



E-SLATE

American Academy of Underwater Sciences (AAUS)

EDITORIAL NOTE – January 2012

Welcome to the first issue of 2012. We have a number of communications from the board, a review of AAUS scholarship research activity and a variety of other items spanning the range of scientific diving interests. The E-Slate is the monthly publication of your academy. Please continue to submit news, announcements, job postings, and images of underwater work to aaus@disl.org. Current and past issues are available at www.aaus.org.

PRESIDENT'S MESSAGE

Michael A. Lang

On behalf of the AAUS Board of Directors, we wish to extend best wishes for a successful 2012 and look forward to working with all AAUS stakeholders on advancing the practice of scientific diving and underwater research. I wish to take this opportunity to thank Christian McDonald for his leadership of the Academy over the last two years. It will be a pleasure to continue moving forward with AAUS topics we have collaborated on thus far. We also extend our gratitude to all past and current Board members for their efforts, to Heather Fletcher for her management of the AAUS Office, and in particular to Roxy Robertson for her effort of many years as editor of the E-Slate.

As I start my third and final tour of duty as President, perhaps it is appropriate to acknowledge the long path we have traveled as a community since 1980 and the progress and successes we have enjoyed to make our underwater research easier, safer and more efficient. Our next evolutionary phase should continue to represent the trained underwater scientists' point of view of the ocean and our goals and needs promoted actively among the marine conservation community and federal and state funding agencies. Our Board of Directors consists of a balanced reflection of our community: Diving Officers and diving scientists, which better integrates the scientific community's support needs for its diving programs. Our international focus is broadening with closer formal relations with the European community (October 2013 Curacao Joint AAUS/ESDP International Symposium with the Scientific Diving Panel of the European Science Foundation Marine Board) and others as our international collaborations and scientific diving projects expand. There continues to be a place for AAUS to continue as a leader in diving safety research as will be demonstrated by the May

18-20, 2012 collaborative project with DAN and PADI on Rebreather Forum 3.0 (www.rf30.org), in which AAUS member participation is strongly encouraged. AAUS management transition has been greatly enhanced with the efforts of our Office Manager Heather Fletcher, which allows the Board of Directors to strategically focus on the big picture policy, versus day to day operations. We greatly anticipate the launch of the new AAUS website in the not too distant future, which shall serve as a primary communications tool and source of information for scientific diving and membership/standards transactions.

Scientific diving standards and training remain integral to AAUS' mission and the Diving Officer and Scientific Diver certification standards are nearing completion, in conjunction with the AAUS organizational member accreditation program effort spearheaded by George Peterson and Steve Clabuesch for the overarching purpose of achieving a measure of quality control and compliance. Coupled with standards, statistics are of utmost importance as a metric to determine their effectiveness, serve as occupational health regulatory support, and as an enduring Academy record. Much attention has been directed towards vetting and characterizing our exposures and outcomes according to standardized, OSHA-recognized criteria by Mike Dardeau, Neal Pollock, Christian McDonald, and Amy Moran. We collectively look forward to the success of our nascent AAUS Foundation and will share information soon on how members can become involved.

I look forward to interacting with you and to working closely with our President-Elect Amy Moran and Past-President Christian McDonald to ensure continuity and scientific diving progress in the coming years.

FROM THE OUTGOING PRESIDENT

Christian McDonald

Diving Safety Officer, Scripps Institution of Oceanography

On behalf of myself and the American Academy of Underwater Sciences, we would like to recognize and thank Chris Rigaud for organizing our 2011 annual meeting, which was held in Portland, ME in October. We greatly appreciate that you so generously contributed your time and efforts to this meeting, which is the preeminent opportunity for scientific divers and researchers from the US and abroad to meet, present their research, and evaluate and receive training on national and international standards

for scientific diving. There were representatives of 81 institutions in attendance, including higher education, governmental, and private agencies, and the scientific proceedings will be published and widely disseminated. We received many favorable comments about the meeting - it was universally seen as a success! – and many people also expressed appreciation for the opportunity to see the facilities and research potential at the Darling Marine Center.

I am pleased to announce that the next AAUS symposium and associated meetings will be hosted by Monterey Bay Aquarium (George Peterson), University of California Santa Cruz (Steve Clabuesch) and Moss Landing Marine Lab (Diana Steller) September 24-29, 2012 in Monterey, CA. Details will be forthcoming. Looking even further ahead, AAUS will partner with the European Scientific Diving Community for the 2013 symposium in Curacao. Your input is welcome as we develop these events.

AAUS SCHOLARSHIP RESEARCH

The effects of ship noise on the stress responses of the Atlantic cod

Tania Lemos Eskin

Professional Science Master's in Marine Biology
(Northeastern University)

Co-advisors: Dr. Randi Rotjan & Dr. John Mandelman

Many people wistfully think of the ocean as a serene, quiet paradise. To anyone who has ever been diving or snorkeling, this vision does not necessarily match the reality of the sea. The sound of boats – big and small – was shocking the first time I dove in New England waters with Northeastern University's Three Seas program. The motors were loud and covered a wide range of frequencies, depending on the size and speed of the vessel. Even the most remote tropical reefs are a symphony of pops, creaks, and groans from a variety of organisms.

These natural sounds of the ocean are of vital importance to sea life and are being masked by man-made noise pollution. In a dense medium like salt water, good vision is of reduced importance when compared to organisms that exist above the surface. Marine animals rely more on hearing, changes in water pressure and movement, and chemosensory clues to compensate for poor eyesight. Sound is used to detect predators, find food, etc. For some animals like the Atlantic cod (*Gadus morhua*), sound is also involved in reproduction. Male cod can produce sounds to compete for the attention of females and sounds can also help to synchronize gamete release, increasing the possibility of successful fertilization.

The Atlantic coastal ecosystems where cod reside are highly trafficked with increasing development and growing ocean commerce. For this prolifically over-fished species, even with new fishing regulations in place, cod numbers today are still dwindling to less than 5% of historical populations. A better understanding of the response of cod to various man-made stressors is pertinent to their continued survival. For my master's research project, I wanted to study the effect of ship noise on the stress levels of Atlantic cod. In the last two decades, fish stress responses to man-made sound has gained greater attention. Studies have shown that cod can produce a stress response and also that these fish can react to anthropogenic sound, but there are presently no studies that explore a stress response in this species specifically in response to a man-made sound source.

There are a number of cascading changes in the blood chemistry of fish that have been established as signs of increasing stress. I was interested in the levels of plasma cortisol (a primary stress response), and the levels of certain electrolytes (calcium, potassium, chloride, and sodium) and metabolites (glucose and lactate) that are classified as indicators of the fish's secondary stress response. Working on the research floor of the New England Aquarium in Boston, MA, I placed 48 juvenile cod into acoustically isolated tanks, to reduce outside auditory inputs. I split the fish into two groups - half would receive a 'sound' treatment, and half as a 'no sound' control group. Dr. Chris Clark from the Bioacoustic Research Program at Cornell University provided a recording of a liquid natural gas tanker to use in the sound treatment. I played this ship noise for 30 minutes through an amplifier and underwater speaker to the cod in the sound treatment 30 dB louder than the ambient tank sound. For fish in the no sound control, I installed the speaker and hydrophone for 30 min, but played no sound.



Tania Eskin bleeding a cod

To determine the stress levels of the cod, all fish were bled 45 minutes after the equipment came out, and 48 hours later. Previous studies suggest that 45 minutes should give the cod time to react to a stressor, and also that within 48

hours, these stress parameters in the blood should return to baseline levels. I bled the same fish 48 hours apart to compare a potentially stressed blood sample with one after recovery (48 hours later). Blood sampling took no longer than three minutes, which minimized bleeding-related stress in the samples. Using this blood sampling technique, I attempted to detect a difference in stress levels for cod in the sound and no sound groups.

My cod showed no statistically significant difference in primary or secondary stress responses to ship noise compared to a no sound control. These results are surprising, but there some possible explanations for my data. Previous studies have shown that chronic sources of stress (stressors) can attenuate the cortisol response to an additional stressor. Our tank system may have presented a chronic confinement stressor in comparison to the relatively large sea pens where the cod were raised. In addition, these sea pens were exposed to ship noise, so the fish may have previously acclimated to man-made sound.

It is possible that my fish were indeed stressed by ship noise, but were not capable of mounting a detectable stress response. To test this hypothesis, I created a positive control for two fish, where I attempted to produce a maximal stress response immediately after the second blood draw. Higher values were observed for four out of six metabolite and electrolyte responses; notably, these responses were higher than any observed during the experiment. Thus, the positive control indicates that cod were capable of producing a stress response, even after 48 hours, and that my assay was capable of detecting them within my sampling window.

Although I was unable to detect a significant difference in stress responses to ship noise, stress is well-known to be complex and my experiments demonstrate that stress in cod may be more highly nuanced than has previously been appreciated. Independent of the stress response, ship noise that masks important auditory cues ultimately reduces the fitness and survival rates of fishes. Populations of Atlantic cod have already experienced heavy losses this century, and with the prospect of busier, louder oceans looming, careful consideration and study into marine anthropogenic inputs are required to secure the future of these and other members of the near-shore shelf ecosystem.

NEWS/ANNOUNCEMENTS

AAUS Welcomes New Organizations

ACSDISSD International School for Scientific Diving
Alaska Pacific University
Center of Coastal Marine Sciences, California Polytechnic State University, San Luis Obispo
Dial Cordy and Associates, Inc.

Geo Marine, Inc.
Khaled bin Sultan Living Ocean Foundation
Occidental College, Vantuna Research Group
Tenera Environmental
The Applied Research Laboratories, U. of Texas at Austin
University of Puerto Rico
Urban Assembly New York Harbor School

AAUS Accreditation Program

Introduction to OM Program Evaluation

If you missed the recent annual symposium hosted by the University of Maine, there were some very interesting topics discussed at the AAUS business and national DSO meetings, one of them being the topic of accreditation. AAUS, in similar fashion to the Association of Zoos and Aquariums (AZA), the Undersea and Hyperbaric Medicine Society (UHMS) and other agencies and professional organizations, will embark to develop a quality control mechanism through an accreditation process. While the implementation of this is still in its infancy the AAUS Board of Directors has a general concept of the basic structure of the process including a potential site review. The Board has appointed an Accreditation Committee made up of representatives from a wide range of organizational members and has tentatively identified a list of individuals to help refine and recommend the next step(s) in the process. This issue of the E-Slate includes an evaluation that will allow you to assess the state of your program and, if needed, perform some proactive measures to ensure your organization is in compliance with the OSHA exemption for scientific diving. It is an extremely useful tool that can help guide the DSO, DCB and administrators of your scientific diving program and can be viewed as an excellent opportunity to get acquainted with both the basic structure of the accreditation process as well as the intricacies of your own program. Please note that this checklist is only a **DRAFT** as the Accreditation Committee members have yet to refine and vote on it and that almost all of the items on the list reflect either the Code of Federal Regulations or OSHA regulations. If you are a member of AAUS and interested in serving on the Accreditation Committee please contact Co-Chairs Steve Clabuesch of the University of California, Santa Cruz and George Peterson of the Monterey Bay Aquarium.

AAUS OM Program Self-Evaluation - **DRAFT**

A. Administration: definitions per OSHA 29CFR1910 or AAUS standards

1. Is the . active scientific diver?
2. Is the DSO an current, renewed instructor from an internationally recognized underwater instruction agency?
3. Is the DSO a full member of AAUS?
4. Are all data and information obtained during the project considered non-proprietary?
5. Are divers either scientists or scientists in training?

6. Do scientific divers function as observers and data gatherers?
 7. Review any incident reports and system for documenting.
- B. Diving Safety Manual (DSM)
1. Is DSM approved (latest revision/review) by DCB and AAUS and cover all OM's scientific diving operations?
 2. Includes diver training and certification requirements?
 3. Includes medical review standards and required physical examinations criteria?
 4. Includes procedures for emergency care, recompression and evacuation
 5. Are required records (certification, medical, dive log, injury, equipment) kept for the minimum intervals?
 6. Is a mechanism in place to collect individual dive log data for AAUS reporting?
 7. Were previous year diving statistics reported to AAUS on time?
- C. Training
1. Is a diver training program of 100 hours with at least 12 training dives for DITs for scientific diver certification conducted?
 2. If no diver training course is part of OM's program, is other training documentation in place?
 3. Review documentation of Instructional Training staff and Lead Diver Qualifications
 4. Are all scientific divers currently certified in diving first aid (oxygen administration, CPR and first aid)?
 5. Have all scientific divers received Hazmat training for transportation of compressed gas cylinders every 3 years as per OSHA?
- D. Field Operations
1. Is a diving accident management plan (with diver emergency contact information) prepared for each operational diving area?
 2. Is a Lead Diver designated for each dive operation?
 3. Review of dive project proposals, including depth authorizations of project divers
 4. Are reciprocity letters reviewed for all visiting scientific divers?
 5. Are at least two comparably equipped scientific divers in constant communication underwater on every dive?
- E. Scuba diving equipment
1. Is all program diving and safety equipment maintained and documented in accordance to manufacturers recommendations?
 2. Review documentation of OM's science divers annual equipment inspections
 3. Is all diving equipment that is in need of repair or maintenance tagged and separated from operational gear?
- F. Air compressor systems
1. Are the operational procedures posted for the air system and compressor?

2. Has an air sample from the system been taken in the last 6 months and tested against CGA Grade E?
 3. Is there a logbook documenting the operational and maintenance history of the compressor and the air system?
 4. Is the air intake located and clearly labeled in an area that is free of potential contaminants to the air supply?
- G. Safety equipment
1. Are a first aid kit and emergency oxygen available?

AAUS Blue-Ribbon Medical Review Panel

The AAUS Blue-Ribbon Medical Review Panel was convened on Monday, November 14, 2011 at the Smithsonian Institution Castle in Washington, DC, with support from AAUS and the Smithsonian Institution. Chaired by Michael Lang, with Edgardo Ochoa attending, the panel members included:

Dr. James Denham
 Dr. Peter Germonpré
 Dr. Chris Jankosky
 Dr. Jim Loewenherz
 Dr. Tom Neuman
 Dr. David Southerland
 Dr. Stephen Thom
 Dr. Nicholas Vandemoer

We thank these diving medical experts for their time and interest in updating the scientific diving medical standards.



Standing left to right : Jim Loewenherz, David Southerland, Chris Jankosky, Peter Germonpre, Edgardo Ochoa, Michael Lang Seated left to right: Tom Neuman, James Denham, Steven Thom, Nick Vandemoer

Highlights of the revisions to AAUS Standards Section 6.00 that were recommended by the diving medical review panel and approved by the AAUS Board of Directors appear below. Organizational member programs should carefully review the entire revised Section 6.00 and associated appendices and update their diving safety standards accordingly.

Laboratory Requirements for Diving Medical Evaluation and Intervals

a) Initial examination under age 40:

Medical History

Complete Physical Exam, emphasis on neurological and otological components

~~Chest X-ray~~

~~Spirometry~~

~~Hematoerit or Hemoglobin~~

Urinalysis

Any further tests deemed necessary by the physician.

b) Periodic re-examination under age 40 (every 5 years):

Medical History

Complete Physical Exam, emphasis on neurological and otological components

~~Hematoerit or Hemoglobin~~

Urinalysis

Any further tests deemed necessary by the physician

c) First exam over age 40:

Medical History

Complete Physical Exam, emphasis on neurological and otological components

Detailed assessment of coronary artery disease risk factors using Multiple-Risk-

Factor Assessment^{1,2} (age, family history, lipid profile, blood pressure, diabetic screening, smoking history). Further cardiac screening may be indicated based on risk factor assessment.

Resting EKG

Chest X-ray

~~Spirometry~~

Urinalysis

~~Hematoerit or Hemoglobin~~

Any further tests deemed necessary by the physician

d) Periodic re-examination over age 40 (every 3 years); over age 60 (every 2 years):

Medical History

Complete Physical Exam, emphasis on neurological and otological components

Detailed assessment of coronary artery disease risk factors using Multiple-Risk-Factor

Assessment^[1] (age, family history, lipid profile, blood pressure, diabetic screening, smoking history). Further cardiac screening may be indicated based on risk factor assessment.

Resting EKG

Urinalysis

~~Hematoerit or Hemoglobin~~

Any further tests deemed necessary by the physician

Oyster Bash to Restore Sealab I

On Friday January 20th, 2012 the Man in the Sea Museum will be holding an Oyster Bash at The Dive Lab. The Oyster Bash will serve as a kick-off to the program hoping to raise \$250,000 for the restoration of Sealab I and to build a suitable structure to contain and display it. Sealab I was first lowered 192 feet in 1964 off the coast of Bermuda after being tested in Panama City Beach, FL. Sealab I provided proof that saturation diving in the open ocean was viable for extended periods and provided information about habitat placement, umbilicals, humidity, and helium speech descrambling. Tickets are available online and at the museum for \$25. Contact Kim Fitzpatrick (kimmelane@aol.com or 850-235.4101).

Rebreather and Advanced Diving Tech Workshop

In 2010, the first NE Rebreather and Advanced Diving Technology Workshop, hosted at the University of Rhode Island, was attended by more than 80 scientific and commercial divers, practitioners, technologists, policy makers, and explorers. This follow-on event will be held February 12, 2012 with numerous rebreathers and related technologies on hand for discussion, special presentations by leading experts in the field, and opportunities for networking within the rebreather and technical diving. Divers are invited and encouraged to bring their rebreathers for a 'show and tell' session where configuration tips and techniques can be shared. Registration is \$25 and limited to 80 participants. Contact <http://www.oceanopportunity.com/attachments/Attach2012RBWorkshop.pdf>

2012 Organizational Member Dues

Outlined in our strategic plan and at the forefront of discussion amongst the Board has been an increase in organizational member (OM) dues and OM applicant fee necessary to fund better central administrative support. The change was approved by the board in 2008 but implementation delayed to address concerns over the economic climate. Despite a continued soft economy, the Board has confirmed that the increase must be implemented to support the services delivered to the Academy. Effective January 01, 2012, OM annual dues will increase to \$500 and OM applicant fees will increase to \$750. The additional revenue will be used to increase the office manager position from 0.5 full-time equivalent (FTE) to 0.75 FTE. The AAUS Office Manager will continue to manage membership services, develop and maintain our website and virtual office, and plan and coordinate our symposia. We intend to grow the office's role in processing OM applications, including coordination of OM mentoring and standards review, and in the production of our monthly E-Slate newsletter. 2012 OM invoices will be sent out the first week of January. To ensure prompt delivery, please check your OM profile to be sure the contact email address listed is accurate.

AAUS Member Statistics Submission

It is time for submission of your organizational member (OM) 2011 scientific diving statistics to the AAUS database. The submission deadline is June 30, 2012. Please begin compiling these numbers now! Though most AAUS web functions now reside on the MemberClicks website, the statistics database resides on an Ego Factory server. This site is linked from the current AAUS homepage (www.aaus.org) or can be accessed directly at http://stats.diveaaus.org/User_Login.asp. For questions about AAUS data collection criteria, please review the "AAUS Statistics Collection Criteria and Definitions" information available on the Statistics Collection page or contact Dr. Amy Moran (MORAN@clemsun.edu) or Mike Dardeau (mdardeau@disl.org) directly.

UPCOMING EVENTS

41st Annual Benthic Ecology Meeting

The 41st Annual Benthic Ecology Meeting (BEM) will be held March 21-24, 2012 in Norfolk, VA at the Norfolk Marriott Waterside Hotel. The meeting will be hosted by Old Dominion University, an AAUS OM. Visit: <http://dl.dropbox.com/u/13470552/BEM%202012%20First%20Flyer.pdf>.

International Marine Forensics Symposium

The Marine Forensics Committee (MFC) of the Society of Naval Architects and Marine Engineers (SNAME) is holding the International Marine Forensics Symposium at the Gaylord National Hotel, Washington, DC, April 02-05, 2012. The symposium will honor the 100th anniversary of the sinking of RMS Titanic (April 12, 1912); the 150th anniversary of the sinking of USS Monitor (December 31, 1862); and approximately the 200th anniversary of the destruction of Commodore Joshua Barneys Flagship, the USS Scorpion during the War of 1812. The event is co-sponsored by: Marine Technology Society (MTS), Royal Institute of Naval Architecture (RINA), American Society of Naval Engineers (ASNE), and Institute of Marine Engineers, Science and Technology (IMARest). Visit: <http://www.rina.org.uk/marineforensics> for details.

Rebreather Forum 3.0

Rebreather Forum 3.0 (www.RF30.org) will be convened May 18-20, 2012 at the Caribe Royale Hotel in Orlando, FL. The meeting is co-sponsored by AAUS, DAN and PADI. This program will be of particular interest to the scientific diving community as there are now evolving rebreather concepts and technologies that are simplified from the technical diving approach with more potential of becoming mainstream scientific diving methodology. Registration prices begin at \$290 (\$275 during the early-bird registration period ending February 01). Multiple pricing packages are available.

JOB OPPORTUNITIES

Southern California Volunteer Coordinator

The Reef Check Foundation seeks a Volunteer Coordinator for Reef Check California's (RCCA) subtidal monitoring network in southern California. RCCA maintains a large network of monitoring sites in this region that is annually surveyed by citizen scientists. The program is directly involved in the state mandated baseline monitoring of the new Marine Protected Areas that will go into effect in southern California in January. This is a half-time position (approximately 20 hours per week) and involves extensive field work and diving, most of which will be performed in Los Angeles and Orange Counties and occasionally in Santa Barbara County. The Volunteer Coordinator will work closely with the RCCA Southern California Regional Manager as well as the Program Director and other staff. Applicants should submit a CV and cover letter via email to colleen@reefcheck.org. More information at <http://www.reefcheck.org> Applicant review to commence on January 03. Tentative start date is February 01, 2012.

Underwater Robotics & Oceanic Technology

The Duke University Talent Identification Program is seeking one instructor and two teaching assistants for the Institute at Eckerd College, St. Petersburg, FL. The Underwater Robotics and Oceanic Technology course is being offered at a summer program for gifted 9-12 grade students. Staff employment dates for this position are July 14-28, 2012. Please visit www.tip.duke.edu/employment for an application. Contact Dr. Nicki Charles at ncharles@tip.duke.edu with questions.

NEW PUBLICATIONS

Crabbe MJC. Coral resilience on the reefs of Jamaica. Underwater Tech. 2011; 30: 65-70.

Awareness of important factors for coral reef growth helps reveal how reef ecosystems react following major anthropogenic and environmental disturbances. Physical measurements by scuba divers, together with an underwater remotely operated vehicle (ROV), have been used to study environmental and climate effects on corals on fringing reefs in Jamaica. The period of this study, from 2002 to 2008, covers the major Caribbean-wide bleaching event of 2005. For 624 non-branching corals at Rio Bueno and Dairy Bull reef near Discovery Bay on the north coast of Jamaica, skewness values for coral populations at the two sites showed generally positive values, indicating that small colonies predominated over large colonies. Measurement of coral sizes together with growth rates allowed the estimation of recruitment dates. This was done for 235 non-branching corals near Kingston Harbour, on the south coast of Jamaica. The aim

of this study was to use coral size and population dynamics as a metric for coral resilience, and to assist marine park managers of coral reefs with regard to coral recruitment and growth. The data show that while recruitment of small corals was returning after the major bleaching event of 2005, larger corals were not necessarily resilient. Therefore there is a need for careful management if the reefs are to survive such major extreme events.

Dzwonkowski B, Park K, Jiang L. Subtidal across-shelf velocity structure and surface transport effectiveness on the Alabama shelf of the northeastern Gulf of Mexico. *J Geophys Res.* 2011, 116, C10012

A 3.33 year time series of velocity and hydrographic data from a mooring site on the 20 m isobath of the Alabama shelf in the northeastern Gulf of Mexico are used to examine across-shelf circulation. The flow structure and surface transport are determined on this wide shallow shelf system, in which wind stress is a primary forcing mechanism, over a wide range of environmental conditions. The relatively long data set allows the along- and across-shelf wind stress responses to be separated so that their individual contributions to the flow structure can be analyzed. This study finds that both along- and across-shelf wind stress play a role in the across-shelf circulation. While the along-shelf wind is correlated with the currents during all seasons, the across-shelf wind is most clearly correlated with the currents during fall and winter when the water column is least stratified and the across-shelf wind stress is strongest. In addition, wind stress magnitude, mid-depth vertical shear of the horizontal velocity, and stratification all show significant relationships with across-shelf transport effectiveness to varying degrees. The wide range of stratification conditions provides new insight on the influence of stratification on transport effectiveness and across-shelf wind stress forcing. Under very low stratification conditions, there is no apparent relationship between stratification and transport effectiveness, and across-shelf wind stress can generate a significant forcing contribution. As stratification increases, across-shelf wind stress becomes less important and the transport effectiveness increases to a point, above which, there is again no clear relationship with stratification.

Hooker SK, Fahlman A, Moore MJ, Aguilar de Soto N, Bernaldo de Quirós Y, Brubakk AO, Costa DP, Costidis AM, Dennison S, Falke KJ, Fernandez A, Ferrigno M, Fitz-Clarke JR, Garner MM, Houser DS, Jepson PD, Ketten DR, Kvadsheim PH, Madsen PT, Pollock NW, Rotstein DS, Rowles TK, Simmons SE, Van Bonn W, Weathersby PK, Weise MJ, Williams TM, Tyack PL. *Deadly diving? Physiological and behavioural management of decompression stress in*

diving mammals. *Proc Biol Sci.* 2011 Dec 21. [Epub ahead of print]

Decompression sickness (DCS; 'the bends') is a disease associated with gas uptake at pressure. The basic pathology and cause are relatively well known to human divers. Breath-hold diving marine mammals were thought to be relatively immune to DCS owing to multiple anatomical, physiological and behavioural adaptations that reduce nitrogen gas (N₂) loading during dives. However, recent observations have shown that gas bubbles may form and tissue injury may occur in marine mammals under certain circumstances. Gas kinetic models based on measured time-depth profiles further suggest the potential occurrence of high blood and tissue N₂ tensions. We review evidence for gas-bubble incidence in marine mammal tissues and discuss the theory behind gas loading and bubble formation. We suggest that diving mammals vary their physiological responses according to multiple stressors, and that the perspective on marine mammal diving physiology should change from simply minimizing N₂ loading to management of the N₂ load. This suggests several avenues for further study, ranging from the effects of gas bubbles at molecular, cellular and organ function levels, to comparative studies relating the presence/absence of gas bubbles to diving behaviour. Technological advances in imaging and remote instrumentation are likely to advance this field in coming years.

The mission of the American Academy of Underwater Sciences is to facilitate the development of safe and productive scientific divers through education, research, advocacy, and the advancement of standards for scientific diving practices, certifications, & operations.

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