWC/FWRI-Eustis), who is excited to fill the position. If you get a chance, let Bob know how much we appreciate him. Thanks for all of it Bob and we look forward to working with you Eric!

Sincerely,  
Travis Tuten  
Florida Chapter AFS President





# Getting in Touch

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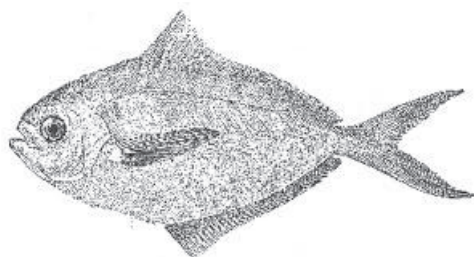
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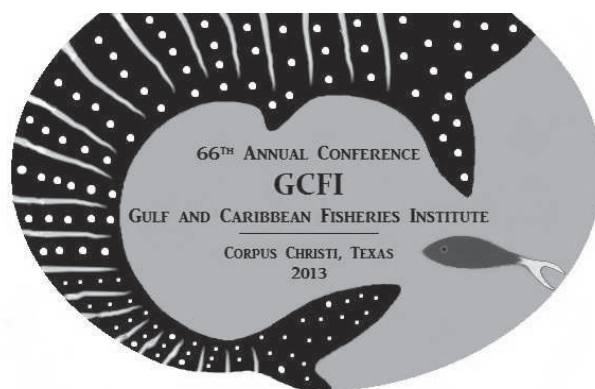


## *Upcoming Events*

**2013. North American Association of Fisheries Economists (NAAFE).** May 21-24, 2013. TradeWinds Island Grand Resort, St. Petersburg, FL, USA

**2013. Joint Meeting of the American Society of Ichthyologists and Herpetologists.** Albuquerque, New Mexico, 10-15 July 2013.  
<http://www.asih.org/>

**2013 Annual Meeting of the American Fisheries Society.** Little Rock, Arkansas. Sept. 8-12.



4 November 2013 - 8 November 2013

**Check out our Parent Society's calendar at  
<http://www.fisheries.org/afs/calendar.html>  
for other events not listed here!**

# Annual Meeting Awards February 2013

## Rottmann Scholarships

The Doctoral-level recipient is **Andrew Barbour**, University of Florida, School of Forest Resources and Conservation, Program in Fisheries and Aquatic Science. His advisor is Dr. Don Behringer.

The Masters-level recipient is **Kyle Wilson**, University of Florida, School of Forest Resources and Conservation, Program in Fisheries and Aquatic Sciences. His advisor is Dr. Mike Allen.

## Best Student Poster

### Best

**Benjamin Belgrad** (Eckerd College). The effect of stormwater on the peripheral olfactory nervous system of juvenile Coho salmon (*Oncorhynchus kisutch*)

### Runner-up

**David Gandy** (Florida International University), and J. Rehage. Nonnative Fishes in Freshwater Canals of the Florida Everglades: Implications for Better Management

## Best Professional Poster

### Best

**Nicole Dunham** (FWC/FWRI), and M. O'Keefe. Estimating Length-Weight Relationships for fishes in Florida Estuaries and Assessing Geographic Differences in Growth Conditions

### Runner-ups

**Kevin Johnson** (FWC/FWRI), J. Dotson, W. Poudel, N. Trippel, and R. Eisenhauer. Effects of Hurricane-Induced Hydrilla Reduction on the Largemouth Bass Fishery at Two Central Florida Lakes

**Amanda Schworm** (FWC/DFFM), **Brandon Simcox** (FWC/DFFM), C. Hartman, M. Call, P. Stevens, and D. Blewett. An Assessment of Fish Communities in Four Anthropogenically Impacted Peace River Tributaries

## Jack Dequine Best Student Paper Award

### Best

**Ross Boucek** (Florida International University), and J. Rehage. The power of the 1%: interactive impacts of extreme and episodic disturbances drive unexpected changes to mangrove fish communities

### Runner-up

**Kevin Mack** (Eckerd College), and P. Key. Lethal and sublethal effects of caffeine and chlorpyrifos, individually and in combination, on *Palaemonetes pugio*

## Best Professional Paper Award

### Best

**Angela Collins** (FWC/FWRI), L. Barbieri, and P. Motta. One fish, two fish, where's that huge fish? Long-term tracking of goliath grouper after catch and release

### Runner-up

**Kerry Flaherty** (FWC/FWRI), T. Switzer, B. Winner, S. Keenan, and A. Tyler-Jedlund. Improving indices of abundance for gray snapper in eastern Gulf of Mexico estuaries: results from four years of habitat-based sampling of polyhaline seagrass beds

**Power Tie Award** – Rob Ahrens with the efficiency of counting Salmonids.

**Lamp Shade Award** – Nicole Kierl for being sent to the office.

# A special thanks to the sponsors of the 2013 FLAFS annual meeting:



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## Thank you to the generous organizations that donated items for the 2013 FLAFS Student-Raffle

STATE	CITY OR AREA	BUSINESS/ORGANIZATION/OR PERSON	STATE	CITY OR AREA	BUSINESS/ORGANIZATION/OR PERSON
FLORIDA	EUSTIS	GEORGE BARTON	FLORIDA	PORT CANAVERAL	RUSTY'S SEAFOOD AND OYSTER BAR
		LARRY AND DIANA CONNOR		QUINCY	VARIOUS BUSINESSES
	GAINESVILLE	BALLY HOO'S RESTAURANT		ST. PETERSBURG	DIANE PEEBLES, ARTIST
		CABOT LODGE		ST. TERESA	FSU COASTAL MARINE LAB
		BRASINGTON'S ADVENTURE OUTFITTERS		TAMPA	FLORIDA AQUARIUM
		FLORIDA MUSEUM OF NATURAL HISTORY		JUPITER	HELTER SKELTER
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		OUTBACK RESTAURANT		GEORGIA	ATLANTA
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	MELBOURNE	CAPTAIN PETER DEEKS		OAK RIDGE	RED LOBSTER
	ORLANDO	P F CHANGS		PIGEON FORGE	MUSIC ROAD HOTEL
	PANAMA CITY	ALAN COLLINS		SWEETWATER	LOST SEA ADVENTURE
		BONEFISH GRILL			
		CANOE SHOP	WEST VIRGINIA	FLAT TOP	WINTERPLACE SKI RESORT
		FIREHOUSE SUBS			
		HOWELL TACKLE			
		PAUL BRENT, ARTIST			
		WALMART			
	PANAMA CITY BEACH	CAPT. ANDERSON FISHING FLEET			
		CAPT. ANDERSON'S RESTAURANT			
	GULF WORLD MARINE PARK				
	HALF HITCH TACKLE				
	J. MICHAEL'S RESTAURANT				
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	JUBILEE DEEP SEA FISHING				
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	WALMART				
	WALKIN' ON WATER PADDLEBOARDS				



### 2013 FLAFS Student-Raffle Committee

**Co-chairs** - Alan Collins (NOAA, retired) and Carla Garreau (UF)

**Members**- Matthew Badolato (FIT), George Barton (Eustis business owner), Erin Bradshaw (UF), Abigail Clark (UF), Larry and Diana Connor (FWC), Kerry Flaherty (FWC), Kathy Guindon (FWC), Dave Kerstetter (NSU), Debra Murie (UF), Eric Nagid (FWC), Daryl Parkyn (UF), Carrie Schuman (UF), Sarah Stephens (UF), Andy Strickland (FWC), Travis Tuten (FWC), Bob Wattendorf (FWC), Joy Young (FWC/FAU)

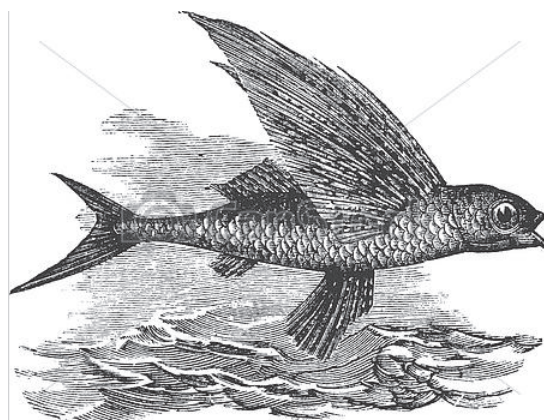
## **Many thanks to the 2013 Student Raffle/ Silent Auction Donors and Volunteers —**

We netted about \$1800 in the Raffle due to the efforts of our many volunteers who requested donations from businesses and organizations around Florida and a few other states. One addition to the list of donors in the poster (above) is for St. Petersburg: Bill Jackson's. A special thanks goes out to our FL Chapter member George Barton, who donated over \$1000 worth of good stuff to the Silent Auction.

Good news for next year, when we hope to increase the number of donors and volunteers in order to further help our great students. Andy Strickland of FWC (Quincy) has told us that he should be back to our annual meeting and will again lend his considerable talents to obtaining donations for the Raffle. Nicole Dunham of FWC (St. Petersburg) has also volunteered to help. Finally, Chris Berry of FWC (Panama City) just offered to help.

We have volunteers for several areas of the state, but we still need help in the Keys, Orlando, Fort Myers, Miami, Ocala, Jacksonville, Tallahassee, and Pensacola. If we could get a few more volunteers in those areas, then we could probably increase the number of total donations to at least 100 (from 55 this year) and greatly increase the number of students attending our 2015 annual meeting.

**So please contact Alan Collins ([lac96@bellsouth.net](mailto:lac96@bellsouth.net), or 850-303-4434) or one of the other volunteers listed in the poster to find out how easy it usually is to get donations.**



## **Minutes of the 33<sup>rd</sup> Annual Meeting of the Florida Chapter American Fisheries Society Business Meeting February 20, 2013, 4-H Camp Ocala, Altoona, Florida**

President Kerry Flaherty called the business meeting to order at 1905h and established a quorum.

Past-presidents of the Florida Chapter in attendance at the meeting were acknowledged and included: Eric Nagid, Wes Porak, Ron Taylor, Chuck Cichra, Dave Kerstatter, Mike Allen. Mike Allen was also recognized as the current president of the Southern Division of the AFS. Mike Allen reported on SDAFS and AFS news. The Southern Division now includes the new Puerto Rico Chapter and has a new website (SDAFS.org). At the next meeting of the Governing Board of the AFS elections will be held to replace Gus Rassam, who will be leaving AFS this year after 13 years of service. Mike also thanked the Florida Chapter for its interest in bidding for the 2017 national AFS meeting. He also suggested that, since the student colloquiums no longer take place, perhaps some new student event, maybe at the Southern Division meeting, could replace it.

Cheree Steward (Secretary/Treasurer) asked and received approval of the 2012 business meeting minutes and then presented the 2012 Treasurer's Report. The Treasurer's Report was also approved. Larry Connor was unable to attend the meeting, so Cheree Steward read the 2012 Rottmann Scholarship Fund report Larry prepared. Assets of the Rottmann Scholarship Fund increased from \$23,535.71 on December 31, 2011 to \$25,769.55 on December 31, 2012, which is a \$2,233.84 increase. Since its inception the Fund has shown an 8.81% annual rate of return. This allows us to fund the scholarships at the current level. Larry suggested that the Chapter may want to consider increasing the scholarships in the future, but he does not recommend any changes to the Rottmann Scholarship at this time.

Kerry Flaherty read the 2012 Membership report that Larry Connor prepared. The Florida Chapter ended 2012 with 219 members, 69 of which were students and 141 of which were parent Society members. This is an increase of 5.3% from 2010. Larry used the 2010 numbers for comparison because in 2011 the Chapter hosted the SDAFS and that made it a unique year for Chapter membership.

Dave Kerstetter (Past-president) introduced Ivy Baremore and Chris Bradshaw as the nominees for the incoming President-elect. Chris gave a brief statement about himself and his goals as President. Ivy was unable to attend the meeting. Ballots were passed out and a vote was taken.

Newsletter editor Daryl Parkyn solicited articles for the Shellcracker newsletter. Submissions are to be sent to Daryl. **Please remember to make this a high priority. Communication is an important priority in our line of business.**

Carla Garreau (Raffle Co-coordinator) highlighted the quality of the prizes donated for the raffle and recognized Alan Collins for his hard work and time invested in getting many of the raffle items. She encouraged us all to solicit donations next year and said that Alan has a simple form to submit to businesses, who are usually very willing to help. She updated the status of the raffle ticket sales and said that there was still time to buy tickets and bid on silent auction items. All Student-Subunit members who received a travel grant were selling tickets.

Chuck Cichra announced the recipients of 2012 Travel Grants and Rottman Scholarships. We had enough money from the 2012 raffle and left over from 2011 raffle funds for all fifteen students who applied for Travel Grants to receive them. Three students who were awarded grants could not attend the meeting because of class conflicts. The most applications this year came from Florida International University (Lauren Barth, Jesse Blanchard, Chris Edwards, David Gandy, Jessica Lee, Vanessa Trujillo). Other schools represented among the recipients included Eckerd College (Marissa Swain), Nova Southeastern University (Jessica Adams), Florida Atlantic University (Joy Young), and the University of Florida (Crystal Hartman, JoEllen King, Erin Bradshaw-Settevendemio, Sarah Stephens). The grants cover the student's room and board for the meeting

## **Minutes of the Annual Meeting of the Florida Chapter of the AFS 2013 cont'd.**

Chuck gave a brief biography of Roger Rottman and a history of the scholarships named for him. He highlighted the accomplishments of the applicants for this year's awards and thanked the judges. There were four applicants for each the Masters and the PhD scholarships this year. The winner of the 2013 Masters Degree Rottmann Scholarship was Kyle Wilson and the Doctor of Philosophy Rottman Scholarship went to Andrew Barbour. Both are student at the University of Florida. Each recipient was given a certificate and a \$500 check.

Eric Nagid presented the Rich Cailteux Award. Eric first went over the purpose of the award, including a brief biography of Rich Cailteux. Wes Porak was named the 3<sup>rd</sup> recipient of the Rich Cailteux award and was asked to step to the podium. Eric read the nomination and presented Wes with the award. Wes received a standing ovation. He then spoke about how much the award meant to him and thanked the Chapter for honoring him.

Carla Garreau (2012 Student Sub-unit Vice-president) gave a report for the Student Sub-unit. The Sub-unit has started a Facebook page with the approval of the parent society. Carla asked that anyone with job or volunteer positions openings please post them on the Sub-unit page. The results of Sub-unit voting during their meeting earlier in the evening were: Ross Boucek, President; Jesse Blanchard, Vice President; and Crystal Hartman, Treasurer.

Kerry moved to old business.

The first topic was archiving old Chapter newsletters in electronic form. Eric Nagid said that there had been little progress so far, but that there was a there was a volunteer to do the scanning and there was hope that things would get started soon.

The next topic of old business was the Chapter bid for the 2017 parent Society national meeting. Kerry summed up the work of the site selection committee and gave a presentation of Tampa as the host city for our 2017 national meeting bid. Travis Tuten moved that the Chapter bid on the 2017 meeting. Nicole Dunham seconded the motion and the motion passed without dissenting votes. Kerry encouraged everyone to volunteer to help with the meeting and pointed out posted committee signup sheets.

Dave Kerstetter returned to the podium to announce Chris Bradshaw as the new President-elect.

Kerry turned the meeting over to Travis Tuten as the new President. Travis thanked Kerry for her service as President and presented her with a plaque.

Travis transitioned to new business.

Travis explained the history and purpose of the endowment to the Chapter from the estate of the late Jack Dequine. He suggested we form a committee to be ready to administer the endowment when the funds arrive. Travis suggested that Mike Allen head the committee, because of his friendship with Jack, and Mike said that he would be happy to serve. Travis also brought a request to the Chapter from the Arkansas Chapter for sponsorship of the 2013 national meeting in Little Rock. The suggested sponsorship was \$1000. Eric Nagid moved that the Florida Chapter sponsor the 2013 national meeting for \$1000. The motion was seconded by Bill Szelistowski and passed with no dissenting votes.

The meeting was adjourned at 2000h.



Treasurer's Report Florida Chapter AFS  
 Cheree Steward  
 1 January 2012 to 31 December 2012

	<b>Checking*</b>	<b>Mutual Funds</b>	<b>Total</b>
January 1, 2012	\$ 20,767.04	\$ 11,329.32	\$ 31,658.50
December 31, 2012	<u>\$ 22,377.70</u>	<u>\$ 13,051.44</u>	<u>\$ 35,429.14</u>
Difference:	\$ 1,610.66	\$ 1,722.12	\$ 3,770.64

**Credits:**

Income from 2012 meeting (includes dues)	\$ 12,322.45
Raffle income from 2012 meeting	\$ 2,180.00
Dues paid thru AFS	\$ 321.60
Jack Dequine Estate	\$ 2,000.00
Rottman transfer	\$ 1,000.00
Income from 2014 meeting	\$ 165.87
Dividend Income	<u>\$ 336.63</u>
Total:	<u>\$ 18,326.55</u>

**Debits:**

2012 Meeting	\$ (11,508.97)
Rottmann Scholarships	\$ (1,000.00)
Dequine Best Student Paper	\$ (100.00)
2012 Raffle Costs	\$ (539.00)
Dividend Reinvestments	\$ (334.70)
Annual bank fees	\$ (300.00)
Check printing and postage	\$ (54.75)
AFS Liability Insurance	\$ (150.00)
2013 Annual Meeting reservation	\$ (1200.00)
2012 AFS Meeting sponsorship	\$ (500.00)
2013 SDAFS Meeting sponsorship	\$ (500.00)
2013 Black Bass Symposium @ SDAFS	\$ (500.00)
Total:	<u>\$ (16,687.42)</u>

[Additional \$250 pledged to WDAFS for 2014 meeting in Mexico]

\* Morgan Stanley + Wells Fargo + PayPal



# Feature Article

## Understanding Swimbladders and their Function in Fishes

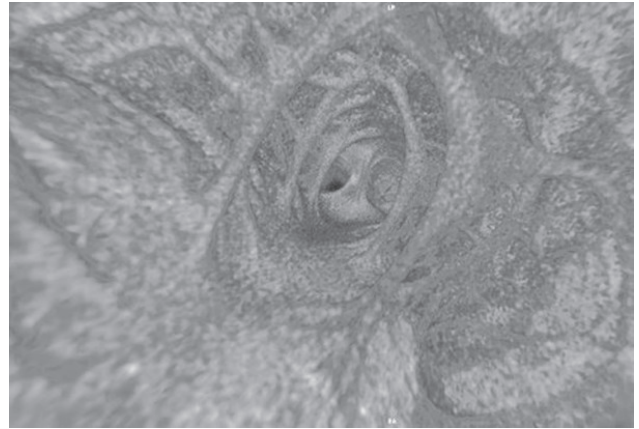
Daryl Parkyn, Fisheries and Aquatic Sciences, School of Forest Resources and Conservation, University of Florida

Most fisheries biologists, recreational and commercial fishers are aware of the final effects of rapid ascent on survival and mortality of fishes. Perhaps less well understood are the physiological limitations placed on fishes' bodies as a result of physiological constraints and anatomical design. These limitations are, in part, dependent on how swimbladders are inflated and deflated in fishes, including physiological limits on how fast oxygen can be mobilized out of the swimbladder.

Fishes are divided into a number of groups based on morphological characters, including the presence and type of swimbladder. For example the most primitive living fishes such as the lampreys, hagfish, and Chondrichthyans (ratfish, sharks and their allies) all lack swimbladders and have never had swimbladders in their evolutionary history. At some point in the very early history of the jawed fishes, an out-pouching of the esophagus formed the first sac capable of holding air. It has been suggested that at least one Placoderm (*Bothriolepis canadensis*) had a lung or swimbladder-like structure but it is a general consensus that this group of fishes did not lead to the line of modern jawed fishes.

Regardless of their origin, once these structures appeared, they quickly diversified. From developmental standpoint the most significant difference between lungs and swimbladders is that the former is generally paired and arises from the ventral margin of the pharynx or foregut. In contrast, swimbladders are generally single and emerge from the dorsal margin of the foregut. It appears from the fossil record that lungs appeared first as a respiratory organ and swimbladders subsequently first as a dual respiratory and buoyancy organ and later as only a buoyancy organ.

One line developed into respiratory lungs in the lobe-finned fishes (Sarcopterygii), giving rise to terrestrial vertebrates. Other jawed fishes in the Actinopterygii possess various forms of lungs and more simple sacs such as swimbladders. All of these structures are connected to the esophagus by a *ductus pneumaticus* perhaps homologous with the trachea of terrestrial vertebrates. The most primitive members of the ray-finned fishes, the Chondrostei (*Polypterus* -the bichir, sturgeon and paddlefish) have a large well developed lungs or swimbladders with a large duct. In the case of the Bichir, it is a functional paired lung complete with alveoli. Based on the composition of gasses in the bladder, it is inflated by gulping air and no gas gland is present. All fishes with a *ductus pneumaticus* as adults are termed "Physoclistous". As these fish are rapidly brought up from depth, they easily dump air out of the swimbladder. The gars (Family Lepisosteidae) also have paired functional lung-like swimbladders virtually identical to those in *Polypterus*



**Figure 1. Internal view of the swimbladder of the Florida gar *Lepisosteus platyrhynchus*. (Photo Credit: Cornell University).**

but it is in *Amia*, the bowfin that we see a more swimbladder-like structure arising that is common to most of the remaining fishes. Interestingly, sturgeon, paddlefish and bowfin have pulmonary arteries like those supplying the lungs of terrestrial vertebrates demonstrating that these ray-finned fishes most likely evolved from ancestors with lungs (Longo et al. 2013).

Many fishes such as tarpon (*Megalops atlanticus*), bonefish (*Albula vulpes*), arapaima (*Arapaima gigas*), and salmonids fill their swimbladders by gulping air and expelling it by belching air out. In fact Arapaima (piracu) also communicate in this manner.

The water pressure directly affects the volume of the swimbladder. Since this is related to depth, the volume must be adjusted to maintain neutral buoyancy. In the particular case of fishes, the relationship between changes in pressure and volume as defined by Boyles law states that the product of pressure and volume at a second depth:

$$P_1V_1=P_2V_2 \quad (1)$$

Where in this case  $P_1$  = pressure at depth 1,  $P_2$  = pressure at depth 2, and  $V_1$  = volume at depth 1 and  $V_2$  = volume at depth 2.

Since Pressure increases with Depth ( $z$ ) we can readily develop an equation describing what is going on in a fishes swimbladder as it goes deeper. Pressure increases by the weight of the column over an object. In fact water pressure increases by approximately 1 atmosphere for every 10 m of depth leading to:

$$P_z = P_a + z/10 \quad (2)$$

Where  $P_z$  = the pressure at depth  $z$  and  $P_a$  = Atmospheric pressure.

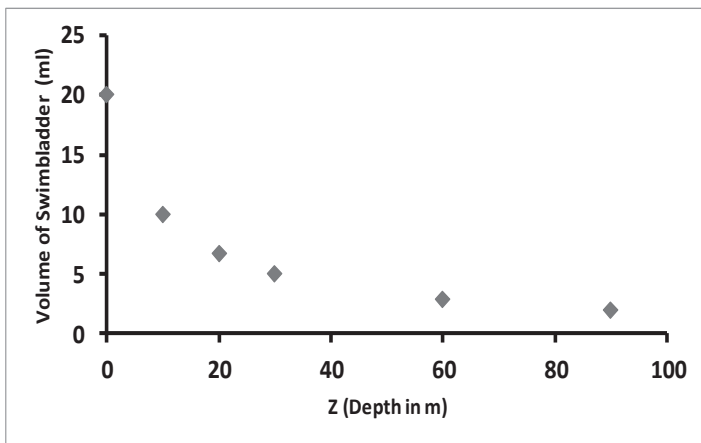
Therefore the resultant equations for a fish gulping air at the surface and moving to depth  $z$  would be:

$$P_a V_1 = (P_a + z/10) V_2 \quad (3)$$

By simple reorganization the end result is

$$V_2 = (P_a V_1) / (P_a + z/10) \quad (4)$$

Equation (4) states that that volume at depth rapidly decreases such that a fish at 10 m depth has approximately half the volume of gas in swimbladder as is observed at the surface and a fish at 90 m having only 1/10th of the original volume, seriously affecting the utility of the swimbladder as a buoyancy device (Figure 2).



**Figure 2. The relationship between swimbladder volume and depth for a fish with a 20 ml volume of gas in its bladder at the surface (1 atmosphere pressure).**

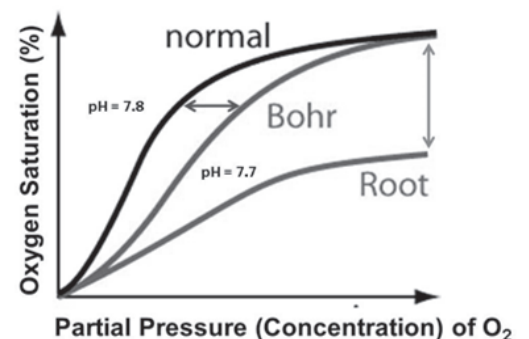
Most fishes are somewhat negative in the absence of an inflated swimbladder, and an inflated swimbladder of a neutrally buoyant fish requires somewhere between 3 and 8 percent of the total body volume regardless of depth, the variation being a function of salinity of the water and the amount of fats in the tissues (Harden Jones and Scholes 1985). Thus, for fishes that inflate the swimbladder by gulping air, neutral buoyancy is possible only in shallow waters. Other means of buoyancy, such as deposited fats may be employed lessening the volume of the swimbladder needed to provide neutral density. For example, deepwater forms of salmonids such as Siscowet form of lake trout (*Salvelinus namaycush*) and the bloater (*Coregonus hoyi*), are extremely fatty, since fats reduce the overall tissue density, compensating for a minimally functioning swimbladder. While salmonid fishes lack a gas-secreting gland and this is evident in the analysis of the composition of the atmosphere inside in the swimbladder (Ingerman 1982), other fishes with this duct connection including esocids (pikes), umbrids (mudminnows), cyprinids (minnows and carps), siluriforms (catfishes), and eels are able to secrete oxygen from their blood into the swimbladder. The evolution of this gas gland gives these fishes flexibility of swimbladder inflation independent of access to the surface.

Because of the restricted depth distribution of many fishes lacking a gas gland, it is tempting to speculate that evolution of a gas gland made it possible for fishes with swimbladders to radiate into niches in deeper water. However, keep in mind that many fishes lacking swimbladders altogether, are distributed across most depths.

### Inflation and Deflation of Swimbladders

Before I get too far ahead of myself, I need to outline the mechanism of how swimbladders with gas glands are inflated. Like most evolutionary adaptations, the inflation mechanism actually arose millions of years before gas glands evolved (Berenbrink et al. 2005). I will explain this paradox shortly. The gas gland functions as a neuronally-controlled reflex by releasing lactic acid into the bloodstream adjacent to the swimbladder. This localized decrease in pH results in conformational changes in hemoglobin, causing some of the oxygen bound to the hemoglobin to be released in the plasma. For normal body tissues this decrease in pH occurs because of oxidative metabolism. The release of  $H^+$  and  $CO_2$ /carbonic acid during respiration of the tissues is the result. Both  $H^+$  and  $CO_2$  bind to the hemoglobin. The binding of  $H^+$  is the trigger for the release of oxygen. Hemoglobin also binds  $CO_2$  to form carbaminohemoglobin, which has a slightly purple tint. Additional  $CO_2$  is stored within the red blood cell through the action of carbonic anhydrase, and the remaining  $CO_2$  remains dissolved in the plasma.

The specificity of this pH-based  $O_2$  delivery and  $CO_2$  removal system ensures only the tissues that are respiring, with localized reduced-pH need more Oxygen. At the somatic tissue level, this change in pH results in two physiological changes in the structure of the heme components of the hemoglobin to deliver oxygen stored in the blood called the Bohr shift and Root effect. Both the Bohr shift and the Root effect are mechanisms that allow Oxygen to be delivered specifically to respiring aerobic tissues. Secondly, these mechanisms have been co-opted to be used to inflate swimbladders in most teleost fishes. These two effects are named for the workers that originally described these phenomena: Danish physiologist Christian Bohr (1855-1911, Father of physicist and Nobel Laureate Niels Bohr) and Duke Marine Lab Physiologist R.W. Root. The Bohr effect and Root Effect are illustrated in Fig. 3.



**Figure 3. Bohr shift and Root effect in the blood of fishes relative to pH, as they affect Oxygen carrying capacity of hemoglobin .**

Essentially, the heme subunits of each hemoglobin molecule are sensitive to changes in pH or temperature. The Bohr shift is a result of conformational changes resulting from a change in pH or temperature but with the added feature that if the partial pressure of oxygen in the plasma is increased, excess oxygen can be re-uptaken by the hemoglobin. Essentially the affinity of hemoglobin to hold oxygen is reduced, however this can be compensated by an increase in oxygen partial pressure as would happen if the liberation of bound oxygen exceeded the uptake from the plasma by the respiring tissues. This is an important feature of the oxygen delivery system of the blood because the oxygen not needed for metabolism in respiring tissue is then taken to other regions where it is also required. Environmental oxygen concentration and temperature can modify which hemoglobins are expressed and hence its ability to take oxygen up at the gills and retain it until conditions are appropriate for its release. As with the Bohr shift, the Root effect which we will discuss next, is also a conformational change in the hemoglobin, and specifically one of the heme sub-units.

The Root effect also results from a conformational change by limiting the number of oxygen molecules the hemoglobin molecule can re-uptake once the oxygen has been released. Without the Root effect, swimbladders would likely not be inflatable. The Root effect is accomplished by the oxygen binding site on one heme sub-unit becoming unavailable under conditions of lower pH, resulting in the heme not being able to re-uptake  $O_2$  from the blood plasma regardless of the partial pressure of oxygen present.

This difference from the Bohr shift provides the essential means to fill the swimbladder, since  $O_2$  is concentrated many times over the ambient partial pressure to match the total ambient pressure. This inflation is an exceedingly slow process, at least in the laboratory. In studies geared to examine decompression of fishes red snapper were acclimated to different depths. Rummer and Bennett (2005) observed that the swimbladders inflated to depth at about  $0.52 \text{ m h}^{-1}$ , while Campbell et al. 2009 observed a more rapid inflation at a rate of  $2.08 \text{ m h}^{-1}$ . While it is possible that fish *in situ* may have faster rates of swimbladder inflation, it is important to reflect upon the amount of oxygen required to inflate a swimbladder at depth. The pressure needed to inflate the swimbladder is equal to the ambient water pressure. However, the oxygen in the water remains at 0.21 atm or less. As a result, a fish at 4 or 5 atm of pressure must divert a lot of oxygen to the swimbladder. This is why this takes so long for fish to acclimate. It is also a major argument against use of hypodermic syringes to deflate the swimbladder at least for non-benthic fish, since that oxygen bled off will have to be replaced when the fish returns to depth: a fish captured and returned to 20 m depth with a deflated swimbladder could take as long as 40 hours to re-inflate it. What is not often realized with teleost fishes is that the Root effect did not evolve to inflate swimbladders but in fact served the role of providing oxygen to the eye, via the choroid rete (Berenbrink et al. 2005). Therefore, the Root effect was later co-opted with the development of a gas gland in more derived teleosts as the main means of swimbladder inflation.

It is now generally accepted that the evolution of oxygen secretion in the swimbladder evolved 100 million years following the earlier evolution of oxygen secretion in the choroid rete of the eye (Berenbrink et al. 2005). The most primitive fish with a choroid rete is *Amia*, the bowfin although it is lacking in gars (Wittenberg and Haedrich 1974). Additionally, it is also found in other primitive neopterygians such as tarpons and salmonids as well as more advanced fishes. The choroid rete like the rete mirabile of the swimbladder is a large collection of looping capillary blood vessels. Associated with the choroid rete is the gill-like structure, the pseudobranch. The pseudobranch is a modified first spiracular gill arch which receives oxygenated blood from the first efferent gill artery (Figure 4). This gives rise to an artery with a main branch being the ophthalmic artery which supplies the choroid rete. The pseudobranch is widely distributed among neopterygian fishes and seldom lost (Wittenberg and Haedrich 1974), which is indicative of its importance as a likely means of supplying Oxygen to the eye tissues.

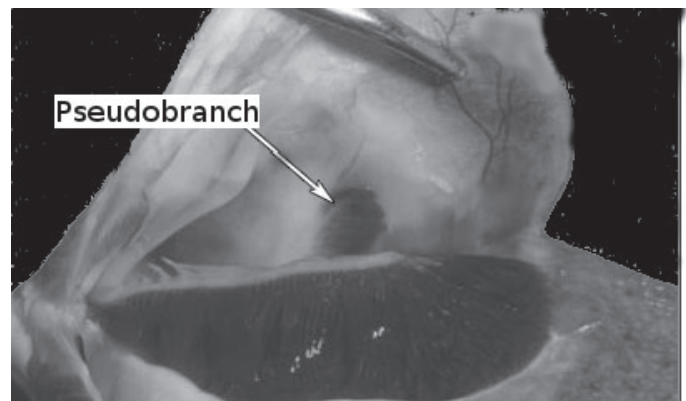


Figure 4. The pseudobranch on the inside of the operculum of a bony fish and the first gill arch. The pseudobranch is involved with the supply of oxygen to the choroid rete and the eye.

Swimbladders are deflated by an entirely different mechanism, not related to the gas gland or the rete mirabile. The rate at which swimbladders are deflated greatly exceeds the rate at which a fish can fill a swimbladder, whether a fish is a physostome or a physoclist. For Physostomous fish the excess gas is merely excreted via the ductus. For physoclistous fish however, removal of excess gases is more complicated. Instead another structure, the ovale, is utilized by these fishes to resorb  $O_2$  back into the blood stream. (Figure 5). The ovale is simple vascularized chamber of the swimbladder that is separated from the remainder of the bladder by a sphincter. To deflate the swimbladder, the sphincter is relaxed, allowing oxygen to enter the ovale. Venous vascularization of this region permits directed uptake of  $O_2$  from the gasbladder into the bloodstream. Control of this sphincter is under hormonal and neuronal control and is likely connected as a reflex to the vestibular (balance sense) system. Positive buoyancy, likely results in relaxation of this muscle to deflate the bladder back to near-neutral buoyancy and contraction to close off access to the ovale when the fish is negative and sinking, along with concomitant stimulation of the gas gland to release lactic acid.

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So now we have presented how the swimbladder inflates and deflates, we can now discuss the concepts of how barotrauma can affect fishes. Like deposition of oxygen into the swimbladder, resorption is rate-limited process. Surprisingly, this is not a well examined topic of study. From Figure 2 it is apparent that small changes in depth can have large effects on the volume of a swimbladder. For fishes like groupers, the rate of oxygen resorption via the ovale chamber of the swimbladder (Figure 5), cannot match the rate of gas expansion, as the fish are brought up. This is because observed ascent rates of red grouper have been observed to be about 0.4 m/s (1.3 ft/s) with a mean maximum ascent rate of 1.8 m/s (6 ft/s) (Parkyn and Murie unpublished data). This rapid expansion can cause substantive internal damage by the displacement and subsequent tearing of the adjacent viscera (Rummer and Bennett 2005). A similar situation exists in the eye due to the high concentration of oxygen. This form of barotrauma can affect any ray-finned fish with choroid rete mirabile including most physotomes.

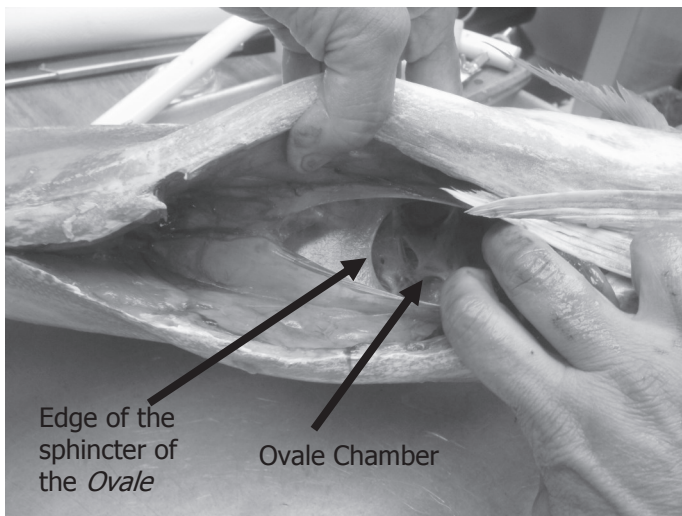
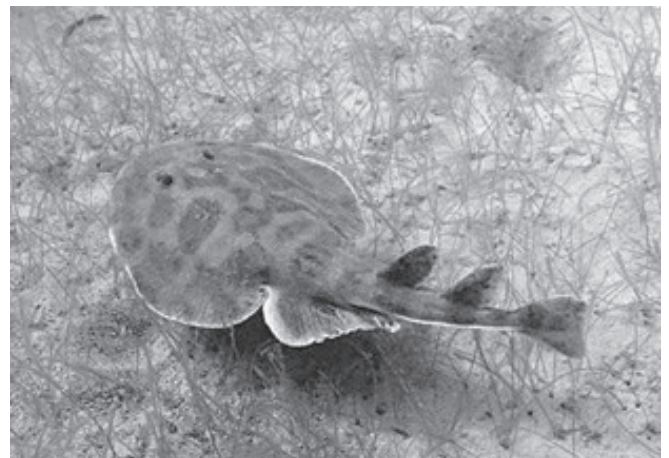


Figure 5. The swimbladder of a greater amberjack (*Seriola dumerili*) showing the relaxed muscular edge of the sphincter of the *Ovale*.

Non-rayfined fishes lacking this rete such as elasmobranchs likely never have this type eye damage. Barotrauma of the eye often seen as popeye and crystallization is incredibly serious. It is thought that close to 100% of fishes with barotrauma damage to the eye suffer mortality post-release (S. Diamond personal communication).

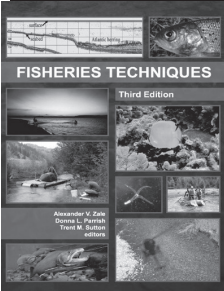
In addition to fishes being brought up faster than gas can be resorbed, strenuous and long capture may result in acidosis some cases (Dobson et al 1986). For fishes with swimbladders, This is factor that hasn't been examined as something that may be slowing or preventing the re-up-take of oxygen by the hemoglobin, since both the Bohr shift and Root effect are pH sensitive. This is especially possible if the Root effect is operating outside of the rete mirabile of the gas gland or choroid rete of the eye. However, this phenomenon has yet to be investigated.

## Name that Florida Fish



Answer: Page 7

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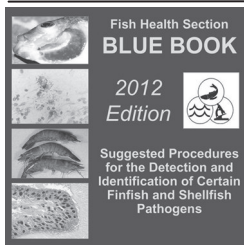


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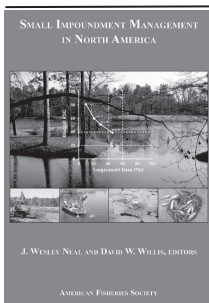


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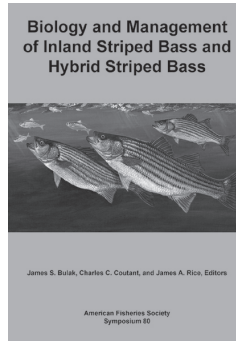


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## Student Sub-Unit News

Congratulations to the incoming President of the Student Ross Boucek (Florida International University). Thank you to Janice Kerns (Ph.D. Candidate, University of Florida) for serving the student chapter as President this past year

Congratulations are also in order to this years winners of Student Awards

**Jack Dequine Best Paper Award:** Ross Boucek (Florida International University), and J. Rehage Runner-up: Kevin Mack (Eckerd College), and P. Key.

**Best Student Poster:** Benjamin Belgrad (Eckerd College). Runner Up: David Gandy (Florida International University), and J. Rehage.

**Roger Rottmann Memorial Scholarship:** Ph.D. Award :Andrew Barbour, University of Florida. Masters Award: Kyle Wilson, University of Florida

Interested in contributing something to the Shellcracker? Email Daryl Parkyn [dparkyn@ufl.edu](mailto:dparkyn@ufl.edu) with articles or information that you would like to be included upcoming issues. The deadline for the next issue is June 28, 2013, so start writing. \*\*Note the Feature Article this month is what you get if you don't help by contributing articles to the editor.