

Forum Phycologicum



Newsletter of the
**Phycological Society
of Southern Africa**

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From the Editor

Greetings from your new editor, and welcome to Volume 79 in the PSSA newsletter series.

When I took on this portfolio at the PSSA 29th Congress in June I was comforted by the knowledge that most of the information for my first newsletter would be provided by congress-related information. Thanks to Wendy Stirk and her team for organising an excellent congress and for providing the abstracts featured here, and to Gavin Maneveldt for the insightful analysis of the productivity of PSSA members in his President's Report; these and other congress-related reports make up the bulk of this edition.

Looking back at the last newsletter, I was struck by two things. The first was that time surely does fly: volume 78 reached us in mid-2012, shortly before Gavin Maneveldt gave up the editorship to become the president of PSSA. The second was the superb quality of the newsletters that Gavin produced. I have not attempted to grapple with producing a newsletter that looks anywhere near as good as Gavin's. Two hackneyed phrases entered my mind. One was the well-known "hard act to follow" and the other was (in the words of a Dolly Parton song, if you can believe that) "Anything's better than nothing". So here it is – Volume 79.

Yours in Phycological Endeavour,



Rob Anderson

PS: Please use the newsletter to let us all know what you and your research groups are up to, from anecdotal accounts of fieldwork to abstracts of recent publications, student projects, etc.

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One alga, two algae

At the risk of seeming pedantic, your editor would like to remind some of the presenters of talks that the word “algae” also has a singular form: “alga”. Widespread misuse of these two forms led John Bolton, many years back, to have a rubber stamp made. With this he could quickly and indelibly stamp “One alga, two algae” all over offending essays and projects.

We are working on an app that will automatically sound an alarm and flash the above phrase on the screen when conference speakers commit this serious offence. It will switch off once they have done an electronic transfer into the PSSA bank account.



29th Congress of PSSA, St Lucia, 21-26 June 2015



Photograph: AJ Smit

Congress Prize-winners

Our congratulations to the prize-winners! Presentations were of a uniformly excellent standard, but eventually the judging panel made the choices featured below. Thanks to AJ Smit for the photographs.



Maggie Reddy, winner of the PSSA award for the best student presentation, is congratulated by our guest speaker, Digby Cyrus, while Past President Gavin Maneveldt looks on.

Maggie's talk was entitled "Re-examining the taxonomy of foliose Bangiales (*Porphyra*) on the South African coast: What do we have and where did they come from?"

Tarryn-May Terry, winner of the runner-up award for student presentations, is congratulated by Digby Cyrus. Her presentation was entitled "Identification and assessment of South African microalgal species for use in carbon mitigation at coal-fired power stations".





Chris Boothroyd (Seaweed Unit, DAFF) won the Klaus Rotmann Memorial Award for the best presentation relevant to the commercial seaweed industry, here presented by Adèle Geldenhuys of Taurus.

Chris presented a poster: “*Gelidium pristoides* along the South African coast: biomass, accessibility and commercial viability”.

29th PSSA Congress: Office-bearers’ reports

Secretary/Treasurer’s Report

The Society has a Money Market Account that is held at First National Bank. Money Market accounts have a basic monthly charge, a small cash handling fee and have higher interest rates than conventional current accounts. There is a cheque book linked to the account but most transactions are done via internet banking because it is convenient and free. There are two signatories for the cheque book (currently John Bolton and Mark Rothman), although withdrawals or cheques only require one signature. Currently all our transactions are done electronically. The following financial report is for the period February 2014 till July 2015.

The Society had an opening balance of R 26 354.27. We made a small profit of about R5 500.00 for this conference, bringing our current balance to R31 871.89 (as at October 2015).

We thank the industry for their continued support of phycology, this meeting and the Society. Taurus Chemicals (Cape Kelp) Pty. Ltd. are sponsoring the Klaus Rotmann Memorial Award for best applied talk/poster for commercial use of seaweed, and we thank them for that. We also thank both Kelpak and Taurus Chemicals (Cape Kelp) Pty. Ltd. for their generous sponsorships towards this conference, and the University of KwaZulu-Natal for their support.

It is a great pleasure serving the Society in the capacity of Secretary/Treasurer.

Thank you,

Mark Rothman

Membership Secretary's Report

The PSSA is at present in a very healthy state, although the numbers have decreased slightly from the previous cycle. Delegates who register for PSSA congresses automatically become members for two years.

Here is a breakdown of the present membership (including the 28th and 29th PSSA Congresses).

	Local	International
Life	10	1
Corporate	4	
Ordinary	15	14
Student	37	
Totals	66	15

Outgoing membership secretary

Derek Kemp

President's Report: PSSA Productivity January 2014 – June 2015

By the end of the financial year, the society had 78 members¹ including 37 (47%) student members, 27 (35%) ordinary members, 10 (13%) life members and 4 (5%) corporate members. Corporate members generally do not participate in peer-reviewed research and so the bulk of the society's research productivity (that potentially generates subsidized government income), arises from the remaining membership categories. For the period between our last two congresses, the following research productivity has been reported, these

¹ Membership is currently based on those attending the congress (43 at the 2015 congress). However, there are a number of 'members' that do not attend all congresses, but are still classified as members either because they are regular participants, or have shown a continued interest in remaining as members.

representing a total of eleven (11) principal investigators (comprising ordinary and life members) from five academic (UCT, UKZN, UWC, Wits, WSU) and two government (DAFF, SAEON) institutions.

Research outputs

The society has been productive over the period January 2014 to June 2015 with an average 4.18 peer-reviewed publications, 0.82 books/book chapters, and 6.91 conference presentations resulting from the efforts of these 11 principal investigators and their research teams (Fig. 1). Despite the strong emphasis on primary research, it is apparent that the society is engaging in the public domain with a reasonable number of popular articles emanating from various research initiatives (Fig. 1).

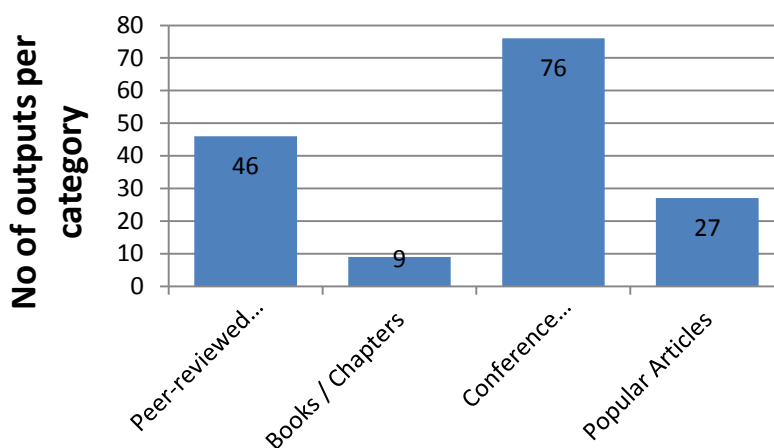


Figure 1. Total number of research outputs for the year under review.

It is apparent from the peer-reviewed research publications that PSSA members are driving much of the research they are participating in, with a large number of publications bearing PSSA members as first and preceding authors (Fig. 2). Noteworthy, however, is the fact that PSSA members are actively engaged in a significant amount of research with other local and international collaborators (Fig. 3).

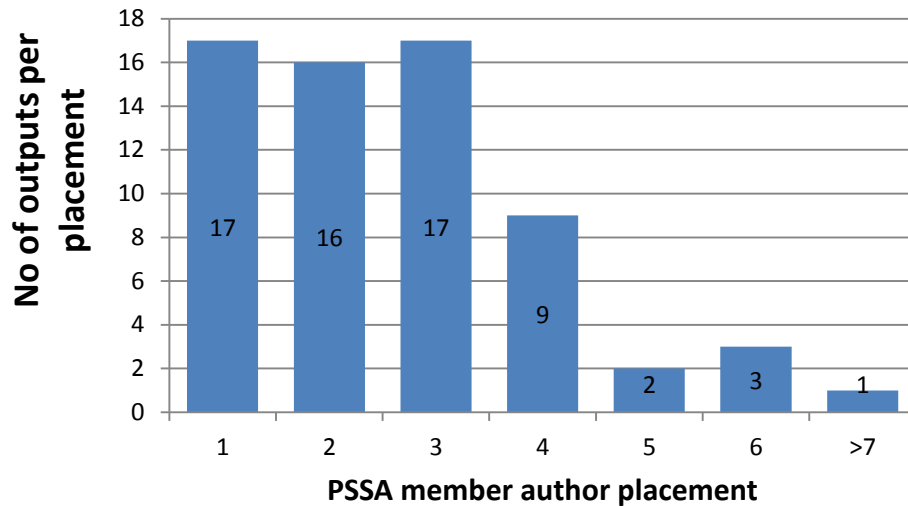


Figure 2. Total number of times PSSA members have served as first, second, third, etc., authors in peer-reviewed primary research publications.

Even more assuring is the high number (53% of PSSA members, 22% of all authors) of publications bearing PSSA student members as first authors (Fig. 4). This demonstrates both the ability of our student members to produce good written works, and the confidence of our more senior researchers in the scholars they are producing.

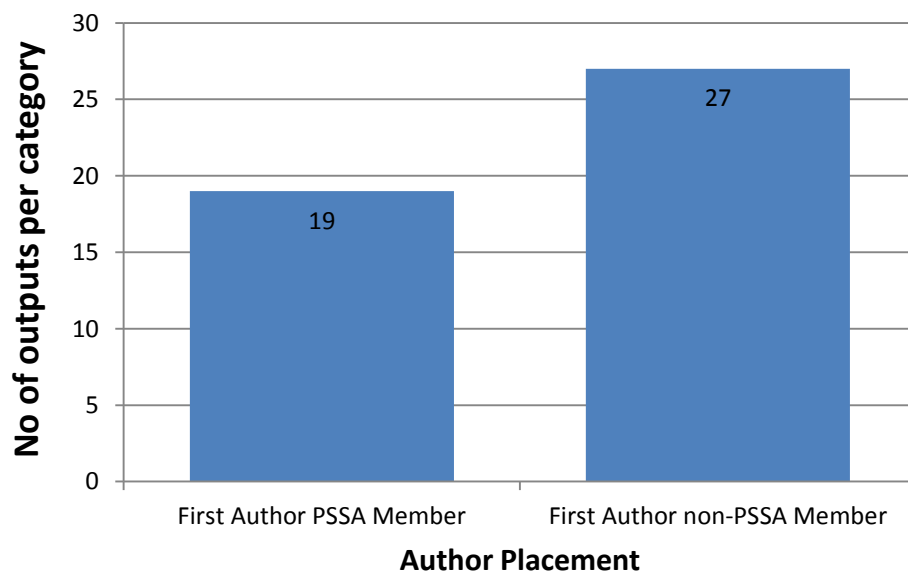


Figure 3. The contribution by all PSSA members as first authors to the total number of peer-reviewed primary research publications.

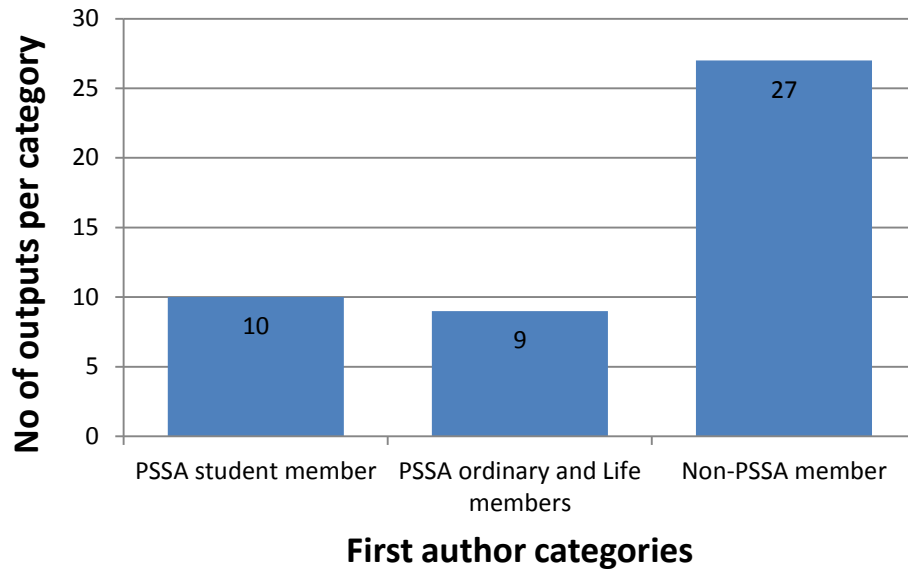


Figure 4. The contribution by PSSA student members as first authors to the total number of peer-reviewed primary research publications.

Student graduations

A reasonable number of Masters and PhD students have graduated over this reporting period (Fig. 5). The reported graduations represent 6 (Masters total X1) and 21 (PhD total X 3) Department of Higher Education and Training subsidy points respectively. These numbers represent a significant contribution to the training of psychologists who themselves have the potential to further the training of, and research in psychology in southern Africa.

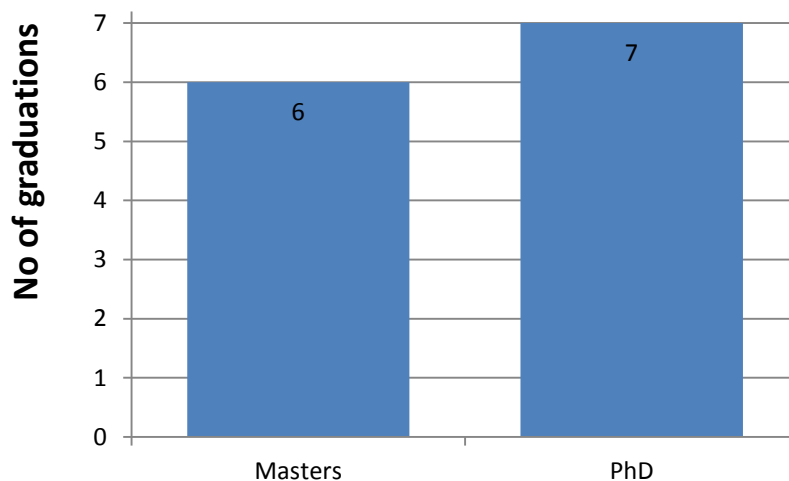


Figure 5. Total number of Masters and PhD student graduations for the period under review.

International standing and collaboration

Psychological research in southern Africa has always caught the attention of the international research community. This past period has been no different and a large number of active collaborations currently exist with colleagues from various international institutions from 14 different countries (Fig. 6). While nearly two thirds (62.5%) of all research collaborations (based on research publications) have been with colleagues from the Northern Hemisphere, research efforts with our Southern Hemisphere partners are by no means lacking. While research institutions from the North American continent hold the largest percentage of collaborative outputs (from three countries, 32.5%), far more collaborations exist with institutions from various European countries (from five countries, 27.5%), with institutions from the Indo west Pacific following closely behind (from three countries, 25%).

Active collaborations based on peer-reviewed publications

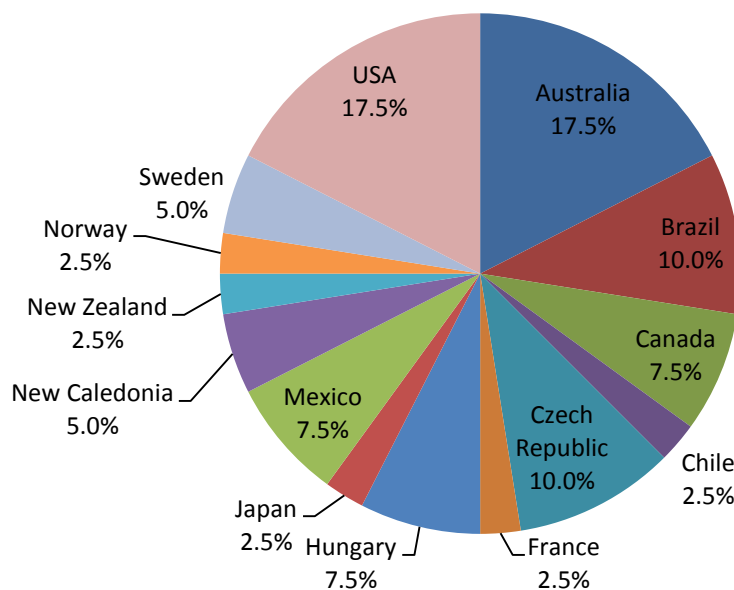


Figure 6. Percentage collaborations per country (N = 40 institutional collaborations) based on co-authored research publications. Each publication was treated independently, but for the same publication, collaborators from the same foreign institution were counted as a single collaboration.

All in all, the period January 2014 to June 2015 has been a most productive period for the society. Although we are a small psychological society in comparison to many others across the globe, we can confidently state that we are at the leading edge of so much international

research and collaboration. The research productivity reported here is testimony to these achievements.

Gavin W. Maneveldt

Past-President, Phycological Society of Southern Africa, September 2015

The 29th Congress of the Phycological Society of Southern Africa

Venue Seasands, St Lucia, KwaZulu-Natal, South Africa

Dates 21-26 June 2015

Congress Organizer Wendy Stirk, University of KwaZulu-Natal

Members of local organizing committee Kannan Rengasamy, Adeyemi Aremu

Sponsors Kelp Products (Pty) Ltd, Taurus Chemicals Cape Kelp (Pty) Ltd, University of KwaZulu-Natal

Abstracts

(In order of presentations; the presenting author's name is underlined)

Plenary lecture

The effects of drought and anthropogenic activities on ecosystem state cycling and the fish fauna of Africa's largest estuarine lake

Digby P Cyrus

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Lake St Lucia, on the East Coast of southern Africa, is a major nursery area for juvenile marine fish and prawns. It comprises 80% of the estuarine area of the Province of KwaZulu-Natal and more than 50% of that of South Africa. In June 2002 drought resulted in mouth closure and hypersaline conditions followed, reaching the highest on record (>200‰) while the lake level dropped to <10% of the system's 325 km². Anthropogenic activities relating to the separation of the Mfolozi River from St Lucia over 50 years ago appear to be the root cause of the extremes reached. With the drought over and the mouth still closed 14 years later, a semi-permanent connection between the two was established in July 2012. This resulted in a significant volume of freshwater entering St Lucia causing the lower part of the system to become fresh. It also caused a reverse salinity gradient to establish which ranged from 1 at the mouth to 15‰ in the northern part of the lake. A switch in ecosystem functioning, from the hypersaline state that typically ranges between 65 and 120‰ (and higher during the most recent event) to a freshwater state with salinities ranging from 0 to 12‰, was also initiated. This paper reviews ecosystem state cycling in St Lucia and the changes that have occurred over the past 12 years as well as the impacts that the hypersaline period has had on the fish fauna.

Oral presentations

The importance of *Ulva* as a feed supplement for the cultured abalone *Haliotis midae*

Morgan J Brand¹, John J Bolton¹ and BM Macey²

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The long term sustainability of aquaculture hinges on progressive development in the nutritional content of feeds. The search for alternative protein sources, other than fishmeal, is a global challenge and inclusion of locally produced ingredients is an important part of this process. South Africa is a world leader in abalone aquaculture, producing more than 1100 tons of abalone annually. Abalone farms have been producing effluent grown *Ulva* since the 1990s with current annual production exceeding 2000 tons (wet weight). We have demonstrated that supplementation of abalone feeds with fresh effluent grown *Ulva* improves consumption and growth of abalone. Furthermore, dietary *Ulva* supplementation appears to have a beneficial impact on the animal's immune response, improving the ability of abalone to render an injected dose of bacteria non-culturable. A significant impact on the gut microbiome of abalone fed *Ulva* was also observed when using denaturing gradient gel electrophoresis (DGGE) as a culture independent molecular technique. The functional component/s of *Ulva*, which are contributing to these observations are yet to be identified. In more recent work, three isonitrogenous diets, containing specific components of *Ulva*, were formulated and tested for their effects on the feed conversion ratio (FCR), specific growth rate (SGR), blood glucose, and gut microbiome of abalone. The diets consisted of (1) effluent grown dried *Ulva* (10% w/w); (2) ulvan (1% w/w), the predominant carbohydrate extracted from the *Ulva*; and (3) glucuronic acid, a monomeric sugar (0.1% w/w). Each ingredient was incorporated into a commercially extruded feed and balanced according to the amino acid profile of *Ulva*. The effects of each diet on FCR, SGR, blood glucose, and gut microbiome will contribute to our understanding of how specific 'functional' components impact animals on multiple (e.g. metabolic, cellular and organismal) levels, allowing for a more targeted approach to dietary formulation.

Two newly discovered *Grateloupia* (Rhodophyta) species on aquaculture rafts on the west coast of South Africa, including the widely introduced *G. turuturu*

Robert J Anderson^{1,2}, John J Bolton², Olivier De Clerck³ Caitlynne M Francis² and Frieda Siyanga-Tembo²

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Compared to other world regions, very few species of marine macroalgae have been demonstrated to be recent introductions into South Africa. Collections of red seaweeds growing on ropes on an oyster farm in Saldanha Bay on the west coast of South Africa included two species of *Grateloupia*. The most abundant one was foliose, and had an identical partial *rbcL* sequence to that of *Grateloupia turuturu*, indigenous to Japan/Korea but introduced into many world regions. The other species was finely branched, and presumably also an introduction, being closest in *rbcL* sequence to *G. carnosa* from Japan, but not identical. South Africa now has three foliose and two finely-branched species of *Grateloupia*.

Echinoculture – a new and exciting chapter for South African aquaculture

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Tripneustes gratilla has been proposed as a viable candidate for aquaculture in South Africa due to its fast growth rate, early maturation and high gonadal production. Internationally, the most commercially valuable urchin gonads are large in size, contain few to no gametes, have a firm texture, and are bright yellow or orange in colour. Previous studies have shown that artificial diets generally produce large gonads that are pale in colour, while natural macroalgae diets produce brightly coloured gonads that are small in size. Our research has focused on the development of an artificial diet supplemented with macroalgae and the optimization of a feeding regime to produce high quality gonads. We demonstrated that a formulated feed supplemented with 20% dried *Ulva* (20U diet) produced high quality gonads in terms of both size and colour. Moreover, dietary *Ulva* supplementation significantly increased protein digestibility, the chemosensory properties of a formulated feed and feed consumption rates of wild caught urchins. Growth studies on hatchery reared urchins were conducted over a 32 week period to optimize a feeding regime. Somatic growth of urchins fed fresh *Ulva* (FU) and 20U was similar after 21 weeks, while the gonads of urchins fed FU were significantly smaller. However, after feeding urchins in the FU treatment an artificial diet, with or without dried *Ulva* supplementation, for an additional 6 weeks, their gonads attained a similar size compared to urchins continually fed 20U. Our results have important implications for the development of a cost-effective and successful echinoculture industry in South Africa.

Role of nutrient assimilation and photosynthetic efficiency in facilitating prolonged bloom persistence of *Cyanothece* sp. in Lake St Lucia, iSimangaliso Wetland Park (South Africa)

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Worldwide, persistent cyanobacterial blooms are becoming more frequent and are often associated with effects of global climate change. In June 2009, a widespread bloom of the unicellular cyanobacterium, *Cyanothece* sp., appeared in the northern basins of Lake St Lucia - Africa's largest estuarine lake - and persisted for 18 months. It remains unclear how the bloom status was maintained for so long. This study investigated aspects of the nutrient (N and P) assimilation and photosynthetic efficiency of *Cyanothece* sp. and how these may relate to maintaining a persistent bloom state during hypersaline conditions. A stable isotope tracer technique was used to evaluate the nutrient uptake dynamics (¹⁵NO₃⁻ uptake, PO₄⁻ uptake and ¹⁵NO₂ fixation) under specific environmental conditions. Pulse amplitude modulated (PAM) fluorometry was used to observe the photosynthetic responses to

specific environmental conditions by *Cyanothece* sp. Nitrogen fixation was observed in this *Cyanothece* sp. isolate from St Lucia. Highest nutrient assimilation rates in all experiments were recorded at the lowest salinities, decreasing progressively up to a salinity level of 120‰, with very little activity observed above this. No $^{15}\text{NO}_2$ fixation was measured above this salinity threshold. Additionally, ^{15}N uptake rates were significantly influenced by environmental variables, particularly salinity, which suppressed uptake rates, and temperature, which facilitated them. Photosynthetic activity was only observed in photosystem I. Temperature significantly influenced the photosynthetic activity of *Cyanothece* sp., with cells maintaining similar activity over the full salinity range. Results indicate that *Cyanothece* sp. is well suited to take advantage of the conditions present during the onset of the bloom. However, once salinity increased above 120‰, cells reduced their nutrient uptake abilities while maintaining their photosynthetic efficiency, thereby surviving under extreme salinities when most of their potential grazers and autotrophic competitors disappeared from the system.

Linking nitrogen pollution in estuaries to rocky shores: A stable isotope approach

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Many coastal regions in KwaZulu-Natal (KZN) are impacted by sewage effluent, but the knowledge and extent of this impact remains poor. Additionally, previous impact studies were restricted to community dynamics and nutrient trends in estuaries and coastal habitats. However, this information can be supplemented by tracing the fate of nitrogen and its sources to coastal systems. An accepted methodology is the use of stable isotopes of Nitrogen (N) to determine anthropogenic origin to both terrestrial and marine systems. This study aimed to determine anthropogenic sources and impacts of N-pollution to three estuaries in southern KZN. To achieve this, stable isotope analysis together with nutrient and community composition data were used in the selected temporarily open/closed estuaries. Source differentiation between the open (summer) and closed (winter) phase of the estuaries and the importance of anthropogenic nitrogen (via estuarine input) was made possible using two species of rocky shore macroalgae, *Hypnea spicifera* and *Jania intermedia*. The $\delta^{15}\text{N}$ in these organisms (algae and mussels) provided evidence that estuarine inputs were more important during the open phase than closed phase and were from anthropogenic sources in two sites (Mhlugwa and Kongweni). Additionally, stable isotope analysis, physicochemical water properties and determination of community composition, when integrated, were found to be useful tools in nutrient pollution studies. The condition of sites chosen for this study indicated a need for mitigation of nutrient pollution in estuaries and a greater need for development of Wastewater Treatment Works along the coast of KZN.

Population properties of the kelps *Ecklonia maxima* and *Laminaria pallida* around the Cape Peninsula

Janine Greuel, Tevya Lotriet, Rudolph Philander and Albertus J Smit

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Ecklonia maxima and *Laminaria pallida* are the dominant habitat forming kelp species along the southern African west coast, with their temperature limits determined by seawater temperature. The thermal regime experienced by both species along its entire distributional range in South Africa is hypothesized to be repeated at a smaller scale within False Bay, with temperatures near Muizenberg expected to approximate those at de Hoop. This research assesses properties of the allometric relationships of the two species and their potential fecundity within False Bay, and contrasts those findings with measurements collected along the western side of the Cape Peninsula. Here we report on morphological properties such as the maximum stipe and frond length and mass of both species, as well as the spore release of *E. maxima*. Our data show that kelps of both species sampled from cooler climates are significantly larger in size and mass compared to their warmer water counterparts. Similarly, there also seems to be a dependence of potential fecundity on seawater temperature. These data will be valuable in assessing how kelps respond to changes in the ocean's thermal regime at the population level.

Comparison of species diversity inside and outside the intertidal rock pools of Mkhambathi Nature Reserve

Zizipho Mnyaka and Thembinkosi Steven Dlaza

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Rocky shores are a dynamic interface between land and the marine environments. This means that the species in these areas are subjected to physiological stresses closer to their ecophysiological tolerance. As a result, species on the rocky shore occupy different habitats as means for adaptation to such stresses. This study thus investigated the species composition inside tidal rock pools, on the emergent rock outcrops immediately adjacent to the rock pools and on rock outcrops far from the rock pool. Quadrats (50x50 cm) were laid inside rock pools, on emergent rocks adjacent to rock pools and 5 m away from the rock pools. Species richness inside the quadrats was determined and species diversity quantified using three diversity indices. Cluster analysis and Principal Component analysis were used to compare the three habitats. The results showed that there was more species diversity inside the rock pools. These three habitats were therefore found to be extremely different from one another.

Intra- and inter-specific variability in kelp $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ isotope signatures – implications for food web studies

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Kelp bed communities are vital ecosystems in shallow coastal habitats along the cooler coastlines of the world's oceans, typically where upwelling is prevalent. On the south-western and west coast of South Africa these macroalgae form complex 3-dimensional habitats, home to diverse faunal assemblages that depend directly or indirectly on these organisms. Kelp primarily enters the marine

food web in the form of detrital particles which are continuously generated from erosion of the distal portions of the kelp fronds. These particles enter the water column and become available to kelp associated filter-feeders which, as a consequence, often dominate the faunal biomass of these habitats. Some of these particles are also exported and utilized in adjacent marine systems and thus, kelp beds have a far-reaching influence on various marine food webs. Accurately determining the dependence of kelp food webs on kelp-derived particles, through stable isotope modeling, requires knowledge about the variability of the kelps in the ecosystem. Isotopically distinct signatures of the two species, *Ecklonia maxima* and *Laminaria pallida* along the south-western coast need to be obtained to understand how these signatures vary through time and space. Samples of different tissue types were collected from both species of kelp at Oudekraal on the West Coast and analysed for $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ signatures in order to identify the natural variability in kelp isotope signatures. The implications of this variability on kelp food web studies are discussed.

Rock pool characteristics and species diversity in four nature reserves found along the Wild Coast of South Africa

Thembinkosi Steven Dlaza¹, Siyamtemba Madyibi¹, Zizpho Mnyaka¹, Celiwe Yekani¹, Sinawo Zali¹ and Francesca Porri²

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²*South African Institute for Aquatic Biodiversity, Private Bag 1015, Grahamstown 6140, South Africa*

The weathering pattern of rocks is determined by the geomorphology and petrology of the rock formation of a particular area. As a result the intertidal rocky shores are characterized by a mosaic of microhabitats such as boulders, cracks, crevices and rock pools. Intertidal rock pools are microhabitats formed by the depression of the rock substrate so as to provide refuge to various marine organisms during low tide. The shape, depth and surface area of rock pools from four nature reserves were thus compared. Seaweeds and invertebrates were identified inside each rock pool for the various nature reserves. Diversity indices, cluster analysis and multidimensional scaling were used to compare the various nature reserves. Rock pool physical characters showed that Dwesa and Silaka were similar while Hluleka rock pools were similar to those of Mkhambathi Nature Reserve. Seaweed diversity was lowest in Mkhambathi rock pools while there were no differences between the other three reserves. Limpet diversity was also similar for Dwesa and Silaka Reserves, while Mkhambathi had diversity values similar to Hluleka. Although there were physical similarities in the rock pools of Mkhambathi and Silaka, similarity indices reflected that Mkhambathi was different from the other three reserves.

Understanding the association between the non-geniculate coralline red alga *Spongites discoidea* and the mollusc *Oxysteles sinensis*

Rosemary Eager, Courtney Puckree-Padua and Gavin W Maneveldt

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Nearly all adult *Oxysteles sinensis* encountered in the Kalk Bay (Western Cape Province, South Africa) shallow subtidal zone were observed to bear a thick, convoluted form of the non-geniculate coralline alga *Spongites discoidea*. To understand the association, various data were collected. The results show

that *O. sinensis* is for the most part restricted to the shallow subtidal zone and rockpools while the morphologically similar *O. tigrina* is largely restricted to the intertidal zone. Fleishy macroalgae were absent from all habitats sampled; much of the primary substratum was occupied by encrusting algae. *Spongites discoidea* was restricted to intertidal rockpools and the shallow subtidal zone where *O. sinensis* was the most abundant wrinkle. Subtidal specimens of *S. discoidea* were generally thicker (7.24±0.55 mm on shells, 6.02±0.67 mm on boulders) than intertidal specimens (2.39±0.21 mm on boulders, 1.02±0.09 mm on bedrock), were more heavily burrowed into (44±3.32% for subtidal shells, 36±3.94% for subtidal boulders), and were more weakly attached (2.2±0.58 kg for subtidal shells, 8.4±0.77 kg for subtidal boulders). Experimental evidence showed that the coralline has no preference for shells of *O. sinensis* and that contrary to our assumption, there is no apparent advantage to the wrinkle bearing the coralline, other than perhaps for camouflage to avoid predation. The high frequency of the association is more likely due to the substantial overlap in the niches of the coralline and the wrinkle.

Limpet distribution and body size variation across four nature reserves along the Wild Coast of South Africa

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Body size is important along the Wild Coast since limpets are harvested for food and bait in this region. Harvesters tend to be size selective, with larger limpets being more susceptible to overexploitation than smaller individuals and species. This poses long term ecological implications since limpets play a vital role in structuring the ecosystem of the intertidal rocky shores through grazing, intraspecific and interspecific competition. The limpet species from four nature reserves were measured for body size using shell length and body mass. Seven species were common across all the reserves. *Siphonaria serrata*, *S. capensis* and *Cellana capensis* were largest in Dwesa but having similar sizes in the other three reserves. On the other hand *Scutellastra longicosta*, *S. granularis* and *Heliccion concolor* were largest in Mkhambathi Nature Reserve. For the limpet species (e.g. *Cellana capensis* and keyhole limpets) that were found both inside tide pools and on the emergent rock outcrops, body size comparison across these habitats was site specific. Although these results revealed differences in body size across the various limpet species, there were no clear geographical patterns on the size structure of limpets along this region.

Determining the effects on intertidal organisms by the recovery response of a known dominant herbivore

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A five year exclusion study (2003-2008) concluded that the herbivorous mollusc *Cymbula oculus* (Born) was the primary biological factor controlling the mid-eulittoral zone community structure on the rocky shores at Kalk Bay (False Bay) and not physical factors associated with desiccation stress as was previously thought. Follow up studies (2010-2015) were initiated to examine the recovery

response of this community once this mollusc was allowed to re-colonise the area. Here we present the findings from data collected annually on the density and biomass of all invertebrates, and the percentage cover abundance of algae and other encrusting organisms from within control and experimental plots.

How does the seaweed derived-biostimulant (Kelpak[®]) influence the phytohormone and phytochemical content in greenhouse-grown medicinal plants?

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Climatic change and the increasing global population are major challenges hampering food security and general agricultural productivity. The effect of a seaweed derived-biostimulant (Kelpak[®] at 1, 2.5 and 5% dilution; v/v) on the growth, endogenous cytokinin (CK) and phytochemical content in *Eucomis autumnalis* (Mill.) Chitt. under hydroponic conditions was evaluated. After four months, the stimulatory effect of Kelpak[®] treatments was more noticeable in the underground organs than in the aerial organs. Total endogenous CK was also higher in plants treated with Kelpak[®] (approximately 1000-1200 pmol g⁻¹ DW) compared to control plants (860 pmol g⁻¹ DW). Isoprenoid CKs (which mainly accumulated in the aerial organs) were more dominant than aromatic-type CKs across all the treatments. A total of 11 bioactive chemicals (8 phenolic acids and 3 flavonoids) and eucomic acid known for their diverse biological activities were quantified in the samples. The most abundant compound was *p*-coumaric acid (6.5 µg g⁻¹ DW) and it was approximately 7-fold higher in 2.5% Kelpak[®]-treated plants than in the control. It was also noteworthy that syringic acid only occurred in the underground organs of 5% Kelpak[®]-treated plants. Eucomic acid which is a major bioactive compound in *E. autumnalis* was significantly enhanced in Kelpak[®] treatments and the leaves accounted for more than 70% of the overall content. Thus, Kelpak[®] elicited a significant influence on the growth, endogenous CK and phytochemical content in *E. autumnalis*. These findings provide additional evidence of the enormous potential of Kelpak[®] as a useful biostimulant with practical applications in various agricultural endeavours.

Variation in chemical components of aquacultured *Ulva* (Chlorophyta) in response to environmental variables

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Marine algae are known to produce a wide range of volatile compounds. Primarily used in chemical communication, these compounds can act either as pheromones or allelochemicals. In *Ulva*, aldehydes are reported to be the main group of volatile compounds. In South Africa, *Ulva* has been a success as

abalone feed, but very little research has been done on its secondary metabolites. In this study, we investigated the potential effects of environmental variables and grazing on the chemical profile, and specifically on the aldehyde-type natural products produced (9.00–10.50 ppm) by laboratory cultured *Ulva armoricana* using ^1H NMR spectroscopy and multivariate statistical analysis. *Ulva* was cultured at different salinities in the range of 5 to 35‰ and nutrients: 100% Provasoli ES medium (high nutrient supply) and 0% Provasoli ES medium (low nutrient supply) at 10°C and 15°C for 6 days under constant light ($39.2 \pm 0.43 \mu\text{mol photons m}^{-2} \text{s}^{-1}$) on a 16:8 hours light:dark photoperiod. Natural and artificial grazing experiments were also performed on *Ulva*. Results indicated that grazing and nutrient experiments mostly affected the aromatic, hydroxylic and carbonyl regions on the ^1H NMR spectra while salinity variations affected mostly the alcohol, ester and phenolic regions. The aldehyde profiles included a prominent peak at 9.76 ppm in almost all treatments that was provisionally identified as hexanal. The present study provides a baseline towards the clarification of the spectrum of non-polar constituents in local aquacultured *Ulva* and its potential change when subjected to environmental variation. Further isolation and characterization studies need to be done in order to validate metabolites of interest and their potential applications in the South African aquaculture industry.

Can seaweed chemicals help turn the tide against antibiotic resistance?

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The rapid development of resistance against common antibiotics combined with the slow pace of new antimicrobial drug discovery and development present a significant health risk. Interestingly, sessile marine organisms such as invertebrates and seaweeds suffer remarkably low levels of microbial infection. We have therefore initiated a programme to explore the antimicrobial potential of South African marine organisms, including seaweeds. A number of crude organic extracts from *Laurencia* spp. were thus screened against five biomedically relevant microorganisms: *Acinetobacter baumannii*, *Enterococcus faecalis*, *Escherichia coli*, *Staphylococcus aureus subsp. aureus* and *Candida albicans*. The active extracts were further fractionated and some thirty different metabolites were isolated. The structures of the metabolites were determined and their activities against the same five microorganisms were evaluated. Several of the isolated metabolites showed potent activity with minimum inhibitory activities (MIC values) of about $1 \mu\text{g mL}^{-1}$.

Alpha-glucosidase inhibitors from *Ecklonia radiata*: In-vitro and In-silico studies

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Type II diabetes comprises 85-95% of all diagnosed diabetes in high-income countries and may account for an even higher percentage in low- and middle-income countries. Diabetes caused 4.9 million deaths in 2014, particularly in Africa where 76% of deaths were due to this disease. Currently available antidiabetic drugs show numerous side effects. Hence, alternative cheaper new drugs are needed to solve this problem and reduce the risk of diabetes without any side effects. The aim of this study was to investigate the chemical constituents of *Ecklonia radiata* collected from Cape Town, South Africa and test them against alpha-glucosidase inhibition. Sulfoquinovosyldiacylglycerol (SQDC); 1-*O*-palmitoyl-2-*O*-myristoyl-3-*O*-(6''-sulfo- α -D-quinovopyranosyl)-glycerol and uracil were isolated from a butanol fraction of *Ecklonia radiata*. The isolated compounds were evaluated for antidiabetic potential through alpha-glucosidase inhibition. *In-silico* prediction of biological activity of the two identified compounds showed remarkable potential with Prediction Probability >7. This result indicates the high probability of finding observed activity through experimentation. Various molecular properties, toxicity profiles and other physico-chemical properties of these compounds were also determined.

Identification and assessment of South African microalgal species for use in carbon biomitigation at coal fired power stations

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In the last 100 years, the atmospheric concentrations of carbon dioxide (CO₂) have risen to current levels of approximately 385 ppm and is currently growing at 1.9 ppm per year. The burning of fossil fuels contributes to this increase. Concentrations of up to 15% CO₂ are found in the combustion gases (flue gas) of coal-fired power stations. Microalgae utilise CO₂ for growth, hence have potential for use to reduce CO₂ being released into the atmosphere. CO₂ biomitigation requires an algal species, or a consortium of species, that utilise CO₂ at a rapid rate. In order to identify microalgal species with high CO₂ assimilation rates, a high-throughput screening method was developed. A total of 63 algal species were isolated from areas surrounding the biomitigation site and species previously collected from areas in close proximity to the site was obtained through the CSIR algal collection. Using the high-throughput screening method, the kinetic growth parameters of 98 uncharacterised algal species have been determined. These results were compared to rates achieved by species from literature known to have high rate carbon uptake. To facilitate the selection of suitable species, the lipid and carbohydrate content of high rate CO₂ assimilators were measured. Further characterisation will include large scale cultivation and the phylogenetic identification of species from 18S rRNA gene sequence identities. The value of this research is highlighted by the fact that algal production for CO₂ biomitigation may also result in the production of potential high value algal products, job creation and the offset of operational costs.

From lab to pond: demonstrating scale up of *Spirulina* production and assessing algal scale-up challenges

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Increasing interest is being expressed in the production of fine chemicals and commodity products in micro-algal systems. The scale up of algal cultivation from the laboratory to commercial scale is challenging and has been reported in many cases to result in sub-optimal performance or, in the worst case, process failure. Controlled laboratory conditions are replaced by fluctuating environmental parameters, contamination becomes a considerable issue, supply of nutrients becomes a costly logistical problem and harvesting and downstream processing can represent a system bottleneck. Key learnings from the production of *Spirulina* at commercial scale are presented. Productivity data were correlated to media composition and environmental parameters at scales ranging from 50 L to 500000 L over three production seasons. The population of bacteria in co-culture in the open ponds was monitored in terms of composition and variation over time. Additional challenges encountered include control of pH and media composition, as well as seasonal variation in harvest volume. The results of this study have enabled conditions for economically feasible *Spirulina* production in South Africa to be established.

Algae Testbed Public Private Partnership (ATP³): Opportunities to engage in open collaborative testbed network activities

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The Algae Testbed Public Private Partnership (ATP³), a multi-institutional effort funded by the USDOE has established a network of operating testbeds that brings together world-class scientists, engineers and business executives whose goal it is to increase stakeholder access to high quality facilities by making available an unparalleled array of outdoor cultivation, downstream equipment, and laboratory facilities. ATP³ utilizes the same powerful combination of facilities, technical expertise to support TEA, LCA and resource modeling and analysis activities, helping to close critical knowledge gaps and inform robust analyses of the state of technology for algal biofuels. ATP³ includes testbed facilities at ASU's Arizona Center for Algae Technology and Innovation (AzCATI), and augmented by university and commercial facilities in Hawaii (Cellana), California (Cal Poly San Luis Obispo), Georgia (Georgia Institute of Technology), and Florida (Florida Algae). A primary objective for ATP³ is to facilitate access to the network's expertise and facilities. ATP³ aims to make significant advancements in the algal biofuels arena by promoting opportunities through an open collaborative testbed network. Our regional testbeds are equipped to accommodate activities across the algae value chain including strain selection and screening, biomass production, testing and validation of cultivation systems, method development and validation of analytical protocols and equipment, evaluation dewatering technologies, as well as biomass production and extraction of valuable microalgae co-products. We successfully began to build a customer base in phase 1, including clients interested in water testing and species identification, productivity and analytical measurements from biomass grown in novel PBRs, identification of bioactive molecules that promote

animal health and associated scale-up processes, and products testing of novel nutrient additives that may boost algae production over conventional nutrient applications. Our network offers access to open, closed, small and large cultivation systems, access to natural salt water, wastewater and CO₂ streams, and integrated harvesting units.

CO₂ mass transfer, mixing through aeration and light provision are key factors for optimization of energy efficiency in airlift bioreactors

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The airlift principle is a key operating principle of many aerated vertical tube photobioreactors as well as the aeration arm of the horizontal tube reactors. Further, the airlift principle can be incorporated into low cost hanging bag reactors. In each of these reactor systems, it is well recognised that algal productivity is typically limited by the supply of light and the rate of supply of CO₂. It is desirable to maximise algal productivity by optimising these factors while minimising energy consumption in the reactor. A trade-off is required as energy consumption increases with aeration rate. In this paper, the impact of aeration rate on CO₂ mass transfer rate, mixing and light supply is investigated. In terms of the former, the volumetric mass transfer rate and mixing times are calculated as a function of aeration rate and related to algal productivity. In terms of the supply of light, the use of positron emission particle tracking is reported for the first time in algal reactors to demonstrate the path of the algal suspension through the airlift system, thereby allowing the light path to be mapped as a function of aeration rate. Through determining the relationship between aeration rate with light path history and mass transfer rate, suitable operational conditions have been proposed. These are related to algal productivity determined experimentally. Through integration of these findings, algal productivity in the airlift system can be maximised on the basis of energy efficiency.

Feasibility of large scale raceway ponds for algal growth within South Africa

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The growth of algae, within South Africa, has the potential to be exceedingly useful due to the large range of products that can be produced, including: biofuels, pigments, proteins, fatty acids, antioxidants, fertilizers and animal feeds, providing a bio-based product route. Algae can be grown on land unsuitable for agriculture and low quality water can be used. Current research indicates that, especially for low-value commodity products, the large-scale growth of algae is currently only feasible, in terms of energy usage and economics, in large shallow raceway ponds. South Africa is particularly well suited to the large-scale production of numerous species of algae; with large amounts of available, non-arable land in regions with the correct climatic conditions for optimal growth and potential sources of low quality water. Growth within raceway ponds has some significant challenges which may include: the supply of inorganic carbon; slow growth rates; short growing seasons; high land usage; and high water and nutrient usage rates. These have contributed to previous attempts at large-scale commercial algal ponds being unsuccessful in the long term, despite excellent short term product quality. The reasons for these failures need to be addressed, along with typical raceway pond

challenges, to ensure the success of future algal businesses within South Africa. This paper explores these challenges and solutions. The need to assess economic and environmental feasibility is acknowledged.

Identification of bacteria in *Spirulina* cultures cultivated in outdoor open-ponds

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To ensure the safety of food grade *Spirulina* products the dried product has to be free from pathogenic microorganisms. Controlling microbial contamination and load in open-pond systems, generally used for *Spirulina* production, is especially challenging. During this study, the bacterial loads associated with *Spirulina* cultured in a 50,000 L open raceway pond was measured over a production season. Further, the influence of sample handling conditions and conditions within the downstream processing on bacterial load were also studied. The culturable bacteria were identified following 16S rRNA gene amplification and DNA sequencing. Eleven isolates were identified, based on their sequence similarities to known sequences contained within the National Center for Biotechnology Information (NCBI) Blast database. All isolates displayed a high degree of sequence similarity (>96%) to halophilic or halotolerant species, as would be expected for *Spirulina* cultivation conditions. One isolate showed 100% sequence identity to an opportunistic pathogen, *Pseudomonas mendocina*, however infection caused by this organism is very rare. Only a small proportion of microorganisms present within any given environment can be cultured using conventional laboratory methods, therefore the presence of other microorganisms was investigated using denaturing gradient gel electrophoresis (DGGE). The introduction of pathogens during the downstream processing of the *Spirulina* biomass was also determined. Recommendations are made to limit microbial contamination and load within open-pond *Spirulina* cultures based on experimental findings from this study. The important roles which microorganisms play within ecosystems, may suggest that the presence of specific bacteria may also be beneficial for *Spirulina* growth and these potential interactions are discussed.

Interactions between temperature and nitrogen concentration influence lipid productivity and fatty acid composition in *Chlorella* strains

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Oleaginous microalgae accumulate lipids when subjected to growth limiting conditions such as nitrogen (N) deprivation. Together with lipid content, fatty acid composition is an important criterion to meet specific biodiesel standards. Temperature is a major environmental factor influencing fatty acid profiles in microalgae. The aim of the present study was to investigate interactions between

temperature and N on growth, lipid productivity and fatty acid composition in three *Chlorella* strains grown at different temperatures (20°C, 25°C and 30°C) in modified Tamiya media with low and moderate N concentrations (7, 21 and 70 mg L⁻¹ N). Both temperature and N concentration significantly influenced biomass accumulation with the fastest growth at the higher temperatures and N concentration. Protein content decreased and lipid content increased with N-deprivation while temperature had little effect. Strain, temperature and N concentration influenced lipid productivity with highest productivity generally achieved in cultures grown in 3% N at higher temperatures. Fatty acid composition was genetically determined with C18:1n9c and C16:0 being the main fatty acids in *Chlorella* sp. MACC-438 and *C. minutissima* MACC-452 and C18:2n6c and unidentified short and very long chain fatty acid methyl esters (FAMES) where predominant in *Chlorella* sp. MACC-728. Temperature influenced the % FAME content with lower temperatures having a higher % FAME in *Chlorella* sp. MACC-438 and *C. minutissima* MACC-452 while N concentration influenced the specific FAME content. Thus, temperature tolerance should be considered when selecting strains for cultivation in outdoor ponds to ensure high lipid productivity while the specific strains response to N-deprivation is important to ensure the quality of the biofuel feedstock.

Eco-metabolomics to assess the temperature stress physiology of *Ecklonia maxima* (Osbeck)

Papenfuss

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Ecklonia maxima is the dominant habitat forming kelp species along the southern African west coast. The species extends as far East as de Hoop, which is presumed to be its upper thermal limit. The thermal regime experienced by *E. maxima* along its entire distributional range in South Africa is hypothesised to be repeated at a much smaller scale within False Bay, with temperatures near Muizenberg expected to approximate those at de Hoop. Work on the chemical responses of seaweeds to abiotic stressors such as temperature has largely been restricted to the assessment of bulk quantities of metabolite groups (i.e. carbohydrates, lipids, proteins). A new approach is eco-metabolomics, which is the untargeted analysis of the metabolites within an organism within an environmental context. We plan to subject *E. maxima* to an eco-metabolomic study by sampling specimens from its distributional (i.e thermal) range in False Bay. The data resulting from this analysis will produce a fingerprint of the kelp's metabolome with respect to the environmental thermal range and variability, thereby providing a novel view of its physiology as it responds to these abiotic cues. This 'proof of concept' study will set the stage for eco-metabolomics as an insightful and important tool in the future of marine photoautotroph ecophysiology.

The effects of kelp forests on the inshore physical environment

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It is unknown how water movement and temperature are influenced by the presence of the kelp, *Ecklonia maxima*. The aim of this project is to understand the modification of the physical environment in kelp forests by the kelps themselves. It is hypothesised that the presence of dense kelp forests will break wave energy and water flow as well as change the albedo within the population, thereby aiding in the temperature stratification of the water column. In order to investigate the temperature profile and flow dynamics within kelp forests, a number of individual kelps will be fitted with an array of temperature and light sensors and accelerometers (HOBO UA-002-64 and HOBO UA-004-64) at different depths along the length of kelps, and at different positions in the kelp bed. These various sensors allow data to be collected on the physical environment in three dimensions in the kelp forest, enabling questions to be answered on the kelp forest's ability to attenuate wave energy as well as monitoring the temperature stratification along the depth profile within the forests. Preliminary data obtained during a cooling event indicate that this set-up can easily detect stratification of the water column due to a cooling event, although the drivers of this stratification remain to be determined.

Towards a South African Coastal Temperature Network (SACTN)

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New research that elucidates the differences in ocean surface temperature detected by satellites and *in situ* instruments is continuously being published in international journals. A study conducted by Smit *et al.* in 2013 found the same trend occurring along the coast of South Africa. The warm bias in satellite data was found to be as large as 6°C at certain points along this ~2,700 km coastline. In lieu of this and other discoveries, researchers are placing more emphasis on the use of *in situ* data for studies in the nearshore (<400 m) region. Even though the biases being shown in satellite data around the world can be large, these data are free and comprehensive in their spatial coverage while most institutions that produce *in situ* data have limited spatial coverage and guard what data they do have closely. The paucity of *in situ* data encourages researchers to use satellite data in the face of growing knowledge about the pitfalls this presents. To ameliorate this issue the SACTN has been proposed for the betterment of the scientific community that relies on accurate temperature records in South Africa and abroad. This system will combine all of the *in situ* coastal temperature data being produced by the disparate governmental agencies and organisations within South Africa into one consolidated online database available to all. These data will be thoroughly validated and all scripts and functions used in the process of creating the SACTN will be fully documented and made publicly available via packages on GitHub and CRAN for the programming language “R”.

The thermal basis for South African macroalgal distribution

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Temperature structures biodiversity. Seawater temperature relates at regional and global scales to the various measures of biodiversity, and has aided our understanding of the evolution and ecology of biological assemblages. It is of paramount importance that the research is underpinned by reliable, accurate and precise temperature datasets, whether they are static long-term climatologies, or dynamic time series from which coefficients relating to the rate of change in temperature with time can be extracted. This research focuses on the static properties of the inshore temperature regime of South Africa, and their consequences for establishing the biogeographical patterns of South Africa's seaweed flora. The following questions are addressed: 1. How does mesoscale oceanic forcing influence seawater temperature properties/processes less than 400 m from the coastline? 2. How does the nearshore thermal regime influence patterns of α -, β - and γ -diversity? 3. What are the structuring processes of seaweed biogeographical patterns along the shore? This research will address these and other questions by looking at the outcomes of a series of modern multivariate analyses, which were developed to determine the exact nature of the physical processes shaping the distribution of life along our shores.

Fluctuations in oxygen-depleted bottom waters, including episodic events of anoxia, in St Helena Bay in the southern Benguela upwelling system

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St Helena Bay is located in the southern Benguela upwelling system and is one of the largest and most productive embayments on the South African coast. Here low oxygen concentrations in bottom waters are driven by high bay productivity and the remineralization of a high flux of organic carbon into these waters. The depletion of oxygen causes a myriad of effects, including a reduction in the habitable range for many higher organisms, and also notable biogeochemical shifts, as oxygen is a key controlling factor for the cycling of carbon and nitrogen. The intention of our study was to quantify oxygen fluctuations in the bottom waters of St Helena Bay through high resolution sampling at a mooring at 50 m depth and from regular sampling of 4 transects comprising a grid of 28 stations. Oxygen depletion was shown to be highest in the southern region of the bay in autumn. At this time denitrification, the process by which bacteria use nitrate instead of oxygen as an oxidant of organic matter was shown to be an important suboxic respiratory pathway resulting in a nitrate deficit in the lower water column. Nitrite as an intermediate in the denitrification process was found in high concentrations. Superimposed on seasonal hypoxia were episodic events of bottom anoxia which

followed the episodic flux of organic matter into deeper waters. Most of the bay (to a depth of around 70 m) was re-oxygenated during winter by wind mixing.

A South African National Phycology Culture Collection for microalgae

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There are currently several microalgal culture collections maintained in laboratories around South Africa; however, there is no dedicated infrastructure or personnel tasked with curating a South African National Phycology Culture Collection (SANPCC) for marine and freshwater microalgae. The need for such a facility has been expressed by various institutions including the South African National Biodiversity Institute (SANBI), the Departments of Agriculture, Forestry and Fisheries (DAFF) and Science and Technology (DST) as well as university departments. A strategic proposal for a self-sustaining SANPCC is presented here to include infrastructure, personnel, funding and policy. It is envisaged that the SANPCC, under the custodianship of the PSSA, will serve as a national resource to promote and facilitate fundamental and applied phycology research. It would be of value to researchers in biodiversity, taxonomy, algal biotechnology, genomics, evolutionary ecology and general phycology as well as public and university education. A committee representing the general phycology community in SA will be the appointed custodians to manage its funding, curatorship and determine data-sharing policies. The internationally registered herbaria at the Universities of the Western Cape and/or Witwatersrand have been identified as potential sites. A self-sustaining financial model is proposed based on the maintenance and sale of algal strains, future research funding, patents and links with the industry. Members of the SANPCC will be involved in fundamental phycology research. This will include projects for developing improved long-term conservation protocols such as cryopreservation under the expertise of Prof D. Mycock. Cryopreservation of algal cells will reduce operational costs. Start-up funds for a salaried curator for 1 year and a standard growth chamber for culture maintenance have been obtained. A SANPCC website will be developed for easy access to information on strains, culture conditions, publications, biotechnology and control and distribution of samples.

MALDI-TOF MS as a tool for taxonomic discrimination and identification of economically significant microalgae strains

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MALDI-TOF MS has been used extensively in the past to identify bacteria and fungi to the species-level and recent developments allow researchers to discriminate some microbiota at the strain-level. The primary objective of this study was to determine whether MALDI-TOF MS can be used to identify microalgae to genus, species and strain level more rapidly with certainty similar to traditional DNA sequencing. Identities of 36 microalgae strains were confirmed using 18s rDNA sequencing followed by BLAST against the NCBI database. Phylogenetic associations were determined (Geneious v7.1.4 software; Tamura-Nei genetic distance model, neighbor joining tree building method and grouping algorithm). These strains represented five distinct microalgae clades including the *Trebouxiophyceae*, *Prasinophyceae*, *Chlorophyceae*, *Rhodophyceae*, and *Eustimatophyceae*. While the PCR based sequencing approach was time and labor intensive, taking on average one week to identify algal strains, the MALDI approach took only 10 hours to complete a full sample set (up to 96 samples). MALDI used a protein extraction method with a one hour ethanol inactivation step on aliquots of the 36 sequenced strains. Triplicate samples were plated on a 96-spot polished stainless steel target plate then analyzed using a Bruker Microflex LRF MALDI-TOF mass spectrometer followed by analysis using BioNumerics 7 and Flex Analysis software. Resulting mass spectra from the 36 strains suggest that every genus, species and strain appears to have a unique spectrum or “fingerprint” which can be used to discriminate between algae samples, although MALDI was not able to group the algae into their respective clades like 18s rDNA. These spectra and corresponding taxonomic nomenclature may be compiled in a library to assist in future rapid identification of microalgae. Ongoing research is being conducted to determine the capability of MALDI-TOF MS to discriminate between microalgae in mixed cultures and for rapid detection of contamination in unialgal cultures.

Cryptic diversity within the genus *Spongites* (Corallinales, Rhodophyta) from South Africa

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Recent molecular studies of non-geniculate coralline red algae from South Africa have suggested that at least one widely distributed species from the genus *Spongites* is really many species passing under that name. Only by sequencing topotype specimens, or much preferred type specimens themselves, can names be assigned unequivocally. Sequencing from type material of *Spongites yendoi* from Japan differs by over 10% from specimens given this name in South Africa. South African *S. yendoi* therefore needs a new name. Even more interesting is that specimens passing under this name in

South Africa possibly comprise seven different cryptic species. Here we present some of our preliminary findings and are forced to question all reports of non-geniculate coralline red algal species said to be widely distributed based solely on anatomical/morphological features. Our DNA sequencing results strongly imply that the number of extant species of non-geniculate coralline red algae has been highly underestimated.

Characterization of the species composition of *Ecklonia maxima* forests on the coast of South Africa

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Kelp forests are important systems from both a biological and socio-economic perspectives. Kelp forests are highly productive systems that not only provide a habitat for various economically important fauna but also act as a source of energy to adjacent marine ecosystems. There is increasing evidence to suggest that kelp forests are under threat due to rising sea temperatures – since temperature is one of the main drivers of kelp ecology and distribution, ocean warming above the kelp's optimum range may have detrimental effects for these ecosystems. This study aims to determine the community composition and environmental drivers of three contrasting kelp communities on the coast of South Africa (Oudekraal, Betty's Bay and Bordjiesrif). Ecological sampling will take place seasonally (winter and summer), and the methodology used will be based on that of the Kelp Ecosystem Ecology Network (KEEN). For the purpose of this work we will focus on the KEEN control plots only, which will allow for comparison of ecological data between the contrasting kelp sites with the intention to use continuously monitored environmental variables (thermal regime; wave exposure; depth; light availability; etc.) and ecophysiological responses (from a sister study) to explain the kelp's ecological performance.

Molecular systematics of South African *Hypnea* (Rhodophyta)

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Hypnea, an economically important genus of red algae (containing κ -carageenan) found globally on tropical and subtropical shores, is shrouded in taxonomic confusion due to morphological plasticity of species and general lack of clear morphological characters. Out of 113 species listed worldwide only half that number is accepted taxonomically. In South Africa there are currently 8 recognized species (*Hypnea arenaria*, *H. ecklonii*, *H. intricata*, *H. musciformis*, *H. rosea*, *H. spicifera*, *H. tenuis* and *H. viridis*). Some of these species are difficult to tell apart and appear to differ only in dimensions, which overlap in some species. In addition, some entities do not fit the descriptions currently in existence for these species. This study has undertaken to re-examine the taxa in this genus using morphological and molecular techniques. Initial research questions posed for this study are: 1. How many *Hypnea* species occur in South Africa? 2. Is *H. spicifera* one species? 3. Do we have true *H. musciformis* in South Africa? When examining phylogenies constructed from mitochondrial (cox1) and chloroplast

(*rbcL*) markers, greater species diversity was found within *Hypnea* than expected, with a number of clades which did not fit known species concepts. None of our South African specimens are true *H. musciformis* (the type of the genus). All *H. spicifera* specimens, from a wide geographical range, are conspecific. The molecular analysis suggests that *H. rosea* is far more complex than previously thought. There are definite clades within the *H. rosea* clade, which contains multiple unidentified species. What we previously identified as *H. tenuis* grouped separately to the *Hypnea* clade in the *rbcL* tree, indicating that *H. tenuis* may not be part of the *Hypnea* genus at all. Detailed morphological analysis is required in order to assess whether an integrated morphological/molecular species concept can be successfully applied in South African *Hypnea*.

A molecular systematic investigation of *Laminaria* (Laminariales, Phaeophyta), focusing on Southern Africa

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A molecular study of *Laminaria pallida* was undertaken. Along the Southern African west coast, *L. pallida* is morphologically variable, at the extreme presenting two forms: i) a solid-stiped form with the stipe widest near the holdfast and ii) a hollow-stiped form which has a longer, hollow stipe that is wider in the middle, narrowing to the distal and proximal ends (at one stage regarded as a separate species, *L. schinzii*). Using sequences from nuclear, mitochondrial and chloroplastic DNA (ITS, *rbcL*, *trnWI* and *atp8*), from Southern African as well as *Laminaria* species from other regions, a phylogeny of *Laminaria* was constructed. Results confirmed that *L. pallida*, in Southern Africa, irrespective of form, is all a single species with the northern Atlantic species, *L. ochroleuca*, as its sister. This sister relationship was also shown in the ITS analysis which also showed that the other Southern Hemisphere *Laminaria* species (*L. abyssalis*) has a similar sister relationship. The *rbcL*/ITS concatenated analysis showed that there is a separation between the species of *Laminaria* from the Eastern Pacific, Western Pacific and the Atlantic while the *atp8*/*trnWI* analysis, focused on the Atlantic species of *Laminaria*, resolved two subclades: a *L. digitata/hyperborea* subclade, and a *L. ochroleuca/pallida* subclade. Early indications are that both Southern Hemisphere species has a Northern hemisphere ancestor that migrated southwards. Clearer discussions on these hypotheses will be greatly assisted by time-calibrated trees.

Re-examining the taxonomy of foliose Bangiales ('*Porphyra*') on the South African coast: What do we have and where did they come from?

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The earliest documented sexually reproductive eukaryotes in the fossil record, the Bangiales, are morphologically simple red algae widely distributed around the globe. The Bangiales have been

traditionally divided into two genera, *Porphyra* (foliose) and *Bangia* (filamentous) until 2011 when a major taxonomic revision of the group split the foliose Bangiales into 8 genera and the filamentous Bangiales into 7 genera, based on genetic evidence. One of the major outcomes of the study was the reassigning of well-known commercial *Porphyra* species grown for Nori into a new genus, *Pyropia*. Prior to 1997 all South African entities in the ‘*Porphyra*’ complex were ascribed to a single species: *P. capensis*. Subsequently, two new species were described, one added, and a third described but not named. According to the latest taxonomic revision of the Bangiales, two of the five species belonging to *Porphyra* have been ascribed to the genus *Pyropia*. A 2010 preliminary survey using molecular techniques suggested that several species may exist along the South African distribution range of this complex. Our results corroborate the addition of several new species in at least two different genera to the South African flora, new species records and possibly new genera. Species distinctions in relation with South African bioregions and varying morphology will be discussed. Some South African specimens share a common ancestry with specimens from southern ocean Islands and continents suggesting an interesting origin and distribution for the South African Bangiales complex.

How reliable is morphological species delimitation in kelp? A study of two closely related South African *Ecklonia* species

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Ecklonia maxima and *Ecklonia radiata* (Laminariales) are abundant along the South African coast, and the latter is the most widespread kelp in Australasia. Genetically they are distinct species, despite laboratory evidence of hybridisation, and they can usually be differentiated morphologically, especially when occurring as geographically separate entities. At two sites they have been reported to be growing together, and plants of apparent intermediate and indeterminate morphology have been observed. This study tested the reliability of morphology in separating these two *Ecklonia* species across their intraspecific range of morphological variation, and from locations where they co-occur. No individual characters reliably separated between species, yet overall size distinctions as well as the morphometric separation of hollow and solid-stiped sporophytes provide good evidence for morphological differentiation of *E. radiata* and *E. maxima*. While *E. radiata* clusters morphometrically, using multivariate techniques, a distinction between Australian and South Africa specimens was observed. In localities where the two species are reported to co-exist (Buffels Bay in False Bay, and De Hoop) morphological distinction is less clear. Environmental data in combination with detailed genetic population analyses are necessary to understand the variation in these populations as well as to clarify the relationship between genetic differentiation and overlapping morphology.

Posters

Gelidium pristoides* along the South African coast: biomass, accessibility and commercial viability*Chris JT Boothroyd¹, Derek A Kemp¹, Mark D Rothman¹ and Robert J Anderson^{1,2}**¹*Branch: Fisheries, Department of Agriculture, Forestry and Fisheries, Private Bag X2, Rogge Bay 8012, South Africa*²*Department of Biological Sciences and Marine Research Institute, University of Cape Town, Private Bag X3, Rondebosch 7701, South Africa*

The intertidal agarophyte *Gelidium pristoides* is endemic to South Africa, and found along about 1 500 km of coastline from Sea Point on the west to the Mtamvuna River on the south coast. Although this economically important species is found in 13 of the 23 seaweed concession areas on the coast, it is currently only harvested in Area 1, where the biomass was previously estimated as 120 tons dry wt. We report biomass estimates for areas 2-9, and rate the *G. pristoides* resources on different parts of the coast according to accessibility to harvesters. Although there are localized areas of high biomass, much of this coast presents access problems. We also comment on this resource on the coast of the former Transkei (Areas 20-23), where it was formerly harvested.

From source to sink: tracing the flow of energy through South African Kelp beds using stable isotope analysis**David C Dyer¹, John J Bolton¹, Albertus J Smit² and Robert J Anderson^{1,3}**¹*Department of Biological Sciences and Marine Research Institute, University of Cape Town, Private Bag X3, Rondebosch 7700, South Africa*²*Department of Biodiversity and Conservation Biology, University of the Western Cape, Private Bag X17, Bellville 7535, South Africa*³*Branch: Fisheries, Department of Agriculture, Forestry and Fisheries, Private Bag X2, Roggebaai, 8012, South Africa*

Kelp bed communities are vital ecosystems in shallow coastal habitats along the cooler coastlines of the world's oceans, typically where upwelling is prevalent. On the south-western and west coast of South Africa these macroalgae form complex 3-dimensional habitats, home to diverse faunal assemblages that depend directly or indirectly on these organisms. Kelp primarily enters the marine food web in the form of detrital particles which are continuously generated from erosion of the distal portions of the kelp fronds. These particles enter the water column and become available to kelp associated filter-feeders which, as a consequence, often dominate the faunal biomass of these habitats. Some of these particles are also exported and utilized in adjacent marine systems and thus, kelp beds have a far-reaching influence on various marine food webs. Accurately determining the dependence of kelp food webs on kelp-derived particles, through stable isotope modeling, requires knowledge about the variability of the kelps in the ecosystem. Kelp beds are ecologically variable in the south-western Cape region, varying in faunal and floral assemblages, as a result of a multitude of natural and anthropogenic factors. Our current understanding of their functioning is therefore limited, as it is based solely on a single historic model of a west coast kelp bed. Understanding how the different organisms interact within these systems, with particular focus on food web dynamics, will provide key insights into the functioning of these habitats.

Documenting the biodiversity of the South African non-geniculate coralline red algae

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Non-geniculate coralline red algae are important occupiers of space in shallow, hard-bottom, marine environments. The South African rocky intertidal and subtidal habitats are rich in diversity and often high in cover of these algae. However, despite their ubiquity they are a poorly known and poorly understood group of marine organisms. Few records of non-geniculate coralline red algae from South Africa were published before 1993 and most of these provided less than adequate descriptions that have not been of modern use in delimiting them. Although much progress has been made since 1993, ongoing collections and their reporting as well as molecular analyses have revealed a number of new and cryptic species. Using traditional histological methods supplemented by molecular data, taxonomic and systematic investigations are being undertaken of the intertidal and shallow subtidal species of non-geniculate coralline alga from the SA coast. Our findings demonstrate that we have highly underestimated the diversity of the South African non-geniculate coralline red algae.

Using niche modeling to analyze drivers of global distributions of South African kelps

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Climate change is affecting kelp distributions and linking their current global distribution to environmental conditions, can assist with predictions of kelp responses in the future. Bio-ORACLE, a global satellite dataset of annual geophysical, biotic and climate variables (environmental variable layers, predominantly satellite-derived) is used in the investigation. Maxent, a maximum entropy modeling system, is further utilized to model species geographic distributions using presence-only data. The global distribution of the world's largest marine benthic organism, the giant kelp, *Macrocystis pyrifera*, is used as an example. *Macrocystis* consists of a single species, which occurs on North and Southern Hemisphere temperate western coasts of the Americas, as well as around the southern hemisphere (South Africa, Tasmania, New Zealand, sub-Antarctic islands). Of the 23 environmental variables from Bio-ORACLE, the five main drivers of *Macrocystis* distribution were identified to be: mean chlorophyll, maximum and minimum sea surface temperatures, maximum cloud cover and phosphate content. The resulting map of the potential global distribution implies that *Macrocystis* could grow in the North Atlantic, where its absence may be due to lack of dispersal, whereas environmental conditions preclude it from areas of the Northwest Pacific (e.g. Japan). Consideration of regional concerns rather than global generalizations may be necessary in to carry these studies further, especially as the use of satellite temperature data may be problematic for upwelling systems, sometimes differing significantly from *in situ* inshore data.

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