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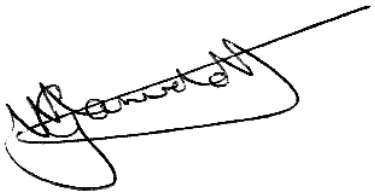
From the Editor

Welcome to the last edition of the PSSA newsletter for 2008. As always, it has been difficult keeping abreast of all the new and exciting things occurring around us. Of particular note this year has been the interest in *algae as bio-fuels* and we highlighted this in our previous issue. Increasingly, mariculture is gaining renewed interest with particular focus on feed formulations, management practices in the aquaculture industry, and digestible energy in food items.

As in previous issues, the December issue has the regular contributions to all segments of the newsletter, but perhaps not as well-represented as in previous editions, and so we thank those that have contributed to the current edition. Global climate change and anthropogenic effects of human-induced change continues to dominate this edition and rightfully so because "man", as custodian of this beautiful planet, continues to threaten "his" own existence.

All formalities aside …, no doubt many, if not all of you, have been busy with your various administrative, teaching and research endeavors, not to mention your planning for the 24th PSSA congress to be held in Paternoster, ... I hope this year has been fruitful for all of you. With this in mind, I wish you all peace, happiness, lots of well-deserved rest and a safe return to work in the new year. For those of you celebrating *Christmas*, here's wishing you all a blessed and safe festive season.

Until we meet at PSSA 2009,
best wishes.
Sincerely



Gavin W. Maneveldt

Synarthrophyton patena
epiphytic on *Gelidium capense*

News and Reviews

1. GEOHAB modeling workshop 2009

An international workshop is being planned to stimulate the development of modeling in relation to the study of Harmful Algal Blooms (HABs). This workshop is being developed under the auspices of the SCOR/IOC program on Global Ecology and Oceanography of Harmful Algal Blooms.

The Workshop will take place from June 15-19, 2009 at the Martin Ryan Institute, National University of Ireland, and is open to graduate students, post-docs and scientists.

There is a 2-step process for application and registration for the workshop. For details, please go to the Registration page. All participants will be expected to submit an abstract for presentation as a poster during the workshop.

The workshop will be organized under the auspices of the GEOHAB Program sponsors, the Scientific Committee on Oceanic Research (SCOR) and the Intergovernmental Oceanographic Commission (IOC) of UNESCO. In addition to these two organizations, financial support for the workshop will be provided by the Irish Sea Fisheries Board, the U.S. National Science Foundation, NOAA's Center for Sponsored Coastal Ocean Research, and the Centre National d'Etudes Spatiales of France.

Detailed objectives, a draft agenda, and logistical information are available on the web at http://www.geohab-models.org/. Applications forms are available on the web site, and are due December 15. Some travel support is available from the workshop budget.

Dennis McGillicuddy
Woods Hole Oceanographic Institution, USA
On behalf of the Organizing Committee

World Science

1. Toll on the World's Oceans

Courtesy: BBC News
Source: http://news.bbc.co.uk/go/pr/fr/-/2/hi/science/nature/7241428.stm

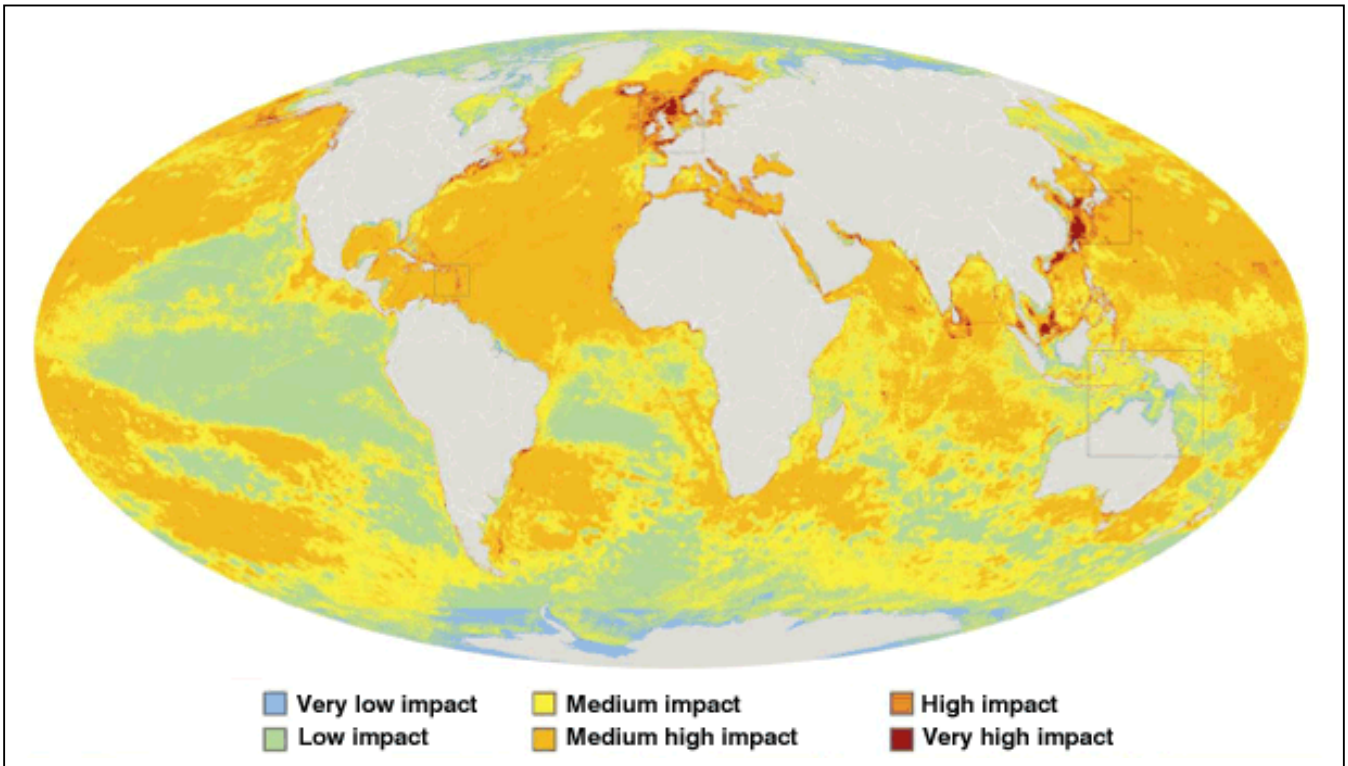
A study in Science journal says climate change, fishing, pollution and other human factors have exacted a heavy toll on almost half of the marine waters. Only remote icy areas near the poles are relatively pristine, but they face threats as ice sheets melt, it warns. The authors say the data is a "wake-up call" to policymakers.

> **"I think the big surprise from all of this was seeing what the complete coverage of human impacts was"**
>
> Dr Mark Spalding, The Nature Conservancy

Lead scientist, Dr Benjamin Halpern, of the National Center for Ecological Analysis and Synthesis in Santa Barbara, US, said humans were having a major impact on the oceans and the marine ecosystems within them. "In the past, many studies have shown the impact of individual activities," he said. "But here for the first time we have produced a global map of all of these different activities layered on top of each other so that we can get this big picture of the overall impact that humans are having rather than just single impacts." Co-author Dr Mark Spalding told BBC News that the map was the first attempt to describe and quantify the combined threats facing the world's oceans from human factors, ranging from commercial shipping to over-fishing. "There's an element of wake-up call when you get maps like this," he said. "Human threats are all pervasive across the world's oceans. The map is an impetus for action, I think that it is a real signal to roll up our sleeves and start managing our coast and oceans."

Complex model

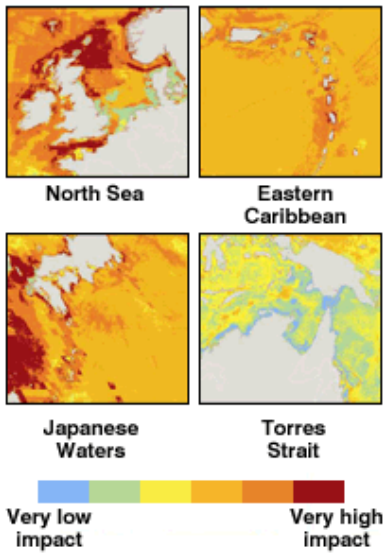
The international team of 20 scientists in the US, Canada and UK built a complex model to handle large amounts of information on 17 different human threats. The researchers divided the world's oceans into 1 km^2 sections and examined all real data available on how humankind is influencing the marine environment. They then calculated "human impact scores" for each



Map showing toll on the world's oceans. Only about 4% of the world's oceans remain undamaged by human activity, according to the first detailed global map of human impacts on the seas (Source BBC News http://news.bbc.co.uk/).

ocation, presenting this as a global map of the toll people have exacted on the seas.

The scientists say they were shocked by the findings. "I think the big surprise from all of this was seeing what the complete coverage of human impacts was," said Dr Spalding, senior marine scientist for international conservation group The Nature Conservancy. "There's nowhere really that escaped. It's quite a shocking map to see." He said the two biggest drivers in destroying marine habitats were climate change and over-fishing. "Out on the high seas, climate change and fishing were far and away the strongest influences," he explained. "The least impacted areas are the polar regions but they are not untouched."



The map reveals the most and least heavily impacted areas (Source BBC News http://news.bbc.co.uk/).

Clear message

The scientists hope the map will be used to prioritise marine conservation efforts. Andrew Rosenberg, a professor of natural resources at the University of New Hampshire, US, who was not part of the study, said policymakers could no longer focus on fishing or pollution as if they were separate effects. "These human impacts overlap in space and time, and in far too many cases the magnitude is frighteningly high," he said. "The message for policymakers seems clear to me: conservation action that cuts across the whole set of human impacts is needed now in many places around the globe." The findings of the study were presented at the 2008 annual meeting of the American Association for Advancement of Science (AAAS) in Boston, US.

Helen Briggs
Science reporter, BBC News, Boston

Featured Article

Recipe for rescuing our reefs

"I've been privileged to see many of the world's finest and least disturbed reefs. Mine were the first human eyes to see many of the remotest reefs at a time when we really could describe them as pristine. I would never have dreamed that they were at risk from people, far less than from something as remote then as climate change.

Today, despite the doom and gloom one reads so much about, one can still find reefs that are vibrant, thriving ecosystems. But sadly, too, there are more and more that look like something from the dark side of the Moon. These degraded reefs have been ravaged by destructive fishing, bad land use practices that smother them with silt, and pollutants that foster disease and overgrowth by seaweeds. More alarmingly, there are large areas that are killed off and degraded by warming seas linked to climate change.

We've all read that global warming poses a tremendous threat to our planet, and that coral reefs will face an uphill battle to survive in warmer waters. Yet the greatest threat to our oceans and to all of its wonders is little known, nearly impossible to see, and potentially devastating. This is not climate change, but does stem from the excess carbon dioxide emissions that contribute to climate change.

Changing chemistry

The ocean absorbs about one-third of the CO^2 entering the atmosphere – a natural process that for millennia has maintained the carbon balance of our planet. In recent times we have upset this balance; global CO^2 emissions are at an all-time high, and our oceans are absorbing more CO^2 and at faster rates than ever before, causing a shift toward greater acidity. This removes carbonate from the water; and carbonate is an essential building block for calcifying organisms, like corals, coralline algae, molluscs, sea urchins and

many other important creatures that live on reefs or help to build them. Too much carbonic acid lowers the natural pH balance of the oceans, causing acidification, which wreaks havoc on marine habitats and species. Just imagine all the colour and vibrancy of coral reefs fading away into fuzzy, crumbling greys and browns, and you're left with a coral reef graveyard that could become the norm if we don't address the threats to our oceans.

> "Imagine all the colour and vibrancy of coral reefs fading away into fuzzy, crumbling greys and browns, and you're left with a coral graveyard that could become the norm"

We need to find ways to convince people to take action, but that is a major challenge. Given the difficulties that many coral reef managers around the world have in controlling such pressing direct threats as destructive fishing, overfishing and pollution, they are understandably hesitant about taking on an issue that they feel is beyond their ability and mandate to tackle. Climate change is often seen as too daunting and too global for them to address, and too abstract for them to communicate.

Fortunately, in some respects, the sudden and startling onset of mass coral bleaching linked to warming seas has changed that a little. We have developed and are applying some straightforward, practical actions to design marine protected networks and zone the individual sites to protect areas that are naturally resistant to bleaching. These areas are key, as they provide larvae that are transported to more vulnerable reefs where they settle and enhance recovery. The high visibility of coral bleaching makes this relatively easy to see and study, but ocean acidification is difficult to detect by sight alone. It is creeping, progressive, and insidious – likened by some scientists to osteoporosis of the reef – a weakening of the reef structure that makes corals and coralline algae more vulnerable to breakage from waves and human use.

We simply do not know yet whether we have reached or surpassed the point of no return for some reef species. If current emission trends continue, we could see a doubling of atmospheric CO^2 in as little as 50 years. This would lead to an unprecedented acidification of our oceans that coral reefs would be unlikely to survive, a scenario that should spur us into action to try and find solutions. A significant lowering of ocean pH would mean potentially massive coral loss. That would lead to the death of countless marine species as well as the devastation of economies dependent on ocean health and productivity.

'Meeting of minds'

> "The high visibility of coral bleaching makes this relatively easy to see and study, but ocean acidification is difficult to detect by sight alone"

It would also mean the end of an era for coral reef and scuba diving aficionados around the world. But, more importantly, it would remove the livelihoods of hundreds of millions of people around the globe who depend on reefs for food, income, coastal protection and stability. Current estimates predict that we could lose all coral reefs by the end of the century – or, in the worst case scenario, possibly decades sooner, if we don't take action now to prevent ocean acidification.

We have to maintain hope and optimism and keep trying to find solutions. The Nature Conservancy recently convened

leading climate change experts, top marine scientists, and prominent coral reef managers from around the globe for a "meeting of the minds" session to chart a course of action for addressing ocean acidification. The key findings and recom-mendations from this gathering were compiled into the Honolulu Declaration on Ocean Aci-dification and Reef Management.

The most logical, long-term solution to ocean acidification impacts is to stabilise atmospheric CO^2 by reducing emissions around the globe. Yet the Honolulu Declaration also outlines tangible steps that can be taken now to increase the survival of coral reefs in an acidifying ocean, while also working to limit CO^2 emissions. For example, we need to identify and protect reefs that are less vulnerable to ocean acidification, either because of good flushing by oceanic water or bio-geochemical processes that alter the water chemistry, making it more alkaline and better able to buffer acidification. We can achieve this protection by designating additional "marine protected areas" and revising marine zoning plans. We also need to integrate the manage-ment of these areas with reform of land uses that generate organic wastes and effluents that contri-bute to acidification. At the local level, we may need to restrict access to more fragile coral communities or limit it to designated trails, much as we do with trails through sensitive environments on land. We should consider designating "sacrificial" reefs or parts of reefs for diver training and heavy visitor use. Another intriguing option is the prospect of farming local corals that prove more resistant to acidification, and "planting" them in place of those that weaken and break apart.

- The oceans are thought to have absorbed about half of the extra CO2 put into the atmosphere in the industrial age
- This has lowered its pH by 0.1
- pH is the measure of acidity and alkalinity
- The vast majority of liquids lie between pH 0 (very acidic) and pH 14 (very alkaline); 7 is neutral
- Seawater is mildly alkaline with a "natural" pH of about 8.2
- The IPCC forecasts that ocean pH will fall by "between 0.14 and 0.35 units over the 21st Century, adding to the present decrease of 0.1 units since pre-industrial times"

The consequences of inaction are too depressing to contemplate. Global leaders, reef managers, and citizens around the globe should give all the support they can to the Honolulu Declaration to ensure the survival of the beauty and benefits of our marine treasure trove for future generations. ❞

Dr. Rod Salm
Director, The Nature Conservancy's
Tropical Marine Conservation Program,
Asia-Pacific region

First published on the BBC News Website, 5 November 2008.

Source:
http://news.bbc.co.uk/2/hi/science/nature/7709103.stm

Popular Student Article

Echinoculture: the potential use of seaweeds for sea urchin aquaculture in South Africa

Mark D. Cyrus

Botany Department, University of Cape Town,
Cape Town

Sea urchin gonads, or roe as it is commonly referred to, have been consumed since prehistoric times by coastal inhabitants around the world in places like Japan, Chile, the Mediterranean and the Caribbean, where roe is often regarded as a seasonal delicacy (McBride *et al.* 2004). Until the mid-1970's Japan was the largest producer and consumer of sea urchin products (Explorations Unlimited Inc. 2003). The Japanese sea urchin fishery peaked in 1969 at 27.5 MT but declined to around 19 MT in the early 1990's and 11.2 MT in 2001 (FAO 2003). At present Japan's total catch is stable between 10,000 – 13,000 MT per year

which is well below its own consumer needs, meaning that they need to import 80-85% of their roe supply. Japan, however, still remains the largest consumer of sea urchin products in the world consuming 75-80% of the total global production (Explorations Unlimited Inc. 2006).

The international sea urchin industry is based on the production of marketable gonads for consumption largely in the sushi restaurant trade. Due to the high degree of importance placed on product presentation, the quality of sea urchin gonads (roe), otherwise known as "uni" in the sushi industry, is very important and influences the price of the product (Robinson *et al.* 2002). The most commercially valuable sea urchin gonads are those that are large in size, contain few to no gametes, have a firm texture, and are bright yellow or orange in colour (Shpigel *et al.* 2004). In Japan uni is considered one of the most valuable seafoods, which in some cases can have a wholesale value in excess of US$ 700 per Kg (Explorations Unlimited Inc. 2006).

Figure 1. Bright Orange/Yellow gonads are considered to be of the highest quality (Photo by Kim Jacobs).

During the last three decades, there has been increasing demand for high quality sea urchin roe (Hammer *et al.* 2006; Siikapuopio *et al.*2007). This major increase in demand has led to extensive exploitation of natural sea urchin populations throughout the world, with over-fishing and declining stocks resulting in many countries (Lawrence *et al.* 1997; Hammer *et al.* 2006; Siikapuopio *et al.* 2007). This trend is reflected in the world sea urchin harvests which peaked in 1995 at approximately 106.7 MT (whole urchin weight) and then declined to 78 MT in 2001 (Explorations Unlimited Inc. 2003). Many countries are now examining the feasibility of sea urchin aquaculture to supply the high demand from future markets (Lawrence *et al.* 1997; Pearce *et al.* 2002a; Pearce *et al.* 2002b; Hammer *et al*. 2006; Cook & Kelly 2007a).

Sea urchin aquaculture or "echinoculture" can be divided into two distinct forms: (1) gonad enhancement, where adults are collected from wild populations, maintained in captivity and supplied ample food in order to increase gonad yield and quality (Vardas *et al*. 2000; Hammer *et al*. 2006); and (2) full life-cycle grow-out where larvae are produced in hatcheries and juveniles grown to commercial size either at sea in some kind of containment systems, or in land-based tanks (Daggett *et al.* 2006; James 2006; Cook & Kelly 2007a). In order for echinoculture to be successful it will require the development of a suitable feed or feeds.

Much of the research into sea urchin aquaculture thus far has been focused around the formulation of artificial feeds with high protein contents which can optimise gonad yield and production. A number of these studies have shown that gonad yield can be significantly increased by feeding sea urchins a high protein diet (Lawrence *et al*. 1997; Olave *et al.* 2001; Pearce *et al.* 2002a; Pearce *et al.* 2002b; Pearce *et al*. 2004; Shpigel *et al.* 2005). However, due to the fact that gonad colour, texture, firmness and flavour are as important as gonad yield when establishing the price and marketability of a product, the increased gonad yield achieved by using an artificial diet will be of little use to commercial echinoculture if the required colour texture and flavour cannot be achieved as well. Previous studies using artificial diets have shown that colour and thus market acceptance of sea urchin gonads can be improved by the addition of specified levels of carotenoids (Robinson *et al.* 2002; McBride *et al.* 2004; Shpigel *et al*. 2005).

Sea urchins obtain carotenoid pigments through their diets, which in nature are generally composed of fleshy macroalgae or tropical seagrasses. Echinenone, which is synthesised from β-carotene, has been recognised as being a particularly important carotenoid in the production of market quality gonads as it is responsible for the yellowish-orange colour that is so sought after in high quality roe (Pearce *et al.* 2002; Shpigel *et al.* 2005; McBride *et al.* 2004). Feeding cultured sea urchins an artificial diet with no pigments will result in large but pale coloured gonads that are commercially unacceptable (Robinson *et al.* 2002; Shpigel *et al.* 2005). The addition of β-carotene to artificial feeds would therefore seem the most appropriate means of improve gonad colour of culture organisms. An important question therefore is what source of β-carotene will produce the best results? According to Robinson *et al.* (2002) pigment origin can affect colour production. They found that natural β-carotene derived from a microalga, produced a significantly better gonad colour than that derived from synthetic β-carotene. Shpigel *et al.* (2005) also showed that natural sources of carotenoids derived from seaweeds were more effective at producing good colouration than comparable concentrations of synthetic carotenoids. In addition to this, synthetic carotenoid pigments are considered to be very expensive and have contributed significantly to salmonid aquaculture production costs (Torrissen *et al*. 1990). Interestingly, it has also been shown that algal-derived β-carotene produces better tasting gonads compared to synthetic β-carotene (Pearce *et al.* 2004).

In addition to the fact that macroalgae contain essential carotenoid pigments needed to produce high quality sea urchin roe, the incorporation of natural seaweeds which are readily consumed by sea urchins may also act as feeding stimulants. The delivery of dietary components (e.g. protein & pigments) to a cultured organism is usually manipulated by varying the concentration or digestibility of the particular components in the feed itself. This may also be achieved, however, by changing the amount of a feed actually consumed by an organism (Jobling *et al.* 2001). One way to do this is by increasing the palatability of an artificial diet by the addition of feeding stimulants (Dworjanyn *et al.* 2007). By giving artificial feeds the desirable chemosensory characteristics, both consumption and digestibility of the feed can be increased (Kasumyan & Døving 2003). The addition of feeding stimulants may be particularly useful for increasing the palatability of diets that use sources of protein that are not normally consumed by the cultured organisms.

Sea urchins are considered to be generalists feeders. However, urchins do display a hierarchy of preferences when offered a choice of natural diets, strongly preferring some algal species over others (Dworjanyn *et al.* 2007; Stimson *et al.* 2007). These preferences have been attributed to factors such as the nutritive value of the food, the physical properties of the food as well as the presences/absence of attractants/deterrents in the food (Stimson *et al.* 2007). The diet preferences displayed by sea urchins are thought to be adaptive as urchins generally grow faster when fed a highly preferred algae species compared to when fed low preference ones (Dworjanyn *et al.* 2007). A study conducted by Dworjanyn *et al.* (2007) showed that individuals fed an artificial diet containing macroalgae as a feeding stimulant had an increased protein consumption of 50% and an increased growth rate of 30%, compared to individuals fed a control diet of only artificial feed (Dworjanyn *et al.* 2007).

The use or addition of algae to existing diets thus appears to have many benefits, and although seaweeds are not common components of artificial aquafeeds at present, many countries are now considering their inclusion. In South Africa, kelp (*Ecklonia maxima*) is now incorporated into some artificial abalone feeds and has been shown to be quite successful (Robertson-Andersson *et al.* 2007). At present we are investigating the potential culturing of the sea urchin *Tripneustes gratilla* using artificial diets with varying algal (*Ulva* spp.) compositions. We have chosen the species *T. gratilla* for two main reasons: (1) it is a common fast growing shallow-water echinoid, ubiquitous to both the tropical and subtropical Indo-Pacific regions (in SA its distribution extends into the subtropics as far south as East London); and (2) it has high quality roe with excellent market acceptance (Dworjanyn *et al.* 2007). In

order for echinoculture to be economically viable, fast growth rates are essential. According to Lawrence & Bazhin (1998) the Toxopneustids (the family to which *T. gratilla* belongs) have high growth rates in nature and therefore are more suited to aquaculture compared to the other two urchin families the Echinids and the Strongylocentrotids. From our study we hope to show that the addition of macroalgae to an artificial diet can act as both a source of natural β-carotene (colourant) and a feeding stimulant, while the artificial component of the diet provides the high protein sources needed for maximal gonadal growth. If successful our research will offer new economic opportunities for commercial echinoculture of *T. gratilla* in South Africa.

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Getting to Know your New Members

New Members for 2008

Margareth Kyewalyanga
(maggie@ims.udsm.ac.tz)


Margareth Kyewalyanga

Dr. Margareth Serapio Kyewalyanga, or Maggie as she is affectionately known, is Head of Department, Marine Biology and Resources Management (MBRM) at the Institute of Marine Sciences, University of Dar es Salaam, Tanzania. Maggie's research focuses are on phytoplankton, primary production and mariculture. Her personal interests include reading and exercising.

Amelia Buriyo
(buriyo@amu.udsm.ac.tz)


Amelia Buriyo

DR Amelia Sylvery Buriyo is a lecturer and researcher in the Botany Department at the University of Dar es Salaam, Tanzania. Amelia's research focuses are on algal ecology, taxonomy and utilization. There research interests include understanding the macroalgal diversity in Tanzania and making their information available and easily accessible to researchers, academia, industry and conservationists. In addition, the availing of information that will facilitate sustainable use of seaweed and their products in view of reducing poverty and disease in the local people is also one of her research goals. On a more personal note, Amelia has an interest in inspiring "young people to be good and credible citizens (through their religious beliefs), environmental conservationists and hard workers".

Conference Countdown

Planned for the Paternoster Lodge, Paternoster, along the South African west coast, PSSA 2009 (19-23 January 2009) is now in its final planning stages and registration has closed. If there are still persons interested in attending, please contact the convenor as soon as possible.

Website: http://www.bcb.uwc.ac.za/pssa/conf2009/.
Convenor: Gavin W. Maneveldt (gmaneveldt@uwc.ac.za)

Calendar of Events

Upcoming Conferences

1. 6th International Multi-Purpose Reef Conference (IMPR 2009), Jeffrey's Bay, South Africa, 18-21 May 2009. http://www.multi-purposereef.com/
2. International Marine Conservation Congress (IMCC 2009), Washington DC, USA, 20-24 May 2009. http://www2.cedarcrest.edu/imcc/index.html
3. GEOHAB Modeling Workshop 2009, Martin Ryan Institute, National University of Ireland, Ireland, 15-19 June 2009. http://www.geohab-models.org/
4. Annual Australian Marine Science Association (AMSA) conference, Adelaide, Australia, 5-9 July 2009. http://www.amsaconference.com.au/
5. 10th Anniversary Conference of the Southern Africa Society for Systematic Biology, Illovo, South Africa, 25-27 July 2009. Contact: Rob Slotow (slotow@ukzn.ac.za).
6. International Phycological Congress (IPC) 2009, Tokyo, Japan, 2-8 August 2009. http://www.ec-inc.co.jp/ipc9/
7. VI Southern Connection Congress, Bariloche, Argentina, 15-19 February 2010. http://southernconnection2010.crub.uncoma.edu.ar/php/index.php

IMCC 2009

International Marine Conservation Congress

Making Marine Science Matter

20-24 May, 2009 ***Washington D.C., USA***

The Marine Section of the Society for Conservation Biology is hosting the first International Marine Conservation Congress (IMCC) from 20-24 May 2009 at George Mason University near Washington D.C. IMCC is aimed at advancing marine conservation by facilitating discussion among scientists, managers and policy makers and developing science-based products that inform policy change and implementation. Major themes are:

- Global Climate Change
- Land-Sea Interface
- Poverty and Globalization
- Ecosystem-based Management

IMCC will serve as the 2nd International Marine Protected Areas Congress (IMPAC2) and maintain the scope and vision of IMPAC1 (held in Geelong, Australia in October 2005).

To address the most pressing marine conservation issues, IMCC will hold exciting plenary talks and solicit creative submissions for contributed presentations, symposia and workshops. Confirmed plenary speakers include: Dr. Daniel Pauly, Dr. Ratana Chuenpangdee, Dr. Rod Fujita, Dorothy Childers and Alexandra Cousteau. Dr. Callum Roberts will be giving the Dr. Ransom A. Myers Memorial Lecture at the banquet.

During interactive symposia and workshops, we will challenge participants to go beyond one-way communication. Each of these sessions will address specific topics within major themes and develop innovative solutions to current conservation challenges. Symposium organizers will invite a select group of speakers and devise creative ways to facilitate discussion. Workshops will consist of multi-disciplinary teams focused on crafting policy and management recommendations, briefings, white papers or peer-reviewed publications.

Please check the IMCC website (www.conbio.org/IMCC) for updates, information and volunteer opportunities. The call for papers, symposia and workshop will be announced in early 2008.

Society for Conservation Biology

IMPAC 2

IMCC Committee Chairs:
John Cigliano, IMCC Chair
Ellen Hines, Chair of the Program Committee
Phaedra Doukakis, Chair of the Fundraising Committee
Wil Burns, Chair of the Venue Committee
Chris Parsons, Chair of the Local Secretariat and Sustainability Committees
Amber Himes, Chair of the Communications Committee

IMCC Steering Committee:
Chair - John Cigliano: Cedar Crest College
Vera Agostini: The Nature Conservancy
Ratana Chuenpagdee: Dalhousie University
Jon Day: Great Barrier Reef Marine Park Authority
Paul Dayton: Scripps Institution of Oceanography
Steve Gaines: University of California Santa Barbara
Dennis Heinemann: The Ocean Conservancy
Ellen Hines: Florida Fish and Wildlife Research Institute, San Francisco State University
Michael F. Hirshfield: Oceana
Dan Laffoley: World Commission on Protected Areas - Marine
Jane Lubchenco: Oregon State University
Jeff McNeely: The World Conservation Union
Elliott Norse: Marine Conservation Biology Institute
Ana Parma: Argentine Council for Science & Technology of Argentina
John Senior: Parks Victoria
Alan D. Thornhill: Society for Conservation Biology
John Waldman: City University of New York
Larry B. Crowder, Duke University

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IMPAC 2