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## Professional Exchanges

Coral reef experts and enthusiasts from around the world use NOAA's [Coral Health and Monitoring Program \(CHAMP\)](#) listserve as a forum to discuss and debate a myriad of coral topics and issues. Discussions are lively and can last for weeks. This section presents some of these dynamic discussions among professionals.

To join the coral-list see Coral-List -- [NOAA's Coral Health and Monitoring Program listserver for coral reef research and news](#) for information about the coral-list and instructions for subscribing.

- [Sequencing a Coral Genome](#)
- [Corals vs. Rain Forests](#)
- [Should \*Acropora spp.\* Be Included on the Endangered Species List](#)
- [Deep water Corals](#)
- [A Future for Coral Reefs?](#)
- [The IndoPacific lionfish invasion of the U.S. south Atlantic sea coast and Caribbean Sea](#)
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The content on this web page was last updated in June of 2009. Some of the content may be out of date. For more information: <http://coralreef.noaa.gov/>.

## Update:

A white paper for the National Institutes of Health's (NIH) National Human Genome Research Institute (NHGRI) was submitted in 2003 for the sequencing of the genome of *Porites lobata*. This and follow-up documents, which included letters of support from about 50 investigators from around the world, reflected the prevailing wisdom that *P. lobata* was the preferred species for sequencing. A sequencing plan for *P. lobata* was submitted to NHGRI for consideration in early 2005. Unfortunately, sequencing a coral genome was not seen as being a high priority for NHGRI. The NIH Coordinating Committee believed that coral sequencing would be valuable for basic biology and that *P. lobata* was probably the right choice of species. However, the Committee did not think, at that time, that sequencing a coral genome was of direct enough significance for the general NIH mission.

Subsequently, genome sequencing studies of the Pacific coral, *Acropora Millepora*, have been conducted by Australian and U.S. scientists. NHGRI provided the funding for the *Acropora millepora* genome survey sequence.

## Sequencing a Coral Genome

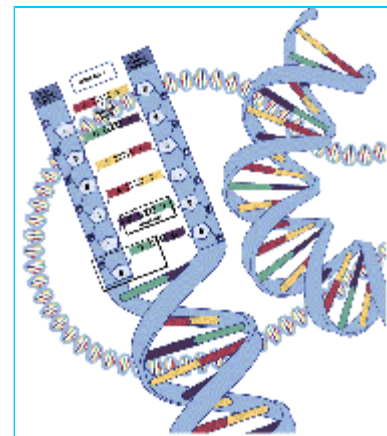
The National Human Genome Research Institute (NHGRI) of the National Institutes of Health (NIH) is considering a \$9 million proposal to sequence a coral genome. The objective of this effort is to identify all the genes in coral DNA, determine their sequences, store information in accessible databases, and compare them with reference DNA sequences in organisms which are better studied to understand gene function. Recent advances in gene sequencing, coupled with the relatively small size of many coral genomes ( $1.12 \times 10^9$  bp/haploid genome) will allow this to be accomplished relatively quickly with appropriate funding. This exchange on coral genome sequencing had three general topics: (1) the importance of sequencing the genome of a reef-building coral species, (2) the specific coral species to sequence, and (3) the concept of selecting a representative species as a coral "lab rat."

[Click here](#) for a list of discussion participants.

[Click here](#) for the summary of professional exchanges on coral genomics.

### Read About:

- ❖ [The Importance of Sequencing a Coral Species](#)
- ❖ [Which Coral Species to Sequence?](#)
- ❖ [A Coral 'Laboratory Rat'](#)
- ❖ [Bibliography](#)



DNA molecule: A (Adenine), T (Thymine), C (Cytosine), G (Guanine), S (Deoxyribose), P (Phosphate). (Credit: NHGRI)  
Click image for larger view.

[Click here](#) to download the complete unedited discussion (pdf, 245Kb).

[Click here](#) for a primer on molecular biology to help those unfamiliar with the subject matter of this exchange.

## The Importance of Sequencing the genome of a Coral Species



The lace coral, *Pocillopora damicornis*, is an inhabitant of Indo-pacific coral reef communities. The species grow as small, bushy-shaped colonies. (Credit: Andrew Bruckner, NOAA Fisheries)

There was unanimous agreement on the importance of sequencing the genome of a reef-building coral species. Participants cited many benefits. The sequenced genome would provide a foundation for new avenues of coral scientific research and also provide a basis for technology development that could benefit coral resource management. It would yield major breakthroughs in phylogenetic systematics.

The sequenced coral genome would also be a major bonus for evolutionary genomics, since corals are representatives of the phylum Cnidaria, a sister group to all the currently sequenced metazoans. The sequenced genome would lay the foundation for all further molecular studies of coral biology. Of major interest to conservation biology would be the molecular mechanisms of stress and resistance, and also the molecular machinery of mutualism between host corals and zooxanthellae. The sequenced genome would make molecular techniques (e.g., microarrays) available to monitor the expressions of

thousands of genes. For instance, genes expressed in normal versus stressed or diseased individuals could be identified, including genes that increase susceptibility or confer resistance to bleaching and disease.

## Which Coral Species to Sequence?

There was no consensus on the "best" species for this first genome sequencing. However, several species were repeatedly advanced throughout the exchange. The authors of the proposal had selected the lobe coral, *Porites lobata*, in part because of "its rising importance as a 'laboratory rat' in coral exotoxicology, coral cell biology, coral immunity and coral neurophysiology." *P. lobata* was also chosen because of its widespread distribution in the Indian and Pacific Oceans, the Red Sea, and the Persian Gulf.



The Indo-pacific lobe coral, *Porites lobata*, has branches that form large lobes. The colonies may be huge, covering several meters. (Credit: Bryan Harry, National Park Service, American Samoa)

Another important advantage of *Porites* over others, such as the acroporids (elkhorn, staghorn and table corals) and star corals (*Montastraea* spp.), is that *Porites* lacks some of the various biochemical interfering substances that make it very difficult to apply molecular and biochemical techniques to many coral families. Finally, *P. lobata* and the mustard hill coral (*P. asteroides*) show a high degree of similarity in many of their enzymes and genes, and it should be easy to adapt technologies that would utilize the gene sequence information of *P. lobata* (e.g., polymerase chain reaction (PCR) gene array, enzyme-linked immunosorbent assay (ELISA), real-time PCR, and immunohistology) for further study of *P. asteroides* or other species of *Porites*.

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In addition to *Porites*, species of *Acropora* (elkhorn corals), *Montastraea* (boulder star corals), and *Pocillopora* (lace corals) were the principal ones advanced as candidates for sequencing. Each of these species was favored for a variety of reasons, including geographic distribution, ecological and economic importance, amenability to molecular techniques, ease of laboratory rearing, growth rate, survivability, susceptibility to disease, and others. No



*The great star coral, Montastraea cavernosa, grows as a mound-shaped colony in the tropical Atlantic waters. (Credit: Andrew Bruckner, NOAA Fisheries)*

consensus was reached about which single species or group should be sequenced first, but the participants were urged by some of their peers to lay aside their personal preferences and support the proposed project. Time was of the essence and the sequencing of the DNA of any coral would benefit all coral science and conservation management.

### **A Coral 'Laboratory Rat'**

There was considerable discussion exploring the concept of a coral "lab rat," a genetically known strain that could be laboratory-reared, mass cultured, and shipped easily with a high chance of survival to any laboratory in the world. Model corals would enable rapid advances by focusing research on fundamental biological concepts broadly applicable across the taxon. Scientists could take advantage of the favorable attributes of this strain to study processes in molecular, cellular, developmental, physiological, and environmental biology. Most of the discussion on this topic focused on the specific characteristics that would be desirable in such a species. There was unanimous agreement among the participants that the coral "lab rat" concept was important and should be pursued. Model corals must be representative of coral diversity, and include Indopacific and Caribbean species, autotrophs and heterotrophs, branching, massive and plating species, and species with different algal symbionts. Because of the corals' evolutionary history, which suggests that extant corals are not a monophyletic group and different families can be both ecologically and physiologically very different, no single species would be representative of corals in general.



*Another view of a great star coral, Montastraea cavernosa, colony. (Credit: NOAA)*

### **Bibliography**

Bruckner, Andrew. Spring 2002. Life-Saving Products from Coral Reefs. Issues in Science and Technology Online.

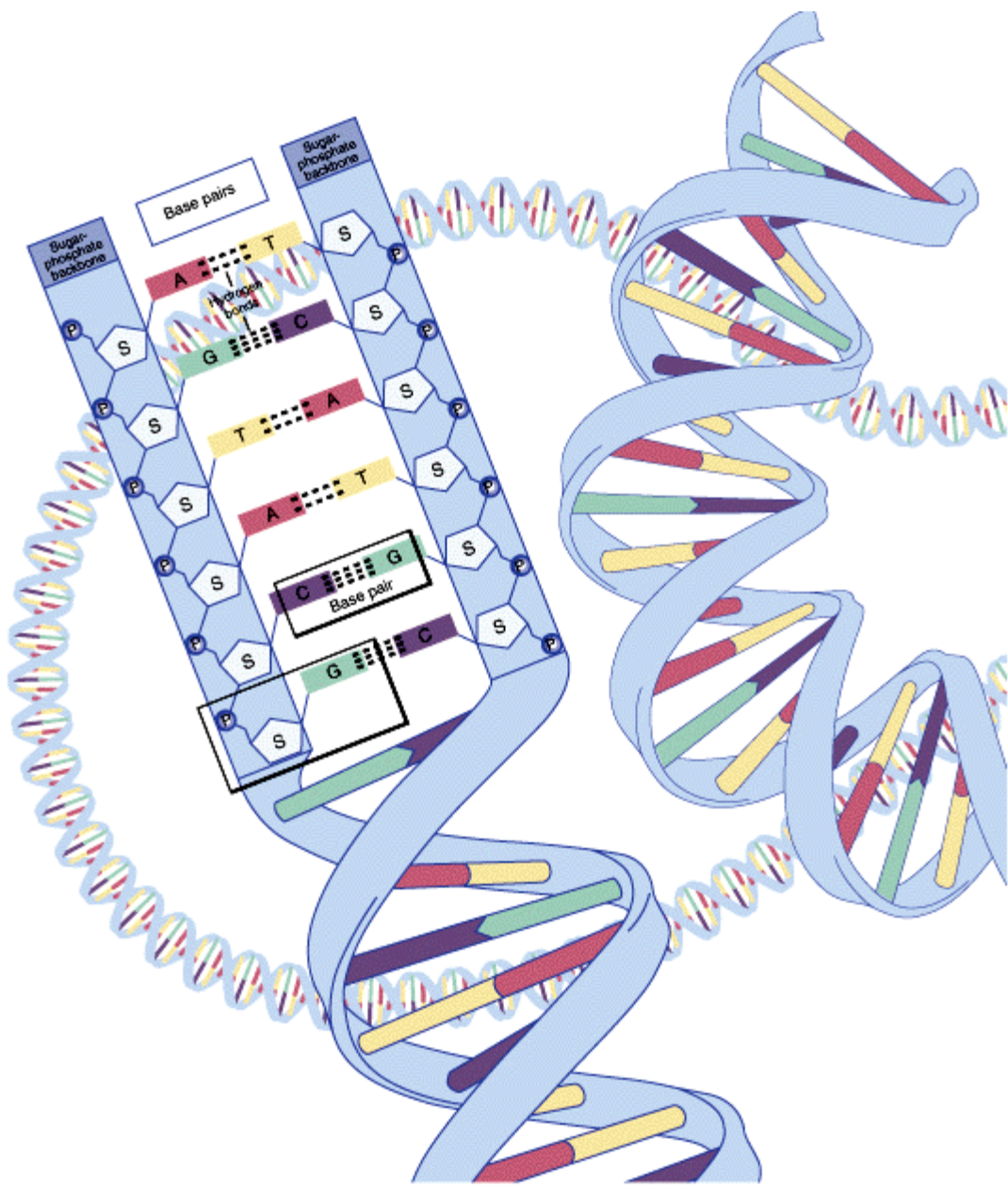
The Human Genome Project, 1990-2003. 2003. Genomics and Its Impact on Science and Society: The Human Genome Project and Beyond. U.S. Department of Energy Human Genome Program.

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## Sequencing a Coral Genome

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## Summary of Professional Exchanges on Coral Genomics

The discussion was initiated by a small group of research partners who asked the coral reef community (via the Coral-list) to provide letters of support for a proposed project to sequence the genome of the reef-building lobe coral, *Porites lobata*. The sequencing of a coral genome would provide a foundation for new avenues of coral scientific research, as well as provide a basis for technology development that could benefit coral reef resource management. Once the genome is sequenced, the work will be published and the entire genome would be made freely accessible to the public. Competition for funds and facilities for genome sequencing is keen and this might be the one chance to have a reef-building coral sequenced in the near future. Many other groups are preparing for large scale sequencing projects and there are only a finite number of laboratories and centers available that have the resources and methodologies to do this work. It is important for the community to come together and explain how and why the information gained from the sequencing would benefit the furtherance of coral research, and what the payoff would be for science and the public.

Responses to the initial posting to the Coral-List were mostly about which species or group of scleractinian corals would be the best candidate(s) for genome sequencing. The project had selected *Porites lobata*, in part, because of "its rising importance as a 'laboratory rat' in coral exotoxicology, coral cell biology, coral immunity and coral neurophysiology." *P. lobata* was also chosen because of its widespread distribution in the Indian and Pacific Oceans, the Red Sea, and Persian Gulf. Another important advantage of *Porites* over others, such as the acroporids (elkhorn, staghorn and table corals) and star corals, *Montastraea* spp, is that *Porites* lacks some of the various biochemical interfering substances that make it very difficult to apply molecular and biochemical techniques, without significant artifact which is present in many coral families. Finally, *P. lobata* and *P. asteroides* (mustard hill coral) show a high degree of similarity for many of their enzymes and genes, and it should be easy to adapt technologies that would utilize the gene sequence information of *P. lobata* (such as PCR, gene array, ELISA's, real-time PCR, and immuno-histology) to *P. asteroides*.



The elkhorn coral, *Acropora palmata*, is a tall, tree-like coral with flattened, fan-like



The mountainous star coral, *Montastraea faveolata*, is a massive, mound-shaped coral colony found in the Gulf of Mexico Flower Gardens, the Florida Keys reef tract, throughout the Caribbean, and other areas of the tropical Atlantic. (Credit: Andrew Bruckner, NOAA Fisheries)

One participant in these discussions replied that the selection of *Porites lobata* as the candidate for sequencing came as a complete surprise. While having a coral genome sequenced would be of great benefit to science, it is critical to select a proper species. He would have preferred a species of *Acropora* or *Montastraea*, as they both seemed to be more advanced in molecular terms than *Porites*. If the species were to be a Caribbean species, another participant offered, one of the *Montastraea annularis* complex species (boulder star corals) would be his first choice, given that this is probably the most important coral today on the Caribbean reefs, and it is affected by multiple diseases. His second choice would be *Acropora palmata* for the same reasons.



branches. It is found in the tropical Atlantic. (Credit: Andrew Bruckner, NOAA Fisheries)

Other participants quickly joined the discussion and suggested other candidate species for sequencing. One advocated *Acropora arabia* from Kuwait because it has adapted to a wide range of environmental stressors, such as wide temperature variations, high salinities, high turbidity, petroleum hydrocarbons on the surface, etc. Perhaps genetic insights could be gained to help other fast-growing acroporids to maintain their distribution better. Another participant added that there are several species of *Porites* and *Acropora* in the Persian Gulf area that have been subjected to, and withstood extreme ranges of temperature (17-35C) and high salinities (40-42+ ppt).

Another participant joined the discussion and questioned the long-term value of sequencing the genome of a threatened or endangered, or regionally local or endemic, species. The interpretation of the significance of the genomic results, in terms of vulnerability, or survival or distribution, would require a great deal more genetic information before one could begin to reap the benefits. A preferable strategy, he added, would be to select a widely distributed cosmopolitan species, and then look for significant differences in the more localized, specialized, or sensitive species. In that sense, *P. lobata*, or one of the widely distributed acroporids or pocilloporids (antler corals) would be as good a choice as any, although with a genus which contains many species, the question of species identification might be a problem. This participant viewed the project in a global, longer-term reef research and preservation framework. He has reservations about the short-term potential of genome research to come up with a 'silver bullet' that will fend off localized extinctions or reef collapses.

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In response to these warnings, one participant summarized the two major benefits of sequencing a coral genome:

(1) a coral genome would be a major bonus for evolutionary genomics, since corals are representatives of the phylum Cnidaria, a sister group to all the currently sequenced metazoans, and (2) a basis will be created for molecular studies of how corals work. Of major interest for conservation biology would be the molecular mechanisms of stress and resistance, and also the molecular machinery of mutualism between host coral and zooxanthellae. Immediate profit would be availability of microarrays to monitor expressions of thousands of genes, which would be a great tool for the fine characterization of coral conditions and stresses.

Following this, he outlined the requirements and features he thought the "model" candidate species should possess. He compared the main candidates, *Acropora* sp, *Montastraea* sp, and *Porites* sp, to the model, which should have the following features:

- A small genome. Most corals have genomes of similar or comparable sizes. The most common diploid number of chromosomes is 28. Therefore genome size, measured in numbers of chromosomes, not in nucleotide content, doesn't matter for most of the candidates. However, genome size is not a function of the number of chromosomes, but related to the size of the chromosomes which vary considerably between species, even within one genus.
- Should be easy to work with basic molecular techniques, such as DNA and RNA isolation. One participant with experience in molecular biology said that *Acropora* is difficult in this respect. *Montastraea* and *Porites* seem to be satisfactory. Nucleic acid isolation and in situ hybridization and RNAi would work better the "meatier" the coral. In this respect, *Montastraea* is favored, especially *M. cavernosa* (great star coral), the fattest coral he ever worked with.
- Amenable to in situ hybridization techniques and RNAi techniques- to study gene expression patterns and knock the genes down, at least locally and temporarily. He did not know of any work with in situ hybridization and RNAi with corals. [In situ hybridization is a method of detecting the presence of specific nucleic acid sequences within a cytological preparation. RNAi (RNA interference) is a cellular mechanism that selectively negates the

effect of any gene by destroying messenger RNA (mRNA). By destroying the targeted mRNA, improper protein synthesis, the cause of most disease, is interrupted, effectively "silencing" the target gene. The process is triggered by double-stranded RNA (dsRNA), where one strand is identical to the target mRNA sequence].

- Should be easily kept in the laboratory, preferably growing. All three candidates meet this criterion. *Acropora* grows fastest and *Montastraea* grows slowest.
- Should be widely distributed and ecologically significant, or be a representative of a closely related group of ecologically significant species, in order that sequence information from the genome project could be used for studies in many places and many similar species. None of the candidates have a single species which is globally distributed. There is a limitation to either the Caribbean or Indo-Pacific. However, at the generic level, all three (*Acropora*, *Montastraea* and *Porites*) are distributed worldwide and are the most important reef-builders. *Acropora* represents the largest genus with about 250 species. *Porites* is second with some 50 species, and *Montastraea* is last with about 10 species. The downside of using species-rich genera is that more taxonomic difficulties are presented.
- Existence of other relevant molecular projects, such as EST sequences. (an expressed sequence tag (EST) is a small part of the active part of a gene, made from cDNA which can be used to fish the rest of the gene out of the chromosome by matching base pairs with part of the gene. The EST can be radioactively labeled in order to locate it in a larger segment of DNA). Existence of supporting molecular projects is very important. In general, there is not much grant money to support coral molecular biology, so the community ought to stay focused. To this participant's knowledge, there were some EST projects on *Acropora millepora*, and another on *Montastraea annularis*.
- Popularity of the species in general as a model for various non-molecular research projects. *Acropora* is probably the most popular, *M. annularis* comes second and *Porites* seems to lag behind.
- Ultimately, the species should be reproducible in the laboratory, completing its full life cycle in less than a year, and be amenable for transgenic manipulations. The author of this model was not aware of any species of coral that would fulfill this requirement.

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Based upon these model features, he concluded that there is no formally best candidate, so the choice would depend on how one would weigh the above eight considerations. He tended to put more weight into general popularity and existence of other molecular projects, so that in his view, *Porites* is not a good candidate. In all other respects *Acropora* seems better than *Montastraea*, except for the notion that it would be more difficult to do molecular work with *Acropora*.



The colonies of the mustard hill coral, *Porites astreoides*, are usually small, but may grow several meters in diameter. They are found in coral reefs of

Other participants in this discussion group responded to this model. A researcher working on a stress related syndrome of *Porites lutea* in the Indian Ocean would be happy to get any sequencing data, regardless of which species of coral, though he believed that the slow growing corals should be sequenced first. Another suggested the lace coral, *Pocillopora damicornis*, as a species that reproduces prolifically by asexual formation of planula larvae. *P. damicornis* has a wide distribution and is easily cultured in aquaria, where it can reproduce asexually in a year or less. *P. damicornis* received another endorsement from a participant for reasons that it grows rapidly in aquaria and is very hardy and adaptable to varying conditions. It has a very fine branching structure and even a modest-sized colony can be fragmented into many uniform-sized branch tips for starting replicate, genetically identical colonies for laboratory work. Very small fragments of *P. damicornis*, with just a few polyps, can be used to start a new colony, and attachment to new surfaces is very rapid. It

*the tropical Atlantic (Credit: Andrew Bruckner, NOAA Fisheries)*

has a high density of large, long polyps that are almost always well extended. The polyps are very transparent, except for their zooxanthellae, and some polyps are almost completely unobscured by zooxanthellae which would be perfect for studies of gene

expression in which genes of interest have been linked. Also, the colonies are relatively unbothered by handling and vibrations.

Another coral expert came down on the side of *Porites* as the best candidate for sequencing because it is an important reef builder in both the Caribbean and Indo-Pacific, and the third largest genus of corals. Also, the huge, massive *Porites* are the sources of climate records. *P. lobata* is the most common of the big massive ones used for climate studies and is one of the most widely spread of all the corals. *Acropora* is also a major reef builder in both the Caribbean and Indo-Pacific. It is also the largest coral genus with some 165 species, so far. *Montastraea* appears not to be a good candidate because, while it is a major reef builder in the Caribbean, it is not in the Indo-Pacific, with only a few small uncommon species.

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Another participant thought that the model would argue against massive growth forms as candidates in the first round of sequencing. What is important in the first round is experimental feasibility. He reluctantly stepped back from *Porites* and supported *Pocillopora*, or a robust and well-characterized *Acropora*. However, he agreed with his colleague that the massive *Porites* have the greatest colony longevity and are widely used as environmental sensors. That, plus widespread distribution and geological and ecological importance, keeps them high on the list of candidate species for sequencing. Low down on the list is *Montastraea* because of its paucity in the Indo-Pacific.

Another participant in this discussion didn't agree that a coral that is primarily useful for fossil/paleoclimate studies would be one of the best choices for a genomics project. He thought that the coral community should figure out what would be the coral equivalent of a laboratory rat or fruit fly. A species should be selected that is most amenable to laboratory manipulations and studies on living organisms; or, a target organism should be found that will provide the most useful leads on the reagents needed to do field studies on mRNA's or proteins isolated from specimens in the wild. He further opined that if no such hermatypic coral exists, the community might be better served by picking another model cnidarian that is more conducive to laboratory manipulation.

A participant with experience in sequencing DNA from many Caribbean corals joined in the discussion. A consideration, also mentioned earlier by another researcher in selecting a scleractinian coral species, is the availability of zooxanthellae-free tissues. DNA from the zooxanthellae is often amplified (and subsequently sequenced) in addition to the coral DNA, unless the tissue is free from zooxanthellae or the primers are specific to cnidarians. The symbiotic dinoflagellates have a genome size which is estimated to be 100 times larger than the coral genome, further complicating the effort. Spermatozoa from broadcasting species were suggested. This investigator's preference for a candidate is *Porites* for a number of reasons: microsatellites for *P. astreoides* have already been developed; there are several representatives in the Caribbean and Indo-Pacific (microsatellites for *Montastraea cavernosa* have also been developed, but it would be more useful for molecular biologists to select a species from a genus with a wide distribution), thus the *Porites* genome can be used as a model for efficiently developing genetic markers for several species of *Porites*; it is easy to conduct molecular analyses on *Porites* (high amplification and sequencing success); and as brooders that release larvae multiple times throughout the year, molecular biologists can take advantage of breeding experiments without having to hope for good weather conditions on the couple of evenings of mass spawning. The participant concluded her remarks with the observation that regardless of what species is selected, the sequencing information would be extremely useful for those interested in genetic structure and gene flow of coral species. Mitochondrial markers used for population genetics on other organisms cannot be used in corals due



*Stylophora is an ecologically important genus of Indo-Pacific corals. The species are branching forms with common names that include club finger coral, brush coral, and finger coral. (Credit: Andrew Bruckner, NOAA Fisheries)*

to the slow rate of evolution in the mitochondrial genome. Therefore, other markers need to be developed, and having a model genome available to develop them will save the research community time and money.

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Other participants presented their cases, pro and con, for the model species. One suggested that *P. damicornis* and the cauliflower coral, *Stylophora pistillata*, are already coral “guinea pigs” and are widely distributed, important reef-builders with large literature bases. Another added that *S. pistillata* has been used extensively in experiments on metabolism and zooxanthellae, and was even referred to as the ‘coral lab rat’ in the 9th International Coral Reef Symposium. It is widespread in the Indo-Pacific, though not as widespread as *P. damicornis*. However, the genus is not present in the Caribbean. In the Caribbean, the acroporids and *Montastraea sp* seem to be the logical choices. In fact they were already selected by the Coral Health and Disease Consortium (CHDC) as candidates for coral ‘lab rats’ in culture. Their life histories are also more representative of the majority of corals.

Another argued that *Porites* made the most sense as the best candidate based on the criteria presented. *Pocillopora* is not as durable in shipping and handling and is susceptible to *Vibrio* (a bacterium) infections. This participant also added a new candidate genus to the discussion, the petaloid coral, *Psammocora*. It is widespread globally, easy to grow and to ship, and has a post-transit recovery capacity at least as good as *Porites*. Another participant offered that the ecological significance of the species really doesn’t matter. What matters is the “phylogenetic pedigree” and a body of work in the offering on gene-environmental processes. These considerations put *Porites*, *Acropora* and *Pocillopora* at the head of the list, in roughly that order, with one of the prominent faviid genera next. He suggested that preliminary trials be done on the top-ranking species before committing to any one, since many of the genetic/methodological criteria for the model may not be known yet for either *Porites* or *Acropora*. He concluded however, that a *Porites* species would probably top the list, as these are widespread and phylogenetically and ecologically important, whether the massive ones, for which we have climate records and can relate genotypes to historical conditions, or the branching ones, which satisfy more of the ‘lab rat’ criteria. *Porites* also has interesting syndromes in the field that would make genetic studies interesting. For example, the pink-line syndrome, abundance of growth tumors, permanent white patches, mucus sheaths of mysterious function, broad temperature acclimation range, long lifespan, etc. Perhaps, he suggests, the yellow finger porites, *Porites cylindrica* (or other branching *Porites*), might do better satisfying the distribution and lab rat requirements, having an interesting evolutionary/ecological history as well as being workable, thus satisfying other criteria. In second place would come one of the widely distributed *Acropora* head/cushion species, with relatively broad environmental tolerance, or *Pocillopora damicornis*, the “lab rat par excellence.”

One participant thought that the proposition that one coral species can be a representative ‘lab rat’ for physiological, etc., studies of corals is flawed by not considering the evolutionary history of living corals. Corals are probably not a monophyletic group and the different families differ significantly in their physiology, ecology, and genetics. Results from one species cannot be safely extrapolated to responses of species from different groups. However, even though there is no single species of coral that is representative of corals in general, a start has to begin somewhere with a single species, and do others as resources may allow. Furthermore, in terms of selection factors, ease of culture, shipping survivability and other practical considerations may be more important in terms of getting as much generic benefit from the genetic results than are the ecological or regional importances of the species.

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A non-U.S. participant, only recently aware of this discussion forum, thought that there were some things that should be more widely known than they appeared to be. It seemed to him that there appears to be misapprehension that a stony coral genome would be the first cnidarian to be sequenced. He thought it more likely that a proposal for sequencing the genome of the starlet sea anemone, *Nematostella vectensis*, will be successful, having strong support from the evo-devo community (in 1999, developmental biology and evolutionary studies



The starlet sea anemone, *Nematostella vectensis*, is a non-tropical cnidarian (not a coral) that occurs in shallow North American and western European coastal waters. It is becoming an increasingly important model system for the study of development, evolution, reproductive biology, genomics, and ecology. (Credit: Biology Department, Technische Universität Darmstadt)

merged when evolutionary developmental biology, or "evo-devo," was granted its own division in the Society for Integrative and Comparative Biology (SICB). Evolutionary biologists seek to understand how organisms evolve and change their shape and form. The roots of these changes are found in the developmental mechanisms that control body shape and form. Developmental biologists try to understand how alterations in gene expression and function lead to changes in body shape and pattern). Further, it seemed essential that the approximate size of the genome of the coral candidate be known. Genome size is a function of both the number of chromosomes and the size of the chromosomes. This participant, in reference to the model criteria put forward, pointed out the requirement or desirability of technology and tools for the coral species selected. In this light, he discussed the advantages of *Acropora millepora*. *Acropora* is the second best represented cnidarian (behind *Hydra*) in the genomic databases. Its genome appears to be at the low end of cnidarian genome sizes. Also, most of the molecular tools are there for *A. millepora* (genome libraries in lambda and cosmid vectors; cDNA libraries for six different embryonic and larval stages, as well as adult colonies; an extensive EST data set; microarrays featuring 3000 EST's of known sequences are available.

In addition, in situ hybridization technology works with *A. millepora*, whereas he doesn't believe this method has been established for any other coral. Therefore, as far as the molecular basics being in place, *Acropora* is a much more advanced system than is any other coral. He is sure that the evo-devo community would strongly support a proposal to sequence the genome of *A. millepora*.

Another coral scientist offered that the proposed sequencing for *Porites lobata* would be a real plus for coral biology. He chided the respondents for nominating their own favorite species instead of the proposed species. In the first go-round they should get squarely behind their colleagues and help them promote an idea, realizing that success with the first species will help everyone move forward. Too much sniping in the community leads to confusion in the funding agencies, which end up funding other disciplines. Another coral scientist also urged that all pull together and support the *Porites* sequencing proposal, noting however, that the postings have been worthwhile and very valid points on alternate species have been brought up. These discussions also pointed out that those that work in genomics need to better convey the power, potential, and applications of the technologies to researchers in other scientific disciplines, as well managers and policy makers. However, she was concerned that the discussion was beginning to lose sight of the real goal in the effort to have a coral genome sequenced: to generate vital coral genome sequence data, and make it widely available to the research community via the public domain. It would be a great advantage for the coral community to have a sequenced coral genome added to the short list of other fully sequenced eukaryotic (organisms with cells having a distinct nucleus with nDNA, and intracellular membranes) genomes. This includes all protists, fungi, plants and animals) genomes. This effort also satisfies a major mandate of the CDHC National Research Plan. The completion of a genomic sequence will have many positive effects on the field of coral research and others, many of which cannot be foreseen. There was a short deadline, ergo, a narrow window of opportunity to respond as a unified research community to say that a coral genome needs to be sequenced, and the community will use these resources to move the field of coral research and conservation management forward.

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Lastly, the scientist that sparked this discussion by asking for letters of support to a funding agency for sequencing the genome of *Porites lobata*, said that for the past couple of years, his group has been evaluating criteria for a 'coral lab rat', an organism representative of scleractinians to be used

as a model for molecular genetics, cell biology, biochemistry, lipid chemistry, sterol/polyphenol chemistry, environmental/physiological monitoring, ecotoxicology, stress physiology, coral immunity, coral oncology, coral endocrinology and coral neurophysiology. He had asked a diverse group of coral biologists to nominate and justify a coral candidate, but the responses were slow. He stated that a laboratory biologist, like himself, needs a 'lab rat' for other laboratories to repeat his experiments or take the work further. From his point of view, the most important criterion for a coral lab rat is accessibility. The point is not to sequence the genome from a Caribbean or Pacific species, as has been mentioned several times in this exchange. Everyone must have relative ease in obtaining genetically identifiable laboratory strains which means that the first strain will come from a single colony and mass cultured. Some group must have the facilities to rear this coral in abundance and be able to distribute it to any laboratory in the world. The coral must also be hardy enough to survive the trip. *Porites* meets the criterion of survivalship. Few species besides *Gonistrea* or *Pavona* has the resilience of *Porites*.

Another issue is the amenability of many of the tools of molecular, cellular and physiological biology applied to that species. He has had considerable experience with *Acropora* and *Montastraea*, and he ruled out both of them. The 'lab rat' also has to be a good species for applying cell culture techniques. He states that acroporids aren't bad and others have had success with *Pocillopora*, *Porites* and *Oculina*. *Oculina varicosa*, or any of its sibling species, would be a good candidate for a 'lab rat'. However it is not a major reef builder and doesn't handle shipping very well. From a laboratory technique perspective, *Porites* exhibits the least amount of technique artifact and can be shipped easily with high success of survival after shipping. In terms of physiological ecology, *Porites* and *Acropora* are found worldwide, but *Acropora* is not as resilient as *Porites*, and is the first to "crash" during an environmental event, such as an oil spill or unusually high sea surface temperature. The candidate species must be vigorous enough to survive after the environmental insult.

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The sequenced genome is a platform that may be used to extend basic research into areas of coral biology where it has been so difficult to go in the past, or a platform to develop new technologies to allow us to see further. Basic science questions can be greatly aided by knowing the sequence of the coral genome. For example, is this coral immunocompetent or endocrine modulated? We need to know the genes that contribute to these systems to explore their individual and combined behaviors. Cnidarians have the most primitive of the metazoan nervous systems. Are their neuropeptides different from higher organisms, and why? Corals often develop areas of abnormal growth referred to as hyperplasms or neoplasms. These areas contain tissues which are radically different from normal polyps. Can our understanding of cancer in mammals be aided by our understanding and the future discoveries of how corals get cancer? The technologies that can be developed from a sequenced coral genome are only limited by imagination and determination.

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As of May, 2004, the funding agency looks favorably on the proposal to sequence the genome of a coral, but a decision has yet to be made on which species, though it probably has come down to *Porites* or *Acropora*. Once that decision has been made, the selected coral species will be prioritized among the other candidates species for sequencing, and a final decision on funding for this cycle will be made.

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# [Coral-List] Sequencing of Porites Genome

**craigdowns** [craigdowns at envirtue.com](mailto:craigdowns@envirtue.com)

*Mon Sep 8 21:15:48 EDT 2003*

- Previous message: [\[Coral-List\] vacancy announcement-MPA programs, American Samoa](#)
- Next message: [\[Coral-List\] question regarding importation of red coral to the USA](#)
- **Messages sorted by:** [\[ date \]](#) [\[ thread \]](#) [\[ subject \]](#) [\[ author \]](#)

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Dear Coral List Server Members,

The sequence of a coral genome would provide a tremendous foundation for coral scientific research, as well as provide a basis for technology development that could benefit coral-reef resource management. Dr. Gary Ostrander (Johns Hopkins University) is leading an effort towards the goal of sequencing the genome of *Porites lobata*. We are soliciting letters of support for this endeavor from the coral reef scientific and management community. Once the genome is sequenced, the work will be published in a peer-reviewed journal and the entire genome will be made freely accessible to the public.

We have chosen *Porites lobata* because of its rising importance as a 'laboratory rat' in coral ecotoxicology, coral cell biology, coral immunity and coral neurophysiology. We have also chosen this species because of its extensive distribution in the Indian and Pacific Oceans, the Red Sea, and the Persian Gulf. Another important advantage of *Porites* over other species, such as *Acroporids* or *Montastrea spp*, is that *Porites* lacks some of the various biochemical interfering substances present in many coral families; substances that makes it very difficult to near impossible to apply molecular and biochemical techniques without significant artifact. Finally, *Porites lobata* and *Porites asteroides* show high similarity for many of their enzymes and genes. It should be easy to adapt technologies that would utilize the gene sequence information of *Porites lobata* (such as PCR, gene array, ELISAs, Real-time PCR, immuno-histology) to *Porites asteroides*.

Attached to this email is a letter explaining this project in more detail, as well as guidelines for a letter of support.

If you have any questions, please don't hesitate to contact Gary ([gofish at jhu.edu](mailto:gofish@jhu.edu)) or I.

Sincerely,

Craig

Craig A. Downs  
President  
EnVirtue Biotechnologies, Inc.  
35 W. Piccadilly Street  
Winchester, Virginia 22601 U.S.A.

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[www.envirtue.com](http://www.envirtue.com)

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**craigdowns** [craigdowns at envirtue.com](mailto:craigdowns@envirtue.com)

*Tue Sep 9 19:15:41 EDT 2003*

- Previous message: [\[Coral-List\] post-doc/graduate stipends available](#)
- Next message: [\[Coral-List\] Coral Genome Sequencing \(3\)](#)
- **Messages sorted by:** [\[ date \]](#) [\[ thread \]](#) [\[ subject \]](#) [\[ author \]](#)

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Dear Coral List Serv,

For some reason, the attachment never came through on the list serv, so I have pasted the letter below.

-Craig

Colleagues,

I am coordinating an effort to sequence (likely 6x coverage) the genome of *Porites lobata*. NHGRI has a deadline of October 10 for "white papers" for sequencing projects and I have enlisted TIGR (Steven Salzberg) and the President of EnVirtue Biotechnologies, Inc. (Craig Downs) as partners. This effort also has the endorsement of Craig Venter, founder of TIGR and President of The Center for the Advancement of Genomics (TCAG). If approved, the sequencing project would be undertaken by one of the NHGRI-funded sequencing centers. We believe it is likely that TIGR and its new Joint Technology Center will shortly



join that group of centers, with their new project to be headed by Dr. Venter.

A very significant part of the application is the letters of support from the community that anticipates using the genomic information that will be generated. In fact, I have learned from others who have written successful papers that these letters are essential and play a major role in determining the priority of the organisms for sequencing. To this end I am soliciting as many member of the coral reef community as possible to provide letters. Without a significant number of these letters (25+) this project has little chance of being selected and funded.

Letters should be no more than one page, must be signed, and should be on your institution's letterhead. Your letter must be specific and should include the following:

1. How will sequencing the *Porties lobata* genome will help your own work? Again, be as specific. What are you studying and what fundamental questions or experiments of significance will you now be able to do with this information? For example, you can just say, we'll expand our efforts in blah blah. Instead, state that your are interested in positional cloning of several genes of the XX disease family and we now have to clone every gene in the region of linkage that we've defined one at a time by screening libraries with degenerate primers, which works only some of the time and often gives us false positives, especially for the XX gene family which is complex. But if the sequence were available we'd just download the sequence, make PCR primers, and screen for mutations in our disease population. You should make it clear that you have the resources to use the sequence deformation and that you in fact will use it. In short, NHGRI wants to know that significant work will now be completed as a result of this effort.

2. How will sequencing of the *Porites lobata* genome help you in the funding of your work (regardless of the agency supporting you) and in particular will this bring others to the field? NHGRI wants to know that this will impact a significant number of individuals and may even expand the number of workers in the field. It would be a severe criticism to NHGRI if they funded the sequence of an organism for 9+ million dollars and 3 years later only a handful of groups were using the information.

3. If you agency or organization can provide any funding toward this effort in any capacity (even "in-kind" efforts) it should be mentioned. For example, it would be great if an agency were willing to underwrite the cost of a meeting, once the data becomes available, to train individuals on how to use the data etc. I have been told that any kind of support from other organizations will carry a lot of weight.

4. A minor point, check your ego at the door. While I have asked you to tell me how the sequencing of *Porties lobata* will help you.. I do not need a lengthy discourse on your own research. What they are

looking for is how completion of this project going to be of global significance. So, as much as possible please, provide some example of the cosmic significance of this undertaking. Feel free to comment aboutwork that may not be related to your own corner of the world/reef! I have been told by someone who helped write the guidelines the committee is not interested so much in the quality/quantity of the science that you have done in the past as they are in what will come out of this effort. They want to see vision. In fact, they don't even ask for CV's.

5. I need your letter by October 1st. Please send me a hard copy or at least a FAX by that time to: Dr. Gary K. Ostrander, Department of Biology, 237 Mergenthaler Hall, 3400 North Charles Street, Johns Hopkins University, Baltimore, MD 21218. My FAX number is 410/516-4100 and you can call (410/516-8215) or email ([gofish at jhu.edu](mailto:gofish@jhu.edu)) with questions.

6. Please give very serious consideration to this request. This may be our one opportunity to accomplish this objective in the near future. Many groups are gearing up for large scale sequencing projects and the competition to access this resources will only get stiffer. Also, there are a finite number of centers and "lanes" available for sequencing at this time.

7. Finally, if you would be kind enough to drop me an email now as to what the major impact of this project will be for you..I can be sure to include it in the text of the white paper now.

Thank you in advance,

Gary K. Ostrander  
Department of Biology  
Johns Hopkins University

Craig A. Downs  
President  
EnVirtue Biotechnologies, Inc.  
35 W. Piccadilly Street  
Winchester, Virginia 22601 U.S.A.

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**Mikhail Matz** [mvmatz at yahoo.com](mailto:mvmatz@yahoo.com)

*Wed Sep 10 15:05:21 EDT 2003*

- Previous message: [\[Coral-List\] Coral Genome Sequencing \(3\)](#)
- Next message: [\[Coral-List\] Porite genome 2](#)
- **Messages sorted by:** [\[ date \]](#) [\[ thread \]](#) [\[ subject \]](#) [\[ author \]](#)

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Dear Craig and all,

The Porites candidate came as a surprize to me. My support would be for Montastraea (since my own molecular work is on M.cavernosa, and by the way, I never encountered the technical difficulties that Craig refers to), or Acropora. These two seem to me much more advanced in molecular terms than Porites.

I do believe that having a coral genome sequenced would greatly benefit all of us and science in general, however, it is critical to select a proper species. I would be very glad to hear opinion of the list on this matter.

In fact, I heard rumors of a couple other projects started that would lead to coral genomic studies, but nothing definite. Would be great to know for sure what is going on (or going to be going on) in this area!

cheers

Mike Matz

Whitney lab, University of Florida  
[http://www.whitney.ufl.edu/research\\_programs/matz.htm](http://www.whitney.ufl.edu/research_programs/matz.htm)

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**Todd Barber** [reefball at reefball.com](http://reefball.com)

*Thu Sep 11 10:18:55 EDT 2003*

- Previous message: [\[Coral-List\] Porite genome 2](#)
- Next message: [\[Coral-List\] Porite genome 2](#)
- **Messages sorted by:** [\[ date \]](#) [\[ thread \]](#) [\[ subject \]](#) [\[ author \]](#)

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As a forward thinking possibility, consider Acropora Arabia from Kuwait which to my knowledge is the Acropora species with that has adapted to the most environmental changes likely to be seen in our earth's future. (Wide temperature variations, high salinity, high turbidity, oil on the surface, etc.). Perhaps we could, in the future, gain genetic insights to help other fast growing acroporas to maintain their distribution better.

Thanks,

Todd Barber  
Chairman, Reef Ball Foundation, Inc.  
President, Reef Ball Development Group, Ltd.  
6916 22nd Street West  
Bradenton, FL 34207

941-752-0169 (Office)  
941-752-1033 (Fax)  
941-752-0338 (Personal)  
941-720-7549 (Cell when traveling)

[reefball at reefball.com](mailto:reefball@reefball.com)

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**Tarr, Bradley A SAJ** [Bradley.A.Tarr at saj02.usace.army.mil](mailto:Bradley.A.Tarr@saj02.usace.army.mil)

*Fri Sep 12 10:33:23 EDT 2003*

- Previous message: [\[Coral-List\] Invitation to ICRI CPC Meeting](#)
- Next message: [\[Coral-List\] Request information on bleaching or no-bleaching from Okinawa, Japan](#)
- **Messages sorted by:** [\[ date \]](#) [\[ thread \]](#) [\[ subject \]](#) [\[ author \]](#)

For that matter, the Persian (Arabian) Gulf contains several species of Porites and Acropora that have been subjected to and withstood extreme ranges in sea temperatures (17-35C) and high salinities (40-42+ppt).

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**craigdowns** [craigdowns at envirtue.com](mailto:craigdowns@envirtue.com)

*Mon Sep 15 10:32:52 EDT 2003*

- Previous message: [\[Coral-List\] Request information on bleaching or no-bleaching from Okinawa, Japan](#)
- Next message: [\[Coral-List\] ALGAL reproduction](#)
- **Messages sorted by:** [\[ date \]](#) [\[ thread \]](#) [\[ subject \]](#) [\[ author \]](#)

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Colleagues,

There have been some questions raised by some of you about the availability of the Porities sequence data to the scientific community. We are writing to assure you that this data will be freely available to everyone in the community.

If approved by NHGRI, the coral genome will be sequenced by one of the NHGRI Centers, which we anticipate will be the new center at TIGR called the Joint Technology Center (final funding decisions will be announced before Sept 30). All data from all NHGRI projects at TIGR's Joint Technology Center will be released with absolutely no restrictions. There will be no costs to obtain the data, and there will be nothing getting in the way of anyone who wants to download it. You won't have to click on a license, you won't have to identify yourself, and you won't have to agree to any restrictive policies. You can redistribute the data, publish new findings based on it, or even sell it if you want!

In our grant application to NHGRI, we emphasized our commitment to free, unrestricted release of all genome data AND all analyses of that data done by the Joint Technology Center, if we are funded. We will produce genome assemblies and automated analyses very rapidly and we will release those immediately to the community.

We cannot emphasize how important it is for us to make it clear to the coral research community what our intentions are on this data release issue. This will be a public resource, publicly funded and intended to benefit the entire scientific community. No one will have special access, not even the center generating the data.

Please feel free to contact us if you have additional questions or concerns or would like to discuss this matter further.

Gary K. Ostrander  
Craig Downs

[gofish at jhu.edu](mailto:gofish@jhu.edu)  
[craigdowns at envirtue.com](mailto:craigdowns@envirtue.com)

Steven Salzberg

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**Andy Bruckner** [Andy.Bruckner at noaa.gov](mailto:Andy.Bruckner@noaa.gov)

*Mon Sep 15 17:16:15 EDT 2003*

- Previous message: [\[Coral-List\] Porite genome 2](#)
- Next message: [\[Coral-List\] Porite genome 2](#)
- **Messages sorted by:** [\[ date \]](#) [\[ thread \]](#) [\[ subject \]](#) [\[ author \]](#)

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Hi folks,

I would like to add my 2 cents to this issue. Not sure if it is too late, but I would side with Mikhail. It seems to me that (if it is a Caribbean species) one of the Caribbean *Montastraea annularis* complex species would be our first choice, given that this is the most

important coral today on Caribbean reefs and it is affected by multiple diseases. My second choice would be *Acropora palmata* for the same reasons.

Andy

---

**Robert Buddemeier** [buddrw at kgs.ku.edu](mailto:buddrw at kgs.ku.edu)

*Tue Sep 16 12:44:20 EDT 2003*

- Previous message: [\[Coral-List\] Porite genome 2](#)
- Next message: [\[Coral-List\] coral genome](#)
- **Messages sorted by:** [\[ date \]](#) [\[ thread \]](#) [\[ subject \]](#) [\[ author \]](#)

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I have been following this discussion with some interest. Since I know relatively little about the potential application of genomics, this may be an ignorant question, but ----

What good will it do us, in the larger sense, to get the genome of a threatened or endangered or or regionally local or endemic species? Wouldn't interpreting the significance of those results (in terms of vulnerability or survival or distribution) require a lot of other genetic information before you could start to reap the benefits?

It seems to me that a preferable strategy would be to go for a widely distributed, cosmopolitan species and than look for significant differences in the more specialized or localized or sensitive species. In that sense, *Porites lobata* (or one of the widely distributed Indo-Pacific acroporids or pocilloporids) would seem to me to be as good a choice as any, although the thorny question of species identification in the morphological and environmental senses will certainly rear its head whatever you choose to look at.

This would seem to me to put the project into a global, longer-term reef research and preservation framework. I have pretty severe reservations about the short-term potential of genome research to come up with a silver bullet that will fend off localized extinctions or reef collapses.

What am I missing about the objectives and potential applications?

Bob Buddemeier

---

**Mike Matz** [matz at whitney.ufl.edu](mailto:matz at whitney.ufl.edu)

*Tue Sep 16 17:48:12 EDT 2003*

- Previous message: [\[Coral-List\] Porite genome 2](#)

- Next message: [\[Coral-List\] coral genome](#)
- Messages sorted by: [\[ date \]](#) [\[ thread \]](#) [\[ subject \]](#) [\[ author \]](#)

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Hi all,

In response to the questions from Bob Buddemeier, let me try to summarize the two major benefits of sequencing a coral genome:

1. Coral genome would be the major bonus for evolutionary genomics, since corals are representatives of the Cnidaria - sister group to all the currently sequenced metazoans.

2. A basis will be created for molecular studies of how coral works. Of big interest for conservation biology would be molecular mechanisms of stress and resistance, and also molecular machinery of symbiosis between host and algae. Immediate profit would be availability of microarrays to monitor expression of thousands of genes, which would be a great tool for fine characterization of various coral conditions and stresses.

For wide scientific community, the first benefit is definitely the most interesting, while the second is more for the specialists in reef biology.

Main candidates nominated for genome sequencing:

Acropora sp (millepora?)  
Montastraea sp (annularis/faveolata?)  
Porites sp (lobata?)

Let's try to compare them, The model should have the following features:

1. should have small genome;
2. should be easy to work with basic molecular techniques such as RNA and DNA isolation;
3. should be amenable to at least to in situ hybridization techniques and to RNAi techniques - to study gene expression patterns and knock the genes down, at least locally and temporarily.
4. Should be easily kept in the lab, preferably growing.
5. Should be itself widely distributed and ecologically significant, or be a representative of a closely related group of ecologically significant species, so that sequence information from the genome project could be used for studies in many places and many similar species.
6. Existence of other relevant molecular projects, such as EST sequences.

7. Popularity of the species in general as a model for various non-molecular research.

8. Ultimately, the species should be reproducible in the lab, completing full life cycle in less than a year, and amenable for transgenic manipulations.

Please add your requirements if you feel necessary.

Discussion:

1. Small genome: to my knowledge, most corals have genomes of similar or at least comparable sizes, most common 2n number of chromosomes being 28. So the first issue would not matter much for most candidates. *Montastraea* is 2n=28, as are most *Acroporas*, I wonder about *Porites*.

2. RNA-DNA isolation: Craig says *Acroporas* are difficult in this respect. *Montastraea* and *Porites* seem to be OK. I have a feeling that generally, this and the next issue (in situ hybridization and RNAi) would work the better the meatier is the coral, so I favor *Montastraea* (especially *cavernosa* - the fattest coral I ever worked with). Still, to my knowledge, nobody ever attempted in situ hybridization or RNAi on coral (please let me know if I'm wrong!)

4. All the three candidates are nicely living in the lab, *Acropora* grows fastest, *Montastraea* - slowest. *Acropora* seems to be more gentle than the other two.

5. None of the candidates has a single species that is distributed everywhere. At least there is a limitation either to Caribbean or Indo-Pacific. Still, at the generic level, all three genera - *Acropora*, *Porites* and *Montastraea* - are distributed worldwide and are of the most important reef-builders. *Acropora* model would represent the most species-abundant genus (some 250 species), which is good. *Porites* comes second in species numbers (some 50 species), and *Montastraea* - last, some 10 species. There is a slight downside of using representatives of species-rich genera - there are more taxonomic difficulties there, but this would not matter much for our situation, I guess.

6. Existence of supporting molecular projects is a Very Important Issue indeed. We don't get too much money for coral molecular biology in general, so it would be much better to stay focused. To my knowledge, there are some EST projects going on *Acropora millepora* (although I don't know what the status is) and another is just coming up on *Montastraea annularis*. I heard nothing about molecular work on *Porites*. This was the main reason why I was so skeptical about *Porites* candidate in the beginning.

7. Popularity: *Acropora* is definitely the star, *Montastraea annularis* comes second. *Porites* seems to lag behind.

8. The ultimate requirement. I am not aware of any coral that would fulfill it.



Conclusion: there is no formally best candidate, so the choice would depend on how one would weight the above considerations. I tend to put more weight into general popularity and existence of other molecular projects, so, in my view, Porites is not a good candidate. In all other respects, Acropora seems better than Montastraea, except for the notion that it might be more difficult to do molecular work, which would be very bad indeed. Could anybody confirm this?..

cheers,

Mike

Mike Matz  
Whitney Lab, University of Florida  
904 461 4025  
[http://www.whitney.ufl.edu/research\\_programs/matz.htm](http://www.whitney.ufl.edu/research_programs/matz.htm)

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## Coral-List] Coral genome

**Ernesto Weil** [eweil at caribe.net](mailto:eweil@caribe.net)

*Tue Sep 16 21:20:16 EDT 2003*

- Previous message: [\[Coral-List\] New--Integrated Monitoring Network: SEAKEYS, CREWS data online](#)
- Next message: [\[Coral-List\] Porites genome](#)
- **Messages sorted by:** [\[ date \]](#) [\[ thread \]](#) [\[ subject \]](#) [\[ author \]](#)

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I'd like to add my 3 cts.in my opinion, as Andy and Mikhail said, if a Caribbean species is to be sequenced, then Montastraea faveolata ought to be the general obvious choice. Second in the list will be A.palmata or Porites porites / P. astreoides, two other very common and widespread species.

EWeil.

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**shashank Keshavmurthy** [iamshanky15 at yahoo.com](mailto:iamshanky15@yahoo.com)

*Wed Sep 17 08:52:14 EDT 2003*

- Previous message: [\[Coral-List\] coral genome](#)
  - Next message: [\[Coral-List\] coral genome](#)
  - **Messages sorted by:** [\[ date \]](#) [\[ thread \]](#) [\[ subject \]](#) [\[ author \]](#)
-

Dear listers,

I have been following the discussion of the coral genome as to which coral has to be sequenced and why porites lobata may not be a better candidate..... Well... as a student...and a coral biology researcher, I am happy for the sequencing idea, whatever may be the coral species.....

As to why I would like to support this particular sequencing is I will be interested in continuing my studies on Pink-Line Syndrome that we have been observing in Kavaratti Atoll, Lakshadweep Islands, India, in Porites lutea every year (cousin of Porites lobata?)....

Though a cynobacteria species associated with this syndrome has been isolated, still we believe that this is some kind of a immune response of this species.....as for as the syndrome is concerned, it is found only when the coral is in intense stress (high temperature, algal dominated areas)...once coral is out of stress, the pink line disappears..... We have found high amount of proteins in the effected corals.....We also believe the increased presence of HSPs during this phase.....Hence, I am fully supporting this sequencing...

I also beleive that it is the slow growing corals that we have to sequence first....as they have lot of secrets embedded in them!!!!.....

Cheers for those involved in this project!!!  
Shashank

=====

"the role of infinitely small in nature is infinitely large"-Louis Pasteur

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**Robert Buddemeier** [buddrw at kgs.ku.edu](mailto:buddrw@kgs.ku.edu)

*Wed Sep 17 12:48:23 EDT 2003*

- Previous message: [\[Coral-List\] coral genome](#)
- Next message: [\[Coral-List\] teachers guide](#)
- **Messages sorted by:** [\[ date \]](#) [\[ thread \]](#) [\[ subject \]](#) [\[ author \]](#)

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Brief followup comments:

Thanks, Mike, for the summary. Seems to me there may a fundamental mismatch between the desire for a growing, reproduce-in-captivity

species and the implicit virtues of a long-lived widespread species. Given the need to get positive results on the first round, experimental feasibility is important -- so I would (reluctantly) step back from Porites and go with Julian's suggestion of Pocillopora, or a robust and well-characterized Acropora. In general that criterion would tend to argue against massive growth forms in the first round.

However, I would like to reinforce Doug's point -- the massive Porites have the greatest colony longevity that has been widely and systematically demonstrated experimentally, and are widely used as environmental sensors. That, plus distribution, plus both geological and ecological importance, should keep them pretty high on the list.

Somebody has to say it, so I'll be the bad guy -- the genus selected should have well-distributed and reasonably important species in both the Atlantic and Indo-Pacific. It might be somewhat defensible to pick a genus that is in the Indo-Pacific and not the Caribbean, but Montastrea just doesn't make it in terms of generalizability.

And, a possibly outdated comment on the message below -- I suspect lobata and lutea may be closer to sibling species than cousins: when I was swimming around in the central Pacific and talking to people who ID corals, the consensus then was that the two grade into each other pretty indistinguishably.

Bob Buddemeier

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**Doug Fenner** [d.fenner at aims.gov.au](mailto:d.fenner@aims.gov.au)

Wed Sep 17 10:44:10 EDT 2003

- Previous message: [\[Coral-List\] Coral genome](#)
- Next message: [\[Coral-List\] Porites genome](#)
- **Messages sorted by:** [\[ date \]](#) [\[ thread \]](#) [\[ subject \]](#) [\[ author \]](#)

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Porites has the advantage that it is an important reef builder in both the Caribbean and Pacific, and the third largest genus of corals. Also, the huge massive Porites are the source of climate records. Acropora is also a major reef builder in both Caribbean and Pacific. It is also the largest coral genus with about 165 species known so far. Montastrea is a major reef builder in the Caribbean, but in the Pacific has only a few small uncommon species. Among the Porites, P. lobata is the most common of the big massives used for climate records, and is one of the most widespread of all corals. P. lobata seems like one of the best choices. -Doug

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Australia

**Craig Bingman** [cbingman at panix.com](mailto:cbingman@panix.com)

*Wed Sep 17 13:07:37 EDT 2003*

- Previous message: [\[Coral-List\] Porites genome](#)
- Next message: [\[Coral-List\] New Version of ReefBase online for evaluation](#)
- **Messages sorted by:** [\[ date \]](#) [\[ thread \]](#) [\[ subject \]](#) [\[ author \]](#)

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I'm not sure that I understand why a coral that is primarily useful for fossil/paleoclimate studies is the best choice for a genomics project. Personally, I think that the community needs to figure out coral biology's closest equivalent to a "lab rat" or "fruit fly" You need to pick the organism that is most amenable to laboratory manipulations and studies on living organisms. Or you need to find a target organism that will provide the most useful leads on the reagents needed to do field studies on mRNA's or proteins isolated from specimens in the wild.

If no such reef-forming coral exists, then it is \*possible\* that the community would be better served by picking another model cnidarian that is more conducive to laboratory manipulation. I'd personally be disappointed if the genomics work was done on something other than a reef-forming coral, but that needed to be said.

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**Tonya Shearer** [tlsnell at buffalo.edu](mailto:tlsnell@buffalo.edu)

*Wed Sep 17 17:07:32 EDT 2003*

- Previous message: [\[Coral-List\] New Version of ReefBase online for evaluation](#)
- Next message: [\[Coral-List\] Porites Genome](#)
- **Messages sorted by:** [\[ date \]](#) [\[ thread \]](#) [\[ subject \]](#) [\[ author \]](#)

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Having sequenced DNA from many Caribbean scleractinian species, I thought I would add a couple of comments. One consideration when choosing a species is the availability of zooxanthella-free tissue (ideally sperm). In my experience, DNA from the zoox is often amplified (and subsequently sequenced) in

addition to the coral DNA, unless the tissue is free from zoox or the primers are specific to cnidarians. Obtaining gametes from broadcasting species is relatively easy, whereas brooded larvae often already have zoox from the maternal colony. I'm not sure how easy it is to get sperm from brooding species.

My personal preference is for a *Porites* species, one because I have developed microsatellites for *P. astreoides* (unfortunately a brooder), and two, because there are several representatives in the Indo-Pacific and Caribbean. Thus this genome can be used as a model for efficiently developing genetic markers for several *Porites* species. Three, conducting molecular analysis on *Porites* (at least Caribbean species) is very easy = high amplification and sequencing success (not the case for some other species). Finally, as brooders that release larvae multiple times throughout the year, molecular biologists can take advantage of breeding experiments without having to hope for good weather conditions on the couple of evenings of mass spawning.

I have also developed microsatellites for *Montastraea cavernosa*. Although technically easier to work with as far as eliminating the concern for zoox contamination by using sperm, I think sequencing a *Montastraea* genome would on the whole, be less useful for molecular biologists than a species from a more widespread genus.

No matter which species is chosen, this information is extremely useful for those of us that are interested in the genetic structure and gene flow (larval transport) of coral species. For those of you that don't know the struggles of doing molecular work on corals, standard molecular markers used for population genetics on other organisms (mitochondrial genes) cannot be used in corals due to a slow rate of evolution in the mitochondrial genome. Therefore we have to develop other markers, which can take years. Having a model genome available to develop these markers will save time, money and the sanity of those doing the work.

Tonya (Snell) Shearer

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*Wed Sep 17 17:58:18 EDT 2003*

- Previous message: [\[Coral-List\] coral genome](#)

- Next message: [\[Coral-List\] New software to calculate parameters of the CO2 system](#)
  - Messages sorted by: [\[ date \]](#) [\[ thread \]](#) [\[ subject \]](#) [\[ author \]](#)
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Dear Coral List Serv,

Dr. Cheryl Woodley will be posting a letter soon concerning this issue, but I thought I should give some comment back.

Almost two years ago, we began evaluating criteria for a coral 'lab rat', an organism representative of scleractinians to be used as a model for molecular genetics, cell biology, biochemistry, lipid chemistry, sterol/polyphenol chemistry, environmental/physiological monitoring, ecotoxicology, stress physiology, coral immunity, coral 'oncology', coral endocrinology, and coral neurophysiology. This quest was formalized at the U.S. CDHC's January 2002 workshop and its subsequent National Report. Personally, I've been asking folks with diverse backgrounds such as Eric Borneman and Phil Dusan to Barbara Brown and Yossi Loya since 1999 to "nominate a coral species candidate and justify." Response has been slow coming. I'm a lab biologist - without a lab rat for other labs to repeat my experiments or take the work further, I'm at a standstill, as are other coral laboratory biologists. Everyone who may be associated with field coral biology has suggested 'their' species as the 'best species'. This is understandable. Heck, my vote was for *Oculina varicosa*.

As a lab rat, the most important criteria is accessibility. Everyone in the world should have relative ease in obtaining 'laboratory strains' of coral. These strains must be genetically identifiable, which means that Strain 1 will come from a single colony from somewhere, and mass cultured. Someone or some entity must then have the facilities to rear this coral in abundance and be able to distribute this coral to any lab in the world that asks for it, whether it be a lab in Eilat, AIMS, or Dalhousie University. The coral must also SURVIVE the trip. As someone who ships and receives corals from all over the world, shipping with the least expense possible of coral that will recover and grow in the lab is an essential reality to consider. Spending \$800 (includes tariffs, custom fees, CITES fees, etc..) for a shipment of 150 grams of coral from Miami to India gets old after awhile if your corals arrive dead. Most folks have seen the phoenix effect with Porites, few species besides *Gonistrea* or *Pavona* have the resilience of Porites.

Also, the point is not to sequence the genome from a Caribbean coral species, or a Pacific one. This has been mentioned several times, I believe the point is being missed and Cheryl will expound upon that issue further.

Another issue is: can many of the tools of molecular, cellular, and physiological biology be applied to that species? As someone who has had considerable experience in this area, I can say that *Acroporas* are

ruled out. Next time you run a western on an *Acropora* sample, and assay for a protein that is cysteine or histidine rich, the really high-molecular weight banding patterns you see are the result of the very rich sulfo-glycolipid composition of *Acroporids* (ask Carolyn Smith).

As the field of Natural Products Research can attest, evidence argues that these compounds come from the dino, dino 'clades' that are found abundantly in fast growing corals, such as *Acropora*. These compounds like to adduct with proteins, which makes protein biochemistry in these species difficult. Besides this, *Acropora* are rich in some very active polyphenols (all symbiotic corals have these to a lesser or greater degree, depends on your dino), resulting in extensive maillard product formation. This can be seen when you isolate DNA from a number of coral species and you DNA pellet is tan or brown. To correct for this, you add PVPP or borate, but you know that the PVPP isn't that great as a Maillard scavenger and borate comes with its own problems. Some folks have mentioned mRNAseq and perhaps microarrays, these nuances have significant affect on the outcome of your results when using these techniques. All of this is unfortunate, because as many have pointed out, *Acroporids* grow extremely fast, and this characteristic would be a tremendous boon.

I've worked and published with *Montastrea*. Its important ecologically in the Caribbean and in the Gulf of Mexico. Draw back is its continuous mucus production when stressed (and I've stressed *Montastrea* from everything from atrazine to oil). And since a lot of folks are getting into the stress biology of corals, this is a draw back. More so, the amount of polysaccharide production inhibitors and polysaccharide degrading enzymes you have to add to *Montastrea* (or *Gonistrea*) for coralcell culture will make you bankrupt. Coral cell culture is a next bigstep in coral laboratory biology, and the lab rat has to be a good species to which apply these techniques. *Acroporids* aren't bad, Gary has had tremendous success with *Pocillipora*, Cheryl Woodley has had success with *Oculina*, and I with *Porites* and *Oculina*. You can put *Montipora* in this category of high mucus content - funny, few elected for this species. When we tried to heat stress *Montipora* on Heron Island to do some bleaching experiments, it was impossible to work with.

Actually, to just argue for a lab rat, *Oculina varicosa* (or any of its sibling species) would win, hand down. Grows fairly quickly, gets disease, beautiful cell culture, and its not an obligate symbiont, something that is extremely advantageous when wanting to do in vivo experiments and not having the presence of the dino interfere, such as during physiology investigations. *Oculina* on protein gels/westerns or running it on a GC-MS for lipid analysis, beautiful! Unfortunately, its not a major tropical reef builder, and it doesn't handle shipping very well.

So from a lab technique perspective, again, *Porites* exhibits the least amount of technique artifact(*Oculina* less so), and can be shipped using a wet paper towel, plastic breather bag, and blue ice with highest success of survival after shipping.

To move into the realm of physiological ecology, environmental assessment, Acroporids and Porites are found in abundance worldwide, though Porites can be found in cooler climates than Acropora (just got to Bermuda or western Costa Rica). Problem with Acropora is that for the most part, they are not resilient species, and are the first to crash during an environmental event, whether that event be an unusually high SST or an oil spill. So if you're looking at a system to gauge its recovery (process), then you need a species that will be around after the environmental event (Jessica diesel spill in Galapagos, or Okinawa after 1998 El Nino).

Objective and potential applications. This seems to be an issue, but I can't understand why. The sequenced genome is a platform, a platform to extend basic research into areas of coral biology where it has been so difficult to conduct in the past, or a platform to develop new technologies to allow us to see further (is this coral immunocompetent or endocrine modulated? How will you assay for this? We need the genes that contribute to these systems to better explore their individual and combined behavior). Cnidarians have the most primitive nervous system. How are their neuropeptides different from ours, and why? Corals also get hyperplasias whose tissues (and their composition) are radically different from 'normal' polyps. Can our understanding of cancer in mammals be aided by our understanding and the future discoveries of how corals get 'cancer'? These basic science questions can be greatly aided by knowing the sequence of the coral genome. Look at the magnitude of success genomics has brought to human biology, yeast biology, drosophila biology, C. elegans biology, etc..

The technologies that can be developed from a sequence coral genome are well, you're only limited by your imagination and determination. Here is an example: some anti-foulant components in boat paint may be having an adverse effect on corals. Some of these components are cyanobacteria biocides, or just general biocides. Corals (all the way up to us) have as part of our innate immunity the production of anti-microbial, anti-fungal, anti-botanical compounds. Some of these are polyphenols, while others are polypeptides. If you can elucidate the biochemical pathway or obtain the gene(s) to the protein that creates these anti-microbial, anti-fungal, anti-botanical compounds from coral, it's possible that you could encapsulate these polypeptides into a nano-structure (capsule) to be added to the paint instead of using something like TBT. You would be using the coral's own anti-foulant chemistry on your boat - and since corals make it, there is a lower probability of toxic side effects on the corals themselves (but that would have to be determined experimentally).

I hope this helps in understanding the position we've taken (Cheryl's letter will reinforce points I had to gloss over).

I also want to point out that the deadline is fast approaching for letters of endorsement and look forward to receiving them.

Sincerely,

Craig



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Saving Tomorrow Today

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**Julian Sprung** [julian at twolittlefishies.com](mailto:julian@twolittlefishies.com)

*Wed Sep 17 21:10:48 EDT 2003*

- Previous message: [\[Coral-List\] New software to calculate parameters of the CO2 system](#)
- Next message: [\[Coral-List\] coral genome](#)
- **Messages sorted by:** [\[ date \]](#) [\[ thread \]](#) [\[ subject \]](#) [\[ author \]](#)

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Dear Mike,

Regarding requirement 8, what about *Pocillopora damicornis*? It reproduces prolifically (by asexual formation of planula larvae), and aquarium spawned colonies can reproduce this way in a year or less. It is also very widespread and easily cultured in aquariums.

Julian Sprung

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**capman at augsburg.edu** [capman at augsburg.edu](mailto:capman@augspburg.edu)

*Wed Sep 17 14:07:03 EDT 2003*

- Previous message: [\[Coral-List\] coral genome](#)
- Next message: [\[Coral-List\] coral genome](#)
- **Messages sorted by:** [\[ date \]](#) [\[ thread \]](#) [\[ subject \]](#) [\[ author \]](#)

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I'd like to add to Julian's endorsement of *Pocillopora damicornis* as a potentially good model system:

1. *P. damicornis* is a fast growing coral in aquaria, and very adaptable to varying conditions. Not quite as fast growing as the fastest *Acropora* species I have grown, but very fast nonetheless.
2. *P. damicornis* (at least the clones I have grown, which are commonly available clones from the aquarium trade) has a finer

branching structure than most of the *Acropora* species, which means even a modest-sized colony can be fragmented into many very uniform-sized branch-tips for starting replicate, genetically identical colonies for lab work. Within a year, each of these new colonies could be fragmented into at least a dozen (or more likely \*dozens\*) of new colonies.

3. Following up on point 2 above, even very small fragments of *P. damicornis* (with as little as just a few polyps) can be used to start a new colony, and attachment to new surfaces is rapid (typically resulting in sheeting growth to anchor the colony before substantial branch growth occurs). In contrast, most *Acropora* species have thicker branches, fewer branch tips, and much larger fragments (longer fragments) are usually necessary in order to start a successful new colony.

4. *P. damicornis* has a high density of large (for a small-polyped stony coral) long polyps, giving the colonies a very fuzzy appearance. What is important here is that these polyps are almost always well extended. In addition, *P. damicornis* colonies are relatively unbothered by handling, or vibrations. With many (most?) corals, if you pick up a colony and put it into a dish of water for viewing under a low-power microscope, the polyps retract and don't extend well for some time...and even when they do extend again vibrations from working with them on the microscope will cause them to contract again. In contrast, *P. damicornis* will retract only partially if handled gently, but then within minutes the polyps will be fully extended again, and will typically stay extended even while being worked with on the microscope. For this reason, *P. damicornis* is the absolute star performer in my teaching labs (where we have about 50 species of growing corals to choose from) for demonstrations and other activities where I want students to be able to work with live, fully extended coral polyps. I can even break fragments off of large colonies just before class and usually have extended polyps during class.

5. Following up on point 4 above, the long, nearly always extended polyps of *P. damicornis* are very transparent except for their zooxanthellae (and the pale polyps from lower shaded portions of healthy growing colonies are almost completely unobscured by zooxanthellae, and the polyps from the most intensely illuminated branch tips are relatively low in zooxanthellae as well). I would think that these polyps would be perfect for studies of gene expression in which genes of interest have been linked, for example, to genes for bioluminescence, so that cells expressing a given gene will glow. Live healthy colonies of such genetically modified *P. damicornis* could be viewed under low-power microscopes, with very clear complete views (both top views and side views) of fully extended polyps, so it should be possible to not only see when genes are turned on and off, but also see precisely where in the polyps this is happening.

Bill Capman  
Augsburg College

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**EricHugo at aol.com** [EricHugo at aol.com](mailto:EricHugo at aol.com)

*Thu Sep 18 00:34:59 EDT 2003*

- Previous message: [\[Coral-List\] coral genome](#)
  - Next message: [\[Coral-List\] Porites genome](#)
  - **Messages sorted by:** [\[ date \]](#) [\[ thread \]](#) [\[ subject \]](#) [\[ author \]](#)
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In a message dated 9/17/03 7:31:27 AM, [julian at twolittlefishies.com](mailto:julian at twolittlefishies.com) writes:

*Regarding requirement 8, what about Pocillopora damicornis?*

Recongizing the length of this thread, I hesitate to add to it, but I agree with this, as well. P. damicornis and S. pistillata arguably are already virtually "coral guinea pigs" and are widespread, important hermatypes, and have a large literature base associated with them.

In the Caribbean, I also agree that the acroporids and Montastraea are the logical choices. In fact the corals mentioned above were already selected by CHDC as candidates for coral "lab rats" in culture.

As perhaps mentioned, their life histories are also perhaps more representative of the majority of corals.

Best,

Eric Borneman  
University of Houston

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**julian** [julian at twolittlefishies.com](mailto:julian at twolittlefishies.com)

*Thu Sep 18 14:23:20 EDT 2003*

- Previous message: [\[Coral-List\] Coral genome](#)
  - Next message: [\[Coral-List\] Coral genome](#)
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I agree that Porites spp. have numerous advantages, and also that Pocillopora is not nearly as durable in transit as Porites. It is in fact a bit delicate in this regard, and is susceptible to Vibrio infections. Porites does make the most sense based on the criteria given.

For the heck of it I'd like to add a name to the discussion since it hasn't been mentioned so far, possibly because it is not so "in your face" as Acropora and Porites, or possibly because no one is really sure how to pronounce it- Psammocora. This genus is widespread globally, easy to grow, easy to ship, and has a Phoenix/reincarnation capacity at least as good as Porites. I'm not sure about its sperm production though!

Cheers,

Julian

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**Doug Fenner** [d.fenner at aims.gov.au](mailto:d.fenner@aims.gov.au)

*Thu Sep 18 17:40:24 EDT 2003*

- Previous message: [\[Coral-List\] coral genome](#)
- Next message: [\[Coral-List\] Coral genome](#)
- **Messages sorted by:** [\[ date \]](#) [\[ thread \]](#) [\[ subject \]](#) [\[ author \]](#)

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Stylophora pistillata has been used extensively in experiments on metabolism and zooxanthellae - in the Bali symposium it was even referred to as the coral lab rat. It is also widespread in the I-P, though not as wide as P. damicornis, but the genus is not in the Caribbean. I have no idea on how easy it is to reproduce in an aquarium or use for genetics. There are only about seven species in the genus and they generally don't dominate reefs.

There are no Pocillopora in the Caribbean. There are about 17 species in the genus and while important in the eastern Pacific the genus is less so elsewhere.

PS - Veron recognizes 165 species of Acropora in his Corals of the World(2000), Wallace recognizes 114 in her Staghorn Corals of the World (1999). Many more names have been applied, but many or all of these are synonyms and don't represent additional species. New species will no doubt continue to be described and some may be 'rediscovered' among the names thought to be synonyms.

-Doug

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**Phil Dustan** [dustanp at cofc.edu](mailto:dustanp@cofc.edu)

*Thu Sep 18 15:31:27 EDT 2003*

- Previous message: [\[Coral-List\] Coral genome](#)
- Next message: [\[Coral-List\] Coral genome](#)
- **Messages sorted by:** [\[ date \]](#) [\[ thread \]](#) [\[ subject \]](#) [\[ author \]](#)

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>Hi Everyone,

I've been watching this scene develop for a few days and I'd like to point out that the proposed sequencing effort of *Porites lobata* is a real plus for coral biology. When everyone jumps in and wants "their favorite" instead of the proposed species. This is just one more example of the coral reef scientific community eating its young. In other disciplines researchers get squarely behind their colleagues and help them promote an idea. They work together for the greater good. The coral reef community has accomplished far less than it could over the years because it tends to snipe, and snipe and snipe until everyone gets tired of defending their ideas and the funding agencies go away confused and end up funding geologists or chemists or astronomers.

Why not get behind Gary and Craig and realize that success with the first species will help everyone move forward and the others will follow if there is meaningful knowledge to be gained from it.

Get a grip people. Put your ego aside and support the project.

Phil

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**David Obura** [dobura at cordio.info](mailto:dobura@cordio.info)

*Thu Sep 18 18:39:21 EDT 2003*

- Previous message: [\[Coral-List\] Porites genome](#)
- Next message: [\[Coral-List\] Coral genome](#)
- **Messages sorted by:** [\[ date \]](#) [\[ thread \]](#) [\[ subject \]](#) [\[ author \]](#)

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Dear all,

Like Bob, I've been following with some interest, and it helps to have Mike Matz's full criteria laid out. At the risk of being labelled a coralist, I cannot see the value in selecting a species/genus that is minor in the global sense, which *Montastrea* is. In the long run it probably does not matter about the ecological importance of the first species to be used, but it does matter about its phylogenetic

pedigree, and any current/immediate-future work related to gene-environment processes. To my mind, this would put Porites, Acropora and Pocillopora at the head of the list, in roughly that order, with one of the more prominent faviid genera (Favia, Favites, Platygyra) next.

Many of the genetic/methodological criteria Mike mentioned may not be known yet for either Acropora or Porites in which case why not do preliminary trials on a short-list of 3-5 species before committing to any one surely the costs would be worth it. In the end, my expectation would be that a Porites species would come first as these are widespread and phylogenetically and ecologically important (whether the massives, for which we can have climate records and can relate genotypes to historical conditions, or the branching ones *cylindrica* for example - which satisfies more of the lab-rat criteria). Second would come one of the widespread Acropora head/cushion species with relatively broad environmental tolerance, or Pocillopora *damicornis*, the lab-rat par excellence.

As Shashank has noted, Porites do have some pretty interesting syndromes in the field that would make genetic studies interesting the pink colouration he mentions, abundance of growth tumours, permanent white patches that nevertheless grow, generation of mucus sheaths of mysterious function, the most plastic and gentle general bleaching responses that I have seen (both to SST and sediment), among the broadest temperature acclimation range worldwide, probably the longest lifespan while also being viable while small, senescence??, probably the most likely candidate for adaptive bleaching ... there are probably more. Most other genera/species just seem to do their thing quietly and consistently. Porites *lutea* is the one I think I've been looking at for years rather than *lobata* ...

Now catching up with later responses perhaps Porites *cylindrica* (or other branching Porites) might do better, satisfying the distribution and lab-rat requirements, having the interesting ecology/evolutionary history criteria above, as well as being workable.

David Obura

--

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**Szmant, Alina** [szmanta at uncw.edu](mailto:szmanta@uncw.edu)

*Fri Sep 19 11:51:59 EDT 2003*

- Previous message: [\[Coral-List\] Coral genome](#)

- Next message: [\[Coral-List\] Welcome to the 10th International Coral Reef Symposium!](#)
  - **Messages sorted by:** [\[ date \]](#) [\[ thread \]](#) [\[ subject \]](#) [\[ author \]](#)
- 

Hi All:

I have been following the thread for selecting a scleractinian coral species for the coral genome project, and just wanted to point out that the idea that one coral species can be a representative lab rat for physiological etc studies of "corals" is flawed by not considering the evolutionary history of extant corals. This is not a monophyletic group from what I've read. Furthermore, the different families can be so totally different ecologically and physiologically (and obviously genetically, as was detailed by Craig Downs) that I do not buy that results from one species can be extrapolated to responses of species of different groups. While we have to start somewhere with a single species, there is no one species that is going to be representative of corals in general. With time and as \$\$ becomes available we need to do as many others as is fundable (hopefully selecting for each new initiative an example from a different family). While I work only in the Caribbean and would love to see one of the Montastraeas or Acropora palmata worked on, most reefs (and corals) are in the Pacific region, so I think it best to start with a species from that region. Furthermore, some of the criteria that Craig suggested for the selected species (ease of culture, shipping survivability) are more important in terms of getting as much generic benefit from the genetic results than are the ecological or regional importance of the species.

Alina Szmant

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**Pedro Alcolado** [alcolado at ama.cu](mailto:alcolado@ama.cu)

*Fri Sep 19 12:39:05 EDT 2003*

- Previous message: [\[Coral-List\] Coral genome](#)
  - Next message: [\[Coral-List\] Porites genome](#)
  - **Messages sorted by:** [\[ date \]](#) [\[ thread \]](#) [\[ subject \]](#) [\[ author \]](#)
- 

I support Dustan's recommendation. Do not dilute initial efforts.  
Pedro Alcolado

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**Cheryl Woodley** [Cheryl.Woodley at noaa.gov](mailto:Cheryl.Woodley@noaa.gov)

*Fri Sep 19 19:13:16 EDT 2003*

- Previous message: [\[Coral-List\] Information request](#)
- Next message: [\[Coral-List\] Welcome to the 10th International Coral Reef Symposium!](#)
- **Messages sorted by:** [\[ date \]](#) [\[ thread \]](#) [\[ subject \]](#) [\[ author \]](#)

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Dear Coral List Members,

First, I'd like to say that the postings have been worthwhile, informative, and have provided very valid points on alternative species. I am encouraged to see such an interest in coral genomics. I also appreciate Tonya Shearer commenting on her sequencing experience that can influence logistics considerably.

I think that the discussions have also served to point out that those of us immersed in genomics everyday need to better convey the power and potential of the technologies (to which we've become so accustomed) to researchers in other scientific disciplines as well as being able to articulate the applications that become possible from this type of endeavor to managers and policy makers. I appreciate Mike Matz summarizing a few of the many benefits of having this resource ( I would even add benefits to fields such as comparative- immunology,- physiology, -biochemistry and providing the means to develop new tools/technologies such as diagnostics and field dipstick technologies).

However, in regard to the effort being made to have a coral genome sequenced, I am concerned that we may have lost sight of the real goal: that is to generate vital coral genome sequence data and make it widely available to the research community via the public domain.

We have a window of opportunity right now to respond as a research community to say that, yes, a coral genome needs to be sequenced and we as a coral research community will use these resources to move the field of coral research and conservation management forward. This window will close October 9, 2003.

Dr. Gary Ostrander and the other collaborators have worked to put together a proposal to have a coral genome sequenced and are simply asking for support of their proposal from the coral community to go forward to NHGRI, the National Human Genome Research Institute. Currently there are 20 fully sequenced eukaryotic genomes with dozens more under development. Passing up the opportunity to add a coral genome to the list at this point, would only serve to leave the coral research community behind the times, in the future.

In all, this is a very important effort and meets a major mandate of the Coral Disease and Health Consortium's National Research Plan. The completion of a genomic sequence will have many positive effects on the field of coral research and others, many of which cannot be foreseen today. So please let's pull together in support of this effort that we all will benefit from either directly, by those involved in genomics and proteomics work, or indirectly, by building on the discoveries made from this unique resource.

Sincerely,  
Cheryl Woodley  
Chair, Coral Disease and Health Consortium



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**David Obura** [dobura at cordio.info](mailto:dobura@cordio.info)

*Tue Sep 23 13:15:39 EDT 2003*

- Previous message: [\[Coral-List\] Coral Spawning Report](#)
- Next message: [\[Coral-List\] coral reef monitoring for management \\*we need your help\\*](#)
- **Messages sorted by:** [\[ date \]](#) [\[ thread \]](#) [\[ subject \]](#) [\[ author \]](#)

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This discussion illustrates one thing the list is useful for. As Craig Downs said, they tried to get some input on species selection before, but without much effect. Unless this discussion goes further than it has to

date, this input will also in the end be pretty minor. It is not a matter of diluting current efforts for personal favourites, but pursuing a productive dialogue on the pros and cons of different species/models. But this has gone as far as is useful in totally open forum.

The next step, to my mind, would be for the originators of the discussion to take it off-list with the various people who have taken time to respond. Try and get some consensus from the laboratory and field people on balancing the criteria, and come up with one or two sets of corals from which further genome work can proceed. And also, of course, select the best species for now and endorse their current proposal. This group can also (and this would be much stronger than individual letters), endorse the proposal to the funders to at least start with something. Meanwhile, the recommendations/findings of the group can be reported back to the list, and from additional responses to that, a core group of genome researchers may have identified themselves and start their own networking process.

Some discussions on the list do peter out in acrimony (which this one is now tending towards), but this one is focussed and could be very productive.

Sincerely,

David Obura

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**David J Miller** [david.miller at jcu.edu.au](mailto:david.miller@jcu.edu.au)

*Mon Sep 29 12:07:43 EDT 2003*

- Previous message: [\[Coral-List\] NIUST RFP for marine biotech/technology proposals](#)
- Next message: [\[Coral-List\] research assistant position](#)
- **Messages sorted by:** [\[ date \]](#) [\[ thread \]](#) [\[ subject \]](#) [\[ author \]](#)

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Dear All

I very recently became aware of this discussion forum, hence my late entry to the coral genomics debate. I thought Mike Matz did a good job in raising some of the pros and cons of the various proposed model corals, but there are a few things that maybe should be more widely known than they appear to be.

First, there seems to be the misapprehension out there that a coral genome would be the first cnidarian genome to be sequenced. This is not the case; it is extremely likely that a current bid to sequence the genome of the sea anemone *Nematostella vectensis* will be successful. All of the cnidarian evo-devo community has strongly supported this application, and I would be very surprised if it is not funded. This animal has special advantages for evo-devo studies, hence the universal support for the *Nematostella* sequencing initiative.

Second, as Mike previously pointed out, it's really important that the 'homework' is done before a coral genome proposal goes forward. By this I mean that it is essential that parameters such as the approximate genome size are known; note in the case of *Hydra* species, *H. viridis* has a genome that is one quarter the size of the more widely studied *H. vulgaris* and *H. magnipapillata*. Note also that genome size is not a function of the number of chromosomes - it's just that the chromosomes of *H. viridis* are smaller than those of the other species. No one should seriously consider using *H. vulgaris* for a sequencing project, despite its popularity otherwise; a bid to sequence *H. viridis* will go forward very soon. Similar criteria should apply in the case of a coral.

Mike also pointed out the requirement or desirability of technology and tools for the coral selected. Please consider the advantages of the coral that we work on, *Acropora millepora*, in this respect. *Acropora* is the second best represented cnidarian in the databases (behind *Hydra*). Indirect estimates put the genome size as small - comparable with the fruit fly and roundworm, and therefore at the low end of cnidarian genome sizes. Most corals have the same number of chromosomes, but those of *A. millepora* are particularly small. Also, most of the molecular tools are there for *A. millepora* - genome libraries in lambda and cosmid vectors, cDNA libraries for six different embryonic and larval stages (as well as adult colonies), and an extensive EST dataset. Microarrays featuring 3,000 ESTs of known sequence are presently available (mail me if you want details of this), and the sequences of these clones will be available shortly; note that we have been holding off releasing these until the first paper is accepted, and that we expect to hear that this has happened within two weeks. The first batch of ESTs was from planulae, and at present we are generating ESTs from other libraries. In addition, thanks to Eldon Ball's efforts, in situ hybridisation technology works wonderfully on *A. millepora*, whereas I do not believe this method has been established for any other coral. Therefore in terms of the molecular basics being in place, *Acropora* is a much more

advanced system than is any other coral, and I am quite sure that the evo-devo community would strongly support a proposal to sequence the genome of this coral. Before putting forward such a proposal, however, we intend to accurately determine the genome sizes of a range of Acropora and other coral species. It should be possible also to do this for any coral for which zooxanthellae-free cells can be isolated.

I don't wish to discount the Porites lobby but, for a coral sequencing initiative to be successful and useful, the molecular parameters outlined above are particularly important.

Regards...

David J Miller  
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## A Primer on Molecular Biology

### Some Benefits of Coral Genomics

Coral reef ecosystems, with their incredible biodiversity and richness of corals and other invertebrates, fishes, reptiles, plants, algae and protists, constitute vast reservoirs of genetic resources with great medical potential. While at least one-half of all therapeutic drugs on the current market are now derived from terrestrial organisms, we can expect many new drugs to be developed from marine organisms in the coming years. These drugs will be used as pharmaceuticals, nutritional supplements, biocides, cosmetics and other life-saving and life-enhancing products (Bruckner, 2002). Coral reef species (e.g., algae, sponges, soft corals, sea slugs) have already been used in the development of anti-cancer and anti-tumor drugs, painkillers, and anti-inflammatory agents.

Only a small percentage of coral reef biodiversity is known, and only small fractions of the known species have been explored as sources of biomedical compounds. With this in mind, the following primer on molecular biology is intended to help nonexperts understand the task of sequencing a genome, and why it is important to do so.

### The Genome

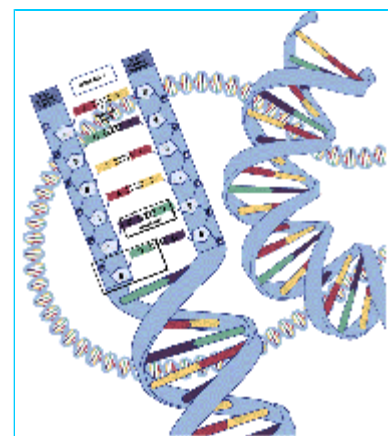
A **genome** is defined as all of the genetic material (DNA) in the chromosomes of a particular organism (i.e., all of the genes in an organism). Genes are specific sequences of base molecules that encode instructions on how to make proteins. Genes comprise only about two percent of the human genome; the remainder consists of noncoding regions, the functions of which may include providing chromosomal structural integrity and regulating where, when, and in what quantity certain proteins are made.

**Chromosomes** are thread-like bodies that are located in the nucleus of cells of most organisms, or dispersed throughout the cytoplasm of primitive cells that do not have distinct nuclei, for example, bacteria. In cells with nuclei, DNA confined within the nucleus (nuclear DNA or nDNA) is distinguished from **mitochondrial** DNA (mtDNA) which is located outside the nucleus. Mitochondria are cellular organelles ("small organs" within cells) that play a key role in releasing cellular energy. Mitochondria cannot be produced by cells *de novo*, but instead are self replicating by the division of preexisting mitochondria, as instructed by the mtDNA.

**Genes** are linear segments along the DNA molecule that are responsible for transmitting hereditary information from generation to generation. Genes control all of the chemical reactions that occur continuously within cells, and thus,

#### Read About:

- ❖ [Some Benefits of Coral Genomics](#)
- ❖ [The Genome](#)
- ❖ [Structure of the Genome](#)
- ❖ [The Human Genome](#)



DNA molecule: A (adenine), T (thymine), C (cytosine), G (guanine), S (deoxyribose), P (phosphate) (Credit: National Human Genome Research Institute) Click image for larger view.

they control all of the cells' activities. Genes accomplish this by precisely directing the synthesis of proteins.

**Proteins** are complex molecules composed of any specific linear sequence and combination of the 20 **amino acids** that are the basic constituents of all proteins. Protein molecules can form long chains that contain thousands of amino acids. The order of the amino acids is determined by the **genetic code** for the particular protein. In addition to providing most of the structural components of a cell, proteins form **enzymes**, which are organic **catalysts** that increase the rates of chemical reactions. Imperfectly formed enzymes are responsible for many of the cellular malfunctions that lead to genetic disorders and diseases.

A gene may also be described as a segment of the DNA molecule that contains the encoded information that directs the formation of a particular protein. **Genomics** is the study of the sequence, structure, and function of the genome. **Sequencing** the genome is the determination of the order of nucleotides in a DNA or RNA molecule.

## Structure of the Genome

To better understand the importance of sequencing the genome, let's examine briefly the structure of DNA and how it directs the formation of proteins.

DNA resembles a **double helix** held together by weak hydrogen bonds of four **nitrogenous bases**: adenine (A), thymine (T), cytosine (C), and guanine (G), which, together with a phosphate molecule and a sugar molecule (deoxyribose in DNA, and ribose in the other nucleic acid, **RNA**), are called **nucleotides**. Nucleotides are repeated *ad infinitum* in various sequences. These sequences combine into genes that govern the production of proteins.

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If the DNA molecule were to "untwist", it would resemble a ladder. The sugar, deoxyribose (together with an attached phosphate (PO<sub>4</sub>) would constitute a section of the rails of the ladder, and each nitrogenous base would constitute one-half of a rung. The bases form pairs (**base pairs**) that form a complete rung, with adenine (A) always bonding with thymine (T), and cytosine (C) always bonding with guanine (G). Thus, we have the base pairs AT and CG bonded together by weak hydrogen bonds. A base attached to deoxyribose and a PO<sub>4</sub> group constitutes a nucleotide. The double-stranded DNA molecule, therefore, is composed of a linear sequence of nucleotides that are repeated *ad infinitum* in various sequences (for example, ATTCCGAGTC). These sequences combine into genes that spell out the exact molecular instructions required to synthesize the production of proteins, which direct the activities of cells.

**RNA** (ribonucleic acid) is the other nucleic acid found in the nucleus and cytoplasm of cells. RNA plays an important role in protein synthesis and other chemical activities of the cell. Its structure is similar to that of DNA, although RNA is single stranded. Also, the base uracil replaces thymine in RNA. Genetic information is stored by DNA involving particular sequences of nucleotides in the nucleus of cells, and RNA carries that coded information to other parts of the cell, where it is converted into proteins.

The total of the proteins produced from all the genes of a genome in a cell is called the **proteome**, which changes from instant to instant in response to thousands of intra- and extracellular chemical signals. Protein chemistry and behavior are specified by gene sequences and by the number and kinds of other proteins simultaneously synthesized in the same cell, and by those interrelationships.

The "**central dogma of molecular biology**" is the principal statement of the molecular basis of gene action. Genetic information is stored in and transmitted as DNA. Genes are expressed by being copied (**transcription**) as RNA, which is processed into **mRNA** (messenger RNA). The information in mRNA is translated (**translation**) into a protein sequence using a genetic code to interpret a sequential triplet of nucleotides (**codons**) as instructions to add one of 20 amino acids or to stop translation. More simply put, *DNA carries the genetic information that is transcribed to RNA and subsequently translated to protein.*

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## The Human Genome

The human genome was sequenced in 2003. Following are a few interesting highlights from the first Department of Energy publications analyzing the sequence:

- The human genome contains 3 billion chemical nucleotide bases (A, C, T, and G).
- The average gene consists of 3,000 bases, but sizes vary greatly, with the largest known human gene being dystrophin at 2.4 million bases.
- The total number of genes is estimated at 30,000 to 35,000.
- The functions are unknown for more than 50% of discovered genes.
- The human genome sequence is almost (99.9%) exactly the same in all people.
- About 2% of the genome encodes instructions for the synthesis of proteins.
- Repeat sequences that do not code for proteins ("junk DNA") make up at least 50% of the human genome.
- Repeat sequences are thought to have no direct functions, but they shed light on chromosome structure and dynamics. Over time, these repeats reshape the genome by rearranging it, thereby creating entirely new genes or modifying and reshuffling existing genes.
- The human genome has a much greater portion (50%) of repeat sequences than the mustard weed (11%), the worm (7%), and the fly (3%).
- During the past 50 million years, a dramatic decrease seems to have occurred in the rate of accumulation of repeats in the human genome.
- Over 40% of the predicted human proteins share similarity with fruit-fly or worm proteins.
- Genes appear to be concentrated in random areas along the genome, with vast expanses of noncoding DNA between.
- Chromosome 1 (the largest human chromosome) has the most genes (2,968), and the Y chromosome has the fewest (231).
- Genes have been pinpointed and particular sequences in those genes associated with numerous diseases and disorders including breast cancer, muscle disease, deafness, and blindness.
- Scientists have identified about 3 million locations where single-base DNA differences occur in people. This information promises to revolutionize the process of finding DNA sequences associated with such common diseases as cardiovascular disease, diabetes, arthritis, and cancers.

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The content on this web page was last updated in July of 2001. Some of the content may be out of date. For more information: <http://coralreef.noaa.gov/>.

#### Read About:

- ✦ [Educational Value/Accuracy](#)
- ✦ [Similarities and Differences](#)

## Coral Reefs - Rainforests of the Sea?



A colorful, *Madracis* sp. coral "landscape" on the Flower Garden Banks.

Are coral reef communities analogous to tropical rainforests? Coral reef specialists discuss the implications of the comparison, and debate whether the analogy is accurate or if it is just a catchy "sound bite" meant to garner attention from a public more aware of rainforest degradation than threatened coral reefs.

The discussion centered on the value of the analogy as an educational tool as well as its degree of scientific accuracy. The analogy also sparked an examination by some participants of the true similarities and differences of the two systems.

**[Click here](#)** for a list of discussion participants.

**[Click here](#)** to download the complete discussion unedited (pdf, 64Kb).

### Educational Value/Accuracy



A colorful, *Madracis* sp. coral "landscape" on the Flower Garden Banks.

Participants discussed how the public generally perceives tropical rainforests as complex, diverse ecosystems that are threatened and worthy of conservation efforts, but a deeper understanding of the rainforest is not widespread. Public understanding of coral reefs tends to be even weaker. Therefore, most participants agreed that as an educational tool used on a fundamental level, the reef/rainforest analogy is relatively accurate and useful, and can raise public awareness about the importance of reefs. Comments from participants not directly involved in coral reef research, (i.e., a filmmaker, an aquarist and a manager of coastal and marine tourism), reiterated this point. The analogy successfully conveys the basic message that both systems are highly diverse, are suffering from human impacts, and are worthy of protection and conservation.

In addition, some participants cited studies on analogical teaching techniques that support the notion that analogies are powerful tools in teaching complex scientific concepts, at least with learners of lower ability or minimal background on the subject. However, the analogy is accurate only on a basic, superficial level. It begins to break down when specific characteristics of the two ecosystems are compared.

### Similarities and Differences

Participants discussed the extent to which the analogy could be applied by exploring the specific natures of the two systems. Most agreed that both reefs and tropical rainforests support a complex habitat structure, and are highly productive and diverse.

However, participants suggested that when specifics of the two ecosystems are compared, the differences begin to outweigh the similarities. For instance, tropical rainforests are richer in species and have higher canopies; reefs have a greater gross productivity. Species diversity and interaction is different between the two ecosystems. Recruitment in tropical rainforests and coral reefs also is different. In a reef environment, broadcast spawning ensures widespread dispersal of coral larvae. In a rainforest environment, however, successful seed dispersal and germination is dependent on a number of sensitive circumstances. Reefs and tropical rainforests differ significantly in taxonomy as well.



*Countless fish species depend on coral reefs for their survival. This queen parrotfish (Scarus vetula) is feeding on coral. While it remains relatively still, a couple of juvenile bluehead wrasse (Thalassoma bifasciatum) can undertake some cleaning work on the fish.*

Another major difference, according to one participant, is that many tropical rainforest organisms feed on the major structure of the forest-trees. Few organisms in a coral reef habitat feed on the major structure of the reef-coral. Another participant suggests that the predation of trees in the tropical rainforest does parallel the predation of coral. Insects and other tropical rainforest organisms prey on trees, injuring but not killing them. Similarly, organisms such as gastropods, crustaceans and fish graze on coral but normally do not kill them. Predators in both systems continually exert pressure on the energy resources of their prey.

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## Coral Reefs - Rainforests of the Sea?

### Listserve Participants

Alex Brylske

Robyn Cumming  
The University of the South Pacific

Osha Gray Davidson  
University of Iowa

Karl Fellenius  
Simon Fraser University

Rob Gould

Rick Grigg  
University of Hawaii

Gregor Hodgson  
Reef Check Global Survey Program

Les Kaufman  
Boston University

Ursula Keuper-Bennett  
Turtle Trax

Don McAllister

Fredrik Moberg  
Stockholm University

Pete Mohan  
SeaWorld Cleveland

Brice Quenoville

Robert Steneck  
University of Maine

Robert Van Woesik  
University of the Ryukyus

John Ware  
SeaServices Inc.

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# Coral Reefs -- Rainforests of the Sea?

## A Coral-List Server Discussion Thread

This message was posted to the [Coral List Server](#) by John Ware, starting an interesting discussion. All of the messages posted thus far concerning this discussion are posted below. This page will be updated as more messages are posted. Some of the writers included a previous posting in their message. For simplicity, the included messages have been replaced by a link to the previous message that was quoted. If you follow that link, moving back in your browser should bring you back to your original position. This should continue to work even if you download the document to your machine. If you have any difficulties navigating this document, send a message to the [CHAMP WebMaster](#).

From: John Ware [jware@erols.com]  
Sent: Thursday, May 25, 2000 2:21 PM  
To: coral-list@coral.aoml.noaa.gov  
Subject: Rain forests of the sea??

Dear Coral List,

One of Jim Hendee's recent messages reminded me that one of the legitimate items for the coral list is "controversial topics in coral reef ecology".

I am not sure that this is a 'controversial topic', but the coral list has been pretty quiet lately. Are coral reefs really analogous to rain forests or is the coral reef community just taking advantage of a catchy 'sound bite' to gain status in the eyes of the ecologically minded public?

There are certainly some similarities, but I have often thought that the differences are large also. Anybody care to share their thoughts on this topic with the list??

John

--

\*\*\*\*\*

*	*
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From: Don McAllister[mcall@superaje.com]  
 Sent: Thursday, May 25, 2000 4:02 PM  
 To: John Ware  
 Cc: coral-list@coral.aoml.noaa.gov; Callum Roberts  
 Subject: Re: Rain forests of the sea??

John Ware wrote:

- >
- > I am not sure that this is a 'controversial topic', but the
- > coral list has been pretty quiet lately. Are coral reefs really
- > analogous to rain forests or is the coral reef community just taking
- > advantage of a catchy 'sound bite' to gain status in the eyes of the
- > ecologically minded public?

I think the conservation community, including myself (!) has taken advantage of this analogy, although really coral reefs stand on their own tentacles. However, work of the IUCN SSC Coral Reef Fish Specialist Group suggests that about 25% of marine fish species are found on coral reefs. That's a pretty high level, given that coral reefs occupy less than 1% of the World Ocean, some 230,000 km<sup>2</sup> according to a recent estimate. Hopefully Callum Roberts and Julie Hawkins will publish this year their fabulous species density maps for coral reef fishes of the world that will show the global hotspots for these fishes.

Marjorie L. Reaka-Kudla in Biodiversity II, however comes up with a better broad answer. She estimates that over 900,000 species (plants, animals, microbiota) inhabit coral reefs.

Another answer can be provided by a scuba/snorkel transect across a reef and into adjacent sandy areas. Lots of species in the first, few in the second.

But it isn't just a tropical affair (:-->), Norwegian studies show 300 species in deepwater coral 'reef' areas off their coasts. We haven't studied such areas thoroughly enough elsewhere to be sure of counts. But mapping deepwater corals off the West Coast of Canada, shows they are much more frequent there than had been hitherto suspected and the available clues suggest a rich variety of biota. This would suggest that it is the

three-dimensional structural diversity in the tropics and boreal zones which provides shelter and food, that intensifies biodiversity.

don  
Don McAllister

---

From: Bob Steneck[Steneck@maine.maine.edu]  
Sent: Thursday, May 25, 2000 6:38 PM  
To: John Ware; coral-list@coral.aoml.noaa.gov  
Subject: Re: Rain forests of the sea??

Coral folk,

It's all relative but both rainforests and coral reefs are unique and probably worthy of the sound-bite analogy. Both concentrate diversity, have complex habitat architecture and are highly productive (high gross productivity). Species richness and canopy heights are greater in rainforests, gross productivity is greater on reefs. Taxonomic composition differs significantly. In rain forests most species are insects, angiosperms and birds. Reefs have no marine insects, hardly any angiosperms and certainly no birds. However, reefs have much greater higher-order diversity (e.g., number of phyla). While there is a wider phyletic range of primary producers (endosymbionts, plankton and multiple phyla of benthic algae) the within group diversity for each is relatively low. For example, species richness in algae is much lower than that for angiosperms, reef fish are less diverse than rainforest birds. There are low diversity reefs (e.g., Clipperton in the eastern Pacific, Abrolhos off Brazil and Hawaii) that have many of the same zones, groups and ecosystem function of high diversity reefs. I don't know of low diversity rainforests - this may reveal my ignorance.

Coral reefs may be most unique because of their role in producing calcium carbonate bioherms (reef rock). In a relatively short period of time, say 500 or 1000 years, they can significantly change their physical environment as they grow to and reach sea level.

Finally, both ecosystems are globally threatened. Would it be useful to consider the rates of change in these two ecosystems? Reefs in the Caribbean have lost much of their largest framework building corals (the acroporids). Are there rainforest analogs? Are the two systems equally resilient to perturbations?

Just some food for thought.

Cheers,

Bob Steneck

-----  
Robert S. Steneck, Ph.D.  
Professor, School of Marine Sciences  
Pew Fellow in Marine Conservation  
University of Maine  
Darling Marine Center  
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The School of Marine Sciences Web site:  
<http://www.ume.maine.edu/~marine/index.html>

---

From: Rick Grigg[rgrigg@iniki.soest.hawaii.edu]  
Sent: Thursday, May 25, 2000 8:41 PM  
To: Bob Steneck; John Ware; coral-list@coral.aoml.noaa.gov  
Subject: Re: Rain forests of the sea??

Dear John,

Perhaps a perspective might be gained by turning the analogy around. Rain forests are the "coral reefs of the land".

Not even, as they say in Hawaiian these days.

Rick Grigg  
University of Hawaii

---

From: Osha Gray Davidson[osha@pobox.com]  
Sent: Thursday, May 25, 2000 9:56 PM  
To: Rick Grigg; Bob Steneck; John Ware; coral-list@coral.aoml.noaa.gov  
Subject: Re: Rain forests of the sea??

Hey, Rick, if you're going to quote from my book, the least you could do is give the proper citation (The Enchanted Braid, p. 6.) ;->  
Osha

Osha Gray Davidson  
Adjunct Associate Professor  
International Programs, University of Iowa

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**Note:** Davidson had Grigg's whole message in his original message. [Rick Grigg's message](#) is already displayed above.

---

From: Gould, Rob[Rob.Gould@itn.co.uk]  
Sent: Friday, May 26, 2000 4:30 AM  
To: 'coral-list@coral.aoml.noaa.gov'  
Subject: Re: rainforests of the sea/raising awareness

Coral people,

I was interested by the recent comparison between reefs and rainforests. I'm producing a documentary for Discovery Channel on the marine research in the Mascarene area of the Indian Ocean. Coral reefs clearly play an important part in the ecology here and these reefs suffered particularly badly in the 1998 bleaching event. The idea that coral reefs are analogous to rainforests is one I've heard and was planning to use as one of the themes in the programme.

One reason for linking the two ecosystems, from my point of view, is the hope that it will raise public awareness of the importance of coral reefs in the way that the destruction of the rainforests became popular cause in the final decades of the last century.

I am structuring the programme at the moment so any thoughts from you, the experts, would be greatly appreciated. Any information about possible implications of reef destruction and, of course, the positive contributions coral reefs make to the wider environment are particularly welcome.

Your knowledge on this subject is obviously far greater than mine so I would very much appreciate any help or ideas.

Many thanks,

Rob Gould

[rob.gould@itn.co.uk](mailto:rob.gould@itn.co.uk)

---

From: Don McAllister[mcall@superaje.com]

Sent: Friday, May 26, 2000 10:06 AM  
To: coral-list@coral.aoml.noaa.gov  
Subject: Re: Rain forests of the sea??

Bob Steneck wrote:

However, reefs have much greater higher-order diversity (e.g., number of phyla).

You could say that rainforest diversity is based mosly on beetles!

:=>

don  
Don McAllister

---

From: Dricot-Fellenius[karlf@sfu.ca]  
Sent: Friday, May 26, 2000 4:23 PM  
To: Gould, Rob  
Cc: 'coral-list@coral.aoml.noaa.gov'  
Subject: Re: rainforests of the sea/raising awareness

Rob,

I am on this listserver to gain knowledge about coral reefs that can be used in the management of coastal and marine tourism. As such, I can appreciate the analogy between rain forests and coral reef environments from a tourism perspective. While tourism is more prevalent in reef environments, ecotourism tends to have more success in rain forests. In accordance with ecotourism principles, the conservation ethic by tourism operators and the extent of local benefit from the operation are two themes that could be elaborated upon in your programme.

There are a number of sites that can be referenced for this kind of info:

<http://www2.planeta.com/mader/planeta/0295/0295shores.html>  
The Challenge of Ecotourism

<http://ecotourism.homepage.com/definitions.htm>  
Dealing with Definitions - John Shores

<http://www.gorp.com/gorp/features/misc/ecotour.htm>  
Principles of Ecotourism - GORP

<http://www.green-travel.com/gtdef.htm>  
Toward Definition



<http://www2.planeta.com/mader/ecotravel/tour/definitions.html>

Definitions - Ron Mader/Planeta.com

<http://www2.planeta.com/mader/ecotravel/tour/latam.html>

Latin American Ecotourism - What is it?

<http://www2.planeta.com/mader/planeta/1196/1196agents.html>

Evaluating Ecotourism Operators and Agents

regards,

karl

"Gould, Rob" wrote:

- > I am structuring the programme at the moment so any thoughts from you, the
- > experts, would be greatly appreciated. Any information about possible
- > implications of reef destruction and, of course, the positive contributions
- > coral reefs make to the wider environment are particularly welcome.
- >
- > Your knowledge on this subject is obviously far greater than mine so I would
- > very much appreciate any help or ideas.

--

Karl Fellenius, Masters Candidate  
School of Resource & Environmental Management  
Simon Fraser University  
Burnaby, BC V5A 1S6  
<http://www.rem.sfu.ca>  
[karlf@sfu.ca](mailto:karlf@sfu.ca)

---

From: Gregor Hodgson[gregorh@pacific.net.hk]  
Sent: Saturday, May 27, 2000 5:19 AM  
To: Gould, Rob  
Cc: coral-list@coral.aoml.noaa.gov  
Subject: Why is it useful to compare rainforests and reefs?

Extending poetic license to ecology, we have used the phrase "coral reefs are the rainforests of the sea" in Reef Check's published and website PR and media materials since 1996, so have probably helped to spread this useful ecological falsehood far and wide. I don't know where the phrase was first used (and I would be interested to find out), but we found it very valuable to convey in a nutshell many of the conservation related ideas already noted by others.

The fundamental message that this phrase carries to the general public is that coral reefs, like rainforests:

- 1) have a high biodiversity

- 2) are suffering heavy human impacts
- 3) deserve protection/conservation.

The public and media have already been through a long learning curve regarding the "save the rainforests" campaign and it is a useful analogy primarily in this sense. However, I have seen some fellow ecologists wince when they hear it.

To add to Bob's ecological comments, I would also note that a major difference between the two ecosystems is that many rainforest organisms such as insects, birds, and mammals are herbivores and EAT the major structural component of a rainforest --- trees (leaves, flowers, fruit etc), whereas, there are few coral reef organisms which directly consume corals. Fish are not insects and corals are not trees.

GH

--

Gregor Hodgson, PhD  
Coordinator, Reef Check Global Survey Program  
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Email: [gregorh@pacific.net.hk](mailto:gregorh@pacific.net.hk)  
Web: [www.ReefCheck.org](http://www.ReefCheck.org)

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From: [Brylske@aol.com](mailto:Brylske@aol.com)  
Sent: Saturday, May 27, 2000 10:20 AM  
To: coral-list@coral.aoml.noaa.gov  
Subject: reefs and rainforests

I've been watching this threat with a great deal of interest, given the nature of my own research as a marine educator. For the past two years I've been studying the role of analogies in human learning, and specially how analogy-based instructional strategies can be used in the acquisition of scientific concepts.

Currently, I'm finishing my dissertation entitled, "The Effects of Analogy-Based Instruction on Concept Learning and Retention in a Non-Formal Coral Reef Ecology Program." My research supports the idea that analogies are powerful instructional tools, particularly with low-ability learners or those with minimal background/experience in the subject area. While my project involved the often-used "coral reef as a city" analogy, there's no reason to believe that the rain forest concept wouldn't be just as effective. If, in fact, you'd like a wonderful example of the reef/rain forest analogy, take a look at Dave Gulko's outstanding book, Hawaiian Coral Reef Ecology (pp. 136-137).

My experience is that scientists often ignore or shy away from the vital role

of communicating their research to any audience except their peers; and I'm very pleased to see educational issues addressed in this forum. I welcome any comments of questions in this regard.

Alex Brylske

---

From: Brylske@aol.com  
Sent: Saturday, May 27, 2000 10:30 AM  
To: gregorh@pacific.net.hk; coral-list@coral.aoml.noaa.gov  
Subject: Re: Why is it useful to compare rainforests and reefs?

In a message dated 5/27/00 5:41:16 AM, [gregorh@pacific.net.hk](mailto:gregorh@pacific.net.hk) writes:

<< to add to Bob's ecological comments, I would also note that a major difference between the two ecosystems is that many rainforest organisms such as insects, birds, and mammals are herbivores and EAT the major structural component of a rainforest --- trees (leaves, flowers, fruit etc), whereas, there are few coral reef organisms which directly consume corals. Fish are not insects and corals are not trees. >>

This is a very important issue. When not used appropriately, analogies are prone to cause misconceptions among learners. Those who have studied the phenomenon--and developed prescriptive procedures for analogy-based instruction--all emphasize that, as part of the strategy, the learner must be told where the analogy BREAKS DOWN as well as where it applies. My definition, an analogy is something similar, not exactly the same as something else.

Alex Brylske

---

From: Ursula Keuper-Bennett[[howzit@turtles.org](mailto:howzit@turtles.org)]  
Sent: Saturday, May 27, 2000 1:45 PM  
To: Brylske@aol.com; gregorh@pacific.net.hk;  
coral-list@coral.aoml.noaa.gov  
Subject: Re: Why is it useful to compare rainforests and reefs?

Hi Alex (others)

re: "coral reef as a city" analogy vs "coral reef as a rain forest".

I've never heard the coral reef/city analogy before but I guess most people know more about a city than a rain forest so educators would go with what

most people know. I can certainly SEE similarities once I get past the huge hurdle that "city" is a human construct and rainforest/coralreef both natural treasures are threatened BY human constructs.

Let's see... similarities.... a city is run by movers-and-shakers and there sure are movers-and-shakers on any coral reef making everything else run. There's all kinds of interdependency and huge changes in activity between day and night. Scavengers and parasites make do as they can... Anyone being in the wrong place at the wrong time and they won't repeat that mistake.

Yes, I can see the analogy.

I still like the coral reef as rainforest analogy better. Never experienced a rain forest --only what I've seen on TV or read about. But a rainforest sure "feels" like a coral reef. Both are 3D worlds with a lot of up and down.

I've shot videotape of a reef system off the coast of West Maui from 1989 through 1999 and for various reasons, need to return to those tapes frequently. As I fast forward one thing strikes me.

It's possible to forget the footage is underwater especially when reviewing wide-angle/distant segments. And when that happens what I don't see a reef system but something that looks for all the world like a furrowed meadow with swarms of bees buzzing about.

I'm fortunate to spend two months on the same coral reef every year. I've frequently found myself forgetting I'm underwater. Very easy to do. And then the corals feel like trees, bushes and hedges, the fish like butterflies and bees and the turtles --our beautiful turtles, FLY like birds.

And here's where our reef is also like a rainforest. Sometimes we just see everything mobile DASH to the bottom hugging the corals. ZING --like that. And we look around knowing something big scared the lot of them. The "insects" fled to the safety of the "trees". I'm sure when BIG shows in a rainforest, small flees to the trees too.

The analogy DOES break down though no question. If a coral reef resident falls off a coral head (even a huge TALL one) gravity is much more forgiving than it is for rainforest trees (even a small short one).

Ursula Keuper-Bennett  
TURTLE TRAX  
<http://www.turtles.org>

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**Note:** *Keuper-Bennett had Brylske's message in his original message. [Brylske's message](#) appears above.*

---

From: Robyn Cumming[Robyn.Cumming@usp.ac.fj]  
Sent: Sunday, May 28, 2000 10:01 PM  
To: coral-list@coral.aoml.noaa.gov  
Subject: Re: Why is it useful to compare rainforests and reefs?

Hi Coral-listers

Since we are discussing similarities between rainforests and reefs I think it is worth pointing out a number of parallels in terms of predation on the main habitat builders – trees and reef-building corals.

A large number of species prey directly on reef-building corals, including echinoderms, gastropods, crustaceans, polychaetes and fish (see for example Robertson 1970, Pacific Science 24:43). In both systems, these predators are grazers which normally injure rather than kill their prey. This opens up possibilities for complex behavioural and defensive responses of the prey. For many of them, with the notable exception of some vertebrates, the prey also provides substrate and protection.

In at least one case, the amount of prey standing crop removed annually parallels that of insect herbivores (2-12% by the gastropods *Drupella* {my data – unpublished}). I will go further to suggest that the ecological role of *Drupella* in coral reefs parallels that of insects in terrestrial forests, in that they exert a continual drain on energetic resources of their hosts.

Also, some species undergo population outbreaks like those of insect herbivores: *Acanthaster planci*, *Drupella cornus*, *Drupella fragum*.

Robyn

\*\*\*\*\*

Robyn Cumming  
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Visit the Biology web page at:

<http://www.usp.ac.fj/biology>

\*\*\*\*\*

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From: Mohan, Pete[Pete.Mohan@seaworld.com]  
Sent: Monday, May 29, 2000 9:20 AM  
To: 'Coral Health Server Posting List'  
Subject: RE: rainforests of the sea/raising awareness

I used the "Rainforests of the Sea" theme for a short video I just completed that accompanies our living coral exhibits here at SeaWorld Cleveland. I felt that public perception of rainforests is often limited to the idea that they are complex tropical systems that are endangered. At this rather simplistic level the analogy works.

Pete Mohan  
Curator/Fishes

---

From: Robert van Woesik [b984138@sci.u-ryukyu.ac.jp]  
Sent: Monday, May 29, 2000 8:31 PM  
To: coral-list@coral.aoml.noaa.gov  
Subject: reefs and rain forests  
RE: Coral reefs and Rain forests

A similarity in diversity maybe the only thing that coral reefs and rain forests have in common; let us not forget Steele's classic paper in 1985 (Steele, J.H. (1985) A comparison of terrestrial and marine systems. Nature 313, 355-358).

Plant communities appear limited by dispersal in both temperate (Tilman's many references) and tropical regions (Hubbell S.P., Foster, R.B., O'Brien, S.T., Harms, K.E., Condit, R., Wechsler, B., Wright, S.J. and Loo de Lao, S. (1999) Light-gap disturbances, recruitment limitation, and tree diversity in a neotropical forest. Science 283, 554-557), where seed shortages keep diversity high and gaps may be occupied at random. Hubbell et al. (1999, p. 557) state "...sites [in a tropical moist forest] are won by 'default' by species that are not the absolutely best competitor for the site". However, in the tropical marine environment 'seed' dispersal does not appear to be a problem, as broadcast spawning ensures widespread dispersal of coral larvae. Many coral communities show no sign of recruitment limitation (except maybe very isolated reefs). Steele (1985) suggested a combination of an immense annual larval production in the oceans with extensive larval dispersal might be a reflection of the dampened short-term environmental variability of that environment. On the other hand, organisms in the terrestrial system must cope with more short-term variability and hence display more restricted dispersal mechanisms than oceanic organisms. A means to the same end (i.e., high diversity) differs between tropical terrestrial and tropical marine systems, the former most likely being dispersal assembled and the latter by some other mechanism(s). Yet, it is hardly surprising that the mechanisms causing high diversity on the land may differ from those in the sea. The environmental variability, for example

temperature, in terrestrial systems is large in both the short and long-term, but the oceans have a smaller amplitude of variability in the short term (Steele 1985); variations to this variability will be more detrimental to organisms in the marine environment than to terrestrial organisms (e.g., the 1998 high SST and consequent coral bleaching), because marine organisms are adapted to small physico-chemical variability. Caution is necessary if we continue to compare the two systems (i.e., coral reefs and rain forests) as similar systems when in fact the processes that shape the systems are completely different.

Rob van Woesik

\*\*\*\*\*

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From: Fredrik Moberg [fredrikm@system.ecology.su.se]  
Sent: Tuesday, May 30, 2000 5:49 AM  
To: coral-list@coral.aoml.noaa.gov  
Subject: Re: Rain forests of the sea??

In the latest issue of the journal of the Royal Swedish Academy of Sciences (*Ambio*) there is an article by Ariel Lugo, Caroline Rogers and Scott Nixon (see abstract below). It deals with the resistance, ruin and recovery of rainforests and coral reefs in the Caribbean.

It also includes a list of the similarities and contrasts between reefs and rainforests.

Hurricanes, coral reefs and rainforests: Resistance, ruin and recovery in the Caribbean

Lugo AE, Rogers C, Nixon S

AMBIO 29: (2) 106-114, MAR 2000

Abstract:

The coexistence of hurricanes, coral reefs, and rainforests in the Caribbean demonstrates that highly structured ecosystems with great diversity can flourish in spite of recurring exposure to intense destructive energy. Coral reefs develop in response to wave energy and resist hurricanes largely by virtue of their structural strength. Limited fetch also protects some reefs from fully developed hurricane waves. While storms may produce dramatic local reef damage, they appear to have little impact on the ability of coral reefs to provide food or habitat for fish and other animals. Rainforests experience an enormous increase in wind energy during hurricanes with dramatic structural changes in the vegetation. The resulting changes in forest microclimate are larger than those on reefs and the loss of fruit, leaves, cover, and microclimate has a great impact on animal populations. Recovery of many aspects of rainforest structure and function is rapid, though there may be long-term changes in species composition. While resistance and repair have maintained reefs and rainforests in the past, human impacts may threaten their ability to survive.

”  
(o o)

-----oOO--(\_)--OOo-----

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---

From: Les Kaufman[[lesk@bio.bu.edu](mailto:lesk@bio.bu.edu)]  
Sent: Tuesday, May 30, 2000 9:05 AM  
To: Robert van Woesik  
Cc: coral-list@coral.aoml.noaa.gov  
Subject: Re: reefs and rain forests

The spatial dynamics of larval delivery make local supply a determining factor even when net larval numbers are astronomically high. This is one contributor to spatial heterogeneity and "storage effects" on reefs.

Les Kaufman  
Boston University Marine Program  
Department of Biology  
5 Cummington Street  
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617-353-5560 office  
617-353-6965 lab



617-353-6340 fax  
Woesik

**Note:** Kaufman's message is in response to [Woesik's message](#) displayed above.

---

From: Brice Quenoville[quenovib@naos.si.edu]  
Sent: Tuesday, May 30, 2000 10:02 AM  
To: coral-list@coral.aoml.noaa.gov  
Subject: coral reefs/plants

Hi,

Talking about comparing terrestrial and marine life, marine life is =  
evolving in three dimensions: latitude, longitude and also vertically. =  
Plancton is very common in the marine realm, as a way of life or as a way =  
of dispersion and most organisms have at least part of their life as a =  
planctonic entity. Now looking at terrestrial life only plants do really =  
compare with marine organisms by using a planctonic way or at least an =  
"aerial" way of dispersion. Such convergence of behaviour could have =  
eventually created similarities in species diversity and occurrence. I =  
don't know enough about all this but coral reefs could then be compared =  
to tropical vegetation because of similar latitude/longitude distribution =  
and maybe such comparisons could also be done for marine life/plants at =  
different latitude/longitude. Recent molecular studies tend to show a =  
higher level of population structure and divergence in marine organisms =  
than previously expected and plants can also be highly structured and =  
diversified on relatively short distances or short height. Hybridization, =  
polyploidy, variation in the number of chromosomes is very commonly =  
recognized in plants and start to be more and more reported or suspected =  
for marine life.=20

Anyway, it's lunch time and my food is not drifting in the air...

brice

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*lasted updated 06/01/00*  
*by [Monika Gurnée](#)*  
*CHAMP Webmaster*



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The content on this web page was last updated in December of 2012.

For more information:

<http://www.nmfs.noaa.gov/stories/2012/11/82corals.html>.

#### Read About:

- ❖ [2012 Update](#)
- ❖ [2004 Update](#)
- ❖ [Should Acropora spp. be listed?](#)

## Update - 2012

November 30, 2012: NOAA Fisheries is proposing Endangered Species Act (ESA) listings for 66 coral species: 59 in the Pacific and seven in the Caribbean.

- In the Pacific, seven species would be listed as endangered and 52 as threatened.
- In the Caribbean, five would be listed as endangered and two as threatened.
- In addition, NOAA Fisheries is proposing that two Caribbean species—elkhorn and staghorn corals—already listed under the ESA be reclassified from threatened to endangered.

In 2009, NOAA received a petition to list 83 species of reef-building corals under the ESA from the Center for Biological Diversity. On February 10, 2010, NOAA found that the Center presented substantial information indicating that listing under the ESA may be warranted for 82 of the 83 petitioned species.

Following the initial finding, NOAA convened a Biological Review Team to initiate a formal status review of the 82 species. The result was a Status Review Report, released in April 2012. The peer-reviewed report incorporated and summarized the best available scientific and commercial data to date.

The agency also conducted a public engagement process between April and July 2012 to gather additional scientific information, allow time for a public review of the Status Review and Draft Management Reports, and to further engage the public. All relevant information gathered was summarized in a new Supplemental Information Report.

Together, the Status Review, Supplemental Information, and Final Management reports form the basis for the proposed listing.

## Update - 2004

On March 4, 2004, the Center for Biological Diversity petitioned NOAA's National Marine Fisheries Service (NMFS) to list elkhorn (*Acropora palmata*) and staghorn (*Acropora cervicornis*) corals under the Endangered Species Act (ESA). After further review, NOAA/NMFS determined that these two species of *Acropora* warranted listing under the ESA. In May 2006, the United States listed *Acropora palmata* and *Acropora cervicornis* as vulnerable under the Endangered Species Act due to their widespread decline throughout their Caribbean range.

## Should Acropora spp. Be Included on the Endangered Species List?

On Jan. 15, 1999, the National Marine Fisheries Service (NMFS) requested comment on the possible listing of elkhorn and staghorn corals as candidates for protection under the Endangered Species Act (ESA). NMFS was considering listing the corals because their populations have been greatly reduced throughout the Caribbean range. Populations declined during the 1980s by up to 96 percent, according to the Federal Register notice. NMFS requested information that would either support or argue against inclusion of these coral species on the candidate list.



Elkhorn coral (*Acropora palmata*) is a branching coral. Branching corals grow in the shallow areas of the reef crest and serve to break up the wave action as it comes onto the reef. The branches of elkhorn coral resemble an elk's rack of antlers, thus its name.

Coral-list participants, which generally were equally divided on the issue, discussed the pros and cons of possible ESA protection for the corals, as well as the legal nuances of the act.

The final participant summed up the lengthy discussion by examining the nature of the debate and the conflict between "reductionist" research and "holistic" research.

[Click here](#) for a list of discussion participants.

[Click here](#) to download the complete unedited discussion (pdf, 127Kb).

## Additional References

Shinn, Eugene. (2004). The mixed value of environmental regulations: do acroporid corals deserve endangered species status? *Marine Pollution Bulletin*. 49(7-8) pp. 531-533, doi: [10.1016/j.marpolbul.2004.07.007](https://doi.org/10.1016/j.marpolbul.2004.07.007)

Bruckner, A.W. , 2002. Proceedings of the Caribbean Acropora Workshop: Potential Application of the U.S. Endangered Species Act as a Conservation Strategy. NOAA Technical Memorandum NMFS-OPR-24, Silver Spring, MD 199 pp.  
[http://www.nmfs.noaa.gov/pr/pdfs/species/acropora\\_workshop\\_2002.pdf](http://www.nmfs.noaa.gov/pr/pdfs/species/acropora_workshop_2002.pdf)

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## Should *Acropora* spp. Be Included on the Endangered Species List?

### Listserve Participants

Jamie Bechtel  
Boston University

Eric Borneman

Bruce Carlson  
Waikiki Aquarium

Gary Casper

Billy Causey  
National Oceanic and Atmospheric Administration

J. Charles Delbeek  
Waikiki Aquarium, University of Hawaii

George Garrett  
Florida Keys

Tom Hourigan  
National Oceanic and Atmospheric Administration

Walt Jaap  
Florida Marine Research Institute

Les Kaufman  
Boston University

Judy Lang

Mary Ann Lucking  
CORALations

Sean Lyman  
Duke University Marine Laboratory

Kenyon Mobley  
Georgia Southern University

Fabrice Poiraud-Lambert

William Precht

LAW Engineering & Environmental Services, Inc.

Robert Steneck  
University of Maine

Alina Szmant  
University of Miami

Susan White  
Florida Keys National Wildlife Refuge

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U.S. Department of Commerce



[http://coris.noaa.gov/exchanges/acropora\\_esa/sup\\_part\\_acropora\\_esa.html](http://coris.noaa.gov/exchanges/acropora_esa/sup_part_acropora_esa.html)

# Should Acropora spp. be included on the Endangered Species List?

## A Coral-List Server Discussion Thread

This message was posted to the [Coral List Server](#) by Tom Hourigan. It started a lengthy and interesting discussion. All of the messages dealing with Acropora's endangered status follow. Many of the writers included a previous message in their messages. For simplicity, the included messages have been replaced by a link to the previous message that was quoted. If you follow that link, moving back in your browser should bring you back to your original position. This should continue to work even if you download the document to your machine. If you have any difficulties navigating this document, send a message to the [CHAMP WebMaster](#).

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From: Tom Hourigan <Tom.Hourigan@noaa.gov>  
To: coral-list@coral.aoml.noaa.gov <coral-list@coral.aoml.noaa.gov>  
Subject: Acropora spp. - Candidates for Endangered Species List  
Date: Tuesday, February 16, 1999 9:50 PM

Dear Coral List,

In the U.S. Federal Register Notice January 15, 1999 (Volume 64, Number 10), the National Marine Fisheries Service (NMFS) requested information on marine Candidate Species for listing under the U.S. Endangered Species Act. This notice is not a proposal for listing; candidate species do not receive substantive or procedural protection under the Endangered Species Act. The goal of the candidate species program is to identify species as candidates for possible addition to the List of Endangered and Threatened Species and encourage voluntary efforts to help prevent listings. The full text of the Federal Register notice can be found on the web at: <http://www.access.gpo.gov/>.

## **ACROPORA SPECIES AS CANDIDATES FOR THREATENED OR ENDANGERED SPECIES:**

In this Notice, NMFS has proposed to add two coral species, elkhorn coral (*Acropora palmata*) and staghorn coral (*Acropora cervicornis*) as candidates for possible addition to the List of Endangered and Threatened Species under the Endangered Species Act (FR Doc. 99-1011, 1-15-99). These two species were among the dominant corals in shallow-water Caribbean reef communities. During the last two decades, it appears that populations of *A. cervicornis* and *A. palmata* have been greatly reduced throughout their range as a result of hurricane damage, coral diseases, increased predation, hypothermia, boat groundings, sedimentation, and other factors. Losses are well documented at several sites in U.S. waters, where populations declined during the 1980s by up to 96%. To date, acroporid corals have not recovered to their former abundance, and remaining populations may continue to deteriorate from natural and anthropogenic factors. The observed low rates of larval recruitment may hinder recovery of

these species, given continuing losses from coral diseases, predators, storms and human impacts.

To be listed under the Endangered Species Act, invertebrates must be shown to be threatened throughout the range of the species (in contrast to vertebrates, which can be listed based on specific populations or the status in U.S. jurisdiction).

NMFS would appreciate any information on these species that would support or argue against inclusion on the candidate species list. Such information could include historic and current population sizes and distribution, assessments of threats, and existing and future protective measures that may assist to recover these species before listing under the ESA becomes necessary.

## OTHER CORAL SPECIES

We have also examined several other western Atlantic coral species that might merit inclusion as Candidate species. They were not included in the Federal Register Notice since the information available was incomplete. They include:

- *Acropora prolifera*
- *Dendrogyra cylindricus* - pillar coral
- *Dichocoenia stokessi*
- *Oculina varicosa*

Other species, such as the *Porites porites* complex, *P. astreoides*, the *Montastraea annularis* complex, *M. cavernosa*, *Diploria strigosa*, *D. clivosa*, and *D. labyrinthiformis* appear to have undergone some declines at certain sites, but do not appear as threatened as the *Acropora spp.*, at this time.

We welcome any discussion and comments members of the coral list may have on the inclusion of these or other coral species on the candidate species list. Formal comments should be sent to the Chief of the Endangered Species Division in NMFS' Office of Protected Resources at the address listed below.

Thanks for your help!

Tom Hourigan

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From: **Bob Steneck** <[Steneck@maine.maine.edu](mailto:Steneck@maine.maine.edu)>



To: "Tom Hourigan" <Tom.Hourigan@noaa.gov>, "Coral List" <coral-list@coral.aoml.noaa.gov>  
Subject: Re: Acropora spp. - Candidates for Endangered Species List  
Date: Sat, 20 Feb 99 12:46:36 -0500

Dear Tom,

It seems to me that the Acropora decline throughout the Caribbean may qualify that genus and all of its species to endangered status. I have seen some recent declines in Porites and to a lesser extent Dichocoenia but some of the other species you have listed I do not think qualify. Most notably is Dendrogyra cylindricus. While I know of no region or reef in the Caribbean where it has ever been abundant, it is remarkably common. Most reefs have a little of that species and most areas I've worked throughout the Bahamas, eastern and western Caribbean seem to have healthy colonies. I suspect you do not want a list of corals that happen to have always had low abundance.

It will be relatively easy to query the Atlantic and Gulf Reefs Rapid Assessment data sets to see if higher than average mortality rates are showing up for the species you list below (see: <http://coral.aoml.noaa.gov/agra/agra1.html>). In April many of us will be assembling in Fort Lauderdale to present data on the condition of Caribbean reefs, perhaps you could get a consensus of opinions at that time (see: [http://www.nova.edu/ocean/ncri/cfp\\_1.html](http://www.nova.edu/ocean/ncri/cfp_1.html)).

Good luck in your efforts.

Bob Steneck

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>merit inclusion as Candidate species. They were not included in the Federal  
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>  
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>sites, but  
>do not appear as threatened as the Acropora spp, at this time.

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From: "**CORALations**" <[corals@caribe.net](mailto:corals@caribe.net)>  
To: "Coral-List" <[coral-list@coral.aoml.noaa.gov](mailto:coral-list@coral.aoml.noaa.gov)>  
Subject: Re: Acropora spp. - Candidates for Endangered Species List  
Date: Mon, 22 Feb 1999 09:58:48 -0400

Based on what we know about the interconnectedness of species in such an ecosystem, how can we still be selecting individual species for protection and ignoring others...For example..saying Acropora would qualify as endangered due to declines throughout the Caribbean does not provide solutions for impacts to other species of coral that result from this decline. Could reef scientists possibly make rational arguments for considering the entire ecosystem as endangered ...including commercially valuable fish and shellfish which play a role in nutrient distribution and recycling etc.?

It seems that the way these systems have evolved is more complicated than mere % distributions of individual species and if we are going to spend time and energy trying to protect them could we possibly shoot for a legislative solution which effectively recognizes this? I have concerns about scientists becoming too conservative in the manner in which they convey impacts to the reef in an effort to propell small, less controversial solutions to society when these solutions may simply not be effective. Look how we've bungled and continue to bungle marine fishery legislation in order to propell small palatable bits of legislation often too little, too late...rarely complied to or enforced.

"The problems we have today, will not be solved by thinking the way we thought when we created them".... Albert Einstein

**Note:** *The writer at CORALations had Steneck's entire message in the original message. [Steneck's message](#) is just above.*

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From: "**Judith Lang & Lynton Land**" <[JandL@rivnet.net](mailto:JandL@rivnet.net)>  
To: "Coral-List" <[coral-list@coral.aoml.noaa.gov](mailto:coral-list@coral.aoml.noaa.gov)>  
Date: Mon, 22 Feb 1999 11:13:39 -0500  
Subject: Candidates for Endangered Species List

Re: the message from CORALations:

In fact an ecosystem approach to species conservation has been our theoretical underpinning since about 20 years ago when the Gulf of Mexico and South Atlantic Fishery Management Councils collaborated on a Fishery Management Plan for Coral and Coral Reefs. The "management unit" here was defined as being composed of about 400 species of fire corals, soft corals, gorgonians, black corals and stony corals. At the time, declaring that its maximum sustainable yield was "incalculable", and that its principal value was in "nonconsumptive uses" certainly was an unusual approach to fishery management!

By and large "management for conservation" is working at what is now the Flower Garden Banks

National Marine Sanctuary (where, incidentally, all types of fishing except with hook-and-lines has also been prohibited since 1992). Stony corals have shown no significant changes in cover, species diversity, species evenness or growth rates since the early 1970's, despite their location near active petroleum platforms in the Northwestern Gulf of Mexico [see review of SR Gittings, TJ Bright and DK Hagman, 1994, pp. 181-187 in RN Ginsburg, (compiler), Proc. Colloquium on Global Aspects of Coral Reefs: Health, Hazards and History].

Sadly, the subsequent history of many reefs in the Florida Keys, where both natural and anthropogenic stresses are considerably greater than 200 km offshore Texas, has been less fortunate. Hence, it seems to me that we should continue to CREATIVELY invoke all available legal options --including the endangered species act, with its provisions for habitat acquisition/protection/restoration --as surely, in the long run, that will only help conserve coral reefs and associated ecosystems.

Judy Lang

**Note:** *Judy Lang had CORALations message in her original message. [CORALations message](#) is just above.*

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From: **Sean Lyman** <sjl3@duke.edu>  
To: CORALations <corals@caribe.net>  
cc: Coral-List <coral-list@coral.aoml.noaa.gov>  
Subject: Re: Acropora spp. - Candidates for Endangered Species List  
Date: Mon, 22 Feb 1999 11:02:24 -0500 (EST)

Good morning:

The CORALations folks bring up a good point about classification of the entire coral reef system as endangered, but I think it's a mistake to so quickly dismiss listing of a single species. I do not disagree with their points, but I do think that listing and protection of a single species can be useful.

Doing what is necessary to protect a single species (or genus) or coral is going to have a positive effect on the entire system, something I've heard referred to as an "umbrella" of protection. The Endangered Species Act in the US certainly has problems, but the listing and protection of charismatic megafauna has often had trickle-down effects on equally-endangered ecosystems in which they live.

I think that we are a long way from the political power to implement an endangered communities act, and therefore should not be shy about using the tools at our disposal. Declaring Acropora as endangered will increase awareness about the decline of the coral reef ecosystems, and steps taken to protect Acropora will most likely benefit at least other corals and at best the entire system.

Cheers,  
Sean

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From: "**Causey, B.**" <bcausey@ocean.nos.noaa.gov>  
To: "CORALations" <corals@caribe.net>, "Sean Lyman" <sjl3@duke.edu>  
Cc: "Coral-List" <coral-list@coral.aoml.noaa.gov>  
Subject: RE: Acropora spp. - Candidates for Endangered Species List  
Date: 23 Feb 1999 11:32:39 -0500

Some food for thought:

Although I am supportive of listing Acropora spp for all the reasons that have been discussed over the past week or so, I too have some comments. The only reason I mention this here is that a few of the comments such as the one from Sean raise some good points about a community approach to protection.

Due to the wide range of threats and many issues facing South Florida, EPA and the USFWS have been developing a Multi-species Recovery Plan instead of using the ESA in a species by species approach. We have in the neighborhood of 82 species of threatened or endangered species and the USFWS has produced a draft plan to comprehensively look at the problems.

I agree that we should move forward with this listing of Acropora spp to heighten the protection, thus the awareness that there is a serious problem throughout the range of this genus in the Atlantic and Caribbean, but realize that a long-range goal of a multi-species approach should be kept in mind.  
Cheers, Billy Causey

**Note:** Causey had Sean Lyman's whole message in his original message. [Lyman's message](#) is just above.

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From: "**CORALations**" <corals@caribe.net>  
To: "Coral-List" <coral-list@coral.aoml.noaa.gov>  
Subject: Fw: Acropora spp. - Candidates for Endangered Species List  
Date: Tue, 23 Feb 1999 14:52:01 -0400

Dear Dr. Precht:

I apologize to you and others on the list if what I wrote was not clear...I did not mean in any way to imply that we should abandon the endangered species act or any other legal avenue of protection people have struggled for years to establish in order to embrace what you described as a "shot gun" approach to coral reef conservation. Further, when I was referring to the interconnectedness of species in such an ecosystem I was not only referring to other coral species, but other reef associated species of plants and animals.

The point on which I was trying generate a professional discussion stems from ever increasing frustrations in finding "real time" solutions to coral reef conservation problems. I posed the question...could another more holistic approach to reef conservation legislation be argued at this time.....based on what scientists have documented about the interdependence or interconnectedness of species within this ecosystem?

Am I correct in interpreting your response to this question as "no" when you wrote:

"Well, I think the data tend to argue against these systems being interconnected (i.e. tightly integrated) "

By systems, do you mean species within the system? If I am interpreting this correctly, it contradicts what I understand about the co-evolution of species within ecosystems and the importance of conserving species biodiversity. This is of concern to me since this is what I attempt to convey as a "grass roots" educator to the general public about reef systems. Please clarify if I am misinterpreting your comment...it may well have been meant only in relation to Acropora and the lack of data supporting any connection between the decline of other coral species in relation to Acropora declines. Any information you, or anyone on the list can send, is always greatly appreciated.

Thanks to the Langs who wrote:

"In fact an ecosystem approach to species conservation has been our theoretical underpinning since about 20 years ago when the Gulf of Mexico and South Atlantic Fishery Management Councils collaborated on a Fishery Management Plan for Coral and Coral Reefs. The "management unit" here was defined as being composed of about 400 species of fire corals, soft corals, gorgonians, black corals and stony corals. At the time, declaring that its maximum sustainable yield was "incalculable", and that its principal value was in "nonconsumptive uses" certainly was an unusual approach to fishery management!"

I had no idea this approach was being taken with any FMP.....let alone 20 years ago and plead ignorant!

Dr. Precht also wrote:

"Although I am in agreement with you that both corals and coral reefs need vigilant protection because they are all at some level of risk, especially at the hands of man coupled with natural disturbances".

I believe we should, in the face of what may be considered time constraints on the survival of this ecosystem, carefully scrutinize past conservation management failures and keep our minds open to innovative and more aggressive practices. Please don't think this statement reflects ignorance about social pressures which govern reef and fish legislation, however, these comments come from Puerto Rico where fishermen from the municipal island of Culebra have been requesting the government establish a Marine Fishery Reserve since 1980 and although final legislation has been drafted for over a year and a half...still awaits final approval from the local government.

If the cost to society is the entire ecosystem...maybe we could justify the discussion of more aggressive or comprehensive management strategies? I have trouble defining the pursuit of any legislative action as being "a shot gun approach" as you stated. Legislative channels often take time and are open for meaningful public participation in the form of public hearings etc.....at least they are where you live.

Indeed, the broad definition given to coral reef ecosystem in Clinton's executive order 13089, must be at

least some cause for concern to the many "hired gun" consultants whose job it appears is to protect big business and government from the added expense of functioning in an environmentally responsible manner.

We should, however, pay close attention and note if even this broad definition given to coral reef ecosystems can effectively be used to contribute to the conservation of these marine systems? For example, much of the money or re-allocation of federal funds associated with this executive order is being focused on mapping and monitoring. Should we be concerned that 20 years from now, scientist may be reviewing what may then be historic information of where the living reefs once were? Should we be concerned that in 20 years scientists may be discussing how hard they "tried" to conserve these systems through the rationalization that the first step must be lengthy mapping and monitoring? Will there be any satisfaction in clearly and empirically demonstrating that these systems were in fact destroyed by multiple anthropogenic stressors ?

Do current approaches to coral reef conservation management and associated fund allocation warrant closer evaluation with respect to their potential effective contribution toward meeting conservation related objectives given the rate of system degradation? Could not this money be better spent addressing, for example, more controversial water quality issues?

Sincerely,

Mary Ann Lucking  
Project Coordinator  
CORALations  
Amapola 14, Suite 901  
Isla Verde, PR 00979  
787-791-7372  
corals@caribe.net

> From: Precht,Bill <BPrecht@kennesaw.Lawco.com>  
> To: corals@caribe.net  
> Subject: FW: Acropora spp. - Candidates for Endangered Species List  
> Date: Monday, February 22, 1999 3:20 PM  
>  
>  
> CORALations:  
>  
> I read with great interest your note to Tom H. regarding the inclusion of  
> Acropora and exclusion of other coral species on the E&T Species list.  
>  
> You state "based on what we know about the interconnectedness of species  
> in such an ecosystem" that we need to look at more than just the  
> acroporids, even at the ecosystem as a whole.  
>  
> Well, I think the data tend to argue against these systems being  
> interconnected (i.e. tightly integrated) -  
>  
> The Caribbean wide demise of acroporids over the last two decades has not  
> been related to the collapse of other coral species. In cases where other

> corals have declined, it has been for other reasons not related to the  
> mortality of the acroporids (white-band disease epizootic and related  
> necrosis). The data clearly show the acroporids to be at risk. This is  
> not so for all coral species in the Caribbean/western Atlantic. The  
> reproductive strategy (poor sexual recruitment success) will not help the  
> acroporids recover anytime soon.  
>  
> I believe it is  
> not prudent or a best management practice to use your shotgun approach  
> listing the whole ecosystem as endangered. Local extirpation of the  
> acroporids has already occurred in some populations and there is a serious  
> risk that in the face of continuing disturbances that we may lose the  
> whole lot. I would love to discuss this in greater detail if you would  
> like. I will send you a copy of some recent publications that I hope you  
> may find interesting....  
>  
> Sincerely yours,  
>  
> Bill  
>  
> William F. Precht  
> Natural Resources Manager  
> LAW Engineering & Environmental Services, Inc.  
> 5845 NW 158th Street  
> Miami Lakes, FL 33014  
> ph (305) 826-5588 x206  
> fax (305) 826-1799

**Note:** *In Bill Precht's quoted message was CORALations' original message. [CORALations' original message](#) appears above.*

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From: **kenyon mobley** <kenyon\_b\_mobley@gasou.edu>  
To: "coral-list" <coral-list@coral.aoml.noaa.gov>  
Subject: ESA  
Date: Tue, 23 Feb 1999 17:03:18 -0500

Food (or fodder) for thought about the endangered species act vs. ecosystem approach.

### **Published Saturday, February 20, 1999, in the Miami Herald**

Scientists sound the alarm for rare, tiny marine critter Is there room for lowly, microscopic marine critters on the marquee list of America's endangered species, next to the popular manatees, Florida panthers and bald eagles?

A coalition of scientists and conservationists is calling the question. They are asking the federal government to grant endangered species status to 11 species and a new genus of bryozoans found nowhere else but on a large sand bar off St. Lucie County.

The marine animals are in immediate danger of extinction, their advocates say, because the Army Corps of Engineers plans to mine sand from Capron Shoal, where they live, to widen 2.3 miles of beach south of Fort Pierce Inlet.

The \$6.3 million project is expected to start late next week -- unless the National Marine Fisheries Service, which lists endangered marine plants and animals, steps in.

The service must step carefully. Listing the bryozoans could have implications for other beach-building projects that Florida uses to pump up its prime tourist draws.

But not considering them for protection might violate one of the nation's most important environmental laws, says attorney Eric Glitzenstein, who represents the bryozoans' advocates.

Quoting the *Endangered Species Act*, he says: "From the narrowest point of view, it is in the best interest of mankind to minimize the losses of genetic variations. . . . They are potential resources. They are keys to puzzles which we cannot solve, and may provide answers to questions which we have not yet learned to ask.

A bryozoan is a tiny, invertebrate marine animal that can live its entire life on a single grain of sand.

Judith Winston, who co-discovered the Capron Shoal bryozoan colonies 14 years ago with a scientist from Denmark, argued in a letter to the fisheries service that the species will become extinct -- and with them the chemical secrets she says might help battle cancer.

"These unique bryozoans belong to the same order taxonomically as the bryozoan species which is the source of a potent anti-cancer agent, Bryostatin 1, wrote Winston, the research director at the Virginia Museum of Natural History. "Bryostatin 1 derives from the bryozoan *Bugula* species . . . which is also present in the currently rich biotic community of Capron Shoal.

"The medicinal properties of the newly discovered bryozoans have not yet been explored, and if the species do not receive emergency listing protection, the opportunity to conduct such research may be lost forever.

There are about 5,000 species of bryozoans, whose name means "moss animals. In his book, *Land From the Sea: The Geologic Story of South Florida*, marine scientist John Edward Hoffmeister says bryozoans grow together to form knobby colonies that can be a foot or more in diameter. They are higher on the scale of life than corals, he says, but not anywhere near as pretty.

Winston, fellow scientist Brian Killday, the St. Lucie County Audubon Society, the St. Lucie Waterfront Council and the St. Lucie County Conservation Alliance asked the fisheries service and its parent, the Department of Commerce, on Feb. 11 for the emergency listing for bryozoans.

The listing would be temporary, lasting up to 240 days -- or long enough for the federal



agency to determine whether or not the species warrant inclusion among 40 plants and animals listed by the fisheries service as endangered or threatened. The proposal asks that the corps not begin dredging until the service decides on the emergency listing request.

Gordon Helm, service spokesman, said the agency was studying the request, which he described as difficult to evaluate given the size of the species in question and complications of searching for it on other shoals.

The corps of engineers, meanwhile, overlooked the bryozoans entirely in its planning. Jacqueline Griffin, spokeswoman for the corps' Jacksonville district, said the agency had "no knowledge of the bryozoans when the project began.

When scientists and conservationists pointed out the omission of the bryozoans, the agency responded: "The effect on these and other species inhabiting the shoal should be minimal.

Winston says the corps' response rests on sheer speculation since scientific research has never been conducted to find these particular bryozoans on other shoals nearby. She has found them only on the shallowest part of Capron, where the corps plans to dredge.

And fellow researcher Eckart Hakansson of Denmark has never seen those species in his work in the Caribbean, Philippines and Australia.

"Whether or not bryozoans exist elsewhere . . . is an important question that must be answered before [the corps] begins dredging the only known habitat of these unique organisms, she wrote.

Of course, many people scoff at the idea of holding up a multimillion-dollar beach-building project while scientists search for bryozoans, but ecologists who've dedicated their careers to preserving biodiversity say that the lowliest deserve protection.

"Some of these tiny, unloved marine organisms are proving hugely important in the pharmaceutical industry for the compounds they're finding there, said Stuart Pimm, a prominent University of Tennessee scientist.

"And that's only one reason to protect these animals. The other is that they're found only in one place. By that, they're telling us that something unique, special and wonderful is going on there.

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From: "**Bruce Carlson**" <carlson@soest.hawaii.edu>  
To: "Sean Lyman" <sjl3@duke.edu>, <"CORALations" corals@caribe.net>  
Cc: "Coral-List" <coral-list@coral.aoml.noaa.gov>  
Subject: Re: Acropora spp. - Candidates for Endangered Species List  
Date: Tue, 23 Feb 1999 13:48:38 -1000

I would like to note that several public aquariums are raising *Acropora cervicornis* in captivity with excellent results (the Florida Aquarium has some in their coral exhibit and it has grown considerably in the past year). I certainly hope that the means will be found to keep *A. cervicornis* and *A. palmata* alive and well in their natural environments, but if it really appears that they are heading towards extinction, it would probably be worthwhile for a few public aquariums to maintain some "genetic diversity" in aquariums, for possible reintroduction to the wild when conditions improve. Based on what we know about keeping *Acropora* spp. in aquariums, they could probably be maintained almost indefinitely, especially if enough institutions maintain them.

We have considered this here in Hawaii to include *A. cervicornis* among our collection of Pacific acroporids, but we are very reluctant to bring in any Caribbean species that might accidentally also bring in a pathogen (if indeed that is what is causing the problem in the Caribbean). If public aquariums get involved, it will have to be those on the mainland U.S.

Just an option for consideration, but a viable option nonetheless.

Bruce Carlson  
Waikiki Aquarium

**Note:** Carlson had Lyman's message in his original message. [Lyman's message](#) is already displayed above.

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From: **Reef Relief** <reef@bellsouth.net>  
To: coral-list <coral-list@coral.aoml.noaa.gov>  
Subject: Acropora palmata discussions/coral nursery  
Date: Thu, 25 Feb 1999 16:03:47 -0500

Reef Relief has released the first year report on the Coral Nursery Project at Western Sambo Reef in the Florida Keys. The report outlines the efforts to stabilize loose fragments of Acropora plamata onto "Acropora rosettes", a design by restoration biologist Harold Hudson, in this cooperative project with the Florida Keys National Marine Sanctuary. Storm-damaged fragments of Acropora palmata were secured with hydraulic cement onto concrete landscaping pads.

The effort was launched to save Acropora palmata that was becoming increasingly rare in Keys waters after substantial damage to populations at Western Sambo Reef as a result of the Ground Hog Day Storm of February 1998.

The rosettes were not cemented down at first because the plan was to move them to a boat grounding site. As a result, they were damaged during Hurricane Georges but quickly re-established by a Reef Relief team led by Craig Quirolo. This time, they were cemented to the ocean floor and survived through Tropical Storm Mitch. Unfortunately, Acropora palmata colonies at Western Sambo, Rock Key and other Keys reefs suffered substantial losses as a result of these successive storms.

REEF RELIEF recommends and encourages the inclusion of all corals in the Acropora genus found in the Caribbean Basin for further protection, including listing through the U.S. Endangered Species Act. The health and abundance of Palmata colonies we have photo-documented in Cuba, Jamaica, and Honduras are being compromised as well.

For a copy of the 70-page color report, contact Reef Relief by e-mail, telephone (305) 294-3100, fax (305) 293-9515, or write P.O. Box 430, Key West, Fl. 33041.

The report is available on our website, located at [www.reefrelief.org](http://www.reefrelief.org).

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From: **Walt Jaap STP** <JAAP\_W@epic7.dep.state.fl.us>  
To: coral-list@coral.aoml.noaa.gov  
Subject: Acropora spp., endangered  
Date: Fri, 26 Feb 1999 10:07:06 GMT

[Moderator's note: this letter to Tom Hourigan from Walt Jaap was reprinted with permission from Walt for the purpose of encouraging discussion and contrasting or complementary viewpoints.]

22 February, 1999

Dear Dr. Hourigan:

I am responding to your internet request about Acropora spp. and other Scleractinian species for inclusion as endangered or threatened species. We have encountered this option several times from different groups over the years; and have looked at the option to see if it was reasonable, possible, and would it do a better job protecting corals than the existing statutes and management regimes. We have

concluded that it is not the best approach for several reasons.

Firstly, to prove that a coral is threatened or at risk throughout the Caribbean, Florida, Bahamas, Bermuda, and places in between is costly, time consuming, and might be very difficult to prove the case.

Are corals currently protected from human exploitation by other statutes and management regimes? I would like to think so. In Florida, we have a state statute that protects all Scleractinia, *Millepora* spp, and *Gorgonia* spp from harvest, being sold in a commercial establishment, and from destruction on the sea floor. This statute has been in effect since the mid 1970s. At the federal level the most extensive coral protection is found under the Magnuson Act: The Gulf of Mexico and South Atlantic Fisheries Councils cosponsored the work that resulted in the Coral and Coral Reef Fishery Management Plan. This plan parallels the Florida statute, protecting the Scleractinia, *Millepora* spp, and *Gorgonia* spp. This management regime was recently incorporated into the Essential Fish Habitat Plan by the Fishery Management Councils.

The Department of Interior manages two National Parks (Biscayne and Dry Tortugas) in which all corals are protected. The State of Florida and NOAA are the trustees of the Florida Keys National Marine Sanctuary which includes all the reefs outside the National Park boundaries from Fowey Rocks to west of Dry Tortugas, again the regulations protect corals and reefs. When anthropogenic events occur, the trustees have successfully prosecuted responsible parties or have negotiated effective restoration and monitoring plans on the sites. Settlements were in the range of millions of dollars. Would the endangered species act have provided immunity from these anthropogenic disturbances? I do not think it would have.

Natural events such as hurricanes, ENSO related bleaching episodes, and global warming are still occurring in spite of the efforts that the coral protection statutes and management regimes. Would additional protective legislation such as the endangered species program provide more protection to the reef resources? I am skeptical that adding a few Scleractinia corals to the endangered and threatened species list would be of benefit.

Coral populations are very dynamic. In the case of *Acropora palmata* (Lamarck, 1816) there is good evidence that it has gone through boom and bust dynamics for quite some time. In 1882, Alexander Agassiz reported 44 hectares of *A. palmata* at Dry Tortugas. In 1982, Gary Davis reported that, *A. palmata* coverage declined to 0.6 hectares, ten years later we measured the remnant population and noted little change. The decline was probably caused by hurricanes and other meteorological phenomena.

In retrospect, or as they claim hind sight is perfect, when the debate over the Everglades Park boundaries was first debated in the late 1940s, Gill Voss told me an initial proposal had all of the Florida Keys with the exception of Key West and Marathon included in Everglades National Park. Local politics prevailed and the end result is a highly urbanized Florida Keys in which the environmental quality has suffered from user abuse. Ah, if we could only go back in time and make it right.

We recognize that your intentions are well meaning and appreciate your concern. We respectfully disagree that the corals mentioned in your communication should be considered for nomination as endangered or threatened species. We do not believe that any of the aforementioned taxa of corals could satisfy the criteria of endangered or threatened species. Since we have existing statutes and management regimes that are designed to protect corals and reefs, the proposed status would have little or no effect on these resources.

Sincerely

Walter C. Jaap Associate Research Scientist Florida Marine Research Institute

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From: **Susan White** <susan\_white@mail.fws.gov> To: coral-list@coral.aoml.noaa.gov  
Subject: More on ESA candidate spp.  
Date: Thu, 25 Feb 1999 09:25:30 -0700

At the risk of beating a dead horse, may I add one more thought into the Endangered and Threatened Acropora 'listing' discussions....

Managing for E & T species, by law, is more than just the individual. The habitat that the species depends upon is a critical part of the protection. There are thousands of species (marine and terrestrial) that deserve listing because they are imperiled. Most of these species are imperiled because of anthropogenic factors, including loss of habitat or habitat degradation. With the current strong U.S. agency focus on ecosystem management -- as opposed to species management -- if a select few representative species are 'listed' and recovery actions are taken to protect the habitat and larger environment of those species; then all the other species within the habitat also benefit. That is why the concept of indicator and keystone species are so useful.

It's a round about way of getting the whole system, and there are loopholes, but it can go a long way for establishing the imperiled status of the reefs.

/s/ Susan

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From: "**CORALations**" <corals@caribe.net>  
To: "Walt Jaap STP" <JAAP\_W@epic7.dep.state.fl.us>, <coral-list@coral.aoml.noaa.gov>  
Subject: Re: Acropora spp., endangered  
Date: Fri, 26 Feb 1999 12:18:41 -0400

Dear Mr. Jaap:

You wrote: " We do not believe that any of the aforementioned taxa of corals could satisfy the criteria of endangered or threatened species."

Can someone discuss this criteria or possibly scan and post? How does this designation differ from appendix II listing?

You wrote: "Firstly, to prove that a coral is threatened or at risk throughout the Caribbean, Florida, Bahamas, Bermuda, and places in between is costly, time consuming, and might be very difficult to prove the case."

Does this mean there is no data backing compliance to ES criteria for the taxa listed? I was under the impression that this discussion originated based on evidence which suggests they fit the criteria. Are reefs considered "shared resources" in these regions with respect to such legislation? Would, for example, a disease diagnosed in one region resulting in extensive mortality of a species of coral be enough of a cause for concern to protect the same species in other regions given that these diseases are distributed by currents, or are you saying extensive monitoring is required in each specific region? In other words, at this point in time, how much investigation actually needs to be done in order to see if criteria are met and to what regions would the protection apply? You wrote: "Are corals currently protected from human exploitation by other statutes and management regimes? I would like to think so."

I would like to think so too. Unfortunately, don't corals continue to decline in large part due to anthropogenic stressors? The big picture is we don't seem to be "managing" our selves very well. We can't even manage trade, let alone less direct impacts from run off etc.... Look, for example, at the large black coral galleries on St. Thomas, Cayman and Las Vegas. There's a two page magazine add that reads like a documentary in American Skies, the American Eagle magazine promoting this "art." How are permits allocated for such exploitation with so little knowledge about the "protected" species? In St. Thomas, the existence of this well publicized gallery has encourage neighboring shops to engage in the trade. Many fishermen in the DR are risking their lives to harvest this coral. My only concern about using endangered species act to protect coral is that the response to the question you posed: "Are corals currently protected from human exploitation by other statutes and management regimes? would be answered as casually with "I would like to think so, they're considered endangered species."

You wrote: "Would the endangered species act have provided immunity from these anthropogenic disturbances? Although, I believe you are specifically referring to groundings when you discuss "anthropogenic events" what about development related stress? Has the endangered species act been used to stop development? With respect to groundings, could the endangered species act be used to create legislation which diverts tanker traffic away from sensitive coral reef areas, minimizing future groundings and tanker related accidents? Has endangered species act ever been used to improve water quality?"

You wrote: "Natural events such as hurricanes, ENSO related bleaching episodes, and global warming are still occurring in spite of the efforts that the coral protection statutes and management regimes. Would additional protective legislation such as the endangered species program provide more protection to the reef resources?"

I believe the answer to this depends on the proposed protective legislation. We should be using past management failures to discuss additional protective legislation. With regard to the endangered species act, I would think we can use this as another tool to minimize additional anthropogenic stress to protected corals from proposed development and water quality issues. Your "natural events" argument better defends why we should do more....not eliminate a legislative avenue that already exists.

You wrote: Coral populations are very dynamic. In the case of *Acropora palmata* (Lamarck, 1816) there is good evidence that it has gone through boom and bust dynamics for quite some time.

Are you suggesting that no anthropogenic stressors are currently contributing to the decline of this species?

I respect you for posting your arguments to the web for discussion. I also have concerns about the effectiveness of the endangered species act to protect corals. To many people, corals are just rocks, or rocks with worms. However, unlike you, I see this as a cause for concern to open discussion about more aggressive comprehensive legislation, not grounds for abandonment of laws currently on the books. Other listers have commented that by protecting one species of coral others will benefit. In my opinion, the strongest argument you present is cost - benefit. However, I feel your cost-benefit argument fails if a substantial amount of data exists which can be used to demonstrate compliance with ES criteria and other corals benefit by proximity to the species being listed.

Sincerely,

Mary Ann Lucking  
Project Coordinator  
CORALations  
Amapola 14, Suite 901  
Isla Verde, PR 00979  
phone/fax: 787-791-7372  
corals@caribe.net

**Note:** *Lucking had Walt Jaap's whole message in her original message. [Jaap's message](#) appears above.*

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From: **Fabrice POIRAUD-LAMBERT** <fp110@calva.net>  
To: Reef Relief <reef@bellsouth.net>, <coral-list@coral.aoml.noaa.gov>  
Subject: Re: *Acropora palmata* discussions/coral nursery  
Date: Fri, 26 Feb 1999 19:09:42 +0100 (MET)

Hi,

Reef Relief Document and Initiative is really interesting according to me, and I think it should be extended to Maldives and other heavily damaged reefs : I'm just coming back from Maldives, and it's really incredible=> 95% of coral coverage as been killed and SPS / LPS corals have deseappered totally in most reefs!

Many colonies has been broken and turned up side down (it happened that I returned 4 still alive Tabular *Acropora* in less than 10 minutes), and many frags are lying in the sand, dying.

SPS and LPS are now very rare in many Maldives Reefs, and I strongly feel that Local Professional Divers and volunteers could help in returning Colonies and using fragments to re-colonize bleached reefs, If it's not too late.

Rgds

Fabrice POIRAUD-LAMBERT

**Note:** *Poiraud-Lambert had Reef Relief's message in his original message. [Reef Relief's message](#) appears above.*

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From: **Bob Steneck** <Steneck@maine.maine.edu>  
To: "Walt Jaap STP" <JAAP\_W@epic7.dep.state.fl.us>, "Coral List" <coral-list@coral.aoml.noaa.gov>  
Subject: Re: Acropora spp., endangered  
Date: Fri, 26 Feb 99 13:46:37 -0500

Dear Walt and others,

Isn't the ultimate result of your argument that management cannot do much for coral decline, so why bother? Or perhaps everything that needs to be done is being done in Florida so let's be patient. However, the idea that we just don't know enough will always be used in all management issues. If we cannot make a good case for an Acropora decline throughout the Caribbean, can we ever hope to make a case to managers or legislators that will work for other issues?

I hope you see that I'm not directly disagreeing with anything you have said. However working with existing legislation... especially legislation that has some real 'teeth' as is the case for Endangered Species Act, makes sense to me. It seems to me that endangered species may become the 'poster-child' for an educational campaign and I see value in that. Protection of endangered species translates to protection of associated species and the entire local system. For example, the spotted owl has saved lots of old growth forests. There are many other examples.

Finally, is there harm in embracing the concept of Acropora meeting the definition of an endangered or threatened species? As far as I can see, only if the science doesn't support it. As you know, there are volumes of studies both qualitative and quantitative that document the Acropora decline. There is a sizable literature arguing for the geological and ecological importance of that genus. Even if there is evidence that this genus has fluctuated in the past (I'm not sure yours is a good example... it suggests the Acropora decline may have begun earlier than we thought), I don't think that should disqualify it from being considered for E & T classification. I also do not think the long-term prognosis for the species has to be good for inclusion to the list. I believe everyone expected the California Condor would go extinct but it was placed on the list anyway. I think that species has surprised some pundits.

Walt - I hope I'm not missing some of your key points as to why there is no value in placing acroporids on the endangered list. If I am - please educate me and everyone else. If the scientific community sees general value, there is a slim chance this could happen. At best, this is a long-shot that might help protect some reefs.

Cheers,

Bob Steneck

**Note:** *Steneck had Jaap's message in his original message. [Jaap's message](#) appears above.*

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From: **Alina Szmant** <aszmant@rsmas.miami.edu>  
To: "CORALations" <corals@caribe.net>, coral-list@coral.aoml.noaa.gov  
Subject: Re: Acropora spp., endangered  
Date: Fri, 26 Feb 1999 17:26:04 -0500 (EST)

I have read with interest but stayed out of the fray until now, regarding the listing of Caribbean Acropora species on the endangered species list. However, the response of CORALations to Walter Jaap's posting made me have to "speak up" because it mis-interpreted much of Walt's message and made some rather inane remarks.

1) The Endangered Species Act is an American piece of legislation that is not binding in other countries. Given that most of the range of these species is outside of US jurisdiction (as opposed to the spotted owl or some such beast), inclusion of the Acropora's on the endangered list won't make all that much difference except to prevent importation of dead skeletons of the corals from places like the Dominican Republic with I think still allow harvesting and export. Harvesting of corals and dredging of coral reef habitat is not allowed in any of the US waters.

2) Walt didn't make the requirements up: the Endangered Species Act has some very specific criteria that need to be met in order to justify a species to be included on the list, not just a few people claiming that the "sky is falling" for the Acropora's. While I agree that in SOME locations there have been dramatic decreases in the abundance of these species, in OTHERS they seem to be doing fine, and in fact I've seen some huge patches of recent Acropora palmata and cervicornis recruitment on the South coast of Puerto Rico that would refute that the species is endangered as defined by the Act. Matter of fact, until Hurricane Georges came along Sept of '98 we had some very healthy and fast growing patches of A. palmata here in the Upper Fla Keys, that were vigorous spawners and much evidence of recruitment, again refuting that the species is truly endangered. I do not know how they will recover from the hurricane and the severe state of bleaching they were in at the time the hurricane struck, and they may not recover fully here on Florida reefs immediately or even after a long time...I don't have a crystal ball... but, as Walt pointed out, until we really have the DATA that demonstrates that the specific species (a) is below reproductive/recruitment capacity in ALL it's range (and I just heard last night about great healthy stands of it in several places in the Bahamas), then they won't meet the specific guidelines to be designated as endangered species. In my opinion, based on what I've seen, they are not.

3) Walt never stated that CORAL REEFS shouldn't be protected, nor that water quality problems should be ignored, nor any of the other snotty comments in the CORALations message. He simply pointed out that there are numerous other routes and regulations in place other than the ESA than should be used, and in some places are being used, to protect CORAL REEF ecosystems, which in the process protect all coral species not just a favorite few.

Alina Szmant

**Note:** Szmant had one of CORALations' messages in her original message. The [CORALations message](#) appears above.

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From: "CORALations" <corals@caribe.net>  
To: "Coral-List" <coral-list@coral.aoml.noaa.gov>, "Alina Szmant" <aszmant@rsmas.miami.edu>

Subject: Re: Acropora spp., endangered  
Date: Fri, 26 Feb 1999 20:26:13 -0400

Dear Alina Szmant and Listers:

I'm sorry if you or anyone perceived my comments about Mr. Jaap's letter as "snotty". I don't know Walt Jaap...and meant nothing personal. I certainly apologize to him if he perceived my comments as an attack. It was not meant that way. His letter was posted with intent to foster discussions and I discussed. I would offer to buy you and Walt an apologetic beer at the next conference we mutually attend, but am afraid all the listers will start hurling insults just to try and cash in on my guilt reflex!

In my own defense...the quotes I commented on were directly taken from Mr. Jaap's letter specifically to avoid misinterpretations! Endangered Species Act is also binding in Puerto Rico and USVI's where, as you stated, there are still living stands of *A. palmata*. There are also many large dead *A. palmata* reefs. If this species was listed as Endangered we may be able to use this listing as a tool to protect reefs like the one you visited from some monstrously ecologically insensitive development. These developments are clearly not endangered. This may also prove a useful tool in the fight for better water quality.

I never implied Walt "made" any Endangered Species criteria up. This is unfair.

You make the comment these species don't fit the Endangered Species criteria based on recruitment and I thank you for listing that criteria.. I think defending his points in relation to this criteria would have made Walt's letter stronger. this is just my opinion. Those questions I asked about endangered species act were not meant sarcastically....I was honestly interested in obtaining more information.

You wrote: "(a) is below reproductive/recruitment capacity in ALL it's range (and I just heard last night about great healthy stands of it in several places in the Bahamas), then they won't meet the specific guidelines to be designated as endangered species. In my opinion, based on what I've seen, they are not."

Could you or someone from this list define "below reproductive/recruitment capacity" and how a healthy stand may indicate this species does not qualify under this criteria. Does a healthy stand automatically imply new new recruits? How is this evaluated? Does this mean that as long as there are healthy stands they will never qualify??? (These are honest questions...not meant snotty. I am trying to learn here! )

Again, very sorry for any misunderstandings,

Sincerely,

Mary Ann Lucking  
Project Coordinator  
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phone/fax: 787-791-7372  
[corals@caribe.net](mailto:corals@caribe.net)

**Note:** Lucking had Aszmant's message in her original message. [Aszmant's message](#) appears above.

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From: "**J. Charles Delbeek**" <delbeek@hawaii.edu>  
To: coral-list@coral.aoml.noaa.gov  
Subject: Re: Acropora spp., endangered  
Date: Sat, 27 Feb 1999 18:37:09 -1000

I too am somewhat confused as to what additional protection placing Acroporids on the ESA will accomplish that is not already being covered. Could someone who is supporting this idea please outline the additional protection thus afforded and how this is of benefit compared to legislation already in place?

I am also perplexed as to how the ESA will protect corals from natural disasters such as hurricanes, or from other affects attributed to coral bleaching i.e. increased surface temperatures?

It is somewhat ironic that while many consider Acroporid species "endangered" in Florida, current legislation makes it extremely difficult to obtain collection permits to maintain and cultivate these species in captivity.

J. Charles Delbeek M.Sc.

Aquarium Biologist  
Waikiki Aquarium  
University of Hawaii

"The fact that my physiology differs from yours pleases me to no end."  
Mr. Spock

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From: "**J. Charles Delbeek**" <delbeek@hawaii.edu>  
To: coral-list@coral.aoml.noaa.gov  
Subject: Re: Acropora spp., endangered  
Date: Sat, 27 Feb 1999 18:44:34 -1000

Mary Ann's questions bring up an interesting dilemma I think. How does one go about measuring recruitment fitness for a potential ESA listing when said organism releases billions of gametes? Was the ESA ever designed to deal with such a fecund organism or was it more for the "warm and fuzzies" than the image challenged?

J. Charles Delbeek M.Sc.

Aquarium Biologist  
Waikiki Aquarium  
University of Hawaii

"The fact that my physiology differs from yours pleases me to no end."  
Mr. Spock

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From: "**CORALations**" <corals@caribe.net>  
To: "J. Charles Delbeek" <delbeek@hawaii.edu>,  
<coral-list@coral.aoml.noaa.gov>  
Subject: Re: Acropora spp., endangered

I've been considering this and listed some examples:

I previously stated how this could be a useful tool to stop a development which may impact offshore areas where the listed species is found, or possibly be used to push legislation for stricter clean water standards...and since posting these comments, have come up with a number of other things. Endangered Species Act loses its "warm and fuzzy" aspects in court\*, during public hearings...when commenting on Environmental Impact Statements for developments, when pushing for protective legislation which can protect spawning grounds etc....Federal courts pay attention to Endangered Species Act.

I don't think any one would challenge your comment that ESA , or any "coral reef" legislation would be effective at protecting corals from natural disasters...but if it can be used to minimize anthropogenic impacts, wouldn't it help reef damaged by such disasters recover?

I think captive propagation of corals may also prove useful...to an extent...if well managed. However, good management means restrictions. It should be difficult to obtain a permit for collection in a species that as you wrote many seem to consider "endangered". Collection should also be one of the easiest anthropogenic stresses to control...but I have doubts as to if even this protective legislation is effective. Not to say it should be thrown out....Just to say we should take inventory of what management works and does not work .....and discuss topics like this.

Why not list? Do we have the data to support? What does recruitment capacity mean?  
(\*.....hope I don't sound mean...comments not meant that way)

**Note:** *The writer of this CORALations had Delbeek's message in the original message. [Delbeek's message](#) appears above.*

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From: "**Jamie D. Bechtel**" <warrior@bu.edu>  
To: coral-list@coral.aoml.noaa.gov, lesk@bio.bu.edu  
Date: Sun, 28 Feb 1999 11:06:13  
Subject: Acropora spp., endangered -legal background

hello all - i have been following the debate with some interest and thought some background information may be helpful. there is an excellent article discussing the role of science in the listing of endangered species. Bogert, Laurence Michael "That's my story and i'm sticking to it: is the best available science any available science under the endangered species act." 31 Idaho Law Review 85 (1994).

despite some recent flexibility mechanisms built into the ESA, it remains a strong legislative tool. the endangered species act (ESA) is unique in terms of environmental legislation in that it contains a flat, substantive prohibition. weighing heavily in favor of the application of the endangered species act is the fact that, beyond a shadow of doubt, congress intended to grant high priority status to endangered species. consequently, the ESA remains a strong legislative tool and is upheld uniformly and

consistently in district courts.

Sec. 7 of the ESA supplies much of the force of the ESA in "insur[ing] that actions authorized, funded, or carried out by [federal departments and agencies] do not jeopardize the continued existence of such endangered species and threatened species or result in the destruction or modification of habitat of such species which is determined by the Secretary, after consultation as appropriate with the affected States, to be critical".

in short, if a project will cause harm to an endangered species, that project can likely be brought to a relatively quick halt. In 1995, sec 9 (regarding illegal taking species w/i the US and the territorial sea) of the ESA won its day in court. the supreme court allowed the definition of "harm" to include "significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering (babbit v. Sweet Home Chapter of Communities for a Great Oregon, S. Ct. US 1995)

it should be noted that, while application of the ESA is unlikely (not impossible) to improve current water quality and habitat conditions, it could go along way in preventing further decline(although some interesting battles are coming up with regards to language in the esa to promote conservation of species). the law was not designed to determine protective measures for different reproductive behaviors. it is likely that we do not need to consider recruitment fitness. (criteria listed below)

it should also be noted that in determining whether a population is threatened, it need not be threatened globally, but throughout a portion of its range. many examples exist, such as the protection of the bald eagle in US domestic populations despite a thriving population in Alaska. distinct population segments can be protected. this arguement is likely to be stronger when additional populations occur outside US states and territories but are threatened within the US.

the esa also allows critical habitat to be protected - slightly more complicated to achieve but based on an endangered species listing.

the application of esa relies solely on the "best scientific and commercial data available." the act allows that listing of a species as endangered or threatend follows certain criteria: if the species experiences 1. present or threatened destruction or modification of its habitat or range. 2. overutilization for commercial, recreational, scientific, or education purposes 3. disease/predation 4. inadequacy of existing regulatory mechanism or other natural or manmade factors affect its continued existence

listing of an organism that is not truly endangered can be extremely dangerous in providing fuel for politicians and industry trying to bring an end to the act.

final thoughts, the legal arena is constantly changing and many questions regarding application of the ESA remain untested until they appear in court.

one thought permeating the legal environment is the idea that scientist don't agree on any thing and data is untrustworthy. unfortunately, a few bad apples etc... however, as a scientist interacting in the legal community, i find it disheartening to have to constantly defend the workings of the scientific community. any suggestions on how to begin dispelling the myth and providing explanation?

hope this information is helpful -

cheers,  
jamie

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Jamie D. Bechtel	Jamie D. Bechtel
Boston University	Boston College School of Law
Graduate School of Biology	885 Centre Street
5 Cummington Street	Newton, MA 02159
Boston, MA 02215	

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From: **George Garrett** <garettg@mail.state.fl.us>  
To: "coral-list@coral.aoml.noaa.gov" <coral-list@coral.aoml.noaa.gov>  
Subject: FW: Acropora spp., endangered  
Date: Sun, 28 Feb 1999 11:35:01 -0500

-----Original Message-----

From: Garrett-George  
Sent: Friday, February 26, 1999 11:13 PM  
To: 'Bob Steneck'  
Subject: RE: Acropora spp., endangered

Bob and Coral-List:

Having had the pleasure of working on both upland and marine management issues, I find this debate to be rather interesting. Though I think that there are arguments for listing, I'm not sure how much it accomplishes as compared to the regulations currently in place (particularly as defined by Walt). I don't believe that the ESA is particularly strong and I don't consider myself to be a "rabid foamy mouth" on the issue.

In Florida and other parts of the United State or its protectorates, harvest or coral is not allowed - period. I think that Walt made a good argument for that. Touching coral or creating relatively minor disturbances can be a problem, and though a contributor to coral decline by some accounts, is probably not the major one. Mind you, I don't believe that the ESA would bring much to bare on this problem either. Regardless of the law, it is ultimately an on the water enforcement issue, dealt with under the prevailing political climate.

First, I have great respect for the ESA and the many refuges that have been established to protect ETS. There are four wildlife refuges in the Florida Keys. However, and Ah ha, a good opportunity for comparative study. If petting Key deer is the comparative equivalent of touching coral, people do it on Big Pine Key all the time. The refuges discourage it, but reasonably can't STOP it. It's that perception of heavy handed enforcement thing.

One more step. It took a third party federal law suit to get FWS to force FEMA to consult with them when issuing flood insurance policies in the Keys (or other flood prone areas with ETS).

Taking this a step further, the fact that insurance policies are being issued indicates a significant impact on the habitat of an endangered species through development of the units requiring insurance. Pineland and hardwood hammock is disappearing daily, though because of local regs, this impact is declining significantly (admittedly influenced and assisted by the ESA). But, development is still allowed in developed subdivisions that contain little habitat - flat in the middle of the Key Deer Refuge.

It's probably not fair to dump this on FWS, particularly on Big Pine Key - the die was cast there before FWS had a Refuge. Platted lots have existed there for a long time and funding for purchase is limited. However, let's look at the concept of an "Incidental Take Permit" (ITP) or an "Habitat Conservation Plan" (HCP). At the time that I worked on the HCP for Key Largo (crocodile, woodrat, cotton mouse, indigo snake) there were probably 4 other HCPs in existence (in a time period spanning the mid 70s to mid 80s). That was about 15 years ago. Since that time I've dealt more in marine matters and have lost count, but there are literally hundreds of HCPs now. At least one view of an HCP is that it is a compromise between what you want for the ETS and what interested developers want from their land. Frequently, this is a compromise garnered from an inability to adequately enforce the ESA, the drives of those who want to develop, and the strength of the Constitutional "Takings" law (Takings in this sense being property rights and land use). I think you can make similar arguments for ITPs, though perhaps not as strongly because they don't tend to affect as broad a part of the range.

I think many of the reasons that the ESA has not been applied more effectively in marine environments (marine mammals and reptiles being the exception) is that reproductive dispersal is perceived to and in fact probably tends to be broad. Walt alluded to this. The coral species being discussed, particularly the Acroporids, are pan Caribbean (and Pacific, etc.) Thus, the ESA would consider this in the listing process and conversely, if listed would not affect these species anywhere but in U.S. states and territories. These are places where they are well protected.

In any event, between the State of Florida (in this case), the various Fisheries Acts, and the FKNMS, the Keys are afforded a fair amount of protection. I don't honestly know how much more protection could be afforded them.

Having played devils advocate for the last page or so, I certainly don't oppose listing the Acroporids. However, don't expect any panaceas. Its typically the bigger things that are not accounted for in such laws, and probably never will be effectively, that impact our reefs - the Mississippi or the Orinoco, global warming, Saharan dust (that one's for you Gene), and atmospheric deposition. More locally and more tangibly (for Florida), its wastewater outfalls on the east coast, phosphate mining on the west coast and general conditions of coastal eutrophication. We've gotten too big for the place in which we live.

We will continue to fight the good fight and do the best we can. Let's list the Acroporids, who knows it may bring greater attention to the things that aren't so heavily regulated.

George Garrett  
Director of Marine Resources  
Monroe County, Florida Keys

PS Regarding the existing laws and least, Walt (and I) argue from the stand point of the laws of Florida, as described above. I do recall some recent permits in Hawaii for marina development in which a

significant area of coral was allowed to be destroyed - though, with significant transplant of some as mitigation). Is there a stronger need for concern nationally, in the Pacific or even Puerto Rico (ref. CORALations)?

**Note:** *Garrett had Bob Steneck's entire second message in his original message. [Steneck's second message](#) appears above.*

---

From: **Eric Borneman** <EricHugo@aol.com>  
To: delbeek@hawaii.edu, coral-list@coral.aoml.noaa.gov  
Subject: Re: Re: Acropora spp., endangered  
Date: Tue, 2 Mar 1999 13:02:32 EST

Hi Charles.

<<I too am somewhat confused as to what additional protection placing Acroporids on the ESA will accomplish that is not already being covered. Could someone who is supporting this idea please outline the additional protection thus afforded and how this is of benefit compared to legislation already in place?>>

I think Jamie outlined some good points in his previous post on this. While there may be geological evidence pointing to boom/bust cycles in various coral populations (and there is), the points brought out earlier I think are important: that is, that irrespective of natural catastrophe and influence, the anthropogenic influence of many factors seems unrelenting. There have been many papers which have investigated long and short term damage resulting from various natural factors, and, while occasionally catastrophic and reefs are largely lost, the majority seem to show slow or even surprisingly quick recovery given proper conditions. However, recovery in stressed or injured animals is remarkably less as energy is allocated to repair. I cannot really see what harm placing *A. palmata* and *A. cervicornis* under ESA guidelines would do, as these stressed communities could potentially benefit from any and all action on their behalf. What concerns me (besides the fact I miss seeing vast thickets of *Acropora* in the Caribbean) is the reef accretion rate without these reef builders. Unlike Pacific reefs, there are fewer species which can grow at the rate or in the conditions tolerated by these two species than in the Pacific. With bioerosion, continued anthropogenic stress, and natural disasters (which, arguably, may worsen in the future), will the next in line reef-builders like *Montastrea* and *Porites* be able to keep up? Looking at the listing of some of the others (*Dendrogyra cylindrus*, etc.), can Caribbean reefs keep up? Only coralline algae ridges to come? ESA won't do a thing to prevent Gaia's wrath, but there is quite a difference between the natural cycles of disturbance and the continuing long term stress on the these reefs.

One thing I have noticed when such debates occur is that there is much "voire- diring" about whether proposed solutions are ideal or optimal...they rarely are. However, in the meantime, the habitat continues to suffer while the debate continues. Perhaps actions which protect the habitat should be implemented, even if not panaceaic, while better solutions are being worked on?

Nor am I particularly convinced that a spawn releasing (hypothetically) one billion gametes is enough. Consider an equally hypothetical 1% successful fertilization, 1% settlement success, and a 1% chance of living past the juvenile stage. Then consider that 95% of these corals are lost (being lost) due to disease/stress/injury/predation, bioerosion, competition, etc. As was mentioned, recruitment is not



keeping up, so I think its more than a case of the "warm and fuzzies". Ordinarily, one could expect for fragmentation to make up some ground, but there aren't enough colonies around to make this of significant value...hence the reason why these species are now considered for ESA protection. The potential for these animals to recover and survive mass mortality is certainly there if conditions are ideal....but they aren't. Not that I am bringing up any particularly earth shattering points here, but it would seem that the loss of these key species is of particular importance to reefs, and I cannot see why all efforts to protect them shouldn't be supported. There is not really any economic value placed on them due to rigorous anti-collection protocol (as you brought up), and hence no real force towards \*not\* implementing protective legislation. Thus, arguably, their most important economic value is in their continued presence for recreational/tourism reasons and supporting the lower end of sport/food fish webs (and, of course, their intrinsic value to the reef itself and to the continued grants for studying the reasons for their mortality <g>)

I do, however, totally agree that efforts on the part of the public and private aquaria arena could (perhaps surprisingly) support some captive grow- out for replenishment. I have long thought that Caribbean species should be available for such efforts with careful and moderated collection.

Eric Borneman

---

From: "**Precht,Bill**" <BPrecht@kennesaw.Lawco.com>  
To: "Jamie D. Bechtel" <warrior@bu.edu>, coral-list@coral.aoml.noaa.gov,lesk@bio.bu.edu  
Subject: RE: Acropora spp., endangered ?  
Date: Wed, 3 Mar 1999 11:46:31 -0500

Dear list:

For what its worth, just a few comments (in a question - answer format) about the spirited Acropora debate.

Q.- Should Acropora spp. be considered for listing?

A. - YES

Q. - What's the evidence for this?

A.- In most US waters (Caribbean & western Atlantic), Acropora populations have been drastically reduced by a number of factors (disease, storms, bleaching, predation, etc...) over the course of the last two decades. This is especially pronounced for Acropora cervicornis.

Q. - Is this reduction just part of natural boom-bust cycles in the local populations. Walt Japp makes some good points about the volatility of Acropora populations in Florida.

A. - Yes, Acropora populations are very volatile. However, the recent declines are not just confined to local populations within individual reefs or reef areas, but have impacted essentially all Acropora populations throughout the region. This includes reef areas far from population sources and major anthropogenic impacts. Belize, Bonaire, Jamaica, the Bahamas, Florida, etc... have all shown similar declines over roughly the same period of time. Florida reefs have been especially impacted. In addition,

recent geologic evidence strongly points to the fact that a "regional" decline in acroporid populations is without historical precedence in the Quaternary.

Q. - Okay, so some Acropora populations have diminished, but there are still some pretty good stands of Acropora spp. here and there. Why should we list a species that is still locally abundant in some areas?

A. - Your right, there are some pretty good stands of Acropora here and there, especially *A. palmata*. The main point being "here and there". Unfortunately, there aren't that many "here and there's" anymore. As compared to 20-30 years ago even these large stands are greatly reduced in size and number. This is based on both solid data and anecdotal evidence. In addition, even in these large stands, very few are "healthy"; that is they show a high incidence of partial mortality. For instance, one of the most beautiful and most luxuriant stands of *A. palmata* (just two years ago) was off Goulding Cay (southwest tip of New Providence Island, Bahamas). Many of these corals (over 50%) have died within the last year due to the 1998 bleaching event, white-band disease epizootics, and predation by mobile fauna. Many of these corals are now standing dead in-situ. This scene is being played over and over again throughout the region. It should be noted that this same reef at Goulding Cay was renowned for its prolific stands and thickets of *A. cervicornis*. This reef was used as a backdrop for numerous u/w scenes in films, including some James Bonds flicks. Stuart Cove the local dive operator there told me that ~ 99% of this staghorn vanished in the early to mid-1980's. Now it seems as though the *A. palmata* is imperiled there as well.

Q. - Well you've convinced me that the acroporids are at risk (maybe). How would implementing the E & T Species Act help here? Aren't the scleractinia already protected in US waters by a host of various regulations and statutes?

A. - The present regulations protect corals from harvest and/or destruction in place (i.e. ship-groundings, anchor damage, etc...) Although illegal coral collection by reef poachers is still common and problematic, the E & T Act goes one step further in that it helps protect the habitat in which that species lives. This is done by designating "critical habitat" for a particular E & T species. Also, additional layers of legal protection are common with E & T species. For instance, The Bald Eagle is protected by the Migratory Bird Act, as well as the E & T Act, plus individual State Statutes. Having an additional layer of protection and the legal ramifications that go with it (violation of the E & T Act is very serious business) will not just help the acroporids but all corals living in association with them.

Q. - It may be determined that only local populations of acroporids are at risk. If so, why place the whole lot on the list?

A. - If this is determined to be the case (based on population data), then there are numerous options available. This includes the listing of a species as "a species of special concern" (i.e. the Burrowing Owl in Florida). Another option, would be (as Jamie Bechtel noted) to list only a local population as E or T. For instance "All Acropora spp. in the waters of Florida" or "All *A. cervicornis* in US Territorial waters" or "All acroporid species in US waters with exception of *A. palmata* in Florida" and so on. The E & T Species Act even protects species because of their similarity with other like species. For example, the Florida alligator is protected because of its similarity with the American Crocodile, an endangered species.

Q. - Will placing the Acropora spp. on the list make getting scientific permits for collecting coral specimens more difficult.

A. - It should not affect those who have just reasons for sampling (permits are already required for

work/research in the Florida Keys), and it will certainly deter the unnecessary collection and sampling of these corals.

Well, this is my spin on some of the stuff that has been going around for the last couple of weeks. Hope this helps.

By the by, Rich Aronson and I recently completed a ms. on the history & volatility of the Acropora spp. as well as on their recent, regional demise. I would be more than happy to furnish copies of this in-press ms. to any that request it.

"Men with the muckrake are often indispensable to the well-being of society, but only if they know when to stop raking the muck." Theodore Roosevelt 1906

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LAW Engineering & Environmental Services, Inc.  
5845 NW 158th Street  
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ph (305) 826-5588 x206  
fax (305) 826-1799

**Note:** *Precht had Bechtel's entire message in his original message. [Bechtel's message](#) appears above.*

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From: Les Kaufman <lesk@bio.bu.edu>  
To: "Precht,Bill" <BPrecht@kennesaw.Lawco.com>  
cc: "Jamie D. Bechtel" <warrior@bu.edu>, coral-list@coral.aoml.noaa.gov  
Subject: RE: Acropora spp., endangered ?  
Date: Wed, 3 Mar 1999 12:52:17 -0500 (EST)

Acropora cervicornis, prolifera, and palmata would in my estimation qualify for a "vulnerable" or higher listing, possibly as high as endangered, in accordance with IUCN criteria after Mace et al.

Les Kaufman  
Boston University Marine Program  
lesk@bio.bu.edu  
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617-353-6965 lab  
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---

From: "CORALations" <corals@caribe.net>  
To: "Coral-List" <coral-list@coral.aoml.noaa.gov>  
Subject: Fw: Illinois State Legislature has introduced a bill that will remove the eastern massasauga from ESA  
Date: Mon, 8 Mar 1999 11:24:58 -0400

> From: Allen Salzberg <x5245@erols.com>  
> To: asalzberg@aol.com  
> Subject: Illinois State Legislature has introduced a bill that will remove the eastern massasauga from ESA  
> Date: Monday, March 08, 1999 10:17 AM  
>  
> Gary Casper <gsc@mpm.edu>  
> Subject: Urgent situation, Illinois de-listing endangered species  
> Please re-distribute appropriately.  
>  
> ILLINOIS STATE LEGISLATORS PROPOSE DE-LISTING ENDANGERED SPECIES  
>  
> Members of the Illinois State Legislature have introduced a bill that will  
> remove the eastern massasauga, brook lamprey, and Indiana crayfish from the  
> list of IL threatened and endangered species. Sponsors are Kurt Granberg  
> and Larry Woolard, who reportedly claim that these three species are  
> "getting in the way" of development in their districts. The bill reportedly  
> made it out of committee Wednesday by a large majority. The date for floor  
> debate is unknown at this time.  
>  
> The IL DNR has distributed a position paper on this bill, coming out  
> strongly against it.  
>  
> The precedent this bill would set, if successful, has implications for all  
> rare species. If non-biologists are allowed to draft bills removing  
> protected status for species without any supportive data showing recovery,  
> simply in order to avoid compliance with endangered species laws, then  
> endangered species laws become non-functional and useless.  
>  
> Letters are urgently needed. Letters can be written to any of the State  
> Reps in Illinois, and letters from Illinois citizens will have the greatest  
> impact. Others are certainly encouraged to write. The bill is HB 2243.  
> Illinois legislator addresses and phone numbers are available at:  
> <http://www.state.il.us/legis/default.htm>  
>  
> The bill has not gone to the senate yet, so letters should be sent to  
> representatives, not senators, at this time.

---

From: **Kenyon Mobley** <gsi19453@gsaix2.cc.gasou.edu>  
To: coral-list@coral.aoml.noaa.gov  
Subject: more on ESA and bryozoans  
Date: Mon, 8 Mar 1999 14:24:47 -0500

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The Palm Beach Post  
March 6, 1999, Saturday, MARTIN-ST. LUCIE EDITION

SECTION: LOCAL, Pg. 1B

LENGTH: 613 words

HEADLINE: DREDGE HALTED BECAUSE OF RARE CREATURE

BYLINE: Jim Reeder, Palm Beach Post Staff Writer

DATELINE: FORT PIERCE

BODY:

Dredges pumping sand onto Fort Pierce's South Beach were stopped Friday by a federal judge who agreed the Army Corps of Engineers may not have done adequate environmental impact studies before starting the project.

U.S. District Judge Henry H. Kennedy in Washington issued a temporary injunction stopping the work until further hearings are held on whether the work should be stopped permanently.

St. Lucie County officials said the work stoppage will cost \$ 50,000 to \$ 80,000 per day in fees that must be paid to Weeks Marine Inc. of Camden, N.J., whether they're pumping sand or not.

"Our money will go to the contractor and we'll have nothing to show for it," County Commission Chairman Paula Lewis said. "The earliest we'll be able to resume work is probably February, 2001, and we'll have no money."

Dredges started work this week and had pumped about 100,000 cubic yards of sand onto the beach, Lewis said. Plans called for nearly 1 million cubic yards to rebuild the beach from the South Jetty to near Ocean Village condominium.

Two scientists and three environmental groups filed suit in Washington Monday seeking the project halt because the Army Corps of Engineers did no studies on the presence of 12 species of ocean creatures called bryozoans.

The only place the species have been found is Capron Shoal, the underwater sandpile 3.5 miles off Fort Pierce where the corps obtained sand to renourish the beach.

Such rare animals are entitled to special consideration under the Endangered Species Act, the suit said.

Kennedy heard arguments Thursday and issued his stop-work order Friday morning, attorney Eric Glitzenstein said.

"The judge said it appears likely we will prevail after further hearings," Glitzenstein said. "The corps says these species likely are found elsewhere, but they haven't looked for them."

Corps officials could not be reached for comment Friday.

I want to see the beach renourished, but I'm disappointed the corps didn't do adequate review of alternate sites and consider these species," Commissioner Doug Coward said.

Commissioner Cliff Barnes is angry opponents torpedoed years of work on the project.

"The allegation these creatures are rare or non-existent elsewhere is completely unsubstantiated," Barnes said. "Nowhere do the opponents say they looked a half-mile away or a mile away to see if these species are there.

"This may save these creatures . . . but it leaves our beaches unprotected through another hurricane season and reduces turtle-nesting areas."

The suit was filed by Judith E. Winston, a Martinsville, Va., researcher; North Beach resident Brian Kilday, who works at Harbor Branch Oceanographic Institute; the St. Lucie Audubon Society, Conservation Alliance of St. Lucie County and the St. Lucie Waterfront Council

Shoal harbors new bryozoan species

Bryozoans are tiny marine animals that live on grains of sand or in colonies between sand grains, seaweed and pilings. Nine new species and a new genus live on Capron Shoal off Fort Pierce.

**HOW THEY LIVE:** Imagine sand grains as giant boulders, water thick as honey and bits of food drifting by in the glop. Stormy weather stirs the sand, causing injury, death and damage.

**WHAT THEY EAT:** Bacteria and microscopic algae.

**KEEPING CLEAN:** When algae soils the colony, it sheds its outer layer.

**SEX LIVES:** They reproduce sexually and asexually.

**LIFE SPANS:** Unknown; believed short.

**VALUE TO HUMANS:** Part of ocean's water-cleansing filter system. Unexplored potential. Bryozoan relatives contain a potent anti-cancer agent used to treat lymphoma and leukemia.

Source: Judith Winston, scientist

NOTES:

Info box at end of text

GRAPHIC: MAP (C), MARK HEMPHILL/Staff Artist, Location Map of Capron Shoal

COMPANY: ARMY CORPS OF ENGINEERS (84%);

LOAD-DATE: March 8, 1999

Defenders of Wildlife  
1101 14th St. NW, Suite 1400  
Washington, DC 20005  
(202)-682-9400 ext. 283  
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LHood@Defenders.org

KBM

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*lasted updated 10/07/99*  
*by [Monika Gurnée](#)*  
*CHAMP Webmaster*



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The content on this web page was last updated in July of 2001. Some of the content may be out of date. For more information:

<http://www.habitat.noaa.gov/protection/corals/deepseacorals.html>.

#### Read About:

- [A Discussion of Terminology](#)

## Deep water Coral "Reefs"



Soft coral species such as these are found in both cold, deep waters and shallow, warm waters. These corals reside off the coast of Hawaii.

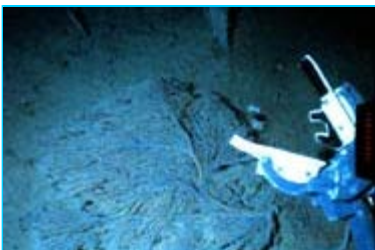
Recent studies have indicated that deep water coral structures occur more frequently than previously believed, and they are rich in biota. For example, Norwegian studies have identified 300 species in deep water coral structures in areas off Norwegian coasts.

Stemming from the debate surrounding the analogy made between coral reefs and rainforests, participants discussed how to define coral assemblages that live in deep and cool water. Are they reefs in the true sense of the word? Or would a different definition be more accurate? The discussion expanded to include other coral-related terminology.

[Click here](#) for a list of discussion participants.

[Click here](#) to download the complete unedited discussion (pdf, 37Kb).

### A Discussion of Terminology



Deep sea submersibles (DSVs) can be used to study deep or cold water reefs. Here, a DSV manipulator arm reaches for a soft coral.

Several participants admitted that they were uncertain about how to correctly define deep/cool water corals. One participant posited that to interpret all coral masses as reefs would be misrepresentative. Another noted that he commonly used the term "grove" to describe deep/cool water corals, but asked if anyone knew of a widely accepted official definition of corals that would differentiate between tropical and deep/cool coral assemblages.

His question prompted several responses. One participant quoted a general definition of a reef as a "structure on which ships can run aground; a chain of rocks or ridge of sand at or near the surface of water that can be a hazardous obstruction." The definition leaves no room for deep/cool water corals, according to the participant.

Another participant further differentiated deep/cool water corals from coral reefs by noting that reefs are structures built by hermatypic (reef-building) corals and other associated organisms, and they usually contain zooxanthellae. In contrast, deep/cool water corals generally do not contain zooxanthellae and are regarded as ahermatypic.

One participant further explained that in most cases, a coral is either zooxanthellate or azooxanthellate. However, a coral is not inherently hermatypic or ahermatypic. Rather, environmental factors determine



whether coral can accrete limestone faster than it is eroded or covered. For example, *Montastrea* spp. occurs in both the Caribbean and off the coast of Florida. Environmental factors allow it to be hermatypic in the Caribbean but not on the West Florida Shelf, the participant stated.



*Although little light can reach depths below 500 ft., this gold coral grows on pillow lava in depths of more than 1000 ft. off the coast of Hawaii.*

The participant concluded by touching on the practical implications of the definition. The distinction made between hermatypic and ahermatypic conditions affects management decisions made in conservation efforts. For example, environmental conditions that support the survival of *Montastrea* could differ significantly from conditions that would support reef development. Managers should consider these circumstances before making conservation decisions.

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<http://coris.noaa.gov/exchanges/deepwatercoral/welcome.html>



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## Deep water Coral "Reefs"

### Listserve Participants

Eric Borneman

Don McAllister

Chip McCarty

Pamela Hallock Muller  
University of South Florida

Alina Szmant  
University of North Carolina at Wilmington

Helmut Zibrowius  
Station Marine d'Endoume

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[http://coris.noaa.gov/exchanges/deepwatercoral/sup\\_part\\_deepwater\\_corals.html](http://coris.noaa.gov/exchanges/deepwatercoral/sup_part_deepwater_corals.html)



# Deepwater Coral "Reefs"?

## A Coral-List Server Discussion Thread

This thread is a spin off from the *Coral Reefs -- Rainforests of the Sea?* thread, which can be found [here](#). The first message in this thread was posted to the [Coral List Server](#) by Don McAllister in response to a message from the *Coral Reefs -- Rainforests of the Sea?* thread, from which Helmut Ziborius's response set of this new discussion. All of the messages posted thus far concerning this discussion are posted below. This page will be updated as more messages are posted. Some of the writers included a previous posting in their message. For simplicity, the included messages have been replaced by a link to the previous message that was quoted. If you follow that link, moving back in your browser should bring you back to your original position. This should continue to work even if you download the document to your machine. If you have any difficulties navigating this document, send a message to the [CHAMP WebMaster](#).

---

From: Don McAllister [mcall@superaje.com]  
Sent: Thursday, May 25, 2000 4:02 PM  
To: John Ware  
Cc: coral-list@coral.aoml.noaa.gov; Callum Roberts  
Subject: Re: Rain forests of the sea??

John Ware wrote:

>  
> I am not sure that this is a 'controversial topic', but the  
> coral list has been pretty quiet lately. Are coral reefs really  
> analogous to rain forests or is the coral reef community just taking  
> advantage of a catchy 'sound bite' to gain status in the eyes of the  
> ecologically minded public?

I think the conservation community, including myself (!) has taken advantage of this analogy, although really coral reefs stand on their own tentacles. However, work of the IUCN SSC Coral Reef Fish Specialist Group suggests that about 25% of marine fish species are found on coral reefs. That's a pretty high level, given that coral reefs occupy less than 1% of the World Ocean, some 230,000 km<sup>2</sup> according to a recent estimate. Hopefully Callum Roberts and Julie Hawkins will publish this year their fabulous species density maps for coral reef fishes of the world that will show the global hotspots for these fishes.

Marjorie L. Reaka-Kudla in *Biodiversity II*, however comes up with a better broad answer. She estimates that over 900,000 species (plants, animals, microbiota) inhabit coral reefs.

Another answer can be provided by a scuba/snorkel transect across a reef and into adjacent sandy areas. Lots of species in the first, few in the second.

But it isn't just a tropical affair (:->), Norwegian studies show 300 species in deepwater coral 'reef' areas off their coasts. We haven't studied such areas thoroughly enough elsewhere to be sure of counts. But mapping deepwater corals off the West Coast of Canada, shows they are much more frequent there than had been hitherto suspected and the available clues suggest a rich variety of biota. This would suggest that it is the three-dimensional structural diversity in the tropics and boreal zones which provides shelter and food, that intensifies biodiversity.

don  
Don McAllister

---

From: Helmut ZIBROWIUS [hzbrowi@com.univ-mrs.fr]  
Sent: Friday, May 26, 2000 3:43 AM  
To: coral-list@coral.aoml.noaa.gov  
Subject: deepwater coral "reefs"?

>But it isn't just a tropical affair (:->), Norwegian studies show 300  
>species in deepwater coral 'reef' areas off their coasts.

This is surely not specific to Norway, such deep-water coral build-ups occurs widely along the Atlantic margin of W Europe and in other parts of the world (for example at Saint-Paul and Amsterdam islands, southern Indian Ocean. Depending on where and on the depth level, the main builders are different species. Surely, these are not reefs in the common established sense, and re-introducing this term in the deep context forgets the efforts made by Teichmann and others to make understood to geologists and paleontologists that not all ancient coral mass occurrences are to be interpreted as reefs, in the sense of tropical and shallow.

One may consider that using again the term reef for these deep-water build-ups "just takes advantage of a catchy 'sound bite' to gain status in the eyes of the ecologically minded public", and connectedly, intends to drain supplementary funding (no problem, these deep communities indeed deserve detailed study).

By qualifying these structures as reefs, one also intends to benefit of "reefs are endangered". And hasn't the whole order of Scleractinia been but on a CITES-list by a bunch of brain-deficient bureaucrats?

>This would suggest that it is the  
>three-dimensional structural diversity in the tropics and boreal zones  
>which provides shelter and food, that intensifies biodiversity.  
Surely. Similar situation with the mainly calcareous algae build-ups in

the Mediterranean, locally known as "coralligene".

Helmut ZIBROWIUS  
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---

From: Don McAllister [[mcall@superaje.com](mailto:mcall@superaje.com)]  
Sent: Friday, May 26, 2000 11:12 AM  
To: Helmut ZIBROWIUS  
Cc: [coral-list@coral.aoml.noaa.gov](mailto:coral-list@coral.aoml.noaa.gov); Risk, Michael  
Subject: Re: deepwater coral "reefs"?

Helmut ZIBROWIUS wrote:

Surely, these are not reefs in the common established sense, and re-introducing this term in the deep context forgets the efforts made by Teichmann and others to make understood to geologists and paleontologists that not all ancient coral mass occurrences are to be interpreted as reefs, in the sense of tropical and shallow.

Zibrowius poses a good question. In my own papers on the topic of northern deepwater corals I have preferentially used the term "groves" to reefs.

Part of my doubt has been due to the lack of information on whether the corals occur in more or less isolated patches, or in relatively dense and large groupings. The second part of my doubt is whether the deepwater corals have been growing in situ for periods of say, centuries, and have built up a reef platform. So my own personal presumption has been that reefs constitute fairly dense and large clusters of colonies over periods measured in centuries and that the process has resulted in the build-up of a reef platform. I would be happy to be corrected on this understanding and if someone would provide me with a concise widely accepted definition of a 'coral reef.' I would hope that, although our understanding of coral assemblages has developed most strongly from tropical experience, that the terminology could be adapted or could coin new terms which would facilitate discussions of deep/cool coral assemblages. Of course where deep/cool coral assemblages do clearly differ from tropical ones is in the lack of zooxanthellae in the colonies - to my knowledge (although zooxanthellae do occur in northern sea anemonies).

The Norwegian and Irish instances show that deepwater corals do grow in masses, many colonies in close approximation and measuring hundreds of metres long. As far as the building up of a platform, it looks like some sort of a platform occurs in Norwegian coral assemblages. In the case of Labrador scleractinian

assemblages, there is a base of fallen dead colonies that goes back about 10,000 years in age, with individual colonies more than a century or two old. So the latter certainly, aside from zooxanthellae, gives the closest approximation to reef-like conditions.

Regards,  
don  
Don McAllister

---

From: Alina M. Szmant [szmanta@uncwil.edu]  
Sent: Friday, May 26, 2000 4:29 PM  
To: Helmut ZIBROWIUS; coral-list@coral.aoml.noaa.gov  
Subject: Re: deepwater coral "reefs"?

"Reef " by definition is a structure that ships can run aground on. Coral reefs are such structures build by hermatypic corals and associated organisms. Deeper 3-D structures built by corals or other organisms (algae, worms, whatever...) are bioherms. I agree we need to stick with correct terminology, and educate the public and press in the process.

Alina Szmant

\*\*\*\*\*  
Dr. Alina M. Szmant  
Center for Marine Science Research  
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Wilmington NC 28409  
TEL: (910)962-2362 FAX: (910)962-2410  
email: szmanta@uncwil.edu  
\*\*\*\*\*

**Note:** Szmant had Zibrowius's whole message in her original message. [Zibrowius's message](#) is already displayed above.

---

From: Don McAllister [mcall@superaje.com]  
Sent: Friday, May 26, 2000 7:27 PM  
To: coral-list@coral.aoml.noaa.gov  
Subject: Re: deepwater coral "reefs"?

"Alina M. Szmant" wrote:

> "Reef " by definition is a structure that ships can run aground on. Coral reefs are such structures build by hermatypic corals and associated organisms. Deeper 3-D structures built by corals or other organisms

(algae, worms, whatever...) are bioherms. I agree we need to stick with correct terminology, and educate the public and press in the process.

Thanks for this enlightenment.

"A dictionary of ecology, evolution and systematics" defines bioherm as:

- 1) Any organism contributing to the formation of a coral reef
- 2) A mound-like accumulation of fossil remains on the site where the organisms lived.

The first lines of "Coral Reefs" in the Ecosystems of the World series says,  
"Reefs are marine, biogenic, wave-resistant carbonate structures, also known as *hermatypic* , or reef-building organisms." [The word hermatypic is in italics].

I don't pretend to know the correct word for deepwater corals lacking zooxanthellae.

don  
Don McAllister

---

From: McCarty and Peters [McCarty\_and\_Peters@compuserve.com]  
Sent: Friday, May 26, 2000 9:30 PM  
To: Coral Reef List Server  
Cc: Don McAllister  
Subject: Deep water corals

Don McAllister commented:

>>I don't pretend to know the correct word for deep water corals lacking zooxanthellae.<<

There are several terms that have been applied to this situation:

ahermatypic - meaning does not build reefs,

asymbiotic - originally coined to mean not containing zooxanthellae, and

azooxanthellate - later used when some curmudgeon reviewer complained that asymbiotic implied no symbiotic relationships at all, whereas what was really meant was no appreciable zooxanthellae concentrations.

This entire debate was fought through over the status of *Astrangia danae*, now *Astrangia poculata*, a temperate coral found in the waters of New England. *A. poculata* occurs side by side in forms with a brown color characteristic of its zooxanthellae and as pure white, with no zooxanthellae, and in various shades in between.

This species is NOT a deep water one, admittedly, as it can occur in as little as 10 feet of water and is found as deep as 90 feet or more. It represents a bridge between the "lifestyles" of the tropical reefs that get

all the attention and the deep water corals known only to those brave or foolish enough to go looking for them <g>.

We presented a poster on the whole "hermatypic does not equal zooxanthellate" argument in 1984 at the Atlantic Reef Committee meeting in Florida -

McCarty, H.B., M.E.Q. Pilson, J. McManus, and E.C. Peters. When is a hermatype not a hermatype? Poster presented at Atlantic Reef Committee and the International Society for Reef Studies, Advances in Reef Science Meeting, pp. 78-79 Abstracts, Rosenstiel School of Marine and Atmospheric Science, University of Miami, 26-28 October 1984.

Just my two cents worth....

Chip McCarty

---

From: Don McAllister [mcall@superaje.com]  
Sent: Saturday, May 27, 2000 7:34 AM  
To: McCarty and Peters  
Cc: Coral Reef List Server  
Subject: Re: Deep water corals

McCarty and Peters wrote:  
> Don McAllister commented:  
>>I don't pretend to know the correct word for deep water corals lacking  
> zooxanthellae.<<  
> There are several terms that have been applied to this situation:  
> ahermatypic - meaning does not build reefs,

Thanks for the terminology, Chip. Those are helpful postings.

But the earlier parts of the thread criticized the use of the word "reef", for these boreal assemblages. Bioherm was proposed as an alternative. But the definitions of bioherm that I found were not altogether supportive of coo/deep clusters of corals.

don  
Don McAllister

---

From: EricHugo@aol.com  
Sent: Saturday, May 27, 2000 10:53 AM  
To: coral-list@coral.aoml.noaa.gov  
Subject: Re: deepwater coral "reefs"?



Hi Alina and coral-list:

Is there a point when a correct usage of "bioherm" over "reef" for such structures became semantically favored? I ask because I find the following perhaps relevant:

Coates, Anthony G. and Jeremy B.C. Jackson. 1987. Clonal growth, algal symbiosis, and reef formation by corals. *Paleobiology* 13(4) 363-378.

(I will not quote directly to avoid copyright concerns, although I also hope that the authors will point out if my translation is incorrect or improper, although I maintain the textual use of the word "reef" and "bioherm" ).

"Rugosan corals that formed reefs likely lacked zooxanthellae because of morphological evidence. Most zooxanthellate corals today and in the fossil record contribute to reef formation, but many others are ahermatypic. Recent reef formation has little to do with being zooxanthellate but depends on environmental factors. Using morphology to indicate the presence of zooxanthellae, there exist recent deepwater analogues to the shallow water azooxanthellate Devonian Edgecliff Bioherm. "

Here we have a concatenation of terms, distribution, history, and ecology that makes this thread all the more intriguing.

Thanks for the clarification

Eric Borneman

---

From: Alina M. Szmant [szmanta@uncwil.edu]  
Sent: Wednesday, May 31, 2000 5:03 PM  
To: EricHugo@aol.com; coral-list@coral.aoml.noaa.gov  
Subject: Re: deepwater coral "reefs"?

Eric:

The definition of a bioherm is a herm (mound) made by living organisms. It can be located in shallow, deep, or intermediate depths. Again, a "reef" is "a chain of rocks or ridge of sand at or near the surface of water" or "a hazardous obstruction" (Webster's New Collegiate Dictionary). Neither has anything to do with corals or zooxanthellae specifically.

Coral reefs are bioherms or reefs made by corals and associated organisms. For the most part, hermatypic corals have zooxanthellae, but many zooxanthellate corals either do not live on or form reefs, or live on reefs but are not really a major contributor to reef formation (e.g. *Favia fragum*...).

The confusion in terminology is due (1) to the misconception that hermatypic means zooxanthellae-containing, and (2) that everywhere there is coral there is a coral reef. Corals can have high cover on a volcanic substrate but that doesn't make it a coral reef in my opinion unless there has been

carbonate accretion over the volcanic substrate. Further, in places like Florida, there is some coral cover over exposed Pleistocene reef substrate, which locally are considered coral reefs (as opposed to a coral community growing over a fossil reef). Everyone wants to have a coral reef in their back yard and many systems that are not true "coral reefs" are being called by that name.

With regard to "deepwater" coral reefs, the only ones that would fit a strict definition would be ones that were drowned (e.g. Conrad Neumann's give-up reefs). Catch-up reefs would also fit since they are usually grow into shallow water. As ships get bigger and have deeper hulls, I guess the "dangerous obstruction" part of the reef definition would include deeper water coral reefs that big ships could run into. If we include submarines, then all depths are fair game....

Anyway, that is how I analyze the terminology based on first principles and dictionaries.

Alina Szmant

\*\*\*\*\*

NOTE NEW ADDRESS:

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 Center for Marine Science  
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\*\*\*\*\*

**Note:** *Szmant had Borneman's whole message in her original message. [Borneman's message](#) is already displayed above.*

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From: Pam Muller [pmuller@seas.marine.usf.edu]  
 Sent: Thursday, June 01, 2000 10:29 AM  
 To: Alina M. Szmant  
 Cc: EricHugo@aol.com; coral-list@coral.aoml.noaa.gov  
 Subject: Re: deepwater coral "reefs"?

I concur wholeheartedly with Alina and would add a couple of small details.

A coral is either zooxanthellate or azooxanthellate in most cases (one can find exceptions to any "rule"). However, a coral is not inherently "hermatypic" or "ahermatypic". Rather, whether coral can accrete limestone faster than it is eroded away or buried by a variety of processes is a function of the environment, in addition to the organism's accretion potential. For example, *Montastrea* spp. are hermatypic in the Caribbean, but not on the West Florida Shelf. There are also many local environments

in the Caribbean where *Montastrea* can live but not construct bioherms.

This distinction is critical to conservation efforts, because a management decision to maintain environmental conditions that can support survival of *Montastrea*, for example, could be quite different than a management decision to maintain environmental conditions that can support reef (meaning "bioherm") development.

Pamela Hallock Muller, Professor  
Department of Marine Science  
University of South Florida

**Note:** *Muller had Szmant's whole message in her original message. [Szmant's message](#) is already displayed above.*

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*lasted updated 06/01/00  
by [Monika Gurnée](#)  
CHAMP Webmaster*



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The content on this web page was last updated in October of 2001.

Some of the content may be out of date. For more information:

<http://coralreef.noaa.gov/>.

#### Read About:

- ❖ [New Scenarios](#)
- ❖ [Causes of Reef Decline](#)
- ❖ [References](#)

## A Future for Coral Reefs?



Is this healthy Florida Keys coral reef destined for extinction?

196Kb).

In a Sept. 6, 2001, article, coral scientist Rupert Ormond of Glasgow University asserts that the future is hopeless for coral reefs (Cropley, 2001). He remarks that coral reefs—the victims of global climate change—would be dead in 50 years, and nothing can be done to save them. Even if humans were to halt the production of greenhouse gases immediately, Ormond claims that coral reefs still would perish because a 50-year time lag exists between limiting carbon dioxide levels and any effect it might have on controlling ocean temperatures.

Participants discussed the implications of this dire prediction. Some discussed the possibility that coral reefs could adapt to changing conditions or expand their range into cooler waters as water temperatures rose. Other participants discussed and debated the likely causes of reef decline.

**[Click here](#)** for a list of discussion participants.

**[Click here](#)** to download the complete unedited discussion (pdf,

### New Scenarios

Some participants raised the possibility that as sea temperatures rise, corals may adapt by relocating to cooler waters that have warmed. However, the consensus on this possibility generally was pessimistic. One participant noted that three geographic features work against the hypothesis. First, shallow water benthic habitats suitable to coral reefs are less common in higher latitudes. Second, light is limited in higher latitudes, a condition that will not change because it is dependent on the sun angle and day length variations. Third, increased atmospheric carbon dioxide, when dissolved in seawater, renders the water more acidic and inhibits reef calcification. Another participant added that in many parts of the world, the presence of land masses and other formations would prevent the corals from shifting geographically, especially in the Indian Ocean, the Red Sea and the Arabian Sea.

Still, many conceded that reef colonization on new shelves is possible, but it may not occur on a time scale detectable by humans. Rather, if one examines the fossil record, as several participants suggested, coral reef acclimation and recovery may occur over the course of thousands or more years, i.e., on geologic time scales. In addition, even if corals could acclimate to rapidly changing conditions within 50



*Scientists prepare to drill into a coral reef to study climate over the past 20,000 years. Paleoclimatology may be able to tell us how corals survived (or failed to survive) past climatic disruptions.*

years, humans may not be able to detect it using currently available data or experimental records, according to one participant. Thus, coral reefs "as we know them" are perhaps on their way out, and possibly will be replaced by a different kind of dominant coral reef community able to adapt to the new conditions, according to several participants.

A few participants also discussed the feasibility of the adaptive bleaching hypothesis (ABH), which theorizes that bleaching may be adaptive as well as pathological, "providing an opportunity for recombining hosts and algae to form symbioses better suited to altered circumstances" ([Buddemeier and Fautin, 1993](#)). One participant recounted the assumptions of the ABH and reasoned that the vital ones are false, thus rendering the hypothesis invalid. A defender noted that the ABH is not meant to be treated as a law and is not meant to apply to every instance of bleaching. Rather, it is meant to be tested and refined as new information becomes available.

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## Causes of Reef Decline

Participants also discussed potential causes of reef decline. One participant noted three general factors affecting reef survival: pollution, level of conservation/protection and population pressure. This participant suggested that population pressure was the "ultimate source of our problems." Others discussed the interplay between global warming and human-induced pollution.

Another participant insisted that land-based sources of pollution most often are the culprits for coral die-offs—more so than global warming effects. The participant believed that land-based pollution is the dominant reef issue. However, few long-term studies exist that can prove its effect, and society likely will not take action until public health costs sink in, according to the participant. In the meantime, he suggested that scientists concentrate their efforts on remediating controllable factors, such as sewage and sediment stress.



*Corals throughout the Caribbean, like this one in the Florida Keys, are bleaching (casting out their algae). Some scientists hypothesize that certain instances of bleaching may have adaptive advantages.*

Another participant questioned the assertion that land-based pollution was the major reason for reef decline. He noted that land-based sources of pollution may not be as important as supposed because the most acute effects often are located near shores, thus sparing reefs farther out to sea. He also asserted that sediment stress reduction may be an unrealistic goal because development activity shows no signs of slowing down. Thus, scientists should concentrate on understanding and mitigating land-based pollution effects to reduce adverse impacts, he stated. Scientists also should devote major efforts now to preserving healthy reefs, especially if those near the shore are being "timed out" geologically, according to the participant.

Finally, several participants noted that reef decline is not the result of one particular stress. The fossil record and research indicate that reefs can adapt to and survive individual stresses, provided favorable conditions return. However, current reef decline likely is the result of a number of interacting, chronic stresses. In the words of one participant, reefs are dying of "a thousand cuts." In addition, managers rely on the scientific community to reach a general consensus on how to attribute relative threats and effects on coral reefs. Trying to convince others that there is one dominant cause for reef decline is unhelpful to managers, another participant stated.

## References

Buddemeier, R., and D. Fautin. 1993. Coral Bleaching as an Adaptive Mechanism: A Testable Hypothesis. *Bioscience*.43: 320-326.

Cropley, E. Sept. 6, 2001. World Coral Reefs to Die by 2050, Scientist Warns. Reuters.

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## A Future for Coral Reefs?

### Listserve Participants

Robert Buddemeier  
University of Kansas

Katherina Fabricus  
Australian Institute of Marine Science

Daphne Fautin  
University of Kansas

Rick Grigg  
University of Hawaii

Jim Hendee  
National Oceanic and Atmospheric Administration

Ove Hoegh-Guldberg  
University of Queensland

Stephen Jameson  
Coral Seas Inc.

Jerry Kemp

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Alan Strong  
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Mike Risk

Bill Tyler  
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John Ware  
SeaServices, Inc.

Clive Wilkinson  
Global Coral Reef Monitoring Network

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# Coral Reefs Doomed?

## A Coral-List Server Discussion Thread

This thread is from the [Coral List Server](#). Some of the writers included a previous posting in their message. For simplicity, the included messages have been replaced by a link to the previous message that was quoted. If you follow that link, moving back in your browser should bring you back to your original position. This should continue to work even if you download the document to your machine. If you have any difficulties navigating this document, send a message to the [CHAMP WebMaster](#).

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Date: Fri, 7 Sep 2001 08:51:29 -0400 (EDT)  
From: Jim Hendee <hendee@aoml.noaa.gov>  
To: Coral-List <coral-list@coral.aoml.noaa.gov>  
Subject: coral reefs doomed?

Dear Coral Colleagues,

I know I'll get raked over the coals on this (especially because I don't have all the literature at my fingertips), but the content and tone of the news article below is troublesome to me, even though such a tone helps to gain attention, as well as funding, so that we can more thoroughly study the problem of coral bleaching and global warming. Of course I respect our colleague's right to a viewpoint, but when I see this, I can't help but have these thoughts:

Such a projection gives no "credit" to adaptation and natural selection, even though such adaptation would have to occur under a relatively short time span (50 years). I believe Ware et al (1996), among others, have addressed this.

As Dr. Al Strong and I have discussed, and as alluded to but unfortunately not expanded upon in the last sentence of the article, if the seas are warming, then you might expect the zoogeography of corals to expand (relocate?) into the cooler areas, as long as the substrate, circulation, light and water quality regimes are conducive. (I would imagine some coral researchers have modeled these possibilities, and I apologize for not referencing your work.)

Even though high sea temperatures are the primary cause and indicator of coral bleaching, that is not the only cause, and no credit is given to the evidence in the literature (e.g., Lesser 1996, among others) that high UV is also an agent in coral bleaching. Higher UV, especially in the tropics, is part of the problem as it relates to the earth's ozone layer.

There is evidence that high sea temperatures that elicited coral bleaching at some localities in the past did not elicit coral bleaching during extended cloudy periods (Mumby et al, in press). (Perhaps the cooler areas mentioned in the above paragraph might also have lower UV?)

There are other causes of coral bleaching (e.g., see Glynn 1993, 1996) and

this manifestation of stress is complex and to my mind public statements on coral bleaching should emphasize this.

Would an annual update to the ITMEMS statement on coral bleaching (<http://coral.aoml.noaa.gov/bulls/ITMEMS-bleach.html>) be helpful for the public in this regard? It is my opinion that it would, that we should address the topics above (among others, e.g., coastal effects), and that it would behoove us to widely circulate the update among the press as a consensus opinion (if that is possible!).

Just my two cents worth...

Cheers,

Jim Hendee  
NOAA/AOML  
Miami, FL

Glynn, P. (1993). Coral reef bleaching: ecological perspectives. *Coral Reefs* 12, 1-17.

Glynn, P. (1996). Coral reef bleaching: facts, hypotheses and implications. *Global Change Biology* 2, 495-509.

Lesser, M.P. (1996). Elevated temperatures and ultraviolet radiation cause oxidative stress and inhibit photosynthesis in symbiotic dinoflagellates. *Limnol Oceanogr.* 41(2): 271-283.

Mumby, P.J., Chisholm, J.R.M., Edwards, A.J., Andrefouet, S. & Jaubert, J. 2001. Cloudy weather may have saved Society Island reef corals during the 1998 ENSO event. *Mar Ecol Prog Ser* (in press).

Ware, J.R., Fautin, D.G., & Buddemeier, R.W. (1996). Patterns of coral bleaching: modeling the adaptive bleaching hypothesis. *Ecological Modelling* 84, 199-214.

----- Original Message -----

World coral reefs to die by 2050, scientist warns  
By Ed Cropley, Reuters  
Thursday, September 06, 2001

GLASGOW, Scotland =97 The world's coral reefs will be dead within 50 years because of global warming, and there is nothing we can do to save them, a scientist warned Wednesday.

"It is hard to avoid the conclusion that most coral in most areas will be lost," Rupert Ormond, a marine biologist from Glasgow University, told a science conference. "We are looking at a loss which is equivalent to the tropical rain forests."

Only the coral reefs in nontropical regions such as Egypt stand any chance of lasting beyond 2050, Ormond said, but even the days of the stunning marine parks of the Red Sea are numbered as sea temperatures continue to creep up.

In the past, reefs have suffered from sediment buildup and the coral-eating crown-of-thorns starfish, whose numbers have exploded due to the over-fishing of their predators.

Now the main threat to the delicate structures that harbor some of nature's most stunning creations comes from warmer seas, which cause coral bleaching.

Microscopic algae that support the coral polyps cannot live in the warmer water, and the polyps, the tiny creatures who actually create the reefs, die off within weeks.

Scientists agree the world's oceans are now warming at a rate of between one and two degrees Celsius every 100 years due to the increased amounts of greenhouse gases in the atmosphere which trap the sun's rays.

But even if humans stopped pumping out greenhouse gases such as carbon dioxide tomorrow in a bid to halt the process, it would still be too late to save the reefs, Ormond said. "I don't know what can be done, given that there's a 50-year time lag between trying to limit carbon dioxide levels and any effect on ocean temperature," he told the conference, held by the British Association for the Advancement of Science.

The implications stretch far beyond the death of the colorful coral structures themselves. The weird and wonderful eels and fish which inhabit the nooks and crannies will become homeless, and many species will die out. "We are looking at a gradual running down of the whole system. Over time, the diversity of coral fish will die," Ormond said.

Humankind will also suffer directly as the dead reefs are eroded and shorelines that have been protected for the last 10,000 years face the wrath of the oceans without their natural defenses.

In an age of relatively cheap scuba-diving holidays, this also means many developing countries in the tropics, such as Kenya or those in the Caribbean, face losing a major source of revenue.

The only cause for optimism was that new coral reefs could start to emerge in colder waters such as the north Atlantic Ocean and Mediterranean Sea.

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Date: Fri, 07 Sep 2001 13:00:01 -0500  
From: "Bob Buddemeier" <buddrw@kgs.ukans.edu>  
To: Jim Hendee <hendee@aoml.noaa.gov>  
CC: Coral-List <coral-list@coral.aoml.noaa.gov>  
Subject: Re: coral reefs doomed?

Jim, et al.,

Good questions, good points, -- and like it or not, a pretty good if disturbing article.

On your question about range expansion to compensate for temperature increase

and inhospitably hot tropics -- there are unfortunately 3 geographic factors that work against that.

1. The available shallow water benthic area decreases rather significantly as you move to higher latitudes (no atolls, narrower shelves, etc.)
2. Light -- see the Kleypas et al analysis -- Kleypas, J.A., McManus, J.W. and Menez, L.A.B., 1999. Environmental limits to coral reef development: Where do we draw the line? *American Zoologist*, 39(1): 146-159. Maximum reef depth shoals dramatically at higher latitudes, even within the thermal mixed layer. This presumably reflects light limitations due to sunangle and day length variations -- which aren't going to change.
3. Carbonate saturation state decrease is squeezing from the high latitude sides -- see the US National Assessment, <http://www.cop.noaa.gov/pubs/coastalclimate.PDF>, section 4.4.

So there is little basis for optimism there.

With acknowledgment of the terminological problems, some form of adaptation/acclimatization probably does have real potential to ensure the survival of corals, but not necessarily "reefs as we know them." The Ware et al article and its precursor, Buddemeier, R.W. and Fautin, D.G., 1993. Coral Bleaching as an Adaptive Mechanism: A Testable Hypothesis. *BioScience*, 43: 320-326, are looking more solid as experimental tests come in (Kinzie et al in *Biol. Bull.* earlier this year, Baker in *Nature* more recently), but for some reason this concept has been anathema to some reef ecology and conservation types. (see also Buddemeier, R.W., Fautin, D.G. and Ware, J.R., 1997. Acclimation, Adaptation, and Algal Symbiosis in Reef-Building Scleractinian Corals. In: J.C. den Hartog (Editor), *Proceedings of the 6th International Conference on Coelenterate Biology* (16-21 July 1995, Noordwijkerhout, The Netherlands). National Museum of Natural History, Leiden, pp. 71-76 for a related issue). This may be because it is seen as diminishing the seriousness of the bleaching problem, but in my view your position is the more valid -- without some mechanistic reason to believe that corals CAN survive, there is very little justification for investing money in research and conservation.

This also relates to my tired old hobby horse of the non-reef coral habitats -- I don't think we are getting the real picture, or doing ourselves any favors, by exclusive concentration on reefs; corals have survived many periods of non-reef-building, and we had better figure out how, why and where.

Thanks for bringing this up.

Bob Buddemeier

--  
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Note: Buddemeier had Hendee's whole message in his original message. [Hendee's message](#) is

already displayed above.

---

Date: Sat, 8 Sep 01 11:06:12 -0400  
From: Stephen C Jameson <sjameson@coralseas.com>  
To: "Bob Buddemeier" <buddrw@kgs.ukans.edu> ,  
"Jim Hendee" <hendee@aoml.noaa.gov>  
cc: "Coral-List" <coral-list@coral.aoml.noaa.gov>  
Subject: Re: coral reefs doomed?

Dear Jim and Bob,

Regarding Jim's:

>Such a projection gives no "credit" to adaptation and natural selection,  
>even though such adaptation would have to occur under a relatively short  
>time span (50 years).

In a nut shell, isn't the overriding problem (which Bob addressed in a plenary session at the NCRI symposium in Ft. Lauderdale) the fact that the increasing CO2 concentration in the atmosphere is changing the pH of the ocean (making it more acidic) and reducing the ability of corals to calcify properly (Bob's point number 3 stated in brief and in relation to high latitude)? So, no matter where a coral goes - it is going to have problems surviving.

Wasn't it also at the NCRI Symposium plenary session where Bob estimated coral reefs had only about 50 years to survive and this prediction was related to the change in pH not temperature (as stated in the press release)?

Best regards,

Dr. Stephen C. Jameson, President  
Coral Seas Inc. - Integrated Coastal Zone Management  
4254 Hungry Run Road, The Plains, VA 20198-1715 USA  
Office: 703-754-8690, Fax: 703-754-9139  
Email: sjameson@coralseas.com  
Web Site: www.coralseas.com

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Date: Sat, 8 Sep 2001 12:26:09 -0400  
From: "Mike Risk" <riskmj@mcmail.cis.mcmaster.ca>  
To: "Jim Hendee" <hendee@aoml.noaa.gov> ,  
"Coral-List" <coral-list@coral.aoml.noaa.gov>  
Subject: Re: coral reefs doomed?

Hi Jim.

Although I share your concerns in general, the bad news is: the conclusion is probably correct. I don't read that as a funding ploy-Rupert clearly says there's stuff-all we can do about it, leading funding agencies to say why

bother?

Notwithstanding the recent stimulating work by Jackson et al on overfishing, the hard evidence from the 20th century (and this one, too) is that land-based sources of pollution have ineradicably slain more coral reefs than all other causes put together. The references on this are close to countless. This trend continues unabated, and science seems slow to respond. (I invite other readers, perhaps offended by this comment, to submit examples of coral reef monitoring programs that are linked to legislation and enforcement by a proper detection/identification/amelioration process.)

Will reefs colonise new shelf areas? Sure. In fact, the rate at which this will occur may be estimated from the drilling work done long ago by Walter Adey, in the Virgin Islands. It takes the ocean about 1,000 years to clean up the shoreline and make it ready for new corals. Presumably, this same process in the future will take even longer, given the necessity for reworking condos and Hondas: plus, that ocean will not be nearly as clean as the advancing Holocene seas were. So: but don't hold your breath. For sure, it will happen after the next election.

Concern about ocean warming is well-placed. One of the best references to this is by Francis Rougerie, in...1988?. This is in French, and hence not as widely read and cited as it should be. Quelle honte.

Concern about oceanic pH is probably overblown:

1. we seem to have forgotten the seminal work of Sillen, in the 60's, showing that silicates, not carbonates, are the long-term oceanic buffers. Lord knows we have done lots to "protect" tropical coastlines from pH change by loading them with chemically-reactive silicates (feldspars, illite, montmorillonite, etc). Large quantities of these minerals are in fact bound up in coral skeletons, hence corals carry with them their own personal buffers (Cortes and Risk, 1985, BMS).
2. the pH of tropical coastlines will no doubt shift-after all the high-mag calcite has dissolved. As HMC makes up a large proportion of reef sediments, this may take some time.
3. as the climate changes and we shift to the other metastable condition of global climate, this will be accompanied by a fundamental reorganisation of the oceans. This will involve (far as we know) vertical mixing, which will put low-pH surface waters into contact with bottom sediments and bottom waters of higher pH. This process was outlined in Smith et al, 1997, April Nature. This process can occur within five years. None of the present ocean models allows for mixing on this vertical and temporal scale, hence all need recalibration. (Some of this work is under way now, using data from deep-water corals.)
4. McConnaughey and colleagues, and Barnes and colleagues, in separate publications within the last 12 months, have shown that corals calcify faster at elevated temps, and in the presence of fleshy algae.

My prediction (Risk, 1999) was that coral reefs, as some of us knew them (and you were one, Jim), will be eradicated by land-based sources from most of the world's shelves long before pH shifts appreciably-in fact, my prediction was even more dismal than Rupert's. I think I said 2020.

I am hesitant about statements, usually made (I'm afraid) by geologists, along the lines of "Corals have been around for a long time, they will survive." It's true, but misleading. Yes, coral relatives-burrowing sea

anemones-are the oldest metazoan fossils yet found: Proterozoic, McKenzie Mountains, NWT. Such statements need to have appended to them the comment that large proportions of the geologic record are virtually barren of reefs, of any type. I consider these statements similar to: "The globe's been hot before, we survived", which we have also heard lately. The globe has been quite hot before, involving a fundamental rethinking of real estate values. Every North American Grade Six kid should do the exercise of drawing the +15-m sealevel contour onto the globe, and estimating the human population involved. Or perhaps we should start with those politicians whose development seems to have been arrested at Grade 6...

It may very well be that some of those we refer to as "deep-water" corals may be a recolonisation/biodiversity resource-let us hope so. This has recently become an extremely productive area of research, and interested persons should log on to the coolcoral site, or contact me for preprints.

This email is devoid of specific page #'s, etc, for refs: my office is being moved, I am fileless, and am celebrating by being a carpenter for a while. Another guy who tried it came back, so what have I got to lose?

Yours in gloom: Mike

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From: "Ove Hoegh-Guldberg" <oveh@uq.edu.au>  
To: "Bob Buddemeier" <buddrw@kgs.ukans.edu>, "Jim Hendee" <hendee@aoml.noaa.gov>  
Cc: "Coral-List" <coral-list@coral.aoml.noaa.gov>  
Subject: RE: coral reefs doomed?  
Date: Sun, 9 Sep 2001 09:01:31 +1000

Dear Bob and others,

I was triggered to respond by the inferences in your statement that some "reef ecology and conservation" types have trouble with the Adaptive Bleaching Hypothesis. Any practicing experimental scientist would have an issue with the state of play regarding support for this hypothesis. The basic problem at this point is nothing to do with "culture" - it is more to do with hard evidence, which is almost completely lacking to support this still very soft and hypothetical explanation for why coral bleach. While experimental tests have been coming in, they have had serious problems in terms of design and the conclusions they draw. Us "reef ecology and conservation types" still wait for the definitive data that shows corals will bleach, get rid of one dinoflagellate genotype and adopt another WHILE the thermal (or other) stress is still being applied to the coral-dinoflagellate association. This has never been shown. Showing diversity in rDNA is interesting but irrelevant if diversity here does not relate to relevant physiological differences. The recent paper by Baker (whom I greatly respect), for example, used light and could not prove (using RFLPs) that his corals had changed from one dinoflagellate genotype to another (simply up-regulating one strain over another is not sufficient - that is acclimation and is not surprising). The experimental design was also confounded by the fact that stressed corals were placed in the two contrasting and confounding (for the experiment) habitats (one, the deeper site, was at the extreme depth limit of the species concerned while the other was clearly more optimal after photo acclimation). It is therefore not surprising that the corals died more at deeper site - which has nothing to do with the fact that they did

not bleach!).

Other issues abound and concern us "reef ecology and conservation types" - the idea of range of expansion is limited (as outlined by several people so far) by the fact that light may be a more important limiting than temperature. I also want to stress that the issue of the decline of reefs (as you, Bob, did state) has nothing to do with the extinction of corals. As the "geo types" (deliberate use here) tell us worse things have happened to corals and they have bounced back (but over thousands if not millions of years). The issue, however, is the current human dependency on coral reef ecosystems - reefs disappearing for even a few decades would present serious issues for several hundred million people. The idea of finding out how reefs survived major extinction events is interesting but largely irrelevant to the current discussion.

So - out I come on my old hobby horse - we still have no evidence of unusual adaptive abilities of corals that will match the fast rate of change. Us reef ecology types keep looking. While looking for this evidence - perhaps we also need to focus on how reefs will change and how we can "adapt" as human societies to these changes. This research direction, if the projections of the future are correct, will assume a major significance as we enter the next few decades.

Best wishes,

Ove

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[http://www.marine.uq.edu.au/CMS\\_pro/www/staff.html](http://www.marine.uq.edu.au/CMS_pro/www/staff.html)

Note: Hoegh-Guldberg had Buddemeier's whole message in his original message. [Budemeier's message](#) is already displayed above.

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From: "Jeffrey Low" <jeffrey-low@mailhost.net>  
To: "'Coral-List'" <coral-list@coral.aoml.noaa.gov>  
Subject: RE: coral reefs doomed?  
Date: Sun, 9 Sep 2001 10:37:06 +0800

Hi everyone,

I hesitate to air my views in this forum, which will be read by the "greats" in coral reef research. However, I beg your indulgence to add my questions and comments to the debate on the destruction of coral reefs.

Factors affecting coral reef survival. I think it is moot to say one factor overrides the other - unless we know ALL the factors, and how they relate to each other, even the "global" factors may only play a small part in coral



survival in a specific regions, and at that point in time. Even then, these factors would probably change faster than science can determine to be of practical use.

Pollution. I use the term liberally here, to include CO2, sediment, sewerage etc. Most, if not all, of the problems related to coral reefs are man-made. While I hear a lot about the biology of corals, their reaction to certain influences, what is being done to link the biology with the "pollution management" sciences? My meaning is that should more be done to address the question of how do we keep our environment cleaner?

Conservation, preservation, protection. Are we trying to keep the coral reefs as they are? Even in the face of environmental change on a global scale? Maybe their "time" has come and we will be powerless to prevent it. Given that humans have caused premature termination of thousands of species, but species extinction has been going on for some time, no? Perhaps the overall degradation of the various ecosystems worldwide is an indication of the (eventual) demise of the human race as we know it.

Population. I would class this as the ultimate source of all our problems (not just for coral reefs). To paraphrase from the movie "Godzilla" - size does matter. 6 billion people ... I can't even imagine what that number constitutes. And it is set to top 7 billion by 2050? How do you manage the waste produced by so many people? How do you prevent overfishing when fish may be the main (and sometimes only) source of protein. How do you prevent over-exploitation of the oceans resources? I recall a funny anecdote in the newspapers about someone who calculated that if everyone of earth passed gas at the same time, it would cause an explosion that would destroy the world. It seemed funny at the time ....

Cheers,

Jeffrey Low  
SINGAPORE  
jeffrey-low@mailhost.net

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From: "Ove Hoegh-Guldberg" <oveh@uq.edu.au>  
To: "'Jeffrey Low'" <jeffrey-low@mailhost.net>,  
"'Coral-List'" <coral-list@coral.aoml.noaa.gov>  
Subject: RE: coral reefs doomed?  
Date: Sun, 9 Sep 2001 16:47:45 +1000

Hi Jeffrey,

Let us hope synchrony in gas does not prevail!

People are key to both the problem and the solution. The same mass scale efforts you refer to in terms of the negative also apply to the other side of the equation. If all of us planted a tree, there would be 6 billion new trees. If everyone in the rich developed countries insulated their homes rather than use heating or air-conditioning, we would have a dramatic decline in the greenhouse gas problem. So - six billion people does not have to be a negative (yes - I know - it rarely is)

On the relative impacts of climate change versus "pollution". There has been a perception of a competition among us of "who has the worst factor for causing reef decline'. I find that silly. While the GCRMN data tend to indicate a dramatic impact of climate events like 1998 (16% loss of living coral in a single year), the truth is that the synergies and interactive effects are probably where the action is as opposed to an isolated and single factor.

Cheers,

Ove

Note: Hoegh-Guldberg had Low's whole message in his original message. [Low's message](#) is already displayed above.

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Date: Sun, 09 Sep 2001 14:32:09 +0100  
From: "Mark Spalding" <Mark.Spalding@unep-wcmc.org>  
To: <coral-list@coral.aoml.noaa.gov>  
Subject: RE: coral reefs doomed?

Just a few quick thoughts on this, because tomorrow and Tuesday I'm going to be facing quite a bit of national and international press regarding the launch of the World Atlas of Coral Reefs. I'm quite expecting a question such as "We heard last week that coral reefs will all be dead within 50 years and there's nothing we can do about it, so why should be bother trying?"

I think the answer is something like.

1 - this is a very extreme view, that is not to say impossible, but it lies at one end of a spectrum, while "no impact whatsoever lies at the other". The reality is somewhere in between

2 - We do not, therefore, give up while what we are talking about is still a remote chance.

3 - What can we do? Well perhaps we can ameliorate the impacts, for example by reducing the mix of other threats facing reefs. While this may not prevent coral death from bleaching, it seems highly likely that it would facilitate recovery. Detailed networks of protected areas may help, and more active management may become essential. For example, even the worst hit areas of the Indian Ocean showed very localised pockets of high survival. These may be critical for subsequent recovery of wider areas, and should be given high levels of protection following a bleaching event. Similarly overfishing of grazing fish may prevent coral settlement as algae grow up, so perhaps there are fisheries management controls we should consider.

4 - The jury is still out on the rates of adaptation of corals, given the timescales genetic adaptation may be out of the question (not completely), but there is also phenotypic plasticity. We need to watch, and to experiment.

If the doomsday scenario really starts to look likely there may still be more active management measures we could take, and research needs to think about these.

Cheers

Mark

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Mark Spalding, PhD  
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or  
Research Associate  
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Downing St  
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UK

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Date: Sun, 9 Sep 2001 17:37:09 +0100 (BST)  
From: JM Kemp <[jmk100@york.ac.uk](mailto:jmk100@york.ac.uk)>  
To: "'Coral-List'" <[coral-list@coral.aoml.noaa.gov](mailto:coral-list@coral.aoml.noaa.gov)>  
Subject: RE: coral reefs doomed?

One small comment about range - expansion and survival of coral and other associated taxa in the face of climate change: Ignoring the details of arguments about acidity, etc, and just thinking geographically, if climate change does force those taxa away from the equator into higher latitudes, a quick look at any atlas shows that the 'range expansion' argument is invalid for some large parts of the GLOBE. Although it may hold water in the Tropical Atlantic, parts of the Pacific, and the densely - packed archipelagos of the Indo-Malay region, in the Indian Ocean (especially the northern Indian Ocean), and other areas this is not the case.

My own stamping ground of Arabia, including the Red Sea and the Arabian Sea, provides good examples: force the many hundreds of taxa endemic to that part of the world any further north and they'll have to develop legs and lungs (which may be taking the adaptation hypothesis a little too far): there's nowhere else for them to go except dry land.

Similarly, any of the numerous reef-coral taxa endemic to remote islands or island chains in the tropics of any of the world's oceans are likely to have nowhere to go, simply because they are unable to disperse and colonise areas away from their present home ranges. For poorly dispersing taxa the distance involved may not even have to be very large before it becomes insuperable.

Just a thought.

Jerry Kemp

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Date: Sun, 9 Sep 2001 13:16:24 -0400 (EDT)  
From: Jim Hendee <[hendee@aoml.noaa.gov](mailto:hendee@aoml.noaa.gov)>  
X-Sender: [hendee@blimpie](mailto:hendee@blimpie)  
To: Coral-List <[coral-list@coral.aoml.noaa.gov](mailto:coral-list@coral.aoml.noaa.gov)>

Subject: Re: coral reefs doomed?

I need to make something clear about my original message in "coral reefs doomed?": I was NOT intimating that R. Ormond's statements were made as a "ploy" (ref: colleague M. Risk's post) to gain funding. I can see how one might draw that inference from what I said, but that was definitely not my intent.

My overall intent in the message was that a more well-rounded statement on coral reef decline might be more helpful in public statements to the press. However, I am beginning to see that a consensus might be impossible, even if a desirable goal.

Cheers,  
Jim

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From: "Mike Risk" <riskmj@mcmail.cis.mcmaster.ca>  
To: "Jim Hendee" <hendee@aoml.noaa.gov> ,  
"Coral-List" <coral-list@coral.aoml.noaa.gov>  
References: <Pine.GSO.4.03.10109091307580.1664-100000@blimpie>  
Subject: Re: coral reefs doomed?  
Date: Sun, 9 Sep 2001 17:29:06 -0400

And, in turn, allow me to make myself clear.

Jim Hendee was not one of the people I hoped would take offense at my posting.

There has been more than a little game-playing by some reef scientists, re obtaining funding to save the world's reefs from disaster. Neither Jim nor I read Rupert's comments as pleas for more dough, but as the sad conclusions of an experienced scientist. I differ from those conclusions only in scale.

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From: BTyler3@aol.com  
Date: Sun, 9 Sep 2001 20:18:34 EDT  
Subject: Re: coral reefs doomed?  
To: coral-list@coral.aoml.noaa.gov ('Coral-List')

Re: Mark Spalding's comments and others...

<<Just a few quick thoughts on this, because tommorrow and Tuesday I'm going to be facing quite a bit of national and international press regarding the launch of the World Atlas of Coral Reefs. I'm quite expecting a question such as "We heard last week that coral reefs will all be dead within 50 years and there's nothing we can do about it, so why should be bother trying?">>

I'd like to throw in my two cents worth about why bothering to study/protect coral reefs IF(??) they are actually on there way to widespread decline as is being discussed here. This probably seems obvious to biologists and managers, but not necessarily to politicians/reporters

controlling/influencing the purse strings.

There are other reasons to protect these areas and to maintain water quality in reef areas other than maintaining hard corals.

What would be the effect of hard coral die-offs from many of the worlds coral reefs? No doubt there would be a change in structure, both physical and ecological. Coralline algae, sponges, and possibly soft corals, would likely become the dominant structure-forming organisms. This change in structural characteristics would lead to community changes in composition, diversity and abundance, but not necessarily complete elimination of important marine resources in these areas.

In the worst case scenario, there may eventually be complete erosion of wave-dissipating functions of the resulting reefs, but this may take much longer. But it seems to me that these altered reef areas would still be valuable marine resources worthy of protection for the future, if nothing else then to help put off the possibly inevitable breakdown of the entire reef structure. Good water quality and management practices should hopefully enhance whatever takes place over the long-term.

Bill

Dr. Bill Tyler  
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Date: Mon, 10 Sep 2001 13:59:40 -0400  
From: "Alan E Strong" <Alan.E.Strong@noaa.gov>  
To: Coral-List <coral-list@coral.aoml.noaa.gov>  
Subject: Re: coral reefs doomed?

Dear Ove, Bob, and others,

It seems about the right time to correct a misimpression that we spoke to at Bali last October. Our Bali paper noted that NOAAs satellite SST data from around the tropics were believed to have been indicating an alarming increase (upward tendency hardly a trend!) over the past two decades latitudinally as high as 0.5 deg C at 5 N latitude! A re-evaluation of these data, through a program sponsored by NASA and NOAA, called Pathfinder has taken all the year-to-year improvements in making correct measurements over that time interval and reprocessed the data in an up-to-date and uniform fashion. More importantly, in-situ SST data from all the drifting and fixed buoys available were utilized to both validate and correct satellite calibrations on a regular basis. From Pathfinder we now believe that we have a more accurate set of NOAA satellite SST observations the best results for buoy comparisons are still seen when using only those Pathfinder satellite SSTs made at night.

>From Pathfinder nighttime SST observations (Paper will be presented at the upcoming Ocean Sciences AGU) it is seen that SSTs through most of the tropical

latitudes have not been rising but holding rather steady. In fact some regions have been showing steady DECLINES in SST. We still are finding greater declines in the southern hemisphere (reported at the Bali meeting) but even northern tropical locations show decreases: e.g., region around Midway; the region known as The Warm Pool both continue to trend downward during the 80s and 90s. Even though much of the Indian Ocean experienced devastating bleaching from high SSTs in the late 90s, this area is basically experiencing a downward SST tendency. There are several regions that may be showing statistically significant increases, but this final say will not be official until the Feb 2002 Ocean Sciences meeting when we expect to have Pathfinder 1999 and 2000 SST data fully incorporated. Regions that have been experiencing upward tendencies are: American Samoa Fiji Cook Islands; some regions of the Caribbean (especially eastern portions); Mexican Pacific coast; Red Sea; Arabian Sea/Persian Gulf; and possibly the extreme southern regions of GBR. There are other regions in the northern Atlantic and Pacific, outside areas of interest to coral folks, that show upward trends. These upward tendencies may be starting to show effects of climate increases that, from the oceans standpoint seem to be mostly noted at higher latitudes in the Northern Hemisphere. see you at Oceans Sciences.

Footnote:

A much scarier scenario is seen when the 1997/98 El Nino period is incorporated, a scenario we believe that will be largely eliminated with the addition of 1999 and 2000 SST data. Any trends ending during such a significant event are statistically flawed. What some are concerned about for the future of coral reefs from the standpoint of temperature is what will El Ninos be like over the next 50 years So far I know of no reliable model with the answer to that question

Cheers,  
Al

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Date: Mon, 10 Sep 2001 21:18:37 -0400  
To: Mike Risk <riskmj@mcmail.cis.mcmaster.ca>, coral-list@coral.aoml.noaa.gov  
From: "Alina M. Szmant" <szmanta@uncwil.edu>  
Subject: Re: coral reefs doomed?

Dear Mike:

In your recent Coral List message you made the following statement:  
"... is that land-based sources of pollution have ineradicably slain more coral reefs than all other causes put together. The references on this are close to countless...."

Having tried to track down peer-reviewed published work on this subject and having found the Kaneohe Bay case, and some of Jorge Cortes and your work on Costa Rica reefs buried in sediments to be the only scientifically credible major studies of reef decline due to pollution, I'd greatly appreciate being directed to the "countless references". I am sure there are others on Coral List whom also would be interested. Hopefully you have a master list of such references on your computer you could send out as an attachment or post on a web site for our edification while your office is being remodeled.

Thanks,

Alina Szmant

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**Presently in Key Largo: (305)453-4595**

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From: "Mike Risk" <riskmj@mcmail.cis.mcmaster.ca>  
To: coral-list@coral.aoml.noaa.gov, "Alina M. Szmant" <szmanta@uncwil.edu>  
Subject: Re: coral reefs doomed? Argh without refs  
Date: Tue, 11 Sep 2001 15:45:39 -0400

Hi Alina.

I always have an excuse for not doing homework. In this case, my wife = (Jodie Smith) is in surgery, I am taking a break to do email, but have = no intention of doing science for several days. (She's OK.)

The largest problem here, as you are no doubt aware, is that, after 30 = years of using the same survey techniques: we have damn few long-term = records. So every argument that land-based sources cause stress may be = met with the counterargument, that you have no basis for concluding = that. (No matter that it's a BS argument-in these days of embracing = traditional knowledge, the one source we refuse to acknowledge is the = memory banks of aging reef scientists...)

BUt here's a start. One of the best/worst places to see this is in SE = Asia. Tom Tomascik has documented disappearance of whole reefs in Pulau = Seribu (Thousand Islands), off Jakarta, within historical times-used old = data sets from the days of Umgrove. His work has appeared in various = iterations, including his book, and the Ginsburg Miami volume. Edinger = worked in several locations in Indonesia, with some of my other = students-published 2000 (?), Mar Poll Bull, plus several other summary = papers. The effect of a combo of sediments and sewage ranges from a = large drop in biodiversity and coral cover, to (most often) complete = extirpation. It classifies as a regional mass extinction: he estimated a = loss of (?) 40% of generic diversity of corals in the past 15 years. = Climate change had zip to do with it.

Sri Lanka lost almost all of its reefs over the past decade...

If I feel like doing science in a few weeks, I'll get back to you. = Promise.

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Date: Sat, 15 Sep 2001 16:28:16 -0500  
From: buddrw <buddrw@kgs.ukans.edu>  
To: <oveh@uq.edu.au>, Jim Hendee <hendee@aoml.noaa.gov>  
Cc: Coral-List <coral-list@coral.aoml.noaa.gov>  
Subject: RE: coral reefs doomed?

Ove, and others --

Part of the reason you are still waiting for hard experimental evidence regarding the ABH is that you consistently misstate and/or misunderstand what it is. Some specific examples:

"the definitive data that shows corals will bleach, get rid of one dinoflagellate genotype and adopt another WHILE the thermal (or other) stress is still being applied to the coral-dinoflagellate association."  
This is part of the ABH only to the extent of requiring continuance of the stressful REGIME (e.g., frequency of high temperature excursions), not of the stressful bleaching-inducing CONDITION (e.g., continuous high temperature). It seems to me that you are attacking the latter proposition, which is NOT what we proposed or modeled (Ware et al).

"used light and could not prove (using RFLPs) that his corals had changed from one dinoflagellate genotype to another (simply up-regulating one strain over another is not sufficient - that is acclimation and is not surprising)." Bleaching is a stress response, and we think that stress adaptation probably doesn't care that much about light, temperature or whatever -- besides which, there is certainly strong evidence for the synergism of light in temperature even in the bleaching episodes attributed primarily to temperature. Sorry if using light is a problem for you -- it's not for us. Further, we are willing to plead guilty to having accepted that which is not surprising -- what you refer to as 'up-regulation' we considered a shift in dominance or inertnal competitive abilities among the varieties of zooxanthellae that could or did inhabit a host -- very much a part of ABH.

Rather than go on and nit-pick your counter-arguments, I'd like to suggest that this is a good opportunity to set up and broaden the debate as a discussion thread -- with the proviso that we rely on direct quotes in context (since the subject is a bit complicated for one-line summaries) rather than on strawman revisions to discuss what the ABH actually is or isn't.

Bob Buddemeier

Dr. Robert W. Buddemeier  
Senior Scientist, Geohydrology  
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Note: [Buddemeier had Hoegh-Guldberg's whole message in his original message. Hoegh-Guldberg's message](#) is already displayed above.

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Date: Sat, 15 Sep 2001 16:10:42 -0500



From: buddrw <buddrw@kgs.ukans.edu>  
To: Coral-List <coral-list@coral.aoml.noaa.gov> ,  
"Mike Risk"@coral.aoml.noaa.gov  
<riskmj@mcmaster.ca> , Jim Hendee <hendee@aoml.noaa.gov>  
Subject: RE: coral reefs doomed?

It's interesting, if mildly depressing, to see so many reasons for pessimism.

I generally agree with most of Mike's points, but there are two that he raises that I think merit comment -- both related to the CO<sub>2</sub> and saturation state issue, and both addressing issues of temporal scale and kinetics.

First, Mike raises the question of 'long-term' silicate buffering. True enough -- in the very long term, none of this is an issue, and even on the thousands of years time scale we are dealing with ocean DIC content that overwhelms the size of the atmospheric reservoir (and essentially all others but the mineral). The critical issue is that we are not dealing with scales of this magnitude -- the anthropogenic CO<sub>2</sub> input has been on the scale of a century (more if you count the beginning of the industrial revolution, less if you start from the rapid rise post-WWII). The mixed layer of the ocean, however, contains DIC in an amount comparable to the atmospheric reservoir with a probably turnover time of a few centuries (cf. many radiocarbon studies of marine apparent ages). For the purpose of considering present problems, it is a reasonable first approximation to treat the mixed layer (which is where all of the reef-building corals live) as an isolated compartment, and on that scale the CO<sub>2</sub> effect is clearly dominant.

Second, the high-mag calcite issue -- I too am out of my office, but in 1986 June Oberdorfer and I published a chapter in Carbonate Diagenesis book edited by Purser and Schroeder that pointed out that reef interstitial water is controlled at the saturation state of high-mag calcite. What is most definitely not true is that this has much effect on the saturation state of the overlying seawater. Here again, the issue is time scales -- in this case of advective open water exchange compared to the flushing of interstitial porewaters (see also the paper by same authors in the ICRS 6 proceedings). There are many orders of magnitude difference -- and in fact the possibility of equilibrating the sedimentary carbonate with the ocean water is on time scales equivalent to the silicate buffer controls, and basically insignificant on the 100 year scales dominated by gas and open water exchange reactions.

A question, Mike -- I didn't understand your point about vertical mixing replacing high pH bottom water with low pH surface water -- did that refer to some particular locale? Certainly for most of the ocean saturation state, pH etc are lower at depth than at the surface.

Bob Buddemeier

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Note: Buddemeier had Risk's whole message in his original message. [Risk's message](#) is already displayed above.

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Date: Tue, 18 Sep 2001 00:58:14 -0500  
From: buddrw <[buddrw@kgs.ukans.edu](mailto:buddrw@kgs.ukans.edu)>  
To: Coral-List <[coral-list@coral.aoml.noaa.gov](mailto:coral-list@coral.aoml.noaa.gov)>, Jim Hendee <[hendee@aoml.noaa.gov](mailto:hendee@aoml.noaa.gov)>  
Subject: RE: coral reefs doomed -- and the ABH

Coral-listers;

I have received, in addition to this broadcast message from Ove, other personal communications that indicate that there is a fairly broad pool of misunderstanding about what the Adaptive Bleaching Hypothesis is and isn't. The comments below address primarily things that it isn't, and I have sent messages to Ove and others on an individual basis to try to get this sorted out so that a productive discussion can ensue.

In the meantime, I heartily recommend recourse to the original literature as a source of primary information -- I, Daphne Fautin, and John Ware will all be more than happy to answer questions or attempt to clear up confusion.

Bob Buddemeier

PS: I stand by my original statements.

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Note: Buddemeier had Hoegh-Guldberg's whole message in his original message. [Hoegh-Guldberg's message](#) is already displayed above.

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Date: Tue, 18 Sep 2001 10:37:27 -1000  
To: buddrw <[buddrw@kgs.ukans.edu](mailto:buddrw@kgs.ukans.edu)>, Coral-List <[coral-list@coral.aoml.noaa.gov](mailto:coral-list@coral.aoml.noaa.gov)>, Jim Hendee <[hendee@aoml.noaa.gov](mailto:hendee@aoml.noaa.gov)>  
From: Richard Grigg <[rgrigg@soest.hawaii.edu](mailto:rgrigg@soest.hawaii.edu)>  
Subject: RE: coral reefs doomed -- and the ABH and carbonate saturation

Dear Bob,

Thank you for shedding some more light on your adaptive bleaching hypothesis and as you point out, there is almost a complete absence of hard evidence either for or against the argument. In this regard, I don't have to remind you, that absence of evidence is not evidence of absence (of coral's adaptive abilities). Also, in this regard, I think we can infer more from the fossil record than most of us seem now willing to accept even though the adaptive responses have the benefit of thousand or even millions of years. BUT, over the millenia, there must have been some rapid bursts of sudden change such as the K-T event itself. Stephen J. Gould's view of evolution by punctuated equilibrium is, in fact, based on such bursts of change. And yet, we don't see much extinction in corals at least at the generic or Family level (Re: Veron's work). Doesn't this imply high adaptive ability? Perhaps we need to revisit the fossil record more often and pull in the views of John Pandolfi and Charley Veron (where are you guys?).

Also, while I am at it, let me ask you to shed some of your exceptional knowledge and experience in marine geo-chemistry on the problem of decreasing carbonate saturation state in the world's oceans as a result of increasing co2 globally. I think there is an equally broad pool of misunderstanding about the degree to which existing carbonate sediments in the world's oceans, can serve as a buffer to this effect??? I for one would appreciate hearing your insights on this question. Hope this question does not pose to great a burden but I'm sure the coral reef community will appreciate your views.

Rick Grigg  
Dept. of Oceanography  
University of Hawaii

Note: Grigg had Buddemeier's whole message in his original message. [Buddemeier's message](#) is already displayed above.

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From: "Precht, Bill" <Bprecht@pbsj.com>  
To: "'Richard Grigg'" <rgrigg@soest.hawaii.edu>, buddrw <buddrw@kgs.ukans.edu>, Coral-List <coral-list@coral.aoml.noaa.gov>, Jim Hendee <hendee@aoml.noaa.gov>  
Subject: RE: coral reefs doomed -- and the ABH and carbonate saturation  
Date: Tue, 18 Sep 2001 17:11:18 -0500

Rick, Bob & the List:

Food for thought...

I had the great fortune to work for the late Cesare Emiliani of the Univ. Miami about ten years ago... one of the topics we often discussed over a few cold ones was the impact of warm global temperatures on the survival of life in the oceans, especially in the topics...

An interesting paper that may be germane to the argument is by Emiliani, Kraus & Shoemaker (1981) Earth Planet. Sci. Lett. 55:317-334 - where they show that about 20% of the late Cretaceous reef-building coral genera survived an abrupt rise in temperature (about 10 degrees C in just a few MONTHS) that was related to the mass extinction at the K/T boundary.

What is the important question here - the fact that 20% survived or that 80% went extinct??

All the best,

Bill

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William F. Precht  
Ecological Sciences Program Manager  
PBS&J  
Miami

Note: Precht had Grigg's whole message in his original message. [Grigg's message](#) is already displayed above.

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Date: Wed, 19 Sep 2001 08:32:34 -0400  
From: John Ware <jware@erols.com>  
Organization: SeaServices, Inc.  
To: "coral-list@coral.aoml.noaa.gov" <coral-list@coral.aoml.noaa.gov>  
Subject: Coral reefs doomed??

Dear List,

For a quantitative view of the effect of acclimation (or adaptation or whatever), you might wish to consider the paper that I presented at the 8th ICRS, Vol 1:527-532; "The effect of global warming on coral reefs: acclimate or die". This was, I believe, the first attempt to quantify the effect of acclimation rate on the expected response of coral reefs. In fact, this might have been the first \*quantitative\* prediction of the effects of global warming on reefs.

One major conclusion is that even with acclimation rates that would be considered long by human standards, say 25 - 50 yrs, the chances of survival of coral reefs are dramatically increased. Acclimation with such large time constants may not be detectable using currently available data or experimental methods.

John

(Note: Despite the rather melodramatic title, this paper has repeatedly been overlooked by even rather meticulous researchers such as Ove. Just my Cinderella complex showing. jrw)

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\*\*\*\*\*  
\* \*  
\* John R. Ware, PhD \*



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From: "Ove Hoegh-Guldberg" <oveh@uq.edu.au>  
To: "'John Ware'" <jware@erols.com>, <coral-list@coral.aoml.noaa.gov>  
Subject: Climate and corals  
Date: Thu, 20 Sep 2001 13:37:00 +1000

Dear John,

Thanks for reminding me (again) about your paper from the Panama meeting, which I have now read. As you know, I tried (in 1999) to go from speculation about climate by interacting with three premier climate modelling groups in Australia, Europe and the USA. This allowed me access to models that simulated important aspects within the climate change debate such as El Nino variability, the impact of aerosols and the forcing due to IS92a greenhouse scenarios. By using several models, I was able to draw on experts in simulating climates and was able reduce the problem of the bias of one model.

As you know (somewhat depressingly), the scenarios for future patterns of bleaching did not differ greatly between models. The issue of acclimation and adaptation is complex and I have a few comments that I will send through in a separate email. I feel this debate (as Bob has noted) is useful and will hopefully clear up some of the recent understandings.

Regards,

Ove

Note: Hoegh-Guldberg had Ware's whole message in his original message. [Ware's message](#) is already displayed above.

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From: "Mike Risk" <riskmj@mcmail.cis.mcmaster.ca>  
To: "buddrw" <buddrw@kgs.ukans.edu>,  
"Coral-List" <coral-list@coral.aoml.noaa.gov>,  
"Jim Hendee" <hendee@aoml.noaa.gov>,  
"Richard Grigg" <rgrigg@soest.hawaii.edu>  
Subject: Re: Fossil lessons  
Date: Thu, 20 Sep 2001 09:44:22 -0400

Hi Rick (-list).

It's hard to concentrate on academic debates with the world in disarray, my office in cardboard boxes, my wife in recovery and my department in ruins. But I will stop whining.

Yes, I could not agree more-the fossil record has a great deal to say about survival and extinction.

We hear a lot about how "resilient" corals are. They aren't.

In general, Phyla are extremely robust. Now that Paleo has done the sensible thing and folded the Archeocyatha into the Porifera, we can observe that no phylum extant in the Cambrian has ever died out. So the trunks of the trees remain, while branches come and go.

Corals have contributed to reefs in varying proportions, from the Ordovician on-but how many Rugosa and Tabulata have you seen on reefs? The real survivors among the Coelenterata are the gorgonians, virtually unchanged since the Ordovician. Along with nereid polychaetes. Perhaps the largest barrier reef in the history of the planet (Guadalupian, W. Texas) is virtually devoid of corals.

Most of our view that corals are robust and omnipresent stems from our experience with Cenozoic reefs, which are well-exposed and preserved in many classical outcrops. Cenozoic reefs experienced three major extinction events: Eocene/Oligocene, Oligocene/Miocene, and Plio/Pleistocene. (See work by Stan Frost, Ann Budd, etc.) The Plio/Pleistocene event was a freeze-out, and not very relevant to what looms. Examination of the Oligo/Mio event, however, is illuminating.

This extinction event was likely caused by a shelf-edge upwelling, bringing in conditions of turbid water and high nutrients. These are the conditions that reefs face now-and I point out that grazing in the Oligocene was unaffected by people. Not even Alley Oop.

Half the corals in the Caribbean died (Edinger and Risk, 1994: PALAIOS 9: 576-598). Some other bad news: bioeroders, primarily filter-feeders, sailed through unchanged: so the balance was severely upset. (I have to point out here that any reef "model" that ignores bioerosion is dealing with less than 50% of the carbonate balance, and hence deserves less than 50% of our confidence.) I suggest that what we are seeing now precisely parallels what the record tells us: massive regional extinctions, shifting of the carbonate balance equation...This event remade the Caribbean coral fauna, reducing it to a fraction of previous biodiversity levels. Although Indo-Pacific representatives escaped the Caribbean event, they have yet to recolonise the Caribbean.

So I suggest that the fossil record allows us to estimate recovery times of reef coral faunas: between 1,000 years (Adey) to >25 million years. You and I won't see it!

Another view from SE Asia: Edinger et al., 2000: Diversity and Distributions 6: 113-127: "...land-based pollution was the primary determinant of coral species diversity and species occurrence on reefs."

I continue to be pessimistic. I feel that present fixation of the biological research community is at least partly driven by a reluctance to deal with the real problems: coastal development associated with population increases.

Mike

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From: "Jeffrey Low" <jeffrey-low@mailhost.net>  
To: "Coral-List" <coral-list@coral.aoml.noaa.gov>  
Subject: RE: Fossil lessons

Date: Fri, 21 Sep 2001 07:07:15 +0800

Dear Mike,

Sorry to hear about the disarray in your life .... hope things work out (eventually). I totally agree with you on your last point - in fact, I came across an article in the newspapers on two papers published in Science (Alroy and Roberts) that claim "humans more lethal than climate change". Of course, they were looking mostly at land extinctions caused by human migration in prehistoric times, but the present day loss of coral reefs (and other coastal habitats) are directly related to population growth. I would hazard a guess that if we (ie the human race) can get our population growth under control, much of the existing problems of overfishing, coastal degradation, pollution and greenhouse gases would be drastically reduced or not exist.

What I don't hear much on this list are projects / research being done related to quantifying the human factor in the degradation. Not the blast fishing / cyanide problems, but more of the "if you have x% less people, then the damage will be y% less and restoration can proceed at z% rate". Perhaps some other list has this kind of on-going discussion?

One final comment - all countries seem to run on the theory that you need to have replacement rates higher than death rates (in the human population) so that (economic) growth can be sustained. Now, if that is the case, doesn't that mean that there is a never-ending spiral of population increase? If I remember my basic biology - this constitutes a positive feedback system .... which will ultimately result in the breakdown of the system (as opposed to a negative feedback, which keeps the system in balance).

Before I end, let me just say that this is just my "coffe-shop" interpretation of the "big picture". I defer to more informed minds on the subject, and would like to hear more on this. Thanks.

Jeffrey Low  
SINGAPORE  
Email: [jeffrey-low@mailhost.net](mailto:jeffrey-low@mailhost.net)

Note: Low had Risk's whole message in his original message. [Risk's message](#) is already displayed above.

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From: "Ove Hoegh-Guldberg" <oveh@uq.edu.au>  
To: "'buddrw'" <buddrw@kgs.ukans.edu>, "Jim Hendee" <hendee@aoml.noaa.gov>  
Cc: "'Coral-List'" <coral-list@coral.aoml.noaa.gov>  
Subject: Adaptive Bleaching Hypothesis (1)  
Date: Sat, 22 Sep 2001 09:41:51 +1000

Dear Bob,

With great respect to you and your colleagues, the effort to discuss the ABH should be seen not as an "attack" but as an attempt to clarify and



expand on this interesting area (aka "spirit of debate"). My intention in responding to your broadcast message (Sep 16) was to also clarify the implication that the resistance to the ABH was somehow not on scientific terms. Given the interest in this area, I agree that it is important to keep the discussions open and visible on the coral-list forum.

To begin with, let us put one assertion to rest. You suggest that I have "consistently misstated" your hypothesis. I understand the hypothesis as encapsulated in your own words (Ware, Fautin and Buddemeier 1996) as: "Buddemeier and Fautin (1993) proposed that bleaching is not merely pathological, but is also adaptive, providing an opportunity for recombining hosts and algae to form symbioses better suited to altered circumstances."

To the first issue - recombination involves re-mixing as well as recombining. If part of the ABH involves shifts in the genotype frequencies of populations of pre-existing mixed dinoflagellate symbionts, then I would argue that "re-combining" as a term is not clear (and hence perhaps the greater confusion) and that "remixing" should be included in these descriptions of the ABH hypothesis. I spoke briefly (as I walked out of a talk in Bali) to Daphne about this distinction in regard to the "adaptation" versus "acclimation" (hence the recent reference to the re-mixing genotypes as "acclimation" not "adaptation"). By the way, this is the only time (prior to recent exchanges in September) that we (you, I or Daphne) have corresponded on this issue. I enjoyed the conversation and was unaware of any anxiety.

Secondly, according to your recent email, I need to also recognise the expanded definition of "altered circumstances" to include a changed regime (more frequent and/or intense bleaching events) as opposed to an on-going stress. I have and have no problems with this. It does not remove the problems, however. More on this in a second email to the list.

At the end of the day, however, we are left with a need (8 years after the ABH was first formulated) to go beyond the partial verification of assumptions and theoretical modelling (as per John Ware and co-authors) to the critical testing of this hypothesis. While there has been attempts to test the assumptions in at least one paper, the critical test for this hypothesis is that new combinations of host-symbiont genotypes with greater fitness arise from changed circumstances with respect to bleaching events (be that changing patterns of frequency and/or severity). "The key observations that corals, when heat stressed, expel one variety of zooxanthellae and take on another more heat-tolerant variety while the heat stress is still present, has never been made." (Hoegh-Guldberg 1999). That statement is still correct but does address a restricted set of ABH possibilities. This statement should be more inclusive given the above: "The key observation: that corals after heat stress or a changed sea temperature regime, shift toward more fit combinations of host-symbiont genotype combinations, has never been made." Unless I am mistaken, no observation like this has not been made. I suppose as a biologist, I would expect this to be a visible and obvious feature of coral-dinoflagellate symbioses, especially before and after the substantial selective pressure of recent bleaching events.

In the spirit of scientific debate, I want to also discuss (in detail as you request) your broadcast proposition (Sep 8 2001) that "Bleaching as an

Adaptive Mechanism: A Testable Hypothesis. BioScience, 43:320-326, are looking more solid as experimental tests come in (Kinzie et al in Biol. Bull. earlier this year, Baker in Nature more recently)." As requested, I will "rely on direct quotes in context" but will do this directly in a separate email to the list.

All the best,

Ove

Note: Hoegh-Guldberg had Buddemeier's whole message in his original message. [Buddemeier's message](#) is already displayed above.

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From: "Ove Hoegh-Guldberg" <oveh@uq.edu.au>  
To: "Jim Hendee" <hendee@aoml.noaa.gov>, "Coral-List" <coral-list@coral.aoml.noaa.gov>  
Subject: Adaptive Bleaching Hypothesis (2)  
Date: Sat, 22 Sep 2001 10:15:07 +1000

Dear Coral-list,

I hope that it is not inappropriate to provoke discussion about this much talked about topic. My sole intention is to explore this important issue. I have chosen to deal with it as a series of carefully defined steps. As will you see, while the theory may have logical appeal, the critical assumptions upon which it is based are either false or unsubstantiated.

Before I begin, a clarification with respect to the biological terms "adaptation" and "acclimation". Adaptation is strictly used to describe genetic changes in a population that lead to genetically based characteristics of that population considered more optimal with respect to the local environment. Acclimation refers to phenotypic change whereby (through changes in gene expression and/or post-translational modification) the characteristics of an organism are made more optimal relative to the local environment. These definitions are held by most textbooks (e.g. Eckert and Randall etc) and are not mutable (as far as I know).

The Adaptive Bleaching Hypothesis (ABH)

In order to proceed logically, exploring the assumptions of the hypothesis makes good sense. These are listed by Ware, Fautin and Buddemeier (1996; Patterns of coral bleaching: modelling the adaptive bleaching hypothesis", Ecol. Modelling 84: 199-214). I find this paper useful because it lists the five critical assumptions of the ABH and then builds a logical model from this grounding, the behaviour of which can be compared to nature. As with any model, however, the assumptions (assuming correct logical deductive processes) are critical for the truth of a model (to state the obvious, if the assumptions are wrong, then the model or argument fails).

Summary table (details below):

- a.. Assumption 1 = true
- b.. Assumption 2 = false at the time scale required

- c.. Assumption 3 = true
- d.. Assumption 4 = false
- e.. Assumption 5 = false if assumption 4 is false

Conclusion (details below):

Critical assumptions 2 and 4 (5 depends on 4) are not currently supported and available evidence (little evidence to the contrary) suggests that they are false. From this analysis, the only conclusion is that the ABH is false.

Details:

What are the assumptions of Ware, Fautin and Buddemeier (1996) and are they true or false?

Assumption 1. "Multiple types of both zooxanthellae and host species commonly exist on a coral reef."

This is true for corals and work by Trench, Rowan, Loh, Baker, Loi, Carter and others have shown that it is true for zooxanthellae (i.e. diversity is high among zooxanthellae).

Assumption 2. 'Some types of zooxanthellae are able to live with more than one host species, and host species may form symbiotic relationships with more than one type of zooxanthella, either simultaneously or serially. The various combinations differ in their adaptation to the environment.'

As you will see from the following, this is false at the timescale required. Other critical pieces of evidence do not exist.

What is true: Some types of zooxanthellae (distinguished via rDNA sequences - note - RFLPs do not have enough precision to distinguish species etc) appear in several corals while other coral species have their own dedicated zooxanthella type (Rowan, Wilcox, Baker, Loh and others, Loh et al. in press). Some hosts show several different rDNA sequences associated with their zooxanthellae (Rowan and Powers 1991, Rowan 1998). There is evidence that some zooxanthellae may specialise in high light or low light habitats (e.g. Rowan et al 1997, see also recent papers by K. Michalek-Wagner, A Banazak re: different zooxanthella biochemistries) - and it is likely that various combinations of host and symbiont differ in the type or quality of the environment that they are adapted for. Specific evidence about heat tolerance of different combinations is lacking although Kinzie et al 2001, Iglesias-Prieto and others have some evidence that different isolated zooxanthellae have different heat tolerances (but see Assumption 3 which states that the tolerance of the host-symbiont combination is all important).

What is unknown: How mutable (changed) are these relationships? An important part of this assumption for the ABH is that new symbiotic relationships can form and disband over very short periods of time. Without this rapid, dynamic feature bleaching will not be important mechanism for the evolution of new combinations. If they are not easily mutable then the long-term performance of different strain and host combinations under new conditions and their impact on reproductive success

of both partners etc. through reduced energy and other inputs will be more important.

Evidence that this is assumption is largely untrue at the time scales needed: To my knowledge, no lab or field infection experiment using dinoflagellates from other hosts (like those of WK Fitt and others) have ever resulted in a new combination of symbiotic algae and host. In cases where foreign types of zooxanthellae were introduced, populations were eventually replaced by the original type of zooxanthella (see also Kinzie and partners 2001, who also obtained this result with field exposed, completely aposymbiotic anemones). Also - no one has seen a change in the types of zooxanthellae occupied by a coral following a bleaching event (i.e. new combinations arising from a bleaching event). Baker (2001)'s techniques do not have the necessary resolution to answer this question. He sees new bands arise within the zooxanthellae isolated within corals translocated to the shallows. However, he cannot say that the new bands are due to invasion of external zooxanthellae or a case of up-regulation of a small existing population of the particular type of zooxanthellae concerned (he would have to clone his PCR products and verify for a large number of transformed clones that there were no sequences - hence zooxanthellae cells - of the new RFLP band in his corals before treatment i.e. that the change is not a product of acclimation as opposed to adaptation).

Implications: The process of symbiont switching operates at a longer time scale making bleaching irrelevant to the process. This is not surprising if the complex requirements of integrating two genomes into a symbiosis are considered. Research on what is required reveals complex self-non-self recognition (McNeil, P. L., T. Colley, Trench, Hohman, et al. (1981). *J. Cell Sci.* 52: 243-270, Muscatine, Hohman and others), metabolite transfer and the host of other specific lock-and-key biochemical and physiological interactions. We need to think of transferring zooxanthellae between hosts as partly akin to transplanting chloroplasts or mitochondria between plant species. Remember also that the types of zooxanthellae that occupy different corals are quite separate genetically and may represent different species or even genera (Trench, McNally et al. 1994 and others) - hence are likely to have a large suite of different requirements and features that have to be integrated (evolved) in order for a symbiosis to function. Adopting life within another cellular environment is not trivial and may involve many coordinated changes in genetic makeup (aka it is not simple to swap from one host to another - hence this process is likely to be constrained in terms of evolutionary speed).

If new zooxanthellae types cannot invade easily, then the ABH is restricted to the dynamics of the zooxanthella populations of a subset of corals which already have multiple strains of zooxanthellae in their tissues. That is, new combinations do not form "easily" (at the very least, they probably form over decades to centuries but not over the days and weeks required by the ABH). At this point, we are left with changes that occur in the relative frequency of existing genotypes within a coral. These are pre-existing genetic combinations. The question at this point becomes, is this "adaptation" or "acclimation"? At first cut - one might call this is "adaptation" because there is a change in the frequency of genotypes within the total zooxanthella population of an geographic area.

This is wrong, however, as populations of zooxanthellae within a host are

largely clonal (asexual) populations of single individuals. If this is the case, then a multi-strain coral host is really an association of three or more individuals (the coral host individual, and 2 or more zooxanthella individuals). The change in the relative proportions of one zooxanthellae individual over another within a host is then a matter of a change in the size of individuals. This then is a phenotypic (acclimatory) not genotypic (adaptive) change. Being multistrained and responding to changed circumstances, then, is no different to a association that having a set range of phenotypic responses with definite limits (there is no such thing as unlimited acclimation). Perhaps in evolutionary time (at least decades to centuries), the switching of symbionts may allow a certain flexibility that is not inherent within a single genome. But the time scale and process do not involve bleaching (adaptive or acclimatory).

Assumption 3. "The upper temperature limit beyond which the symbiosis is disrupted is characteristic of the host-symbiont combination rather than of the host or symbiotic alga alone."

This is probably true given the highly integrated nature of symbiosis. Specific thermal tolerances of corals/zooxanthellae associations and their variance with thermal regimes were largely first identified by Steve Coles and Paul Jokiel. Many recent studies (Goreau, Strong, Hayes, Brown) culminating in the SST and HotSpot work by NOAA and others. New work by Ray Berkelmans (in press) further confirms that thermal tolerances vary on a geographic basis with water temperature.

Assumption 4. "Bleaching provides an opportunity for the host to be repopulated with a different type of partner."

This is unproven and most evidence suggests that it is false. As I have repeatedly stated, we have yet to see a single experiment that shows that a bleaching event or set of disturbances results in a change of the type of symbiont with corals (during or after). No one has evidence of a more fit recombination of host and symbiont as a result of changed circumstances. Even the recent Kinzie et al (2001) study with aposymbionts of the sea anemone (*Aiptasia*) found that they did not take up new types of zooxanthellae. Apart from the problem of having very limited genetic resolution due to limitations of the RFLP technique (same problem as with AC Baker's 2001 study), Kinzie and co.'s aposymbiotic anemone hosts only became infected by the original type (B) of zooxanthella (To quote them: "All *Aiptasia* that became infected when exposed to natural seawater were found to harbour clade B, which is the zooxanthellar clade normally found in this anemone").

Unfortunately for the ABH, other observations militate against this assumption being true:

Firstly, corals that appear totally white still have many zooxanthellae in their tissues (e.g. Hoegh-Guldberg and Salvat 1995 - bone white corals ranged as high as  $1.0 \times 10^4$  cell/cm<sup>2</sup>). These are probably the source of repopulation of corals by zooxanthellae in the event of recovery after bleaching. If competition by the original zooxanthellae is so effective (i.e. "originals" win every time according to WK Fitt, D Schoenberg and others who have done the rigorous experiments in this regard), then it would appear that this is a major obstacle to the idea that "bleaching provides an opportunity for the host to be repopulated with a different

type of partner." That is, bleaching does not make a coral or other cnidarian host an open slate. The inherent algae in recovering corals probably will always have the upper hand.

Secondly, as stated above, no one has seen a single case of bleaching providing "an opportunity for the host to be repopulated with a different type of partner". If this were a major forcing function within the evolution of coral reefs, shouldn't we see large scale examples of this? William Loh from my lab has been searching for changes in rDNA sequence types of zooxanthellae with corals and reefs after bleaching events in Okinawa with his Japanese colleagues. What he has seen is potential selection against some zooxanthella genotypes and associations (their coral host species died out) but never the advent of a new association of host and symbiont. That is, on the short term scales of bleaching events, William has seen a diminishing not increasing stock of combinations (not good for adaptation as you will appreciate). At risk of repeating myself, the advent of new combinations probably requires a longer time period (because of the biochemical complexities of symbiosis) than the few generation times required. See above.

An added assumption is added by the authors under assumption 4. They state: "We assume no mortality of bleached corals, regardless of the severity of bleaching or whether there is a zooxanthella type with which the coral is compatible under the existing temperature conditions."

I assume that this addition is a condition for the computer model to work. In the face of overwhelming field evidence, this is simply false (GCRMN, Wilkinson and many others). A model that requires this falls over heavily at this point. Perhaps John can explain how critical this element is and how dependent the ABH is on it.

Assumption 5. "Stress-sensitive combinations have competitive advantages in the absence of stress, which implies a reversion to stress-prone combinations under non-stressful conditions."

This remains unknown. However, if we haven't seen assumption 4 holding true (i.e. that bleaching leads to new fitter combinations), then we obviously don't have assumption 5 (the reversion of these combinations in periods of non-stress) in the bag.

In conclusion:

The ABH has more than a few problems in terms of the stated assumptions and should be discarded. It was a "nice" idea but now is largely falsified through the fact that critical assumptions like 2 and 4 above are (at the very least) false.

I hope that this helps progress the ABH debate in a positive way. I am very interested in engaging in discussions over the details above. Most of all - I want to strongly emphasize that this is not an attempt to denigrate the ABH authors but more an attempt to improve our understanding of mass bleaching by critically examining important ideas and suggestions. I am aware that coral-list members may have much to add and that I probably have not done justice to all authors (if there are critical pieces of literature, please bring them to the list's attention).

Regards to all,

Ove

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Date: Sat, 22 Sep 2001 20:48:36 -0500 (CDT)  
From: FAUTIN DAPHNE G <fautin@falcon.cc.ku.edu>  
To: coral-list@coral.aoml.noaa.gov  
Subject: The Adaptive Bleaching Hypothesis

Dear Coral-Listers,

I am taking this opportunity to respond to several recent messages concerning the Adaptive Bleaching Hypothesis (ABH) that was proposed by Bob Buddemeier and me, and then modeled by John Ware, with input from us. I helped formulate the ABH because I am eager to understand the symbioses. I am writing now because I perceive some of the recent exchanges ostensibly concerning the ABH deal with matters that are not part of the ABH and thus do not advance that understanding.

The ABH was our deduction from experimental results and empirical observations that had been published at the time we developed it; those data and what they contributed to the ABH are detailed in our publications. Thus it is not true, as one lister recently asserted, that there is no evidence for the ABH.

The writers of some recent messages seem to regard the ABH more as a law than a hypothesis. In framing it as "a testable hypothesis," we recognized that additional data could prove to be inconsistent with our inferences about the workings of zooxanthellae symbioses, entirely or in part. Thus, in the manner that science works, falsification would result in more refined hypotheses being advanced and tested, gradually improving our understanding of the symbioses. In a recent message in which he claimed falsification of some of the five critical assumptions of the ABH, Hoegh-Guldberg advocated "discarding" the ABH. What I seek in combination with data that are truly inconsistent with the ABH are second-generation hypotheses that take into account the new data - using the parts of the ABH that work, and substituting for the unworkable parts. More importantly at this juncture, I am not persuaded that those assumptions have been falsified.

The ABH was not meant to apply to every instance of bleaching. By way of

analogy, that natural selection is not the only selective force in evolution does not falsify natural selection. To take one clear example, some stresses that result in bleaching are lethal, to some or all the bleached corals, and so, obviously, the ABH is irrelevant in such instances. This is why we confined the models of Ware et al. to non-lethal stresses. (Hoegh-Guldberg correctly inferred this is not an assumption of the ABH but a condition under which the model was run, so I am puzzled why he even raised it; it is irrelevant to the substance of the ABH.)

We did propose "that bleaching is not merely pathological, but is also adaptive, providing an opportunity for recombining hosts and algae to form symbioses better suited to altered circumstances" (Ware et al. 1996). We also recognized that the organisms might be unable to take advantage of such an opportunity. For example, even with sublethal stresses, in places with low zooxanthellae diversity, a new combination would be unlikely. And superior combinations might not form by chance, for the hypothesized recombination is a stochastic - not a deterministic - phenomenon. We also explicitly stated that the ABH applies to the level of bleaching under which the symbiosis evolved -- what has been considered "background" - and that a mechanism that evolved under that level may not be adaptive if what we are now experiencing is as unprecedentedly severe and widespread as some believe (which is consistent with what Hoegh-Guldberg reported has been found in Japan).

The "replacement" zooxanthellae, according to the ABH, can be either exogenous or endogenous. At the time we formulated the ABH, an endogenous source was thought by many experts to be impossible, since it was then considered that any cnidarian polyp or colony would harbor only one "strain" of zooxanthellae. We inferred from the published literature that "strains" could coexist, and so saw a proliferation of one "strain" at the expense of another to be a possible response to altered circumstance. We now know that multiple "strains" can coexist. Thus the comment that "Baker (2001) cannot say that the new bands are due to invasion of external zooxanthellae or a case of up-regulation of a small existing population of the particular type of zooxanthellae concerned" is not germane to the ABH - either alternative supports it. The exogenous source is the surrounding water, and therefore ultimately are zooxanthellae in their free-living stage or those were released under stress. Whether those that leave in the bleaching process are viable, much less infective, was raised in the original publication as a matter to be investigated; it has not, to our knowledge, been resolved. Thus criticisms such as that of Hoegh-Guldberg (1999), "The key observations that corals, when heat stressed, expel one variety of zooxanthellae and take on another more heat-tolerant variety while the heat stress is still present, has never been made," misrepresent the ABH and thus do not test its tenets.

The preceding quote and several recent list messages have focused on thermal bleaching. This is not a requirement of the ABH, which was proposed to operate as a result of any stress or combination of stresses that provoke bleaching.

Hoegh-Guldberg began a recent message with 'a clarification with respect to the biological terms "adaptation" and "acclimation."' I am uncertain how this comment relates to the debate. We have tried to be consistent in application of those terms - see papers in the recent "American Zoologist"



volume concerned with how coral reefs adapt, acclimate, and acclimatize (especially that of Gates). Hoegh-Guldberg's definition of adaptation as "genetic changes in a population that lead to genetically based characteristics of that population considered more optimal with respect to the local environment" is the sense in which we created the ABH. For we explicitly regard the zooxanthella-host complex as an ecological entity that is not the sum of its parts (an additive model was used by Ware et al. to be mathematically tractable, but its departure from our concept was made explicit). Thus, in the ABH, under identical circumstances, a species of coral with one "strain" of zooxanthellae might be maladapted but well adapted with another. This seems to be substantiated in patterns of "strains" of zooxanthellae that live in shaded and lighted portions of a single coral colony, and of "strains" of zooxanthellae that live in shallow and deep colonies of a single species of coral. Part of the decision on whether to use the pigeon-hole "adaptation" or "acclimation" that Hoegh-Guldberg raises may depend on one's concept of who is "in charge" in the symbiosis - if the animal is making a selection, it may be nearer the "acclimation" end, whereas if the zooxanthella is choosing a suitable home, it may be nearer the "adaptation" end.

In his message, Hoegh-Guldberg disputed the mutability of host-zooxanthella combinations on the time scale required for the ABH to operate. Our inference that the change could happen was based on experiments such as those of Fitt cited by Hoegh-Guldberg, who stated "To my knowledge, no lab or field infection experiment using dinoflagellates from other hosts (like those of WK Fitt and others) have ever resulted in a new combination of symbiotic algae and host." In fact, we interpreted Fitt's data (and those of Kinzie and Chee) as showing that new combinations could be established in short order - although allochthonous zooxanthellae did not establish in all hosts, some did so temporarily, and others remained longer. Hoegh-Guldberg continued "In cases where foreign types of zooxanthellae were introduced, populations were eventually replaced by the original type of zooxanthellae." As we wrote in the original BioScience paper, because the scientists controlled conditions to minimize stress on their experimental subjects, those experiments were conducted under laboratory conditions that were known to be suitable for the subjects - which are those in which the "native" zooxanthellae-host combination is favored. Thus a reversion to the pre-existing combination is precisely what would be predicted by the ABH. The recently published experiment by Baker put corals into situations that persisted - and his results are also consistent with the ABH.

Hoegh-Guldberg's comment "Also - no one has seen a change in the types of zooxanthellae occupied by a coral following a bleaching event (i.e. new combinations arising from a bleaching event)" is beside the point in the debate over the ABH for several reasons. I stated one above - unless the stress that produced the bleaching persists, the pre-existing combination will be favored, so no change is to be expected. A practical one is being able to know what the situation was before the stress and what it is afterward. For we are searching for changes in an entity that, until very recently, was viewed by most people as unitary (that is, there was one "strain" of zooxanthellae) and we do not yet know the extent of the diversity because we do not yet know what differences might exist. Part of our proposing the hypothesis was to encourage scientists to find ways to distinguish the members of this all-important symbiosis, individually and in combination. Moreover, the ABH does not require that every

"strain" of zooxanthellae be capable of living in every host species - we explicitly modeled the ABH on there being generalists and specialists on both sides of the symbiosis (just as there are anemonefish and host sea anemones - in the former case belonging perhaps to two genera, in the latter certainly to three families). I, for one, do not "think of transferring zooxanthellae between hosts as partly akin to transplanting chloroplasts or mitochondria between plant species" - a bit of evidence that clearly shows zooxanthella symbiosis is a less well integrated one is the phenomenon of bleaching itself. The possibilities Hoegh-Guldberg raises with the comment "the types of zooxanthellae that occupy different corals are quite separate genetically and may represent different species or even genera (Trench, McNally et al. 1994 and others) - hence are likely to have a large suite of different requirements and features that have to be integrated (evolved) in order for a symbiosis to function. Adopting life within another cellular environment is not trivial and may involve many coordinated changes in genetic makeup" provide grist for investigation, but do not constitute falsification of the ABH.

We inferred that "stress-sensitive combinations have competitive advantages in the absence of stress, which implies a reversion to stress-prone combinations under non-stressful conditions" to account for the continued existence of combinations that are vulnerable to conditions that recur (such as the annual bleaching Jokiel and others found in Hawaii, and that Fitt has more recently documented in Florida). Otherwise the system would be ratcheted to increasingly stress-resistant combinations with a time course that would seem too rapid for any other known mechanism. Using this assumption, Ware was able to create a model that bears remarkable resemblance to the time course of actual bleaching events.

I look forward to advancing understanding of bleaching and its consequences through well-crafted experiments that are published in the peer-reviewed literature.

Sincerely,  
Daphne G. Fautin  
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lab web page: [www.nhm.ku.edu/~inverts](http://www.nhm.ku.edu/~inverts)

direct to database of hexacorals, including sea anemones, released  
12 July 2001  
\*\*\* <http://www.kgs.ku.edu/Hexacoral/Biodata/> \*\*\*

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Date: Wed, 26 Sep 2001 17:01:03 -0500

From: "Bob Buddemeier" <buddrw@kgs.ukans.edu>  
To: Richard Grigg <rgrigg@soest.hawaii.edu>  
CC: Coral-List <coral-list@coral.aoml.noaa.gov> ,  
Jim Hendee <hendee@aoml.noaa.gov>  
Subject: Re: coral reefs doomed -- and the ABH and carbonate saturation

Rick and not-quite captive audience –

I'll answer your questions/comments in reverse order. As far as I know there is no published/refereed statement of the putative effects of Mg-calcite on reef calcification, so it will have to be what I think about what I think it is.

I. As I understand what I will call the Magnesium Salvation Theory (MST for a convenient shorthand), it goes something like this:

1. There is a lot of magnesian calcite in the (low-latitude) carbonate sediments of the world ocean.
2. High-Mg calcite is more soluble than aragonite.
3. As saturation state and pH of the surface ocean drop as a result of anthropogenic CO<sub>2</sub> additions (or for any other reason), high-Mg calcite will dissolve before aragonite does, buffering the surface ocean carbonate saturation state.
4. Therefore concerns about the effects of lowered carbonate saturation state on calcification by corals and coralline algae are not warranted.

Points 1-2 are valid, point 3 is valid in principle but questionable in practice, and the extension to point 4 isn't valid. For the MST to work, two conditions would have to obtain:

- a. The saturation state at which the high-Mg calcite buffers the surface water would have to be high enough to avoid negative calcification effects, and
  - b. The equilibration (that is, dissolution kinetics) would have to be rapid on the 50-100 year time scale of anthropogenic CO<sub>2</sub> additions.
- Neither of these two conditions will be met.

Since Greek letters do not translate to text files, I use OM in place of Omega, the saturation index (where 1 = solid-solution equilibrium, larger numbers = supersaturation, and smaller numbers = undersaturation). OM<sub>h</sub>= saturation state of high-Mg calcite, OM<sub>a</sub>= saturation state of aragonite. OM<sub>c</sub>= saturation state of calcite.

1. Considering point a above:

Aragonite is more soluble than calcite and the ratio of their saturation states is well-known: to 2 significant figures, OM<sub>c</sub>/OM<sub>a</sub> is 1.5. High-Mg calcite is a little less precisely definable because it is not a well defined molecule, but rather a range of solid solutions (0-30 mole % MgCO<sub>3</sub> is stable, <8% has little or no effect on calcite solubility, 11% has approximately the same solubility as aragonite), we will be close enough to use the value of OM<sub>a</sub>/OM<sub>h</sub> = 1.3-1.5.

Essentially by definition, chemical dissolution does not occur at all above a value of OM = 1. We can see that when high-Mg calcite would first start dissolving, OM<sub>a</sub> would be 1.3-1.5 or less. If we consider the modeled results of Kleypas, J.A. et al., 1999. Geochemical consequences of increased atmospheric carbon dioxide on coral reefs. *Science*, 284(2 April 1999): 118-120 (figure 1C), we see that the most extreme and extended prediction is for an average tropical surface ocean OM<sub>a</sub> of >1.5 in the year 2100. It is this prediction on which the predictions of

calcification decline are based, and all of the projected calcification effects occur before there could be any large-scale dissolution of high-Mg calcite – hence, no salvation by magnesium.

## 2. Relevant to both points a and b:

Equilibrium is defined as the net balance between forward and back reactions (in this case precipitation and dissolution). Not only the fact that the surface oceans are strongly supersaturated with respect to calcite and aragonite, but also a great deal of experimental work testify to the extremely limited occurrence of inorganic (as opposed to biogenic) precipitation. Reaction kinetics are strongly hindered and absolute rates are very slow, almost certainly due to the occlusion of mineral surfaces by organics and/or less soluble mineral phases. Chemical symmetry raises the question of why we would expect the surface ocean saturation state to be controlled by mineral dissolution in the near future when it is not currently controlled by mineral precipitation

This is probably the point to insert the qualifying comment that organisms are constrained by environmental chemistry, but not absolutely controlled at the rates and/or equilibria of inorganic chemistry (that is, they may be able to get around some aspects of thermodynamics, but they are stuck with ultimate conservation of mass and energy). The observations to date indicate that zooxanthellate corals and coralline algae exhibit high rates of calcification at  $OMa > 4$ , and that most species show significant declines at levels that are still supersaturated but well above 1.

## 3. Relevant to point b:

Apart from the micro-scale inhibition of dissolution and precipitation at the carbonate surface, there are macro-scale advective issues that reduce potential reaction rates. The large inventory of Mg-calcite in the world sediments is mostly buried. Only the top few cm (in high energy environments) or mm (in low-energy environments) is in any kind of well-exchanged contact with the overlying water. Below that, pore water residence times rise exponentially. Interstitial pore water in reef systems is normally (or at least often) controlled at the saturation state of high-Mg calcite, with the help of biogenically mediated solution or precipitation, but the volumetric exchange of this water with the overlying water is extremely slow compared to both surface layer mixing and the physical and biological processes acting in the open water and at the air-sea interface to maintain the (super)saturation state there. Empirical evidence for this is that the Holocene reef sediments (up to 8000 years in age) are neither flushed of high-Mg calcite by dissolution, nor totally locked up by diagenetic cement formation. And, there is no reason to expect a major change in pore water residence times in the near future.

Another comment or two – the one place in the ocean where you do see reasonably prompt responses of saturation equilibria is in the lysocline-carbonate compensation depth region. This is far below the mixed layer, and is driven by organic/carbonate ratios in the sedimentary rainout – all of which, in the pelagic world, have much higher specific surface areas and therefore reaction rates than the big, organic-rich lumps on a reef. The reason that the surface ocean can maintain its saturation disequilibrium so well is that the mixed layer is rather strongly compartmentalized in terms of its dissolved constituents (as opposed to particulates, which can fall through the pycnocline). And, since the exchangeable carbon inventories of the mixed layer and the atmosphere are similar in size, and air-sea exchange keeps them nearly in equilibrium, surface ocean response to CO<sub>2</sub>

input to the atmosphere is prompt and substantial.

Recommended or suggested reading (sorry if this seems egocentric, but obviously it's easiest for me to remember and judge relevance of what I've been involved in, so there are a thoroughly disproportionate number of Buddemeier things):

- Morse, J. W. and Mackenzie, F. T., 1990. *Geochemistry of Sedimentary Carbonates*. Elsevier, Amsterdam, 707 pp.
- Gattuso, J.P., Allemand, D. and Frankignoulle, M., 1999. Photosynthesis and calcification at cellular, organismal and community levels in coral reefs: A review on interactions and control by the carbonate chemistry. *American Zoologist*, 39(1): 160-183.
- Kleypas, J.A. et al., 1999a. Geochemical consequences of increased atmospheric carbon dioxide on coral reefs. *Science*, 284(2 April 1999): 118-120.
- Kleypas, J.A., Buddemeier, R.W. and Gattuso, J.-P., 2001. Defining 'coral reef' for the age of global change. *International Journal of Earth Sciences*, 90: 426-437.
- Kleypas, J.A., McManus, J.W. and Menez, L.A.B., 1999b. Environmental limits to coral reef development: Where do we draw the line? *American Zoologist*, 39(1): 146-159.
- Tribble, G.W., Sansone, F.J., Buddemeier, R.W. and Li, Y.-H., 1992. Hydraulic Exchange between a Coral Reef and Surface Seawater. *Geological Society of America Bulletin*, 104: 1280-1291.
- Buddemeier, R.W. and Oberdorfer, J.A., 1986. Internal Hydrology and Geochemistry of Coral Reefs and Atoll Islands: Key to Diagenetic Variations. In: J.H.S.a.B.H. Purser (Editor), *Reef Diagenesis*. Springer-Verlag, Heidelberg, pp. 91-111.
- Buddemeier, R.W. and Oberdorfer, J.A., 1988. Hydrogeology and Hydrodynamics of Coral Reef Pore Waters. In: J.H. Choate et al. (Editor), *Proceedings, 6th Int. Coral Reef Symp.*, Townsville, Australia, pp. 485-490.
- Buddemeier, R.W., 1994. Symbiosis, calcification, and environmental Interactions. In: F. Doumenge (Editor), *Past and Present Biomineralization Processes*. Musée Océanographique, Monaco, pp. 119-137.
- Buddemeier, R.W. and Fautin, D.G., 1996a. Global CO<sub>2</sub> and evolution among the Scleractinia. In: D. Allemand and J.-P. Cuif (Editors), *Biomineralization '93, 7th International Symposium on Biomineralization*. Bulletin de l'Institut océanographique, Monaco, pp. 33-38.
- Buddemeier, R.W. and Fautin, D.G., 1996b. Saturation state and the evolution and biogeography of symbiotic calcification. In: D. Allemand and J.-P. Cuif (Editors), *Biomineralization '93, 7th International Symposium on Biomineralization*. Bulletin de l'Institut océanographique, Monaco, Monaco, pp. 23-32.

## II. ABH –

I think, and sincerely hope, that Daphne's recent response will have clarified the issues. Most of the so-called debate or criticism has consisted of other people redefining or misinterpreting our statements and then claiming that there is something wrong with the concept on the basis of their revision.

Related to your comments – one of reasons for proposing the existence of an adaptively flexible multilateral symbiosis was precisely the points you make – long taxon lifetimes in both corals and algae, in combination with an obligately variable preferred habitat and no particular evidence of high extinction rates. The ecospecies concept preserves the benefits of very rapid adaptation (of the symbiotic combination) in the presence of the other features.

I thought it might be good to get the idea as close to a one-liner as possible – a brief synopsis:

The question is: Can the application of stress (any stress or combination, not just warm water) that results in a diminution of the pre-existing population of endosymbionts (a.k.a. bleaching) lead to a change (from either endogenous or exogenous sources) in the balance or nature of the symbiont types that results in an increase in the fitness of the host-symbiont complex (ecospecies) with respect to environmental stresses?

We hypothesized (on the basis of very real hard, if indirect evidence) that the answer is yes, and proposed some tests. We consider both the indirect and the direct evidence emerging since then to support, but certainly not to 'prove' the hypothesis.

Bob Buddemeier

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Note: Buddemeier had Grigg's whole message in his original message. [Grigg's message](#) is already displayed above.

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From: "Mike Risk" <riskmj@mcmail.cis.mcmaster.ca>  
To: "buddrw" <buddrw@kgs.ukans.edu>,  
"Coral-List" <coral-list@coral.aoml.noaa.gov>,  
"Jim Hendee" <hendee@aoml.noaa.gov>  
Subject: Re: coral reefs doomed for sure.  
Date: Thu, 27 Sep 2001 22:02:02 -0400

Bob, List-Some comments re the general discussion of changes in alkalinity, dooming of reefs, etc.

Some of the following builds on previous postings on this list, and some amounts to a Discussion of the Kleypas et al 1999 Science paper. I was going to write a formal Reply to this, never got around to it...

In general, my reservations about some of your positions are based on my belief that there has been insufficient consideration of two of the big Bio's in reef science: bioturbation and bioerosion. In addition, I have reservations about some of the chemical models/assumptions.

1. Bioerosion. The first quantitative work on the importance of bioerosion was published so long ago only me and Hendee were alive. Since then, there have been several large, exhaustive and exhausting studies of this signal process, and they have all come up with the same answer: on "normal" reefs,

bioerosion and calcification are in approximate balance. On most fringing reefs, subject to increasing terrestrial nutrient input, therefore, the balance has already been shifted towards destructive processes. I will cite no references here. Knowledge of bioerosion should be an integral part of every reef scientist's knowledge base. In short, looking at corals is way less than half the picture: you should all know this.

Unfortunately, this field seems to have fallen off the radar screen in the past few years: in the Amer. Zool. 1999 volume, for example, the word does not appear once. (Stop for a moment, and think of the gaping hole in our understanding that this reflects...) If it weren't for the French, there would be virtually no ongoing research on this process. (Salud, mes amis...et amies.) Any "reef monitoring" program that does not include assessment of bioerosion is a colossal waste of money-and I know of only one that does. Not only does this ignore most of the action-it excludes some prime bioindicators.

Any "reef model" that does not include it...it's hard to be polite, here. These models would better be termed "Less-than-half-of-the-reef models."

2. Bioturbation. Again, an exhaustive literature-lagoon and shelf sediments are vertically mixed on a timescale measured in months. Any number of critters involved here, of which the front-runners (in the Cenozoic) would be the thalassinid shrimp.

3. Oceanic/Climate Models. Notwithstanding their protestations to the contrary, I have found modellers to be resistant to data that upset their models, with that resistance being directly proportional to the amount of federal money invested to date. "One major problem with the current generation of GCM's is that the treatment of ocean circulation is still very crude." (Ruddiman, 2001: Earth's Climate).

The implications of Smith et al, 1997, are that a meltwater pulse can divert or shut down the Gulf Stream in less than 5 years. To all of you out there: when the oceanic part of GCM's can model this, then start believing them-not before. The strong compartmentalisation of the mixed layer to which Bob refers is metastable, and temporary.

4. The Magnesium Salvation Theory-sort of reads like a cure for constipation, doesn't it? Stick to science, Mike.

While I concur with some of what Bob says here, re porosity of reefs and reef sediments, I am not wholly persuaded:

- "...high magnesian calcites are dissolved preferentially in these sediments, although the sediment contains a mixture of (all types of carbonates). In deposits composed primarily of red algae, this early diagenetic reaction has resulted in dissolution of 75% of the carbonate." (Morse and Mackenzie, 1990: Geochem of sedimentary carbonates).

- "The data indicate that all samples are very close to equilibrium with Mg-calcite....alkalinity shifts relative to sea water indicate that initial precipitation may be followed by gradual dissolution in response to CO<sub>2</sub> added..." (Buddemeier and Oberdorfer, 1986).

-etc etc. And finally, Bob Halley and his USGS colleagues have done some very nice experimental work, some of which was reported in Bali, showing that, indeed, HMC dissolves.

As far as the large inventory of HMC being buried-I think Callianassa and its cohorts have a great deal to say about that. Ain't going to happen. The sediments that reefs will produce in future, moreover, will likely be lower in relative concentration of HMC. The main contributors of HMC are the calcareous algae-CCA. As we eat the grazing fishes, and the urchins die off, and fleshy algae bloom in eutrophied coastal waters-reef sediments will likely be higher in organics and lower in HMC.

Some other points, perhaps more peripheral: high pH's have been recorded inside coral heads-indeed, pH's at which silicates are very unstable (Risk and Muller, Middle Holocene, Limnol. Oceanogr.-give me a break, I have only unpacked the first of 20 boxes of books). This will trigger dissolution of reactive silicates-in fact, the pH inside corals probably shifts 3-4 full units, making possible all sorts of neat chemistry. Don't forget, the sediments being delivered to the world's coastlines now are very different from pre-agricultural times. Now, we see reactive silicates-andesitic ash from 5-year-old falls, delivered to the coastline by rivers, may be seen hydrating and dissolving under 10-cm of carbonate sediments, at several locales in Indonesia. This is not a millennial timescale.

So, in short, Kleypas et al:

1. depends on reef models that ignore > 50% of the process
2. depends on outmoded oceanic circulation models
3. ignores some fundamental chemical questions.

Other than that-we have to admit that it was an important paper, because it has stimulated a great deal of discussion. From that standpoint, congratulations to the authors. (Most of my papers disappear as neatly and as quickly-and as deeply- as Olympic springboard divers.)

My main concern with that paper is that it may have diverted intellectual and financial resources from more pressing problems. Sure, changes in saturation state will eventually affect....what? What will be left, in say 100 years? pH changes in the ocean, in my opinion, don't make the Top Twenty Reef Threats. The rate of present destruction from land-based sources and overfishing simply dwarfs everything else.

But we have three predictions running, now: I say (something like) "reefs, as some of us knew them, will be gone from most coastlines by 2020." Rupert Ormond says 50 years. Kleypas et al say a century. I hope to God they are right-but I don't think so. In fact, the reason I felt able to make that dire duo-decadal forecast is: it's already come true.

I hesitate to enter the discussion about ABH-not because of ignorance (that has not worked in the past), but because Ove's doing a pretty good job stirring this pot. It seems to me that there might be some help, again, in the fossil record. One would assume that corals would adapt to rising temperatures (perhaps better than falling ones?). I am afraid, however, that my knowledge of the record isn't good enough, nor are the temperature data. Sea-surface temperatures are believed to have gone well above 30 in the Mid-Cretaceous, and mid-Cretaceous "reefs" (piles of rudists, really) are very low in corals...but this is far from conclusive. Perhaps one could look more closely at rudists, which had zooxanthellae, same as does Tridacna...corals, of course, have had zoox since the Paleozoic (Risk et al, Early Holocene, same excuse).



The other problem with the record is the paleotemperatures. Planktonic forams give excellent results, for the open ocean. We really need shelf data-but many reports in the literature of paleotemperatures from benthic shelf critters are just not dependable. The problem is, the six people in the world who really understand KIE don't publish enough, and those that don't, publish too much. So this remains an open, and intriguing, question.

On another note: I have to apologise to the List for exposing some of my personal affairs. That was forgivable only given my state of mind at the time. Nonetheless, several people whom I had never met sent condolences and best wishes! So-thank you, and it will never happen again.

She has gone from liquid food-IV drip, to liquid food-juices, to solid food-mushy stuff, to liquid food-gin and tonics. So recovery is well under way.

Mike

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Date: Fri, 28 Sep 2001 11:55:34 -0500  
From: "Bob Buddemeier" <buddrw@kgs.ukans.edu>  
To: Mike Risk <riskmj@mcmaster.ca>  
CC: Coral-List <coral-list@coral.aoml.noaa.gov>, Jim Hendee <hendee@aoml.noaa.gov>  
Subject: Re: coral reefs doomed for sure.

Mike,

Thanks very much -- you raise good points for discussion, and I think this is an area where real (as opposed to definitional) debate can and should be developed. You obviously feel about bioturbation and bioerosion much as I do about pore-water dynamics -- and clearly the two have to meet up somewhere at the budgetary scale. So, let's see if we can get there.

But first, to aid in the determining just what the topic/discussion thread is -- you addressed issues related to my point #3 (heavily) and #2 (somewhat). However, if my point #1 is not in contention, then this is probably a new start and not part of the "are reefs doomed" thread -- that point stated that due to the solubility products/saturation indices of the various carbonate minerals, in combination with the observed effects of reduced saturation state on coral-algal calcification and the projected/modelled saturation state changes, the question of whether or not high-Mg calcite buffered the surface ocean would be moot, because any such buffering would be at a saturation state below that which would produce the projected calcification effects over the next century.

So -- do you buy off on that? Or does anyone else in the audience have doubts/comments on that? That's probably the first point to dispose of; if that's not an issue we can move on to the sediment biogeochemistry questions as a separate topic.

Bob Buddemeier

Note: Buddemeier had Risk's whole message in his original message. [Risk's message](#) is already displayed above.

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Date: Mon, 1 Oct 2001 13:45:42 +0200  
To: coral-list@coral.aoml.noaa.gov  
From: "christine.schoenberg" <christine.schoenberg@mail.uni-oldenburg.de>  
Subject: coral reefs - calcification and bioerosion

Dear list,

just a few comments on Mike Risk's latest letter, from a bioeroding sponge worker's point of view:

>they have all come up with the same answer: on "normal" reefs,  
>bioerosion and calcification are in approximate balance. On most fringing  
>reefs, subject to increasing terrestrial nutrient input, therefore, the  
>balance has already been shifted towards destructive processes.

This matches my own experiences when working on the Central Great Barrier Reef, where the balance may still be better than most other places. We still need to keep an eye on it though.

The common sponge *Cliona orientalis* reacts to elevated nutrient conditions. Extreme situations may have negative effects, however, so that the sponge's growth is slowed. Bioerosion of this sponge appears to be enhanced by a higher concentration of nutrients. This is a sponge, which is just everywhere on Australian (and other Pacific) inshore reefs, which grows over large surfaces, several m in diameter and which is able to invade live coral.

Another thing I would like to mention: this sponge also contains zooxanthellae, as do some other successful, competitive bioeroding sponges. *Cliona orientalis* bleaches under extreme conditions (evidence from the aquarium), but during the 97/98 bleaching on the GBR all sponge colonies I knew survived just nicely (in contrast to most corals on my sample site). Revisiting my site at Orpheus Island end of 2000 showed me a reef much reduced in live coral cover and coral diversity, but the bioeroding sponges did very well and seemed much increased in their abundance (no quantification done).

Just some food for thought...

Cheers, Christine

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internet <http://www.uni-oldenburg.de/zoomorphology/Whoiswho.html>

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Date: Mon, 01 Oct 2001 09:36:40 -0500  
From: "Bob Buddemeier" <buddrw@kgs.ukans.edu>  
To: "christine.schoenberg" <christine.schoenberg@mail.uni-oldenburg.de>  
CC: coral-list@coral.aoml.noaa.gov  
Subject: Re: coral reefs - calcification and bioerosion

All,

Christine's comment raises some points that relate back to Mike's comments and the whole issue of CO<sub>2</sub> and carbonate balance. It is important to distinguish between net and gross bioerosion and among the various functional components of bioerosion --

1. chemical erosion, which returns solid carbonate to dissolved inorganic carbon and is the only kind that is directly involved in CO<sub>2</sub> and acid-base considerations; and,
2. mechanical/physical erosion, which reduces the integrity and grain size of solid features (of greatest concern, reef plates and lithified substrate), and which can have two different outcomes:
  - a. change in the structure, relief, and distribution of grain sizes on the reef itself; or
  - b. loss of carbonate material from whatever we choose to define as the reef system.

The two forms are related -- a minor amount of chemical erosion can precipitate physical breakup on a much larger scale, and smaller grains resulting from mechanical (bio)erosion have a higher surface-to-mass ratio that facilitates dissolution, especially in porewater environments.

I assume that discussions of the balance between production and bioerosion are referring to a gross balance that includes all forms of bioerosion -- if not, straighten me out on the conventions in the field, please.

Note that I'm using 'grain' in the geographic sense of granularity, not in the colloquial sense of 'something small.'

All of these, plus the related issue of import of carbonate from elsewhere to a specific reef system, are addressed in conceptual models presented by Kleypas, J.A., Buddemeier, R.W. and Gattuso, J.-P., 2001. Defining 'coral reef' for the age of global change. *International Journal of Earth Sciences*, 90: 426-437.

I hope this clears up the point Mike addressed about carbonate models that do or do not include bioerosion. A carbonate budget model of a reef system has to include bioerosion, but a calcium carbonate production or calcification model addresses the gross input to that system. The CO<sub>2</sub>-calcification models are production models, not total budget models, which require local/regional input and calibration, as suggested in the reference given above.

Bob Buddemeier

--  
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Note: [Buddemeier had Schoenberg's whole message in his original message. Schoenberg's message](#) is already displayed above.

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Date: Tue, 02 Oct 2001 10:24:15 +1000  
To: <coral-list@coral.aoml.noaa.gov>  
From: Katharina Fabricius <k.fabricius@aims.gov.au>  
Subject: Are coral reefs doomed? // Land based sources of pollution

Another, recently published study from the Indo-Pacific province, in which we looked at the effects of increasing turbidity on biodiversity:

Fabricius KE & De'ath G (2001) Biodiversity on the Great Barrier Reef: Large-scale patterns and turbidity-related local loss of soft coral taxa. Pp 127 - 144 in: Wolanski E (ed) Oceanographic processes of coral reefs: physical and biological links in the Great Barrier Reef. CRC Press, London.

The article is best to be read in the original book which contains a CD with the colour images and animations of processes. In our chapter, we present a spatial model of increasing turbidity (originating from a single-point-discharge), related to decreasing biodiversity. However I'm happy to send out free reprints in paper form (black & white print) or electronically (colour).

**Abstract:**

Spatial patterns and abiotic controls of soft coral biodiversity were determined from an extensive reef surveys on the Great Barrier Reef (GBR). Taxonomic inventories of soft corals, and estimates of cover of the major benthos forms and of the physical environment, were obtained from 161 reefs, spread relatively evenly along and across the whole GBR. Reefs on the mid-shelf between latitude 13=B0 and 16=B0 represented the "hotspot" of taxonomic richness in soft corals on the GBR. Overlapping distributions of in-shore and off-shore taxa maximised richness on mid-shelf reefs. Taxonomic richness decreased with increasing latitude, and was low and relatively even across the shelf south of 21=B0 lat. Soft coral richness was strongly depressed in areas of high turbidity. It was also weakly positively related to the amount of sediment deposited, and strongly increased with depth. Total cover of hard corals and soft corals was poorly explained by physical and spatial variables, however both varied with depth. The findings presented here have three major management implications: (1) Turbidity and sedimentation affect the generic richness of soft corals. Reefs with highest soft coral richness are < 20 km from the coast, well within the range of terrestrial run-off, and hence a loss of biodiversity could result if turbidity increases due to land use practices which generate soil loss; (2) Taxonomic composition is more strongly related to environmental conditions than total hard and soft coral cover. Taxonomic inventories are thus better indicators of environmental conditions and human impacts than are assessments of total cover. (3) Richness and cover change more within a single site between 0 and 18 m depth, than between

reefs hundreds of kilometers apart along the shelf at the same depth. Valuable additional information can be gained in a cost-efficient way if monitoring and survey programs covered several depth zones rather than a single depth.

Regards,

Katharina Fabricius

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<http://www.reef.crc.org.au>

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Date: Tue, 02 Oct 2001 09:59:43 -0500  
From: "Bob Buddemeier" <buddrw@kgs.ukans.edu>  
To: Katharina Fabricius <k.fabricius@aims.gov.au>  
CC: coral-list@coral.aoml.noaa.gov  
Subject: Re:Land based sources of pollution//source estimates

Katharina, or anyone --

Do you have either estimates or expert-judgement opinions on the relative extent to which (or the geographic areas in which) the observed high-turbidity areas are primarily related to:

- a. medium or large river discharge;
- b. stream, small river or open coast runoff; or
- c. local resuspension of existing sediments?

Getting some idea of the relative importance of these components of the turbidity forcing is critical to deriving impact predictions from climate, wave, and land-use models.

Thanks,

Bob Buddemeier

--  
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Note: Buddemeier had Fabricius's whole message in his original message. [Fabricius's message](#) is already displayed above.

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Date: Tue, 2 Oct 2001 09:23:09 -0600 (MDT)  
From: Joanie Kleypas <[kleypas@cgd.ucar.edu](mailto:kleypas@cgd.ucar.edu)>  
To: <[coral-list@coral.aoml.noaa.gov](mailto:coral-list@coral.aoml.noaa.gov)>  
Subject: Re: coral reefs doomed for sure

Thanks to Mike Risk for bringing up some misunderstood issues regarding ocean chemistry changes in response to increased atmospheric CO<sub>2</sub> and how coral reefs might respond. Some of his comments are good (e.g. that bioerosion is too often overlooked) but some were broad misrepresentations of science (e.g. his comments about ocean modelers and about the Kleypas et al. paper in Science). So I am compelled to address several of his points:

#### FIRST

- > Any "reef model" that does not include it [bioerosion]...it's hard
- > to be polite, here. These models would better be termed
- > "Less-than-half-of-the-reef models."

I agree that any modeling effort needs to take bioerosion into account. (and contrary the claim that the word was not mentioned in the Amer. Zool. special issue, Kleypas et al. in the Am. Zool. issue DO mention bioerosion several times as an important control on coral reef development). We have also discussed bioerosion prominently in a follow-up paper in Int. J. Earth Sci. (Kleypas et al. 2001).

Our paper in Science did not model reefs - nor were we trying to model reefs. The thermodynamic calculations and modeling effort concentrated on simply determining carbonate ion concentrations as a function of temperature and pCO<sub>2</sub>. It is a simple calculation yes, but measured data obtained through the JGOFS, WOCE and other programs illustrate that ocean chemistry is indeed behaving as predicted. So I don't think the challenge to predicted ocean chemistry changes is valid. The chemistry will indeed be complicated in shelf environments by other processes, but the buffering on most reefs, e.g. those which receive significant exchange with open ocean water, will be minimal.

#### SECOND

- > 3. Oceanic/Climate Models. Notwithstanding their protestations to the
- > contrary, I have found modellers to be resistant to data that upset their
- > models, with that resistance being directly proportional to the amount of
- > federal money invested to date. "One major problem with the current
- > generation of GCM's is that the treatment of ocean circulation is still very
- > crude." (Ruddiman, 2001: Earth's Climate).
- >
- > The implications of Smith et al, 1997, are that a meltwater pulse can divert

- > or shut down the Gulf Stream in less than 5 years. To all of you out there:
- > when the oceanic part of GCM's can model this, then start believing them-not
- > before. The strong compartmentalisation of the mixed layer to which Bob
- > refers is metastable, and temporary.
- >

-----  
Prof. Risk misrepresents the science presented in the Kleypas et al. paper. The HAMMOC model results were added to illustrate that the time-scale to bolster alkalinity (via dissolution of reactive sediments in response to increased atmospheric CO<sub>2</sub>, which depends on deep ocean circulation) was too long to show an appreciable buffering of the system over the next 200 years or so. At least in terms of open ocean geochemistry, there is no source of alkalinity which can adequately buffer the increased atmospheric CO<sub>2</sub> for a few centuries, at least. There have been many papers on this and a good place to start is with David Archer's.

And in defense of modelers! (I myself am not a modeler, but the coral-list should hear their side):

The Smith, Risk, Schwarcz and McConnaughey paper above (Nature 1997) is a nice presentation of isotopic changes in deep-water coral skeletons during the Younger Dryas event. These data undoubtedly record a change in the water mass overlying Orphan knoll (50° 26'N 46° 22'W and 1600 m depth - note that this location is not really the Gulf Stream, but the North Atlantic Deep Water). However, these data do not \*necessarily\* record a change in the western boundary current. Western boundary currents can remain unchanged while water masses change (in fact, the Gulf Stream tends to maintain its track under a wide range of conditions). So this challenge (with insult) to modelers to duplicate implied boundary current changes, based on corals from a single location, does not provide adequate evidence that "a meltwater pulse can divert or shut down the Gulf Stream in less than 5 years". Now that being said, in terms of modeling changes in the Gulf Stream (and North Atlantic circulation in general) in response to surface buoyancy changes (i.e., changes in temperature and/or freshwater input), there ARE models that do capture such changes, and they show that the response CAN be rapid (5-10 years). Two examples of such papers: Gerdes and Koberle, 1995. *J. Phys. Oceanography* 25: 2624-2642. Lohmann and Gerdes. 1998. *J. Climate* 11: 2789-2803.

THIRD:

- > So, in short, Kleypas et al:
- > 1. depends on reef models that ignore >50% of the process
- > 2. depends on outmoded oceanic circulation models
- > 3. ignores some fundamental chemical questions.

Regarding 3 - Bob Buddemeier has already provided enough answers. Certainly there are complications in carbonate chemistry near continental margins, which will result in a range of reef response to changes in carbonate chemistry. But given the volume of the oceans versus that of river and reef sediments, isn't it likely that coral reefs will be bathed in waters overwhelmed by the increasing pCO<sub>2</sub>? I personally would like for Mike's #3 to be true, but none of the chemical oceanographers that I have spoken with (Takahashi, Broecker, Archer, Tans, etc.) have pointed to

any ignored fundamental chemical question in this hypothesis. My fear is that Mike's statements like those above will convince many to dismiss the carbonate chemistry issue based on hunches rather than adequate scientific justification.

**FOURTH**

- > My main concern with that paper is that it may have diverted intellectual
- > and financial resources from more pressing problems. Sure, changes in
- > saturation state will eventually affect....what? What will be left, in say
- > 100 years? pH changes in the ocean, in my opinion, don't make the Top Twenty
- > Reef Threats. The rate of present destruction from land-based sources and
- > overfishing simply dwarfs everything else.

I agree that reefs sadly face many threats. We anticipated the that some scientists would feel that their own "reef issue" would be overshadowed by this problem. Because the calcification question is global in nature, and because it is a direct and predictable consequence of CO2 (even predictions of bleaching involve questions about just how much the oceans will warm), I and others consider this a serious chronic and increasing threat to reefs (and perhaps to other calcifiers such as coccolithophorids - see Riebesell et al. 2000). But politically, the issue is powerful, and any solution which would mitigate increases in CO2 would certainly mitigate many of the other threats to reefs as well. And honestly, this issue has gotten so minimal attention and funding since the paper was published that I can only conclude that most people don't fully understand its scope. I take some of the blame for not pushing it hard enough, but there is also a significant amount of misinformation that is going around.

**FINALLY**

Thanks again to Mike for bringing up these issues.

cheerio, J Kleypas

~~~~~  
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~~~~~

---

From: "Mike Risk" <riskmj@mcmail.cis.mcmaster.ca>  
To: "Joanie Kleypas" <kleypas@cgd.ucar.edu>, <coral-list@coral.aoml.noaa.gov>  
Subject: Re: coral reefs doomed for sure  
Date: Tue, 2 Oct 2001 14:24:21 -0400



Joanie has provided a spirited defense of her and her co-authors' work. I remain far from convinced that some of these matters are solved beyond the need of further debate. I will respond at length soon, after I finish getting in this year's firewood. But some quick comments-

It seems that most scientific "clarifications" carry with them the seeds of further misunderstandings. Here are some additions:

1. The comment about climate modellers not wishing to accept data that contradicted their models wasn't mine-it came from a well-known NOAA climate modeller, whom I will mercifully not name. My prior attempts to convince modellers to accept the need for extremely rapid ocean overturning were met with benign neglect. I felt it appropriate, therefore, to accept the valuation of someone in the field.

2. The top of Orphan Knoll lies directly in the Gulf Stream Return Flow, so to suggest it is not connected with the Gulf Stream is misleading.

3. Some modellers listen, and solicit data. We are now working very closely with several groups on the East Coast (BIO modellers and their US colleagues), as we begin to obtain long-term proxy records of the NAO, Labrador Current, and the inner Gulf Stream: information that was previously unavailable.

4. I don't consider that land-based sources of pollution are my "reef issue." (But I admit, I feel they are THE reef issue.) As we have seen, there is zero political will in North America for CO2 reductions. (Canadians are worse than the USA, by the way, just to demonstrate that I am an equal-opportunity slagger.) There will be action on this front only after the enormous public health costs sink in, and even then the response will be slow. In the meantime, something could be done about sewage and sediment stress. This is not rocket science, but would require that at least a large proportion of reef scientists speak with one voice. There is already a trend among reef managers to blame "global change" for impacts that have clear local causes.

Back to the maul (not mall).

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Date: Wed, 03 Oct 2001 06:57:39 -0500  
From: "Bob Buddemeier" <buddrw@kgs.ukans.edu>  
To: Katharina Fabricius <k.fabricius@aims.gov.au>  
CC: coral-list@coral.aoml.noaa.gov  
Subject: Re: Land based sources of pollution//source estimates

List --

Comment first, then some more discussion of (mostly sediment-related) issues.

Special thanks to Katharina and Alina for their observations and comments. Katharina is right on with her comments on single variable arguments -- the problem is, we have to understand the variables one by one to get to the point of effective integration, and that seems to tempt a lot of people into the all-or-nothing false dichotomy. Another problem is the gravitation toward polar positions: "reefs are

doomed real soon because people are killing them off" vs "not too worry, they're robust and it's just a natural fluctuation." The first is a very slightly more credible position than the second, I think, but only slightly, and the most useful synthesis combines and is offset from that discussional axis.

Turbidity and sediment are good examples. Without claiming that they are totally generalizable, let's take the recent contributions to the discussion to show that resuspension of sediment (as opposed to new input) is a significant stress factor. I suggest that this is at least partly a 'natural cycle' development. Continental shelves and shallow coastal areas are excellent sediment traps, retaining a lot of what comes off the land. Our present situation is geologically and environmentally anomalous -- a relatively stable 3-6,000 year sea level high stand (the range of times is because it's local, not eustatic, level that counts operationally, and the Caribbean and much of the Indo-Pacific have different local sea level histories). That accounts for a lot of sediment build-up (with or without human intervention), and I suggest that a number of areas may 'simply' have reached a critical threshold in terms of the inventory or load of resuspendable sediment. A glance at the Pleistocene sea level curve will show why corals and reefs are not necessarily adapted to this kind of environment.

I put 'simply' in quotes above to underline Katharina's point that it never is simple -- in this case, one of the complicating human factors is change in the ocean climate. As I understand it, a number of regions of the oceans have shown significant increases in mean wave height over the past few decades. This is the resuspension driver, so it may be that either natural climate cycling or human-induced climate change have pushed the sediment resuspension effects across the threshold very recently.

This underlines a point that I hope was obvious from the earlier discussions -- reef researchers need to understand some oceanography, as well as issues of large-scale dynamics (the latter comment is a shameless plug for an upcoming special issue of Coral Reefs -- sorry).

It also puts some other perspectives on the questions of reef doom and what to do about it. Note that I am going to talk about a particular variable or suite of variables, and do not intend to imply that there aren't others, that people aren't problems, etc.

1. 'Land sources' in the real-time sense may not be as big a sediment issue as often supposed. Most large and medium -sized drainage basins have had their water flow (for sure) and sediment discharge (probably but not always) reduced and regulated by damming and diversion. Local coastal runoff and small/undeveloped basins have the potential for dramatic increases in sediment load in response to land use and cover changes, but the acute effects of these are often localized near shore (although there is the general contribution to shelf sediment load build-up).

2. There is no realistic prospect of modifying either the coastal zone sediment inventory or the marine energy regime, so -- if this formulation is valid -- chronic sediment stresses in most offshore areas may be something that simply has to be lived (or died) with. This implies a focus on understanding its contribution to multi-stress synergism in hopes of finding a different factor that can be managed to reduce the combined system impact.

3. Conservation/preservation: I have been beating the drum for a triage approach to reef research conservation, and management, and I have also from time to time expressed a fondness for atolls (but outer-shelf reefs can be OK too). I suggest that this example reinforces both -- if continental reefs really have "timed out" in terms of Holocene habitat development, the places to look for healthy or at

least preservable systems are in very well-flushed, no-soft-sediment coastal areas or away from terrigenous sediment sources (e.g., ocean islands, especially with small land mass).

4. Research implications: This point goes beyond the sediment resuspension issue to the larger question of combined (and especially land-derived) threats. The idea of chronic stress build-up to a threshold transition that we are now observing implies not only that we are not currently working on normal or 'healthy' systems, but also that what we take as our pre-transition baseline was probably seriously affected at the subclinical level. This means that much of the coral literature on function and condition has to be interpreted very cautiously if one is interested in determining 'normal' or 'optimal' function. Jeremy Jackson has made this point with respect to anthropogenic ecosystem alterations; I propose extending it to a broader suite of 'natural cycle' considerations including sediment buildup on shelves, the implications (for accommodation space and circulation, among other factors) of reef 'catch-up' with sea level, etc.

All of which may help explain why I am of the opinion that most 'reefs-as-we-know-them' are on their way out of the picture, especially if they are closely associated with a major landmass. I would rather not use 'doomed' as a blanket statement, because I think there may be some (significantly altered) oceanic survivors. The moral of the story: Go to sea.

Bob Buddemeier

Katharina Fabricius wrote:

- > Hi Bob and others,
- >
- > at present the general assumption seems to be (at least here locally) that
- > turbidity is driven by physics, ie, resuspension forced by wave height,
- > depth, and particle sizes. However, present-day levels of erosion of soils
- > and discharge of sediments may increase in some areas the amount and
- > proportion of clay and other fine material, which creates greater turbidity
- > and remains suspended for longer than equal concentrations of larger
- > particles. Together with a group under Terry Done at AIMS, we just started
- > looking into modelling it all spatially, to create some sort of "turbidity
- > risk map" for the GBR (and we'd appreciate any thoughts/suggestions/
- > contributions about this).
- >
- > I also have data which show that both sediment quality (eg, concentrations
- > of transparent exopolymer particles) as well as short-term exposure to
- > sedimentation (hours to days) are important factors influencing the scope
- > of coral reefs to be recolonised by corals, and these two factors are often
- > not part of the lines of argumentation put forward by some sedimentologists.
- >
- > With regards to the debate of whether global climate change, increasing
- > CO2, or run-off are the "greatest" threat to coral reefs, I am getting
- > worried that we may not be getting anywhere with single-cause explanations:
- > the coral reef ecosystem is so complex that reefs are dying of a thousand
- > cuts rather than of just one single cause, as each individual species and
- > life stage has its own little sensitivities to one or the other of the
- > human alterations of their environment - and what will suffer first is
- > biodiversity. But I'm also convinced that run-off is hampering the capacity
- > of reefs to recover from all sorts of disturbances: adult corals can handle
- > relatively high loads of nutrients and sediments, but recruits don't. Once

> the adults are wiped out by COTS or bleaching, we'll wake up if the  
> juveniles are missing. That's what I'm observing here in some near-shore  
> areas of the GBR close to intense land use at present (but again, we need  
> to be cautious coming to any single-cause conclusions about our low juvenile  
> numbers: we don't have historic data on previous juvenile densities nor on  
> larvae supplies vs survivorships from the region).  
>  
> Regards,  
> Katharina  
> (for people who may want to send me questions/comments: please apologise  
> delays in my replies, I'm off to Palau tomorrow for 3 weeks)  
>  
> At 09:59 AM 2/10/01 -0500, you wrote:  
> >Katharina, or anyone --  
> >  
> >Do you have either estimates or expert-judgement opinions on the relative  
> >extent  
> >to which (or the geographic areas in which) the observed high-turbidity areas  
> >are primarily related to:  
> >a. medium or large river discharge;  
> >b. stream, small river or open coast runoff; or  
> >c. local resuspension of existing sediments?  
> >  
> >Getting some idea of the relative importance of these components of the  
> >turbidity forcing is critical to deriving impact predictions from climate,  
> >wave,  
> >and land-use models.  
> >  
> >Thanks,  
> >  
> >Bob Buddemeier

Note: Buddemeier had Fabricius's whole message in his original message. [Fabricius's message](#) is already displayed above.

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Date: Wed, 03 Oct 2001 12:06:23 -0500  
From: "Bob Buddemeier" <buddrw@kgs.ukans.edu>  
To: "Alina M. Szmant" <szmanta@uncwil.edu>  
CC: buddrw@KU.EDU, Katharina Fabricius <k.fabricius@aims.gov.au> ,  
coral-list@coral.aoml.noaa.gov  
Subject: Re: Land based sources of pollution//source estimates

Alina et al. --

1. Conrad and Ian covered most of the basic points, but I think that what is potentially a new twist is considering the role of the build up of specifically terrigenous sediment (more fines) as a regional, as well as a local lagoon-specific phenomenon.
2. Your wind comments fit well with my memory of encountering the increased wave height findings somewhere -- alas, location forgotten. There are a lot of climate and ocean data available if one pokes around the web...
3. My callous pragmatism says that if all of the factors are operating against a reef, the manager should flick it in and find something that promises to respond better to management -- and that's especially true if any of the stresses are long-term endogenous factors, as existing sediment load could turn out to be. If we

try to save everything we may wind up saving nothing, especially in few of the apparently inevitable increase in some of the stress factors (committed warming and CO2 effects).

It seems obvious from the exchanges that a lot of us have ideas and observations we never got around to publishing -- maybe the question is how we turn the discussion thread into a minireview of some sort (?).

Bob

"Alina M. Szmant" wrote:

> Bob and others:

>

> Conrad Neumann and Ian MacIntyre published the phrase years ago about  
> coral reefs being "shot in the back by their own lagoons" Proc 5th Internat  
> Coral Reef Congr, Tahiti 1985: vol 3 pg 105-110), which is the Holocene  
> sea level scenario you described in your email. I agree that for some  
> areas (such as Florida Keys) resuspended sediment is a major factor  
> limiting coral recruitment (especially sand-blasting by coarse sediments  
> during winter storms) and this may have been happening for decades if not  
> longer and thus be one reason why patch reefs in Fl Keys often have higher  
> coral cover and diversity than more offshore (exposed) reefs inspite of the  
> lower water quality (turbidity etc) closer to shore (see Miller et all,  
> Coral Reefs vol 19 (2)). I am always amazed at the high numbers of coral  
> recruits we see on these inshore patch reefs ins spite of what the text  
> books tell us are unfavorable conditions. However, bioerosion is likely  
> higher inshore and not many of these patch reefs amount to much.

>

> I have a hypothesis that I have been bandying around for a few years that  
> it's been more windy since the mid 1980s and 1990s which could be an effect  
> of global warming (more heat, more wind) [this is based on a gut impression  
> that in spite of having bigger and better boats than I had access to in the  
> 1970's, we have more days that we are weathered out now than a few decades  
> back]. More frequent or more severe storms all year long could result in  
> lower overall water clarity in areas like the Florida Keys where there is  
> lots of sediment to resuspend (I gave a presentation about all this in  
> Bali, but mea culpa, mea culpa I haven't written it up yet). If those of  
> you that like to work with climate data would have access to good wind  
> records, I suggest someone look at the frequency and duration of higher  
> wind events over the past 50 years or more, by passing the data thru some  
> kind of filter that looks for the higerh energy events (e.g. 15+ knots for  
> 24+ hrs): it takes a minimum period of high winds to really get things  
> stirred up, but if the rough conditions persist for too long, suspended  
> sediments are likely flushed out of the system). Thus, not enough  
> resuspension could result in fine sediments building up to eventually  
> become a problem (nutrients will also build up); frequent moderate energy  
> events may make the system turbid a lot of the time depending on whether  
> net flow rids the system of the resuspended fines; occasional major events  
> help flush the system of both sediments and nutrients. Thus wind regimes  
> (and their change over time as climate changes) could make a big difference  
> in the environment conditions reefs have to deal with, and their "health".

>

> Again, things are much more complicated than one-factor causality, and the  
> various factors work at different time and spatial scales. Effects of  
> elevated temperatures and over-fishing strike pretty much everywhere which  
> is why I think they are at the top of my list of what needs to be addressed

> by managers; sediments and nutrients are very important in some areas and  
> not others, and should be addressed where appropriate. Some poor reef  
> areas have all of the above impacting them and that is real sad. I agree  
> with those that write that we shouldn't try to make our favorite cause of  
> decline be accepted by everyone as THE ONE to be concerned about, but I  
> think we do need a scientifically founded way to attribute relative effects  
> because whether we like it or not, that is what the managers need.

>  
> Alina Szmant

--  
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From: "Mike Risk" <[riskmj@mcmail.cis.mcmaster.ca](mailto:riskmj@mcmail.cis.mcmaster.ca)>  
To: "Joanie Kleypas" <[kleypas@cgd.ucar.edu](mailto:kleypas@cgd.ucar.edu)>, <[coral-list@coral.aoml.noaa.gov](mailto:coral-list@coral.aoml.noaa.gov)>  
Subject: Re: Beyond bioerosion.  
Date: Thu, 4 Oct 2001 23:38:38 -0400

I feel there is more that needs to be said on this, and other, issues. This will, however, be my last submission on this particular topic.

Given the involvement of CO<sub>2</sub>, I am moved to consider the analogy of scientific papers as automobiles. I view most of my papers as I view my 12-year-old Subaru, that sits mutely rusting outside: inconspicuous, easily ignored, battered and beaten-but dependable transportation nonetheless. Should someone volunteer to put some Bondo on it to fill in some of the holes-well, be my guest. (You have Bondo? We need it up here.)

The responses of Kleypas and co-authors to my comments on Kleypas et al (hereafter KEA, not to be confused with KIE) put me in mind of someone waxing a brand-new BMW: putting further polish on that which is already near perfection. Woe betide those who would point out dents in a fender, or nicks in a windshield...I had hoped for a response something along the lines of: "OK, we know there were some holes in the first version. We invite you all to help us do better next time."-but that isn't going to happen here. The difference between a discussion and an argument is: in an argument, no one has any intention of changing their mind. This is an argument, one that has gone on for over a month.

In that month, I estimate (using totally questionable assumptions!) that SE Asia will have lost 2-3 coral species, and that coral cover on some of the Florida Keys will have dropped another 2%. Reefs are in the midst of a mass extinction event right now, and pH hasn't budged. (Yes, I know about the open-ocean estimates-irrelevant, as you point out.) In the time I have spent crafting these responses, I could have written a formal rebuttal of KEA, and that is what I will now set out to do.

I also sense that the tone of the exchanges is becoming harsher, which is upsetting. I realise I am to a large extent at fault, here, being a direct and rude type. Those who know me may feel I have been well-behaved, whereas those who don't may wonder why Jim Hendee let this raving maniac on in the first place. So. After this one, I will give up. I have concluded that there will be no substantive response to any of my comments.

I remain, as always, available for comments and exchanges, and would be delighted to give of advice or information in any of the areas in which I have some competence, as soon as I figure out what those areas may be.

## PREDICTIONS

To begin with: KEA have made their predictions, based on models they have described in print and on the list. I am a field man (Omega, to me, always meant expensive wristwatches), so I tend to look at field evidence. Just about every reef worker (including Gattuso and Buddemeier) reports solution of carbonate at night, when CO<sub>2</sub> is elevated-and Halley's work shows that this is solution of HMC. Additionally, KEA predict that corals should show a 6-11% decline in calcification since about 1880. Lough and Barnes (2000) show an INCREASE in calcification of 4%, an increase that closely matched the prediction of increased calcification from elevated SST's. So at least one of their predictions is wrong already.

When I first saw KEA, I predicted that it would be used by managers to divert resources away from local problems. This has already happened. In addition, my doomsday scenario (Twenty and Out) is still running well, and I will finish no worse than .500.

## OCEAN MODELS

My rude comments about modellers (which really weren't mine, as I point out-although I ascribe to them) were met by Dr. Kleypas with the following series of responses (paraphrasing):

-KEA really only used the HAMMOC model to illustrate the long time-scale to buffering (although the model doesn't react quickly)

-there are models out there now that CAN react quickly (but we haven't used them)

-and besides, there are all these famous oceanographers out there who agree with us.

What can I possibly do, faced with this response, but retreat licking my wounds? Seriously now, this is not convincing.

Dr. Kleypas attempts to bolster her defense of the ocean models by denigrating/downplaying the importance of Smith et al, Nature 1997 (that's OK, so do the modellers). While she claims "corals from a single location...do not provide adequate evidence", that same finding was trumpeted, by one of her own quoted oceanographers, as "The New Archive that we've all been waiting for." Would you have asked Newton to wait for MORE apples??? Sure, it's only one location-but it's the most precisely constrained major climatic event ever to be described from the ocean record. The results won't go away. The implications are that the Gulf Stream Return Flow disappeared/deviated/whatever in 5 years. This implies a fundamental mixing of the oceans during major climate changes, mixing which will screw up the rest of the predictions in KEA. (I treat these postings as my lectures-I only repeat myself if I feel the audience wasn't listening.)

Note: for those of you interested in paleoclimatology: Smith et al 1997, and the companion piece, Smith et al, 2000 (PALAIOS), provide an isotopic Rosetta Stone, a solution to the annoying effects of KIE (this is a process which makes many coral isotopic climate records simply undependable). Precise water temperatures, any ocean, any coral, any depth. The "lines" paper, in PALAIOS, took corals from all over the world, used thousands of isotopic measurements to show that the slopes of lines in O-C space, independent of KIE, were a thermometer.

## BIOEROSION

After Dr. Kleypas' response, I went back, and I searched through that Am. Zool. volume, and By God I found it! In Kleypas et al, on p. 153, we see (refs removed to save typing) "...nutrient excess probably limits reefs indirectly by enhancing macroalgal competition for space, phtoplankton competition for light, and bioerosion." And that's all. Instead of claiming to have "mentioned bioerosion several times as an important control on reef development," I think she should have 'fessed up, said "OK, we left it out, we'll do better next time. Can you help us?" Ain't going to happen. (By the way, the Gattuso et al paper in that same volume is one of the nicest summaries of coral gas and nutrient metabolism I have read.)

I'd like to go over some of this again. I do apologise in advance for some of the self-citations: there has already been too much of this in these exchanges. I do so only when one of my rusty old beaters was the only one on the lot at the time...

The classic studies on reef budgets were done in the early 70's, based on field work done (in some cases) commenced in the 60's. The results have never been challenged: bioerosion equals calcification, with large errors. (Where calcification spikes up, we get reefs-where it does not...sediment.) There have been a few studies directly relating bioerosion rates to nutrient concentrations. Rose and Risk (1985-Mar Ecol 6: 345-363) found that density of *Cliona delitrix* increased in lockstep with the abundance in the water column of fecal bacteria. (No phosphates, no nitrates-plain old poop. Turtle poop.)

Since the early 70's, when those papers were done, coastal nutrient concentrations/eutrophication levels have AT LEAST doubled. In other words, bioerosion is now FAR MORE IMPORTANT than the corals! The treatment of this subject in the Amer Zool volume simply exposes the huge lacuna in the skill-set of today's reef biologists.

So reef monitoring programs that omit bioerosion are a joke, as are reef growth models. It is to be hoped that rapid readjustments are under way as we speak.

But let us examine the role of bioerosion in calcification budgets/alkalinity reduction studies.

Microborers have been around since the PreCambrian, and comprise several phyla: blue-green algae (yeah, I know, Cyanobacteria-but geologists still call them blue-greens), greens, reds, fungi...They are in every grain of sediment, every coral, every shell, every coral that has ever been stuck into a metabolic chamber...most of the destruction is done by the green algae, via secretion of short-chain organic acids, such as formic, oxalic (good for taking rust off cars), malic. As usual, the stoichiometry eludes



me, but here is what I see:

- because they manufacture short organic acids thru photosynthesis, the CO<sub>2</sub> balance may be close to a push (one in, couple out).
- their eroding activities, however, crank up alkalinity values, via a process that appears in the gas-exchange models as PS. In other words, the O<sub>2</sub> production of the corals, which is calcification, is mixed with the O<sub>2</sub> production by alkalinity-pushers.

That's just the greens. There is evidence that the blue-greens may be heterotrophic-like graduate students, there's no telling WHAT they do at night...the fungi are saprobic, dikaryomycotan anamorphs-common terrestrial fungi. You have some in your fridge now, on the bottom shelf, at the back there. (Kendrick et al. 1982, Bull Mar Sci 32: 862). They invaded via beachrock or.....African dust!

I had hoped that Bellamy and Risk (1982: Science 215: 1618-1619) would have been more widely absorbed by calcification modellers: we found very large amounts of oxygen, produced by boring algae, stored in the tips of Millepora on the GBR. If you "ping off" a tip, not only will you see clouds of bubbles, you may even hear the hiss of escaping gas. (No, please don't do it!) Shasher and colleagues, in Israel, in a series of elegant experiments on "life in extreme environments", estimated that the amount of respiration, the metabolism, of boring algae lying directly under live coral tissue was small-so perhaps they may safely be ignored? No.

On the contrary: the ones in corals are light-limited. In sediments and hardgrounds, they have a major impact. Tudhope and Risk (1985: J. Sedimentary Petrology 55: 440-447) estimated that boring algae dissolved between 18 and 30% of the TOTAL sediment input into GBR lagoons. These were extremely conservative estimates, and the real value is undoubtedly higher. In that paper, there is a section on the relevance of the results to whole-reef calcification estimates using alkalinity reduction techniques. P. 446: "...loss of carbonate from the reef system due to dissolution of sediments by microborers is a more important factor in whole-reef budgets than previously recognised"-and it remains unrecognised.

I would invite KEA to explain to me, and the list, how the influence of microborers on gas exchange over reefs has been handled in their models.

Finally, I am deeply distressed that my anguish at the demise of the ecosystem in which I have spent most of my life should be dismissed as pique at "my own reef issue being overshadowed" by the predictions in KEA. Firstly, I don't think their predictions are worth much-but far more importantly: I am as far as I know the only reef scientist who has had the courage to speak out in print against the factionalism that paralyses reef science (Risk 1999, Mar. FW Res 50: 831-837). It is unacceptable to me that I be accused of the same turf-war mentality. It is unacceptable, and I am very angry about it.

Message ends-thank you all for your indulgence.

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Date: Fri, 05 Oct 2001 19:07:00 +1000  
To: "Mike Risk" <riskmj@mcmaster.ca>,  
"Joanie Kleypas" <kleypas@cgd.ucar.edu>,  
<coral-list@coral.aoml.noaa.gov>

From: Clive Wilkinson <c.wilkinson@aims.gov.au>  
Subject: Re: coral reefs doomed for sure

Mike and others

I have watched this from afar - but feel that I must comment.

"land-based sources of pollution ... are THE reef issue."

This is attempting to put the magic solution of a single cause to a problem, when in fact there are often multiple causes of reef decline.

Pollution by nutrients and sediments are very pertinent on reefs surrounded by shallow water, with lagoons or in embayments; these are minor issues for remote oceanic reefs with deep water adjacent and strong currents. In SE Asia and nearby, the major destructive forces for such remote clean-water reefs are destructive fishing, especially blast fishing.

However, of the 11% of reefs reported lost in the last Status of Coral Reefs of the World 2000 report, most were either dredged up, smothered in sediment, or had airports and the like built on them. A further 16% were severely damaged in 1998 during the major El Nino / La Nina climate switches. Many of the others are severely threatened by the usual mix of impacts - pollution, sediments, over-exploitation including coral mining, and engineering activities. Many of these threats act together and Global Climate Change will probably add to all of these while also causing bleaching. So reef loss will rarely be attributed to a single cause.

Clive

Note: Wilkison had Risk's whole message in his original message. [Risk's message](#) is already displayed above.

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lasted updated 10/29/01  
by [Monika Gurnée](#)  
CHAMP Webmaster



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The content on this web page was last updated in June of 2013. Some of the content may be out of date. For more information: <http://coralreef.noaa.gov/>.

## Update

The first documented capture of a lionfish within the Atlantic Ocean occurred in 1985 near Dania Florida (Morris and Atkins, 2009). While it has often been reported that the lion fish invasion is tied to an accidental release of six to eight lionfish from an aquarium during Hurricane Andrew, Walter Courtenay was quoted in 2010 as saying he would like to "put this idea to rest". In 1995, Courtenay was one of the first to make a connection between lionfish and Hurricane Andrew (Courtenay, 1995). Years later Courtenay now describes his original report: "It was second-hand information, which unfortunately continues to spread, so that Andrew is often mentioned as the reason for the catastrophic lion fish invasion" (Morell, 2010). The most probable explanation for the invasion of the lionfish in the Atlantic Ocean remains the aquarium trade but the Hurricane Andrew release as the source of the invasion has since been refuted by one of the original reporters.

### Read About:

- ❖ [Introduction and background](#)
- ❖ [Impact on coral reef ecosystems](#)
- ❖ [Sightings and dispersal](#)
- ❖ [Education, research, and communication](#)
- ❖ [Population control](#)
- ❖ [Threat to humans](#)
- ❖ [Future possible range extension](#)
- ❖ [Information Sources](#)

## Update

In January 2010 during the general assembly of the International Coral Reef Initiative (ICRI), the Secretariat agreed to set up an *Ad Hoc* Committee to develop a strategic plan for the control of lionfish in the Wider Caribbean. This committee organized a regional workshop at Cancun, Mexico, on August 25-27, 2010, with a view to develop a strategy for the prevention, control, and management of Lionfish (*Pterois* sp.) in the Wider Caribbean. A summary of the workshop may be found at: <http://www.icriforum.org/icri-meetings/agenda>

## The IndoPacific lionfish invasion of the U.S. south Atlantic sea coast and Caribbean Sea

*Lionfishes are venomous species of scorpionfishes which are native to IndoPacific and oceanic coral reef ecosystems and adjacent habitats. Because of their colorful and dramatic appearance, they are prized by aquarists around the world. Through accidental and purposeful release into warm Atlantic waters, they have become established as voracious alien species that pose a serious threat to coral reefs in Bermuda, the American tropics of Florida, the Gulf of Mexico, the Caribbean islands, Central America, and northern South America.*

*The participants in this discussion were concerned with the sources of introduction of lionfishes into the Atlantic Ocean, the increased number of sightings of at least two species of lionfishes in various locations, the nature of threats posed by these fishes to Atlantic coral reefs, and what protective or control measures could be applied to reduce these threats.*

[Click here](#) for a listing of discussion participants

[Click here](#) to download the complete unedited discussion (pdf, 101 KB)



## Introduction and Background

In addition to natural and anthropogenic threats and stressors to coral reefs (e.g., coral bleaching, pollution, development, sedimentation, overfishing, disease, habitat alteration, ocean acidification, violent storms, etc.), the recent invasion and establishment of two sibling species of voracious and predatory lionfishes – the red lionfish (*Pterois volitans*), which has been most heavily sighted in the Atlantic, and the devil firefish (*Pterois miles*) – pose a major new threat to south Atlantic and Caribbean coral reefs.

Lionfishes possess a stunning appearance. They have distinctive brown, red, maroon, and white stripes or bands covering the head and body. Fleshy tentacles are located above their eyes and below the mouth. They have fan-like pectoral fins and separated dorsal, pelvic, and anal spines, each of which is capable of delivering a venomous, painful puncture wound.



A red lionfish (*Pterois volitans*)  
photographed in the Atlantic  
Ocean (NOAA photo)

Lionfishes are now established off of the Atlantic Coast of the United States from Florida to Cape Hatteras, North Carolina. Juvenile lionfish have been found in near-shore waters off New York, New Jersey, and Rhode Island since 2001; however survival of these fish is not expected due to cold winter temperatures. The northward transport of lionfish eggs and larvae by the Gulf Stream has most likely enhanced dispersal of lionfishes along the Atlantic coast. In addition, lionfishes have become established in Bermuda, the Bahamas, Columbia, Cuba, the Dominican Republic, Jamaica, Puerto Rico, Turks and Caicos, and the Cayman Islands. There are also reported sightings in Belize, Haiti, U.S. Virgin Islands, Mexico, and Aruba, Curacao, and Bonaire.

The most probable explanation for the invasion of the lionfish in the Atlantic Ocean is the aquarium trade. Other proposed explanations include the transport of lionfishes, during one or more of their life stages, in the ballast water of ships traveling from the Pacific Ocean, although this scenario does not hold much credence among experts. In 1992, at least six lionfish from a beachside aquarium were accidentally released into Biscayne Bay during Hurricane Andrew, although lionfish sightings have been reported prior to 1992. The present populations of red lionfish are probably the descendents of these fish and others released accidentally or purposely into the warm South Atlantic waters.

Lionfishes have the potential to disrupt coral reef community population structure and dynamics. Not only are they voracious predators that out-compete many other species for food resources, but they also have few known natural predators of their own. Their diet consists of numerous shrimp, crabs, and other crustaceans, including juveniles of the commercially important spiny lobster (*Panulirus*

*argus*). Lionfish are also responsible for great reductions in fish numbers on reefs where they become established. They prey on herbivorous fishes that consume macroalgae and help protect corals from algal overgrowth. In addition, cannibalism is not unknown among lionfishes. To feed, lionfishes often use their wide-spread pectoral fins to herd and trap their prey in corners or against walls and then swallow them with one vacuum-creating movement of their jaws.

The red lionfish, a member of the scorpionfish family, is known by many names, including lionfish, turkeyfish, zebrafish, butterfly cod, ornate butterfly cod, peacock lionfish, and red firefish. It is more easily identified than other lionfishes because it is widely distributed, stands out in its habitat with its bizarre appearance and coloration, and has been documented to be dangerous to humans because of its venomous sting. Venom glands at the base of the dorsal, pelvic, and anal fin spines produce neurotoxins that are injected into a potential predator. Penetration of the spines delivers an extremely painful but usually non-fatal envenomation which however, should be treated as a serious medical emergency.

The red lionfish is widely distributed throughout the western Pacific from southern Japan to Micronesia, Australia and the Philippines. *P. volitans* occurs throughout most of Oceania (including the Marshall Islands, New Caledonia, and Fiji) east to French Polynesia. The closely related species, the devil firefish (*P. miles*), is found primarily in the Indian Ocean, Red Sea, and eastward to Sumatra. Typically, these fishes inhabit lagoons, rocky ledges or crevices, caves, and coral reefs to depths exceeding 150 meters. However, they also have been sighted in estuaries, bays, and harbors, where they may have been introduced via ballast water, although this scenario does not hold much credence among experts.

After courtship and spawning, the planktonic eggs and larvae of lionfishes are dispersed over wide areas. A particular issue in controlling their numbers is their huge reproductive potential and age of reproductive maturity. NOAA researchers have determined that lionfish reach sexual maturity within two years and spawn multiple times during the spawning season, which may be year round. Each spawn can produce up to 30,000 eggs. Unfortunately, scientists have concluded that the red lionfish populations will continue to grow and cannot be extirpated using conventional methods. Due to their fecundity, rapid and wide-spread distribution, adaptability to a variety of shallow and deep habitats, and behavior, scientists believe the lionfish invasion could become the most disastrous in history, devastating coral reef ecosystems throughout the Americas.

[\(top\)](#)

## Synopsis of Participant discussions

### Impact on coral reef ecosystems

Lionfish experts are in agreement that invasive lionfish populations will continue to grow and cannot be eliminated using conventional methods. Lionfishes have become established along the southeastern coast of the United States, Bermuda, the Bahamas, and throughout the Caribbean. This places swimmers, snorkelers, divers, and fishermen at risk from their painful, venomous sting and leaves native reef fish populations and coral reef community stability at great risk from their interactions with this species. In a five-week experiment, scientists in the Bahamas established that lionfish can cause significant reductions (by 79%) in the recruitment of native fishes. One large lionfish was observed consuming 20 small fishes in a 30-minute period.



*A lionfish spreading its fins herding and trapping prey fishes*

Lionfishes may, directly and indirectly, cause harm to coral reef ecosystems. As aggressive ambush predators with few predators of their own in their introduced range, lionfishes can quickly and alarmingly reduce local native reef fish (and some invertebrate) populations to the point where native piscivores cannot compete for these prey animals. This in-turn can cause a reduction in the growth and survival of the native predators. Stomach content analyses of lionfishes reveal a wide diversity in prey species and size classes. As stated by one participant in the discussion, lionfishes are eating nearly anything that will fit into their mouths.

Most lionfish prey on crustaceans and small-bodied forage fishes, including commercially and recreationally important snappers and groupers. Compared to total local reef biomass, lionfishes consume a considerable amount of prey biomass from the reef. In addition, experiments have shown that native reef fish may avoid feeding on juvenile lionfish, probably because of their venomous defense apparatus. There is great concern about the effect of the invaders on commercial and recreational fisheries. Since lionfishes feed on smaller fishes that are usually consumed by groupers and other native fishes, their existence could negatively affect the food chain of many commercial and other species. As one NOAA coral reef manager in North Carolina stated, "our biggest concern is how they impact the economic value of the shelf reef ecosystem. There may be reduced economic returns from commercial fisheries. The economic value of heavily impacted and devastated reefs may be reduced also as recreational divers and snorkelers stop visiting, and perhaps causing a major collapse of the local tourist industry. Recreational and commercial value of reef-related pelagic and benthic species is close to a half-billion dollars each year to the Carolinas."

As lionfish colonize more territory in the Caribbean, they can have a devastating effect on coral reefs already stressed by climate change, pollution, disease, overfishing, sedimentation, and other stressors.

[\(top\)](#)

## Sightings and Dispersal

Lionfishes were first reported in Atlantic waters in the 1990s and have since become established along the U.S. east coast from Florida through North Carolina and east to Bermuda. They are also regular inhabitants throughout the Bahamas and Caribbean nations. They have been sighted as far south as Colombia and the Netherlands Antilles and as far east as the U.S. Virgin Islands. Their expansion has been extremely rapid and even exponential in scope.



*Distribution of lionfish in the Atlantic Ocean in 2009*

One of the topics discussed by participants related to whether any solid

hypotheses existed explaining how lionfishes spread throughout the coastal United States and Caribbean. Through DNA analysis, scientists now believe the initial population of lionfish, which contained at least 10 females and was comprised of two species, *Pterois volitans* and *Pterois miles*, established itself in the western Atlantic waters of the Key Biscayne region. It is surmised that the eggs and larvae of this population were then carried northward in the warm waters of the Gulf Stream to different destinations, which most likely explains the lionfish sightings in New York and New England. It still remains a mystery, however, as to how lionfish populations exploded so rapidly and spread over large distances as far westward as Bermuda and southward to Colombia and Aruba. A question was posed as to whether a lionfish is such a strong swimmer that it could traverse large expanses of open water to Bermuda. (There has been reported sightings of lionfishes swimming in open waters off the east coast midway to Bermuda.) Another participant inquired whether regional water current pathways match the chronologies of lionfish sightings across the Caribbean. Can dispersal of young lionfishes be aided by rafting? Is there DNA sequencing evidence to suggest that the invasive populations are related to the "founder" population in Key Biscayne? Or does the evidence suggest multiple releases by aquarists in the U.S. and Caribbean nations "who can't be bothered to kill or return their pets to the pet shop?" Understanding how lionfish populations have been expanding and spreading so widely and quickly may help identify ways to slow its dispersal or at least prevent expansions of its range to Brazil and west African coasts.



A NOAA flyer requesting information on lionfishes from divers



In 2004, NOAA scientists collected 28 lionfish on one shipwreck off the coast of North Carolina during a single dive. Twenty five more were collected later at this same location. (Photo credit: Christine Addison)

Local experts in Puerto Rico reported sightings of lionfishes in both eastern and western coastal waters of the island during the daytime, which prompted one participant to inquire whether sightings included night-time censuses. (This participant would typically see more lionfishes while diving at night in Palau.) Another reported sighting was in Roatan, one of the islands in the Bay of Honduras. The Cayman Islands Government reported captures and sightings of significant numbers in Grand Cayman, Little Cayman, and Cayman Brac, from depths ranging from about one meter to 34 meters on all sides of the islands and in many different habitats. First reports of lionfishes in Cuba were in June 2007. The first observations from the Turks and Caicos (South Caicos) were also in 2007, when 23 individuals were observed in depths shallower than eight feet (2.4 meters) in habitats as diverse as patch reef, mangrove, seagrass, and deep reef. In January 2009, the first confirmed lionfish was reported and captured in the Florida Keys National Marine Sanctuary. Additionally, lionfishes were sighted in the Bay of Granate, Colombia on May 13, 2009.

Lionfishes adapt to many different habitats. In the Bahamas, they have been found at depths ranging from about four feet (1.2 meters) to more than 450 feet (137 meters) on reef walls, patch reefs, rocky areas, hard bottom with ledges and crevices, mangrove creeks, isolated coral heads, blue holes, ship wrecks, man-made structures, and various debris collections. One participant described them as "habitat generalists," as they require only a habitat that provides shade and a surface against which to trap their prey. Another participant observed that lionfishes in Sri Lanka are more likely to be found on rocky reefs rather than coral formations, while juveniles are common in estuaries.

(top)

## Education, Research, and Communication

Some locations are now working to develop local lionfish response plans. To assist with this development, the Reef Environmental Education Foundation (REEF) has partnered with NOAA, USGS, and

Simon Fraser University to hold lionfish workshops focused on educating local managers, dive operators, and fishermen about the current state of knowledge and ongoing lionfish research, potential solutions available for addressing the invasion, early grace detection and rapid response strategies, handling techniques, proposed legal changes related to lionfish collection, and local market development initiatives. Workshops have been conducted in the Bahamas with more than 40 representatives from government agencies and non-governmental organizations, in the Turks and Caicos Islands, NOAA's Florida Keys National Marine Sanctuary, and elsewhere. REEF's critical research and education efforts on the invasion of the lionfish into Atlantic and Caribbean waters have been featured in several news stories, publications, and video media.



*A diver tracks a lionfish in a seagrass meadow*

Scientists at NOAA's Center for Coastal Fisheries and Habitat Research in Beaufort, North Carolina and others working in the South Atlantic Bight have taken lead roles in addressing the status and impacts of lionfishes along the U.S. east coast. Research on lionfish reproductive biology, age/growth studies, predatory relationships, population dynamics, parasites and diseases, genetics, and more has been published recently or is being reviewed for publication. Other scientists from Simon Fraser University, the University of British Columbia, and Oregon State University have been studying similar issues and impacts in the Bahamas and areas of the Caribbean Sea.

The U.S. Geological Survey (USGS) maintains a database of nonindigenous aquatic species (NAS), including lionfish sightings. The USGS also has developed mapping tools and an early warning alert system for lionfish sightings in new locations.

<http://nas.er.usgs.gov/taxgroup/fish/lionfishdistribution.asp>

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## Lionfish Population Control

The participants agree that it is unlikely that the lionfish invasion can be reversed. Due to their extensive geographical range and diversity of habitats and depths they occupy, any major attempts to eradicate existing lionfish populations would be impractical and doomed to failure. Control is now the only option left. Possible control measures that have been considered include recovering and maintaining native populations of predators, such as large groupers, sharks, and others that prey on lionfish eggs, larvae, and juveniles. A participant noted that in Palau, locations with high numbers of large and medium-sized groupers also had low numbers of lionfish. Other measure to control the lionfish population explosion include killing those lionfishes that are easily spotted and captured; controlling the aquarium trade in lionfishes in the Americas; encouraging a lionfish fishery for human consumption and other commercial uses, such as harvesting for the aquarium trade; reducing fishing pressure on native competitors that occupy the same ecological niche; and biological control (although no specifics were offered).

A participant reflected upon missed opportunities to set up a coordinated observation network in the Caribbean during the mass mortality of the long-spined sea urchin, *Diadema antillarum*, in 1983-84. He suggested that now is the time to use "our superb and ubiquitous" skills in communication to establish a coordinated observation/communication network to determine the impact of lionfishes on populations of small reef fishes. Eradication, he feels, is not a workable solution to the invasion in the Caribbean. He thought it best to anticipate the future of Caribbean reefs with established populations of lionfishes. He recommended that scientists and managers continue to collect data and develop measures to control the expansion of lionfish populations, while also identifying and reducing the negative impacts of established populations on different marine communities in the Caribbean.

Another participant stated that while complete eradication is not an option, control efforts, such as culling lionfishes from coral reefs, are vital to limit the impacts on local reef communities which are



already stressed. REEF trained and licensed over 160 dive professionals in the Cayman Islands alone to respond to lionfish sightings and remove them using early detection and rapid response protocols. The use of volunteer divers in early detection and response may help to slow the spread of lionfishes and control populations at key high-priority locations. Another participant was skeptical that volunteer collectors' efforts at manual removal of lionfishes would achieve anything other than a "highly localized effect at few sites," noting that the aquarium trade in the Pacific has not resulted in any reduction of lionfish numbers on their native reefs where their natural predators exist.

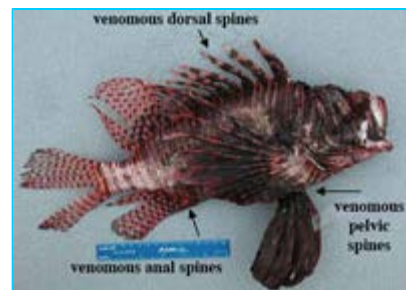
Another participant noted that the lionfish invasion story might have a silver lining compared with the devastating effects in the Mediterranean of an "escaped" invasive species of seaweed, *Caulerpa taxifolia* used to decorate saltwater aquariums. It "escaped" from human control in the 1980s and has spread like a cancer throughout the Mediterranean, overwhelming native species and habitats. However, with adequate coordination, both removal of lionfish individuals (aimed at containment and control) and study of this organism (aimed at how the Caribbean will survive with a controlled lionfish population), we may diminish or control the disastrous effects of lionfishes on Caribbean reef fauna. If nothing is done, however, there may not be much of a future for Caribbean reef communities.

Several participants also suggested that a special fishery might be possible to help control lionfish populations. Although it requires careful harvesting, lionfishes "make wonderful sushi and cerviche." They also are excellent when eaten fried whole or filleted. There are websites that provide recipes and techniques for harvesting and preparing lionfishes for edible consumption. The Bahamas Reef Environmental Educational Foundation (BREEF) encourages the consumption of lionfish and has been actively promoting the capture, safe handling, cleaning, and preparation for the table. One participant noted that while lionfishes have been exploited as a food fish in some areas, he has no information of any noticeable decline in their population numbers.

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## Threats to humans

Another subject of discussion concerned the treatment of lionfish stings. The first response is to immerse the affected part in hot water for about 30 minutes. Lionfish toxins, which are proteinaceous in nature, are degraded and denatured by heat. Hospital treatment is then used to decrease the pain and monitor for systemic and allergic reactions. Medical analgesia, removal of spines, administration of prophylactic antibiotics, and tetanus immunization are the mainstays of treatment. A lionfish sting is usually non-fatal but in extreme cases could lead to allergic reactions, nausea, vomiting, and cardiovascular events.



*The venomous spines of a lionfish*

Lionfish spines are not like hypodermic syringes or pit viper fangs, i.e., they are not hollow with venom sacks located at the base. Instead, a loose integumentary sheath covers each spine and during envenomation, the sheath is pushed down the spine, causing compression of two venom glands located at the base. The neurotoxic venom then travels from the glands through depressions (grooves) in the wall of the spine and into the puncture wound. There have been at least four toxins identified: an antigenic heat-labile protein (the primary toxin); acetylcholine (a neurotransmitter); a neuromuscular toxin; and a low molecular weight non-proteinaceous ichthyotoxin.

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## Future possible range extension of the lionfish

Assuming that lionfishes in the southeast U.S. coastal waters and Caribbean are here to stay and that their numbers will increase, the future potential range of these fishes can be predicted based on survivable minimum bottom temperatures. Morris (2009) presented a map (below) that shows the potential range of lionfishes encompassing the U. S. south Atlantic coast, Gulf of Mexico,

Caribbean Sea, and South America from Colombia to southern Brazil.

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## Information Sources

Albins, M.A. and M.A. Hixon. 2008. Invasive Indo-Pacific lionfish (*Pterois volitans*) reduce recruitment of Atlantic coral-reef fishes. *Marine Ecology Progress Series* 367: 233-238.

Courtenay, W.R.. 1995. Marine fish introductions in south-eastern Florida. *American Fisheries Society Introduced Fish Section Newsletter*. 14(1):2-3

Morrel, V. 2010. Mystery of the Lionfish: Don't Blame Hurricane Andrew. Science Insider.

<http://news.sciencemag.org/scienceinsider/2010/04/mystery-of-the-lionfish-dont-bla.html>

Morris Jr., J.A. The Biology and Ecology of the Invasive Indo-Pacific Lionfish. [doctoral dissertation]. [Raleigh (NC)]: North Carolina State University; 2009. 168pp.

Morris, Jr., J.A., J.L. Akins, A. Barse, D. Cerino, D. W. Freshwater, S J. Green, R. C. Muñoz, C. Paris, and P.E. Whitfield. 2008. Biology and Ecology of the Invasive Lionfishes *Pterois miles* and *Pterois volitans*. *Proceedings of the 61st Gulf and Caribbean Fisheries Institute*, Gosier, Guadeloupe, French West Indies, November 10-14, 2008.

Morris Jr., J.A. and J. L. Akins. 2008. Feeding Ecology of Invasive Lionfish (*Pterois volitans*) in the Bahamian Archipelago. *Proceedings of the 61st Gulf and Caribbean Fisheries Institute*, Gosier, Guadeloupe, French West Indies, November 10-14, 2008.

[Morris Jr., J.A. and J. L. Akins. 2009. Feeding ecology of invasive lionfish \(\*Pterois volitans\*\) in the Bahamian archipelago. \*Environmental Biology of Fishes\*. 86\(3\): 389-398. doi: 10.1007/s10641-009-9538-8.](#)

[NOAA Ocean Service Education](#)

[Nonindigenous Aquatic Species \(NAS\) Fact Sheet](#)

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Potential future range of lionfish based on the lethal thermal minimum of 10°C (Morris J.A. 2009).



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## The IndoPacific lionfish invasion of the U.S. south Atlantic sea coast and Caribbean Sea

### List of participants

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Eesat Atikkan

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Roatan Marine Park

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[http://coris.noaa.gov/exchanges/lionfish/participants\\_list.html](http://coris.noaa.gov/exchanges/lionfish/participants_list.html)



University of the West Indies

Alina Szmant  
University of North Carolina

\*\*\*\*\*

## A Coral-List Server Discussion Thread: The Indopacific lionfish invasion of the U.S. south Atlantic sea coast and Caribbean Sea

**[Coral-List] Coral-List Digest, Vol 14, Issue 24; RE: Lionfish has arrived on Curacao, Netherlands Antilles**

Lauren Saulino [l.saulino at gmail.com](mailto:l.saulino@gmail.com)  
*Thu Oct 29 20:36:05 EDT 2009*

---

**RE: Lionfish has arrived on Curacao, Netherlands Antilles**

Lionfish have now also arrived in Bonaire, NA. This past week Marine Park manager Ramon de Leon responded to two sightings of juvenile lionfish at the dive sites Nukove and Something Special. While at least one of these reported fish was successfully located and removed from the protected waters of Bonaire's marine park it is disconcerting to know that these fish have managed to swim against the currents (literally) and reach this southern Caribbean island.

~Lauren Saulino  
CIEE (Council for International Educational Exchange) - Bonaire

**[Coral-List] Lionfish has arrived on Curacao, Netherlands Antilles**

Mark J A Vermeij [vermeij at hawaii.edu](mailto:vermeij@hawaii.edu)  
*Wed Oct 28 13:51:22 EDT 2009*

Dear All

Divers at Ocean Encounters West, a dive school at the western tip of Curacao, found a lionfish at Watamula, a nearby dive site. The animal was captured later that day. Another one was supposedly observed at East Point (which the complete opposite side of the island) 2 weeks ago but there wasn't (in

contrast to the aforementioned one) a photo or any other official documentation of that individual.

Best regards

Mark

---

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July 2009

Steve LeGore [slegore@mindspring.com](mailto:slegore@mindspring.com)  
*Sun Jul 5 12:34:30 EDT 2009*

Some may remember a message I sent several weeks ago suggesting that a specialty fishery might be possible to help control Caribbean lionfish populations. Those that do may be interested that the widely read Florida Sportsman Magazine published an article in its July 2009 issue titled: "Eat the Invaders" on page 31 ff. It provides handling tips for the recreational public, as well as informing them that lionfish make "wonderful sushi and ceviche," and are terrific fried whole or filleted. It also refers readers to [www.lionfishhunter.com](http://www.lionfishhunter.com), where additional information and recipes may be found.

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June 2009

Ernesto Weil [eweil@caribe.net](mailto:eweil@caribe.net)  
*Wed Jun 17 13:20:37 EDT 2009*

Rectifying my earlier message, I was just informed the fish has been observed and collected in La Parguera too.

EW

Ernesto Weil [eweil@caribe.net](mailto:eweil@caribe.net)  
*Wed Jun 17 11:56:14 EDT 2009*

A friend of mine who snorkels frequently on the west coast of PR just told me that he saw a couple of lionfish while snorkeling at the "Tres Palmas Natural Reserve" in Rincon during the week of May 16-23rd. There are now sightings from both the east and west coast of the island. So far, there have not been any sightings in La Parguera, but is just a matter of time.

Saludos

Dr. Ernesto Weil  
Professor  
Dept. of Marine Sciences  
University of Puerto Rico

Glauco A Rivera [glauco150@aol.com](mailto:glauco150@aol.com)  
*Thu Jun 18 16:38:58 EDT 2009*

Dear listers:

Concurring with Ernesto's posting, my brother-in-law observed a lionfish while diving at El Natural reef on June 13, just north of Crashboat beach, Aguadilla, PR.? He was told another fish has been observed south?at?Crashboat beach.

regards,

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cel. 787-645-9534  
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Nick Bach [nicbach@yahoo.com](mailto:nicbach@yahoo.com)  
*Mon Jun 8 17:01:17 EDT 2009*

Having slowly spread throughout the greater Caribbean over the course of the years, the lionfish has now finally reached the Bay Islands. On May 22nd, a local dive shop reported the capture of an 8inch (front of mouth to base of tail) specimen near Punta Gorda (in the NE part of Roatan). It was found in 21ft of water, inside the barrier reef and about 200 m from shore. The specimen is currently being kept in an aquarium and will be used



for educational purposes. As yet, there have been no further sightings but we expect many more in the coming future.  
With the lionfish here to stay, we will be assessing possibilities of dealing with this invasive species

Promoting Research, Education & Conservation

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Charles Booth [booth at easternct.edu](mailto:booth at easternct.edu)

*Wed Jun 10 10:32:32 EDT 2009*

Nick Bach wrote:

"With the lionfish here to stay, we will be assessing possibilities of dealing with this invasive species." Just got back from San Salvador Island, Bahamas, where I was told by the dive master at the Riding Rock Resort and Marina that people are finding ways to filet and eat lionfish. She was planning to go to Long Island (Bahamas) to learn more about this method of dealing with the fish.

Chuck Booth

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Elizabeth Brill [elizabeth.brill at mac.com](mailto:elizabeth.brill at mac.com)

*Wed Jun 10 22:16:21 EDT 2009*

Check out [breef.org](http://breef.org).

And maybe this will help:

<http://www.breef.org/InvasiveSpecies/Lionfish/tabid/91/Default.aspx>

BREEF {and others} have been encouraging eating lionfish and are addressing education, safe handling, cleaning, etc. I think I even recall seeing a recipe in one of their newsletters, so maybe it's on their website. . .

Buon appetito!

Elizabeth R. Brill

Rachel Odom [rachelodom at gmail.com](mailto:rachelodom@gmail.com)

*Mon Jun 1 13:41:31 EDT 2009*

Rob,

Freshwater et al. 2009 examined the genetic relatedness between the Floridian and Bahamian populations: "These results indicate that the source of the Bahamian lionfish is egg and larval dispersal from the United States east coast population, and support previous models of reef fish dispersal that suggest a low level of connectivity between the Bahamas and east coast of Florida."

I can't recall where, but I remember reading somewhere that were likely multiple introductions. Perhaps there were multiple introductions into US waters that formed the population that spread to the Bahamas and beyond?

Reference:

Freshwater, D. W., A. Hines, S. Parham, A. Wilbur, M. Sabaoun, J. Woodhead, L. Akins, B. Purdy, P. E. Whitfield, C. B. Paris. 2009. Mitochondrial control region sequence analyses indicate dispersal from the US East Coast as the source of the invasive Indo-Pacific lionfish *Pterois volitans* in the Bahamas. *Marine Biology* 156: 1213-1221.

Best Regards,

Rachel Odom  
Graduate Student  
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May 2009

Jeremy Woodley [jdwoodley at yahoo.co.uk](mailto:jdwoodley@yahoo.co.uk)

*Tue May 5 13:30:57 EDT 2009*

I agree with John that the creature is probably here to stay. However, people who have researched its life-history, natural distribution and ecology could tell us if there is some weak point at which it might be susceptible for control, or could enhance attempts to capture them. But it's hard to imagine that divers with nets and spears can do the job: not enough divers and too many less accessible reefs.

Jeremy

Tupper, Mark (WorldFish) [M.Tupper at CGIAR.ORG](mailto:M.Tupper@CGIAR.ORG)

*Wed May 6 06:08:06 EDT 2009*

Lionfish have been one of the more popular species in marine aquaria for a long time, as well as being exploited for food in a few places, but I've never heard of any noticeable declines in their populations, even where locally harvested for the aquarium trade. I rather doubt that any kind of removal program would have much effect.

As far as I know, their major predators are large groupers and other lionfish. There are definitely fewer large grouper species in the tropical west Atlantic than the Indo-Pacific, and there is the question of whether any predator in the Atlantic would find them palatable. What are the predators of scorpionfish in the Atlantic, if any? They might also be able to prey on lionfish. I suppose one could hope that lionfish numbers in the Caribbean might reach an equilibrium if their cannibalism rate eventually equals their recruitment rate, but who knows what sort of population density would be needed for that to happen...

Mark Tupper

John Ogden [jogden at marine.usf.edu](mailto:jogden@marine.usf.edu)  
Mon May 4 10:44:35 EDT 2009

Thinking back to the Diadema mass mortality of 1983-84 and the opportunities that were missed because of poor communications across the region, now would be a very good time to use our superb and ubiquitous communications to set up a coordinated observation network to see what is the impact of lionfish on populations of small reef fishes. It appears that this idea could be trumped by well-meaning but ultimately futile attempts to remove them. Who doubts that they are here to stay? It would be best we anticipate the future of Caribbean reefs with lionfish and try to get some data to help get our minds around this.

Cheers all.

John C. Ogden, Director  
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*From: Gulf and Caribbean Fisheries Institute Network*  
*[mailto:[GCFINET at LISTSERV.TAMU.EDU](mailto:GCFINET@LISTSERV.TAMU.EDU)] On Behalf Of Dave Anderson*  
*Sent: Sunday, May 03, 2009 9:24 PM*  
*To: [GCFINET at LISTSERV.TAMU.EDU](mailto:GCFINET@LISTSERV.TAMU.EDU)*  
*Subject: [GCFINET] Cayman Islands Lionfish Update*  
*This message was originally submitted by Bradley Johnson*  
*[mailto:[Bradley.Johnson at gov.ky](mailto:Bradley.Johnson@gov.ky)] to GCFINet.*

Hi all,

As of 30th April 2009 we have caught 90 lionfish! This includes the 2 caught in Cayman Brac and Little Cayman in 2008 and 3 live specimens. They have been caught in water ranging from 3' down to 110', on all sides of the islands, and in all habitats.

By island we have:  
Grand Cayman - 44;  
Cayman Brac - 8;  
Little Cayman - 38.

Cayman Brac was hit by Hurricane Paloma in November and sustained severe damage to the Island, including their dive operations. The sightings have so far been primarily from divers, so with practically no diving in the Brac we are getting fewer reports of lionfish from there. We assume this will increase once the dive operations reopen.

We have licensed approximately 163 divers to remove lionfish for us having 130 in Grand, 3 in the Brac, and 30 in LC. We will increase the number of licensed divers in the Brac once they get more dive staff back.

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Brice Semmens [brice.semmens at noaa.gov](mailto:brice.semmens@noaa.gov)  
Tue May 5 14:12:57 EDT 2009

John,

No one doubts mosquitoes are here to stay, yet most folk appreciate control efforts (particularly in your neck of the woods!) Efforts aimed at culling lionfish are principally intended to limit impacts to already stressed reef communities. Put another way, the efforts are only futile if the goal is eradication. I don't believe anyone involved in these (well coordinated) efforts has eradication as a goal at this point. It's also worth noting that any rigorous efforts aimed at identifying lionfish impacts on a whole-reef scale should probably attempt some version of BACI... note the 'control' part of BACI.

So, the big question -- are you suggesting that folks forgo control efforts in order to focus exclusively on documenting the undoubtedly horrific effects of this invasion? To me that's like studying the wiring diagram of a time bomb that's about to go off -- I'd rather spend my time figuring out how to avoid as much of the blast as possible.

My two cents.

Brice Semmens

John Ogden [jogden at marine.usf.edu](mailto:jogden@marine.usf.edu)

*Tue May 5 15:19:58 EDT 2009*

Bruce,

Good first point and more or less what I meant to say. Let's distinguish control and eradication. Control (living with) lionfish requires knowledge that could be side-tracked by expensive, extensive, well-meaning but ultimately futile eradication measures (and there are many people thinking this way). I suggest that the time is now to use the event of invasion not just to document but to look at what is happening on Caribbean reefs as this invader is established. Surely this will help gather knowledge useful to control. In my opinion we will be living with lionfish from here on out.

Cheers.

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andrew ross [andyroo\\_of72 at yahoo.com](mailto:andyroo_of72@yahoo.com)

*Tue May 5 18:24:51 EDT 2009*

Regarding those stressed reefs, do lionfish hunt among the branching coral (staghorn-type) thickets on their native reefs?

Andrew

Tupper, Mark (WorldFish) [M.Tupper at CGIAR.ORG](mailto:M.Tupper@CGIAR.ORG)

*Wed May 6 05:06:50 EDT 2009*

Not usually. I mostly see lionfish hunting along overhangs and caves in the forereef or reef wall. They use their pectoral fins in a "herding" technique to trap small fish. I think this works best along wider surfaces than most branching corals would provide.

Mark Tupper

andrew ross [andyroo\\_of72 at yahoo.com](mailto:andyroo_of72@yahoo.com)

*Wed May 6 09:42:47 EDT 2009*

Will and Mark,

My question was a little leading- do you suppose that the lack of this elaborate/extensive refuge habitat may somehow be facilitating the success/spread of this invader and its eventual impact, particularly on artisanal reef-fisheries?

To rephrase Mark's observations- a tractor can't corner rabbits against a cattle fence.

A

Justin R Grubich [justinrg at gmail.com](mailto:justinrg@gmail.com)

*Wed May 6 12:33:11 EDT 2009*

Colleagues,

To add to Mark's observations of lionfishes in their native ranges, we recently documented lionfish species diversity and biogeography during an expedition to the southwest islands of Palau this past summer. Interestingly, we found very low numbers of lionfishes but high species richness and abundances of groupers. In addition to healthy populations of large groupers among these remote reefs, there was also high densities of medium and small groupers species that are likely keeping them in check as ecomorphological competitors of lionfishes. If anyone is interested in more details, the results of this rapid assessment of lionfishes will be coming out in Coral Reefs soon. For those interested in the raw data, the specimen and tissue collections are being housed at the Field Museum of Natural History in Chicago

-Justin Grubich

Lad Akins [Lad at reef.org](http://ladatreef.org)

*Wed May 6 15:05:51 EDT 2009*

HI John, Paul, Brice and all.

Glad this issue is catching your eye. It has been on the radar for some time now and much is being done in both control and documentation of the impacts relative to this invasion. It's been a while since we've updated on the coral list, so I maybe this is a good time to do so.

Relative to documentation of the impacts, James Morris, Paula Whitfield, Roldan Munoz and others at NOAA's Beaufort lab as well as others working in the South Atlantic Bight have been taking a lead role in addressing status and impacts of this invasion along the US east coast. Work on reproduction, age/growth, predation (on and by lionfish), population dynamics, genetics, parasitology, and more have been either recently published or are in final review.

Stephanie Green and Isabelle Côté at Simon Fraser University, James Morris at NOAA, Mark Albins and Mark Hixon at Oregon State, Nicola Smith at University of British Columbia and others have been looking at similar issues and impacts relative to coral reef systems in the Bahamas and other invaded areas of the Caribbean.

REEF has been working in close coordination with those along the US Coast and in the wider Caribbean to facilitate research but also to implement outreach/awareness, early detection/rapid response and control programs. Over the last 6 months we have worked with the Bahamas, Turks and Caicos, Cayman Islands and the Netherlands Antilles to conduct workshops on outreach/awareness, detection and response, medical issues, collection and handling techniques and monitoring and assessment protocols. We were able to train and license over 160 dive professionals in Cayman alone to respond to sightings and remove fish via early detection/rapid response protocols. Upcoming projects and workshops are planned for Belize (<http://www.reef.org/programs/exotic/lionfish/trips>) , the Florida Keys, Bahamas and USVI/PR this summer. (visit [www.reef.org/lionfish](http://www.reef.org/lionfish) for updates)

The USGS has been the focal point for databasing lionfish sightings and has dedicated significant resources to hosting the lionfish sightings database on their NAS website (<http://nas.er.usgs.gov/taxgroup/fish/lionfishdistribution.asp>). They have also developed mapping tools and maintain an early warning system to alert users (anyone can sign up) of lionfish or other non-nativespecies sightings in new areas.

The recent GCFI (Guadaloupe), ICAIS (Montreal) and the upcoming Marine Bioinvasions (Portland) conferences all have lionfish special sessions where the latest work has been/is being presented. There is a very good summary of what is currently known about lionfish including discussion on control and management from the recent GCFI symposium ([http://www.ccfhr.noaa.gov/documents/morrisetal\\_2009.pdf](http://www.ccfhr.noaa.gov/documents/morrisetal_2009.pdf))

We (NOAA/REEF) now have funding to conduct a series of regional workshops this summer and fall and many research and control programs are set to start up early this summer.

I hope this eases some of the concern relative to the control and impacts issue. If you have any questions or would like more info, feel free to contacts us. Let's all work together to ensure that research and control will work hand in hand to come up with successful solutions to this issue.

All the best,

Lad

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*Wed May 6 16:58:56 EDT 2009*

During the recent CaMPAM Training of Trainers course in Tobago, a representative from the Bahamas Department of Fisheries related how a pair of

lionfish were observed from an ROV platform at greater than 400' - they are here to stay! Kathleen Sullivan-Seeley and others in the Bahamas developed a very comprehensive plan to deal with them.

Here are the oral and poster abstracts relating to lionfish from the November 2008 GCFI symposium on Invasive Species held in Guadeloupe, FWI:

REEF'S VOLUNTEER PROGRAM FOR EARLY DETECTION AND RAPID RESPONSE OF NON-NATIVE MARINE SPECIES

Lad Akins<sup>1</sup> and James Morris<sup>2</sup>

1REEF P O Box 246 Key Largo, FL 33037 US [Lad at reef.org](http://Lad.at.reef.org) 2NOAANational Centers for Coastal Ocean Science 101 Pivers Island Rd Beaufort NC 28516 USA

ABSTRACT  
Lionfish (*Pterois miles/volitans*) have rapidly become established along the east coast of the U.S., Bermuda, Bahamas, and the north-central Caribbean. A nearly perfect invader, lionfish have spread throughout these regions since 2000 and recent studies have demonstrated significant impacts of lionfish on native reef fish communities. The use of volunteers in early detection and rapid response may provide significant aid in slowing the expansion and controlling populations at key locations of high priority. The Reef Environmental Education Foundation (REEF), a U.S. based NGO, in partnership with NOAA, the USGS, the National Aquarium in Washington D.C., Simon Fraser University, Oregon State University, local dive operators and volunteers has developed methods and materials for outreach, detection, reporting, and response which can serve as a model for downstream countries preparing for the invasion. Volunteer divers and snorkelers are the eyes and ears of the coral reef environment. REEF provides training for these marine enthusiasts in identification and survey techniques and provides materials for them to report their sightings to a central, publicly accessible database ([www.reef.org](http://www.reef.org)). These data provide a valuable baseline resource and continually updated monitoring information and may be the first line of defense in early detection efforts. Since January 2007, REEF has conducted 15 week-long lionfish projects in the Bahamas. Over 190 volunteers have participated, helping to gather over 1700 specimens for researchers. The protocols developed during these projects provide an example of how volunteer collection teams can be enabled to minimize impacts of lionfish through regular detection and control activities.

KEYWORDS: volunteers, lionfish, fish surveys, stewardship, non-native species

EFFECTS OF THE INVASIVE INDO-PACIFIC LIONFISH (*PTEROIS VOLITANS*) ON BAHAMIAN CORAL-REEF FISHES: PREDATION AND COMPETITION

Mark Albins and Mark Hixon

Oregon State University, Department of Zoology 3029 Cordley Hall Corvallis, OR 97331 USA [albinsm at science.oregonstate.edu](http://albinsm.at.science.oregonstate.edu)

ABSTRACT  
The Indo-Pacific lionfish (*Pterois volitans*), introduced to Florida waters in the early 1990s, is currently spreading rapidly throughout the Caribbean region. This invasive carnivore may cause both direct and indirect deleterious changes in coral-reef ecosystems via predation on native fishes and invertebrates as well as competition with native predators. We are conducting a series of controlled field experiments on a matrix of small patch reefs in the Bahamas to examine the short-term effects of lionfish on native reef fishes. In 2007, lionfish caused significant reductions in the recruitment of native fishes by an average of 79% over a five-week period. Twenty-three of thirty-eight species recruiting to both lionfish-absent (control) reefs and lionfish-present reefs -- including four of five parrotfishes -- were negatively affected by lionfish. This strong effect on a



key life stage of a broad variety of coral-reef fishes suggests that invasive lionfish are already having substantial negative impacts on Atlantic coral reefs. In addition to the demonstrated direct predatory effect of lionfish on small fishes, substantial reductions in this important prey resource may indirectly lead to reduced growth and survival of native piscivores. We are currently conducting experiments investigating potential competitive interactions between lionfish and native serranids, including coney and Nassau grouper. We will also present the results of these ongoing investigations.

KEYWORDS: invasive species, community interactions, piscivory, marine fishes, recruitment

#### THE OCCURRENCE OF LIONFISH (TELEOSTEI: SCORPAENIDAE: PTEROIS SP.) IN CUBAN MARINE WATERS

Hansel Caballero<sup>1</sup>, Pedro Pablo Chevalier<sup>2</sup>, and Olaechea Armando<sup>2</sup>  
<sup>1</sup>Acuario Nacional Cuba Ave.1ra y 60, Miramar, Playa, Ciudad de La Habana, Cuba [hanselc at acuaronacional.cu](mailto:hanselc@acuaronacional.cu) <sup>2</sup>Acuario Nacional de Cuba Ave.1ra, esq.60, Miramar, Playa Ciudad de la Habana Cuba

#### ABSTRACT

The natural distribution of the lionfish *Pterois volitans* (Linnaeus, 1758) includes the Indian and Pacific oceans in a very extensive area. The finding of this fish in American and Caribbean waters is not new, but was confirmed the occurrence in Cuba since June 2007, when it was observed for first time in the southeast region and in August, more specimens were catch in the central North region, reported by Chevalier et al. (2008). At the moment, U. S. Geological Survey (USGS) has in its data base, around 470 reports (<http://nas.er.usgs.gov/queries/collectioninfo.asp.htm>) of the occurrence of the lionfish where includes several reports of the 51 from Cuba until July of the 2008. Our goal is to explain the efforts that the Cuban research institutions are doing, to study biological and ecological aspects of the lionfish in Cuban water. These studies are carried out by the National Aquarium of Cuba (<http://www.acuaronacional.cu>), with the participation of other institutions dedicated to the marine research with the support of the CHM ("Mechanism of Facilitation for information on biodiversity in Cuba") ([www.ecosis.cu/chm/chmcuba.htm](http://www.ecosis.cu/chm/chmcuba.htm)), the Project PNUD/GEF (Network of Voluntary Monitoring of Early Alert) ([alcolado at ama.cu](mailto:alcolado@ama.cu)). Among other aspects, the study includes examine and determine the abundance and distribution of the lionfish in different zones from the Cuban archipelago; to implement a program of environmental education and to develop a data base of sighting of the species in Cuba.

KEYWORDS: Nonindigenous species, Scorpaenidae, Marine introductions, Lionfish, *Pterois volitans*

#### THE RED LIONFISH INVASION OF SOUTH CAICOS, TURKS & CAICOS ISLANDS

John Claydon, Marta Calosso, and Siri Jacob  
The School for Field Studies Center for Marine Resource Studies 1 West Street South Caicos, Turks and Caicos Islands [jclaydon at fieldstudies.org](mailto:jclaydon@fieldstudies.org)

#### ABSTRACT

The first observation of red lionfish (*Pterois volitans*/miles) in the waters around South Caicos, Turks & Caicos Islands was made in December 2007. From this time until the end of July 2008, lionfish sightings were recorded by staff and students from The School for Field Studies Center for Marine Resource Studies in South Caicos . Twenty-three individuals have been observed. Although effort was made to capture all specimens seen (with 21 individuals captured), sightings represent opportunistic observations made during other activities. All except one were recorded in waters shallower than 2.5m, and specimens have been found in patch reef (n=14), seagrass

(n=6), mangrove (n=2), and deep reef (25m; n=1). Although individuals captured ranged in size from 4.1 to 27.7cm TL, all but 2 individuals were <15cm TL. This study documents the invasion of South Caicos by red lionfish, and although the effects of this invasion are unknown, the exponential increase of sightings per month is worrying. Future monitoring will include targeted searches for red lionfish.

KEYWORDS: red lionfish, invasion, Turks & Caicos Islands, ,

PREDICTING THE IMPACT OF INVASIVE LIONFISH (PTEROIS VOLITANS AND P. MILES) ON NATIVE REEF FISH POPULATIONS IN THE CARIBBEAN

Stephanie Green and Isabelle Côté

Simon Fraser University Department of Biological Sciences 8888 University Drive Burnaby, BC V5A 1S6 Canada [stephanie.green@sfu.ca](mailto:stephanie.green@sfu.ca)

ABSTRACT

Indo-Pacific lionfish (*Pterois volitans* and *P. miles*) have recently invaded and rapidly spread throughout temperate and tropical Western Atlantic habitats. Lionfish use an ambush strategy to consume whole prey fish and have few predators in their introduced range. To understand the impacts of lionfish on native fish communities in the Bahamas and to predict their impacts on the wider Caribbean, the prey and habitat preferences of lionfish on reefs along the southwest coast of New Providence, Bahamas, were studied. Prey-sized fish density, diversity and size distribution, reef complexity and topography, and lionfish density and habitat preference data were collected from 14 sites varying in habitat types, depths and lionfish densities. From January 2007 to July 2008, 500 lionfish (TL = 50 - 424 mm) were collected from these sites. Stomach content analysis revealed that lionfish prey heavily on many species and size classes of native reef fish. Comparisons of diet to prey availability suggest preferential predation on species with behavioural characteristics and morphologies that increase encounter rate and ease of capture. Furthermore, compared to total available biomass, lionfish consume a considerable amount of prey biomass from the reef. Finally, lionfish density was positively correlated with both reef complexity and relief, and prey-sized fish density. Results indicate that lionfish have the ability to significantly impact native reef fish communities. These findings can be used in conjunction with fish community and habitat profiles from elsewhere in the Caribbean to predict the impact of lionfish as they continue to spread throughout the region.

KEYWORDS: invasive species, lionfish, predation, prey selection, habitat selection

BIOLOGY AND ECOLOGY OF THE INVASIVE LIONFISH, PTEROIS MILES AND PTEROIS VOLITANS

James Morris

NOAA 101 Pivers Island Rd Beaufort, NC 28516 USA [james.morris@noaa.gov](mailto:james.morris@noaa.gov)

ABSTRACT

The Indo-Pacific lionfishes, *Pterois volitans* and *Pterois miles*, are now established along the U.S. south east coast, Bermuda, Bahamas, and are presently becoming established in the Caribbean. While the lionfishes are popular in the aquarium trade, little is known regarding the biology and ecology of these species. Given the rapid establishment of lionfish and the potential impacts lionfish may have on native reef fish communities, we set out to describe lionfish reproductive biology, feeding habits, and venomology using laboratory and field observations. Observations of lionfish reproduction indicate that lionfish are iteroparous, asynchronous, indeterminate batch spawners. Lionfish spawning periodicity measurements indicate that lionfish are spawning monthly, with spawning events occurring during most months of the calendar year throughout their invaded range.

Laboratory experiments designed to investigate predation on juvenile lionfish indicate that some native reef fishes avoid lionfish as prey, likely due to their venom defence. Lionfish stomach content analyses reveal that lionfish are preying mostly on crustaceans and small-bodied forage fishes including commercially and recreationally important snapper and grouper. These efforts are providing new insight regarding the integrated biology and ecology of the non-native lionfish and further demonstrate the need for aggressive early detection and rapid response efforts in the marine environment.

KEYWORDS: *Pterois miles*, *Pterois volitans*, lionfish

INDO - PACIFIC LIONFISH INVASION IN BAHAMAS: A CASE STUDY OF RESEARCH, OUTREACH AND MANAGEMENT PLANNING

Kathleen Sullivan Sealey<sup>1</sup>, Nicola SMITH<sup>2</sup>, Lakeisha Anderson<sup>3</sup>, and Deon Stewart<sup>4</sup>

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ABSTRACT

The invasion of the Indo-Pacific lionfish to Bahamian waters raises considerable concern due to the uncertainty of its ecological impacts and its potential threats to commercial fisheries, tourism and human safety..

Lionfish have been reported throughout the archipelago and are the focus of several research and monitoring initiatives. The Bahamas has a National Invasive Species Strategic Plan, but marine invaders require unique partnerships to gather and collate information, launch educational initiatives, and develop realistic management options. The Government of The Bahamas has limited funds to address major resource management issues; hence, collaboration with non-governmental agencies, and tertiary education institutions is imperative.. The lionfish invasion has created a novel opportunity for the formation of innovative public-private partnerships to address the ecological, social and economic impacts of biological invaders.

KEYWORDS: Lionfish, Invasion, reefs

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Tupper, Mark (WorldFish) [M.Tupper at CGIAR.ORG](mailto:M.Tupper@CGIAR.ORG)

*Wed May 6 22:19:22 EDT 2009*

The Akins and Morris talk sounds very interesting (as do all these presentations) but I am a bit skeptical of the statement "The protocols developed during these projects provide an example of how volunteer collection teams can be enabled to minimize impacts of lionfish through regular detection and control activities". I doubt that manual removal will achieve anything other than a highly localized effect at a few sites. If the aquarium trade cannot make a dent in lionfish numbers on their native reefs,

I'm not sure what volunteer collection teams can do in an area where lionfish seem to have no natural predators or competitors.

Dr. Mark H. Tupper  
Scientist - Coral Reefs and Reef Fisheries  
The WorldFish Center

Tupper, Mark (WorldFish) [M.Tupper at CGIAR.ORG](mailto:M.Tupper@CGIAR.ORG)  
*Wed May 6 22:20:51 EDT 2009*

Dear Justin and colleagues,

Did your rapid assessment include night-time census? I lived in Palau for nearly 3 years and while I saw lionfish only occasionally during the day (usually in caves or overhangs), I would typically see at least one and often two or three during night dives.

Cheers,

Mark Tupper

Tupper, Mark (WorldFish) [M.Tupper at CGIAR.ORG](mailto:M.Tupper@CGIAR.ORG)  
*Wed May 6 22:31:34 EDT 2009*

Andrew,

I think that is quite possibly the case. Lionfish appear to be habitat generalists - they are just as likely to appear around artificial structures (wrecks, piers, rigs, etc.) as on reefs - anything that provides shade and a surface against which to trap their prey.

Mark

Nishan Perera [boraluwa at gmail.com](mailto:boraluwa@gmail.com)  
*Thu May 7 01:31:20 EDT 2009*

With regard to lionfish ecology, in Sri Lanka they are more common on rocky reefs rather than coral rich areas. And despite heavy collection for the aquarium trade they (in particular \*P. volitans\*) are present in large numbers so I doubt they can be physically eradicated from the Caribbean. Juveniles are often found in estuaries so this may have something to do with their distribution. Overall I see more lionfish here than anywhere else I have been to in the Indo-Pacific. Sometimes in groups of 5-10 together as compared to the occasional individuals elsewhere. And their distribution seems correlated with sediment and freshwater input (just observation and not based on stats). We see more lionfish on silty rocky reefs than on coral reefs or offshore reefs with good visibility. Also more lionfish on the west coast of SL where there are more rivers than on the east coast where there is less freshwater input.

Cheers,

Nishan

Les Kaufman [lesk at bu.edu](mailto:lesk@bu.edu)

*Wed May 6 12:31:28 EDT 2009*

Sorry if I missed part of this thread, but everybody does know about Hixon et al's continuing work on expat lionfish biology?

Les

Les Kaufman  
Professor of Biology  
Associate Director  
Boston University Marine Program  
and  
Senior PI  
Marine Management Area Science  
Conservation International

Sarah Frias-Torres [sfrias\\_torres at hotmail.com](mailto:sfrias_torres@hotmail.com)

*Tue May 5 07:41:03 EDT 2009*

John,

I think we all agree that we must take advantage of the many ways we can communicate today, so we can work together on the lionfish invasion in the Caribbean. I was not around (at least not yet as a scientist) for the *Diadema* mass mortality, but coming from a country who is very ineffective at almost everything, I can see how poor communication can ruin the best of intentions.

As for the removal of invasive lionfish, I do disagree with you. We might not get rid of them completely, but major containment/ control by physical removal could be one of the objectives from a coordinated effort.

Coming from the Mediterranean Sea, and based on our most recent invasive experience, the lionfish invasion in the Caribbean still has a silver lining. In the Mediterranean, the invasive tropical algae *Caulerpa taxifolia*, has taken over most of our seagrass beds of the endemic *Posidonia oceanica*. Nothing is quite effective removing this pest. Even when you try to remove the caulerpas, if a small fragment of the algae is left in the substrate, it will grow again. When uprooted, propagules will spread away to colonize other parts, or cling to your dive suit, to your hair, or to the hull of your boat, so you become another agent for spreading them. This is the stuff from a Hollywood alien movie!!!

However, the invasive lionfish comes in discrete, single units. Albeit, thousands of them, but still in "ones". So, with adequate coordination, both removal (aiming for contention and control) and study (aiming at how the Caribbean will survive with a controlled lionfish population) of these aliens can be completed. And in the process, we can get some fish sticks! If we do nothing, I don't think there is much of a future for the Caribbean fauna as we know it.

Sarah Frias-Torres, Ph.D. Marine Conservation Biologist Ocean Research & Conservation Association  
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Murdoch, Thad [tjmurdoch at gov.bm](mailto:tjmurdoch@gov.bm)  
*Thu May 7 12:49:57 EDT 2009*

Please follow the link below for news on how Bermuda is tacking the  
invasive lionfish problem locally.

<http://www.royalgazette.com/siftology.royalgazette/Article/article.jsp?sectionId=60&articleId=7d85e3330030009>

Best Regards - Thad

Dr. Thad Murdoch  
BREAM: Bermuda Reef Ecosystem Assessment and Mapping Programme  
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www.bamz.org

Eva Salas [salas.e at gmail.com](mailto:salas.e@gmail.com)  
*Fri May 15 12:43:01 EDT 2009*

Lionfish has been spotted in Costa Rica, Cahuita and off Punta Uva, by  
marine biologists Ulises Arrieta and Carlos Jiménez, between april and may  
2009. We are investigating how many sightings by fishermen and divers have  
been done and where, so we can estimate an approximate arrival time. Helena  
Molina and Carlos are coordinating with the government to start management  
actions.

Eva Salas

Rob Hilliard, imco [rhilliard at imco.com.au](mailto:rhilliard@imco.com.au)  
*Fri May 29 17:41:33 EDT 2009*

Dear Listers

I was hoping Melissa Keyes' May 7 question (on why/how lionfish now seem to  
be spreading so fast and wide) would invoke some responses -  
apologies if I've missed them!

Is it right to assume this apparent rapid spread - and sometimes across  
large distances (e.g. outward to Bermuda / southwestward to central  
America and still going south ) is not an artifact? Or is it because  
more divers in more areas are now specifically searching for it - but it is  
such an obvious species to spot....

After its Florida discovery in the early nineties, is it correct to say  
that it showed a 'conventional' northward spread (Gulf stream assisted)  
- with its larvae occasionally showing up in New York by the early or  
mid naughties?) So if the apparent southward explosive spread in the last  
2-3 years is real, does it have the larval characters / juvenile behaviors to  
achieve it solely by self-spread - and do the regional water current  
pathways match the chronologies of its reported sightings across the  
Caribbean?

Or are there some human or seaweed rafting vectors lending a helping hand to the larvae or young?

Has anyone looked at the DNA - are they all closely related to the 'founder' population off Florida? Or does the evidence imply multiple releases by Caribbean aquarists who can't be bothered to kill or return their pets to the shop?

I see there's a 2002 article (Whitfield) noting its potential to be spread by the ballast water of trading ships - does the current evidence knowledge base support this?

It strikes me that understanding how it's been spreading so widely - and apparently so quickly - may help identify ways to slow it down or at least prevent large jumps - before it ends up along the whole western Atlantic seaboard - from north of the Carolinas to Cabo Frio / Rio - plus a large chunk of the west African coast plus the Atlantic islands in between...

Cheers

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Melissa Keyes [mekvinga at yahoo.com](mailto:mekvinga@yahoo.com)  
*Thu May 7 15:23:01 EDT 2009*

Hello, Listers,

Is there any theory as to how these fish are spreading? From what I've gathered, they're first seen as large juveniles or adults. I've never seen a photo of a tiny one, do they resemble adults soon after being born/hatched? Are the young much stronger swimmers to go so many miles? To have gone across the Atlantic to Bermuda is amazing, but to have reached Belize, well, where do the currents go, anyway?

I think it's very very strange that Lionfish are just recently being seen in the Florida Keys. They've made it many hundreds of miles to the east and south of Miami, their origin.

Lionfish have recently arrived in the Virgin Islands, as adults.

We certainly cannot depend on large Groupers to eat many of them.

Regards,

Melissa E. Keyes  
Saint Croix, USVI

Brad Baldwin [bbaldwin at stlawu.edu](mailto:bbaldwin@stlawu.edu)  
*Sat May 31 18:55:40 EDT 2008*

Hi Folks,  
Sorry if this has already been discussed but just came back from a field class trip on San Salvador in the Bahamas and found plenty of lionfish there. Although its an amazing fish, it would sure be nice to eradicate it. I work on invasive freshwater inverts and fish and so realize this will be very unlikely. However, I would love to hear what you folks think about efforts to control it, its documented ecological impacts, and safety issues related to working in its new turf. I'll search websites for this as well but always find your feedback helpful. Thanks, Brad

Date: Thu, 14 May 2009 14:22:22 -0700 (PDT)  
From: Valeria Pizarro <[valepizarro at yahoo.com](mailto:valepizarro@yahoo.com)>  
Subject: [Coral-List] first report of a lion fish in continental Colombia - Granate  
To: [coral-list at coral.aoml.noaa.gov](mailto:coral-list@coral.aoml.noaa.gov)  
Message-ID: <[636530.89102.qm at web45109.mail.spl.yahoo.com](mailto:636530.89102.qm@web45109.mail.spl.yahoo.com)>  
Content-Type: text/plain; charset=iso-8859-1

Dear coral listers,  
Yesterday (May 13th) the first lion fish was spotted in the continental reefs of Colombia in the bay of Granate (near Santa Marta city). The observation was made by the marine biologist Juliana Gonzalez and the instructor Santiago Estrada.  
Don't know if the discussion on how to deal with this invasion problem resulted in any specific actions but we have to start doing something if we don't want to see our reefs more deteriorated.

Kind regards,  
Valeria Pizarro  
Valeria Pizarro, PhDDocente TitularPrograma Biolog?a MarinaUniversidad Jorge Tadeo Lozano,?Sede Santa MartaCra. 2 No. 11-68, Edificio Mundo MarinoRodadero, Santa Marta, MagdalenaPBX: + 57 5  
[4229334valeria.pizarro at utadeo.edu.co](mailto:4229334valeria.pizarro@utadeo.edu.co)

## March 2009

Kirah Forman [kirahforman at yahoo.com](mailto:kirahforman@yahoo.com)  
*Fri Mar 13 18:01:07 EDT 2009*

The first lionfish was caught in Belize on March 12, 2009. It was caught by a dive master from San Pedro who spotted it during there dive tour in Turneffe Atoll. He caught the fish and brought it in. This now confirms the sightings previously reported.

Kirah Forman  
Marine Biologist  
Hol Chan Marine Reserve  
P.O. Box 60  
San Pedro, Ambergris Caye



Phone: (501)226-2247

FEB 2009

Michael Lombardi [explore at oceanopportunity.com](http://www.oceanopportunity.com)

*Fri Feb 6 14:17:54 EST 2009*

Hi folks,

Your responses have been overwhelming, and consistent! Thank you for the links and resources. They have been forwarded to the team of physicians managing this patient. Naturally, with HIPAA and whatnot, I probably won't learn much from what transpires. However, I do now that the info is appreciated. This is naturally a rare occurrence here in Northeast hospitals (the injury occurred in warm waters.no need to panic about the northward lionfish migration!).

Cheers,

Mike

Michael Lombardi

<<http://www.oceanopportunity.com/>> Oceans of Opportunity  
The Explorer's Club, MN'07

Eran Brokovich [eran.brokovich at mail.huji.ac.il](mailto:eran.brokovich@mail.huji.ac.il)

*Fri Feb 6 13:16:06 EST 2009*

For first aid, immerse in hot water, as hot as the help giver can stand. Immerse for about 30 min. make sure this doesn't waste evacuation time. The poison is a protein degrading in the heat. In the hospital they usually treat for pain and monitor systemic and allergic reactions. Medical analgesia, removal of residual spine(s) and consideration of prophylactic antibiotics and tetanus immunisation are the mainstays of treatment. Non fatal usually but in extreme cases could lead to allergic reactions, vomiting, nausea and cardio-vascular collapse. The hot water immersion soon after envenomation will help tremendously in controlling the amount of poison going into the body. It will reduce pain and venom quantities resulting in a less severe injury

Eran Brokovich

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Lad Akins [Lad at reef.org](http://ladatreef.org)

*Tue Feb 10 15:44:04 EST 2009*

HI All,

Following is the link to a recent paper on invasive lionfish providing a summary of lionfish biology and ecology gleaned from the literature and recent observations.

[http://www.ccfhr.noaa.gov/documents/morrisetal\\_2009.pdf](http://www.ccfhr.noaa.gov/documents/morrisetal_2009.pdf)

As lionfish are rapidly spreading into the Caribbean (and soon to be Gulf of Mexico), we hope this information will provide local managers with accurate information, which they can use to educate the public and increase awareness and management actions. We are continuing to track to the spread of lionfish, so please remember to report any sightings/collections to the USGS/NOAA/REEF international sightings database

<<http://nas.er.usgs.gov/queries/FactSheet.asp?speciesID=963>>

<http://nas.er.usgs.gov/queries/FactSheet.asp?speciesID=963>.

If you want to stay informed about sightings in new locations, please sign up to receive lionfish alerts at

<<http://nas.er.usgs.gov/AlertSystem/default.asp>>

<http://nas.er.usgs.gov/AlertSystem/default.asp> .

Some locations are now working to develop local lionfish response plans. To assist with this, the Reef Environmental Education Foundation (REEF) is partnering with NOAA, USGS, and Simon Fraser University to hold lionfish workshops focused on educating local managers, dive operators and fishermen with early detection and rapid response strategies, handling techniques, and local market development initiatives. A media summary of the last workshop in the Turks and Caicos can be found seen at:

<<http://wiv4.wordpress.com/2009/01/30/the-decer-holds-conference-on-controlling-lion-fish-migration/>>

<http://wiv4.wordpress.com/2009/01/30/the-decer-holds-conference-on-controlling-lion-fish-migration/>

The abstract for the review paper is below.

Best Fishes,  
Lad

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Biology and Ecology of the Invasive Lionfishes, *Pterois miles* and *Pterois volitans*. JAMES A. MORRIS, JR., J.L. AKINS, A. BARSE, D. CERINO, D.W. FRESHWATER, S.J. GREEN, R.C. MUÑOZ, C. PARIS, and P.E. WHITFIELD  
ABSTRACT

The Indo-Pacific lionfishes, *Pterois miles* and *P. volitans*, are now

established along the U.S. southeast coast, Bermuda, Bahamas, and are becoming established in the Caribbean. While these lionfish are popular in the aquarium trade, their biology and ecology are poorly understood in their native range. Given the rapid establishment and potential adverse impacts of these invaders, comprehensive studies of their biology and ecology are warranted. Here we provide a synopsis of lionfish biology and ecology including invasion chronology, taxonomy, local abundance, reproduction, early life history and dispersal, venomology, feeding ecology, parasitology, potential impacts, and control and management. This information was collected through review of the primary literature and published reports and by summarizing current observations. Suggestions for future research on invasive lionfish in their invaded regions are provided.

KEY WORDS: Lionfish, invasive species, Pterois

Carrie Manfrino [manfrino at reefresearch.org](http://manfrino.at.reefresearch.org)

*Sun Feb 1 19:13:27 EST 2009*

Unfortunately, we have 2 lionfish in a tank at the Little Cayman Research Centre. Divers caught them last week. It has been an entire year since the first sighting on Little Cayman. Several (6) more fish are being reported on the reef in Little Cayman. Fish are being sighted in Bloody Bay Marine Park which is located on the north side of the island and on the south side of the island as well.

The local Department of Environment is monitoring the situation. CCMI completed a rapid assessment in August 2008 and found no lionfish. We have a rapid assessment planned for August 2009. Please visit our website if anyone is interested in participating.

Carrie Manfrino  
Central Caribbean Marine Institute  
PO Box 1461  
Princeton, NJ 08540  
<http://reefresearch.org>

Michael Lombardi [explore at oceanopportunity.com](http://explore.oceanopportunity.com)

*Fri Feb 6 08:42:26 EST 2009*

Hello folks,

I'm posting on behalf of a friend/colleague who is a physician doing a toxicology rotation. Yesterday a patient visited the ER with an extremely swollen hand, saying that he had contact with a lionfish while diving about ten days ago. No problems occurred since then. Has anyone had experience with lionfish toxins? First response? Known household treatments? Any specific medicines that work better than others?

Thanks for any guidance

ML

Michael Lombardi

<<http://www.oceanopportunity.com/>> Oceans of Opportunity  
The Explorer's Club, MN'07

January 2009

Steve LeGore [slegore at mindspring.com](mailto:slegore at mindspring.com)

*Sat Jan 31 12:49:56 EST 2009*

A friend, a marine ornamental fish collector, tells me he captured a lionfish in Bahia Montalvo adjacent to one of the mid-bay mangrove islands on Saturday, January 17th. The water was about 6 ft deep and the 5.5 inch-long fish was found in a grass bed with mud bottom.

The catch has been reported to local NOAA folks, who visited and photographed the fish, and who were scheduled to visit the site for taking GPS coordinates, so I assume a more formal report will be forthcoming.

Steve

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Hernandez Edwin [coral\\_giac at yahoo.com](mailto:coral_giac at yahoo.com)

*Sat Jan 31 14:24:22 EST 2009*

Hola, Steve et al.

According to local fishermen in Culebra Island, 27 km east of Puerto Rico, when some of them were confronted with lionfish pictures they claimed having seen the fish for the past 10-15 years or so around Los Corchos and La Puso reefs, east of Culebra, particularly in deeper waters, 80-140 feet. They described their shape, color, size, behavior, and preferred reef habitat perfectly matching the known characteristics of the species. These are the northeasternmost coral reefs of PR state waters, and are located several km west-northwest of Red Hind Bank, St. Thomas, USVI. I have not personally seen any of them yet.

Regards.

Edwin

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*Thu Jan 8 15:57:28 EST 2009*

Recently one of my students (Luis Lora) went diving in Colombia (First two weeks, Dec 08). He emailed me a picture of a lionfish - He contends that the observation was at the following location, as per his email:

"I don't know if you got this: location of the area where the lionfish was observed. Providencia and Santa Catalina islands are located between the coordinates 13° 17' y 13° 32' N y 81° 17' y 81° 26' W, approximately 600 Km.. From Cartagena de Indias, a major Colombian tourist city, 200 Km. away of Central America, only 20 minutes flight from San Andrés island in the Colombian Caribbean.

Alojamiento Old Providence y Santa Catalina"

That observation would put the range of the 'lionfish' further south than the 6 Jan 09 update of the USGS Lionfish Sightings map:

<http://nas.er.usgs.gov/queries/FactSheet.asp?speciesID=963>

E. Esat Atikkan

Jay Robs [jayrobson at gmail.com](mailto:jayrobson@gmail.com)

*Sat Jan 10 12:21:20 EST 2009*

I have heard many reports of Lionfish in the Florida Keys, even one urban legend of someone catching them with live shrimp.

-JayR

December 2008

Katherine Cure [katherine.cure at gmail.com](mailto:katherine.cure@gmail.com)

*Thu Dec 18 21:47:50 EST 2008*

Hello to all,

I just got the first report for lionfishes at Turneffe Atoll, Belize. I haven't personally seen them, but got the report from dive master at The Agressor, a local liveaboard. Pictures, gotten by a local diver on the eastern side of Turneffe are available for species ID. Can those colleagues involved in dealing with this invasive species contact me with further information?

Cheers,

--

Katherine Cure, M.Sc.  
Field Coordinator/Coral Reef Researcher  
Oceanic Society  
Blackbird Caye, Belize  
T: (501) 220-4256

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Mark A. Albins [albinsm at science.oregonstate.edu](mailto:albinsm@science.oregonstate.edu)

*Sat Dec 20 01:49:07 EST 2008*

Hi Katherine,

Our lab has been conducting a broad range of lionfish research over the last two years, focusing primarily on their interactions with native Bahamian reef fish. I've attached a pdf of our recent MEPS publication, in which we document that single lionfish transplanted onto small patch reefs reduce recruitment of native fishes by nearly 80%! Unfortunately, lionfish are currently spreading rapidly westward and southward, and it is likely only a matter of time before this ravenous, invasive predator is literally all over the Caribbean. This does not bode well for native reef communities.

I'd be more than happy to take a look at your photos and help to confirm the species ID. I also strongly suggest that you report your lionfish sighting to the USGS aquatic invasive species database.

Report sightings here: <http://nas.er.usgs.gov/SightingReport.asp>

They seem to have the most comprehensive online compilation of lionfish sightings, as well as a recently updated fact sheet:

<http://nas.er.usgs.gov/queries/FactSheet.asp?speciesID=963>

You can see from their maps (see links in fact sheet) that your sighting, if confirmed, will be the first from Central America.

Please let me know if you have any questions about our research, or about lionfish in general. I'd be happy to try to answer them, or refer you to someone who can.

Aloha,

Mark

Lad Akins [Lad at reef.org](http://ladatreef.org)

*Sat Dec 20 10:07:40 EST 2008*

HI Katherine, Mark and all,

Thanks Mark, for chiming in with info and forwarding the USGS NAS site. A number of us have been collaborating on research, education/outreach, early detection/reporting/rapid response and control and have many lessons learned from the past few years of intense work in the Bahamas, Bermuda, the US East Coast and the Caribbean. I thought I'd respond to Katherine's info request and pass along more info to those interested in the lionfish (and other non-natives) issue.

First, the report...we are aware of this one and vetting final details before putting the word out. The report came in to us on December 11<sup>th</sup> (the day the fish was sighted) from one of Peter Hughes' dive vessels. An instructor (who has significant experience diving in New Guinea and knows her fish!) found the lionfish about mid-day on the 11th at a site referred to as Doc's Place on the east side of Turneffe. The fish is approx. 8-10cm and was observed in the open at a depth of 85'. We do have photo confirmation of the fish (I've seen the images and confirmed the sighting) and are working on final details before putting the fish into the USGS NAS sightings database.

For those of you interested in staying current on lionfish distribution and new reports, please consider signing up for the USGS early warning notification system. All data that we receive is forwarded into this master database and any new records of lionfish or other non-native species are broadcast to those signed up for the early warning system. You can access the site at <http://nas.er.usgs.gov> <<http://nas.er.usgs.gov/>> and follow the links to the taxa of your choice.

For each of the records listed in the lionfish distribution map, additional info is accessed by clicking on the map dot. Records in this system are well vetted and QA generally requires an image or very strong evidence of occurrence before inclusion, hence the delay in getting the Belize fish into the system.

Another site of interest may be the lionfish progression map showing the spread of this invasion by year.

[http://fl.biology.usgs.gov/lionfish\\_progression/lionfish\\_progression.html](http://fl.biology.usgs.gov/lionfish_progression/lionfish_progression.html)

This map is updated regularly though not daily.

I encourage the reporting of all sightings of lionfish or any other non-native species via either the REEF Exotic Species Reporting page

<http://www.reef.org/programs/exotic/report>

or the USGS NAS System <http://nas.er.usgs.gov/SightingReport.asp>

If anyone is interested we also have a lionfish project already planned for Belize in June (13th-20th) aboard Peter Hughes' Sundancer liveaboard. This was originally planned to be an education/awareness project, but it looks like we may be doing more now with this early arrival.

Best Fishes,

Lad







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The content on this web page was last updated in April of 2012. For more information:

<https://sites.google.com/site/thechagosarchipelagofacts/>

## Update

### The Chagos Archipelago - New Web Site Launched

## The Chagos Islands - The World's Largest Marine Protected Area

The United Kingdom's (UK) Chagos Archipelago, located in the middle of the Indian Ocean, is the world's largest coral atoll. It is often compared to the Galapagos or Australia's Great Barrier Reef in terms of its importance as a hotspot of biodiversity. As one of the most pristine and resilient tropical marine environments on Earth, the Chagos Archipelago is home to 17 species of breeding seabirds, about 1,000 species of fishes, 220 species of corals, and two species of endangered sea turtles. Leading scientists from around the world support the UK designation of this immense area as a no-take marine protected area. Opposition, however, has come from the native islanders (Chagossians) who were evicted between 1967 and 1971 to make way for a US military facility on the largest island of the archipelago, Diego Garcia. The Chagossians have been battling the British government in the UK courts for the right to return to the islands.



British Indian Ocean Territory (BIOT) Coat-of Arms

This professional exchange discussion is a fairly balanced airing of opinions and ideas on environmental protection and conservation throughout the Chagos Archipelago, as well as a discussion of social issues involving the displacement and return of the Chagossians. It is important to note that while this professional exchange was ongoing, the UK had yet to announce a decision on designating the Chagos Archipelago as a no-take marine protected area (MPA).

On April 1, 2010, the United Kingdom's Secretary of State designated the Chagos Archipelago as a no-take marine reserve. This declaration makes it the largest marine protected area in the world, totaling more than 210,000 square miles (545,000 square kilometers), and doubles the total global area of marine reserves.

[Click here](#) for a listing of discussion participants

[Click here](#) to download the complete unedited discussion (pdf, 143 kb)

### Read About:

- ❖ [Introduction and background](#)
- ❖ [Synopsis of Discussions](#)
- ❖ [Final Chapter](#)
- ❖ [Information Sources](#)



*The Chagos Archipelago in the middle of the Indian Ocean*

## Introduction and Background

The islands of the Chagos Archipelago were discovered by Portuguese explorers in the early sixteenth century and claimed by France in the eighteenth century as a possession of Mauritius. African slaves and Indian laborers were brought to the islands to establish copra plantations on the main island of Diego Garcia. In 1810, Mauritius was captured by the British and ceded to the United Kingdom (UK) four years later. Then, in 1965, the UK split the Chagos Archipelago from Mauritius and combined it with three islands from the Seychelles to form the British Indian Ocean Territory (BIOT). In 1976, however, the Seychelles attained its independence and the three islands were returned, leaving only the six main island groups of the Chagos Archipelago to comprise the BIOT.



*Middle Brother Island, one of the many uninhabited Chagos islands (Photo: Courtesy of the Chagos Conservation Trust/ Anne & Charles Sheppard)*

In 1966, the British Government purchased and closed down the copra plantations and extradited the entire population of Chagossians (also called "Ilois") to Mauritius. Five years later, the UK and the United States signed a treaty, leasing the island of Diego Garcia to the American military for the purposes of building a large air and naval base. Work on the military base began with several long range runways and a harbor suitable for large naval vessels.

The evicted Chagossians, principally residing in Mauritius, the



*U.S. Air Force Base on Diego Garcia (Photo: United States Air Force (USAF))*

Seychelles, and the UK, have continually asserted their right to return to Diego Garcia. The British Government established a trust fund as compensation for the displaced islanders, but the Chagossians continue to pursue a series of lawsuits against the British Government seeking further compensation and the right to return to the territory. In 2006 and 2007, British courts invalidated immigration policies that had excluded the islanders from the archipelago but upheld the special military status of Diego Garcia. The following year, the House of Lords, as the final court of appeal in the UK, ruled in favor of the British Government by overturning lower court rulings and finding no right of return on the part of the Chagossians.

It is uncertain whether the Chagossians will ever be permitted to return to Diego Garcia. However, should resettlement occur, the terms of the no-take marine reserve now established in the Chagos Archipelago would need to be adjusted to allow, for example, sustainable subsistence fishing by the residents.

The Chagos Archipelago, at the southern end of the Laccadives-Maldives-Chagos atoll chain, is an isolated group of coral atolls and reefs in the central Indian Ocean (centered at about 6°S, 72°E), about halfway between Africa and Indonesia. It is comprised of five atolls, 10 other shallow reef banks and submerged shoals, about 55 uninhabited islands, and Diego Garcia, which houses military and civilian contractors at the joint UK-US military facility.

The Chagos Archipelago contains the world's largest coral atoll and has one of the most pristine and healthiest shallow-water reef ecosystems in the world. It also supports a number of deep sea habitats, including deep trenches, oceanic ridges and sea mounts, each of which harbors specially adapted species.

Chagos contains up to one-half of the healthy reefs in the Indian Ocean and is one of the most ecologically sound reef systems on the planet. Elsewhere in the Indian and Indo-Pacific Oceans, reefs are under pressure from the effects of massive human population growth and are nearly all in decline. Pollutant levels in Chagos waters and marine life, however, are exceptionally low, mostly below detection levels at one part per trillion, making it an appropriate global reference baseline. The ecosystems of the Chagos have thus far been resilient to coral bleaching and environmental disruptions. The archipelago and its surrounding waters support an incredible biodiversity, but it is this diversity that is under threat with at least 60 species on the IUCN (World Conservation Union) Red List of Threatened Species. The area is also critical for the repopulation of coral systems along the East Coast of Africa and to the recovery in marine food resources in sub-Saharan Africa.

The uninhabited (except Diego Garcia Island), isolated, and centrally-located shallow water and deepwater ecosystems act as 'oases' and banks for marine and island species. They are invaluable as stepping stones, crucial refuges, staging posts, and breeding grounds for marine biota and the richest diversity of seabirds in the Indian Ocean. The archipelago is the source of an abundance of larval and juvenile marine animals that drift or migrate long distances, restoring reefs and sustaining marine populations throughout the region.

Free of human disturbances, the archipelago's water is far clearer than most waters around coastal reefs, allowing corals to grow at deeper and cooler depths. This also enabled the corals to survive a severe, temperature-related coral-bleaching event in 1998. Deeper corals



*A healthy reef in the Chagos Archipelago (Photo: Courtesy of the Chagos Conservation Trust)*



*(Photo: Courtesy of the Chagos Conservation Trust)*



*Gold-spotted Trevally protected in the no-take MPA (Photo: Courtesy of the Chagos Conservation Trust)*

provided a reservoir for larvae that replaced the dead corals at shallower depths. The Chagos reefs proved resilient and returned to good health, while many reefs in the broader Indian Ocean region did not recover.

With the creation of the Chagos Marine Protected Area (MPA), an area covering 210,000 square miles (545,000 square kilometers), the UK doubled the global coverage of the world's oceans under protection.

The MPA includes a no-take zone where all commercial fishing and deep-sea mining activities are banned.

In support of the argument to quickly designate the Chagos as a no-take MPA, one of the participants in this Professional Exchange (University of Warwick) stated that "Every ocean needs at least one set of reefs where no run-off, no dredging, no building, no fishing, no nutrient enrichment and no pollutant and pesticide release whatsoever takes place. For the Indian Ocean, the reefs of Chagos are the prime candidate, and perhaps are the only sensible possibility. In the late 20th century, there are now very few others which fit the bill."



*Nesting bird populations in the Chagos Islands (Photo: Courtesy of the Chagos Conservation Trust)*

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## Synopsis of Discussions

All participants in this discussion were concerned scientists and conservationists. Most differed in their views only with respect to the timing of the Chagossians return to the Chagos islands or the Chagossians rights to establish a viable economy based on conservative subsistence exploitation of local, living marine resources.

The first post to the Chagos Island discussion was brought by a participant who called attention to the United Kingdom's (UK) three-month public consultation on extending conservation protections for the Chagos Islands and its surrounding waters. He stressed the importance of the Chagos Archipelago as a large, still pristine tropical marine environment, comparable in importance to the Australian Great Barrier Reef and the Galapagos Islands. He also noted that the three main consultation options were (1) a complete no-take over the entire exclusive economic zone (EEZ); (2) complete EEZ MPA, zoned and with no-take in shallow waters but continued pelagic fishery; or (3) no-take over the reefs and shallow waters. Most leading scientific and non-governmental organizations (NGOs) supported the creation of the first option. However the Chagossians, as well as Mauritius (who claim the islands), were largely excluded from initial discussions and have made clear that while they support conservation, they do not agree with a total no-take zone everywhere. A fourth option suggested was to develop an MPA with very large no-take elements but with a provision for continued conservation under future political scenarios, such as the Chagossians returning or Mauritius gaining sovereignty over the area. (The UK government has promised this once the military base is no longer needed.)

Another participant, who set the tone for subsequent discussions, thought it "disingenuous" to propose the creation of this protected area without mentioning how, and in what manner, the former occupants of the archipelago were removed. He noted that when the UK and the US planned and established the Naval Support Facility at Diego Garcia Island, there was no apparent input from or consultation with the soon-to-be-displaced islanders. He raised the question of Chagossians' rights to return to their homes, human rights, and the



Diego Garcia Island (Photo: USAF)

role of scientists and conservationists in a discussion that should focus on social considerations. He opined further that creating a wholly exclusionary conservation zone might be ill-advised, as a full no-take conservation zone "will eventually be overtaken, anyway, through encroachment of human activities and abandonment of conservation laws by future governments. Whereas, having an established community with a vested interest toward conservation would create a stronger and longer lasting presence in the Chagos islands to ward against encroachment."

Still another participant noted that he could "not see any circumstances in which it would be disadvantageous to anyone (other than ocean fishing fleets) to have this large reef system protected in their entirety now, given that in the event of a change in sovereignty or settlement, conservation arrangements could be modified. Designating these reefs, islands and surrounding waters now as fully protected would safeguard them for the future, whatever that may be."

A different participant, who championed the Chagossians right to return to the islands, noted that the Chagossians were ill-served by their unwilling removal and that a no-fishing declaration would prohibit their only means of livelihood should they return. He inquired as to why the government was in such a hurry to designate the island area as an MPA. He noted that the coral reefs and adjacent ecosystems have remained in remarkable health for the last 40 years. He also mentioned that extra immediate protection for this remote area would probably not be achieved by the designation, as there exists a lack of real enforcement resources. In reply, a proponent of immediate protection of the Chagos Archipelago stated that "the goal is to fully protect the near-pristine coral reef and other marine environments of the central Indian Ocean, and anything that would delay or derail that effort should be avoided. Protecting this area would be an enormous contribution to the conservation of the world's marine environment. The UK Government has no other marine area under its jurisdiction that is as rich biologically, which could be protected as cheaply, or which would be so universally beneficial. Conservation now would be to the advantage of any future resident population, should things change in that respect, and to no one's disadvantage, least of all to other residents of the Indian Ocean."

Boiled down to its simplicity, the UK had two options related to declaring the Chagos Archipelago a MPA: (1) the UK could delay any decision on the MPA, considering the plight of the Chagossians and future political changes, or (2) the UK could quickly declare the area a MPA because of continued damage from (legal) fishing to numerous species and, partly, because the opportunity to designate the area as a MPA might not recur.

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## Final Chapter

On April 1, 2010, the UK Foreign Secretary, David Miliband, announced the creation of a Marine Protected Area (MPA) in the British Indian Ocean Territory. This included a "no-take" marine reserve where commercial fishing was banned.

*I am today instructing the Commissioner of the British Indian Ocean Territory to declare a Marine Protected Area. The MPA will cover some quarter of a million square miles and its establishment will double the global coverage of the world's oceans under protection. Its creation is a major step forward for protecting the oceans, not just around BIOT itself, but also throughout the world. This measure is a further demonstration of how the UK takes its international environmental*



(Photo: Courtesy of the Chagos Conservation Trust)

*responsibilities seriously. The territory offers great scope for research in all fields of oceanography, biodiversity and many aspects of climate change, which are core research issues for UK science.*

*I have taken the decision to create this marine reserve following a full consultation, and careful consideration of the many issues and interests involved. The response to the consultation was impressive both in terms of quality and quantity. We intend to continue to work closely with all interested stakeholders, both in the UK and internationally, in implementing the MPA.*

*I would like to emphasise that the creation of the MPA will not change the UK's commitment to cede the Territory to Mauritius when it is no longer needed for defense purposes and it is, of course, without prejudice to the outcome of the current, pending proceedings before the European Court of Human Rights.*

Note: Marine and wildlife filmmaker, Jon Slayer, made a video highlighting the incredible biodiversity of the Chagos. The three-minute film can be viewed on the website [www.protectchagos.org](http://www.protectchagos.org).

## Update

Updated April of 2012.

### The Chagos Archipelago - New Web Site Launched

A new website has been launched giving access to detailed information about the Chagos (also known as the British Indian Ocean Territory).

<https://sites.google.com/site/thechagosarchipelagofacts/>

The website provides a unique reference point to a wide range of material (scientific, general factual, legal, and human rights). It is intended to be a 'real time' resource, being updated with material obtained from the British Government and other sources. A wide range of documents can be freely downloaded. There is also an extensive research bibliography.

The site is essential reading for any scientist who wishes to work in the area, or anyone interested in the Chagos Archipelago. It also contains details of known research, past and current in the Chagos, and discussions of research areas that may be controversial.

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## Information Sources

Chagos Environment Network

<http://protectchagos.org/>

Consultation Report: Whether to Establish a Marine Protected Area in the British Indian Ocean Territory

<http://www.fco.gov.uk/resources/en/pdf/3052790/2010/marine-life-apr-2010>

Wikipedia: Chagos Archipelago

[http://en.wikipedia.org/wiki/Chagos\\_Archipelago](http://en.wikipedia.org/wiki/Chagos_Archipelago)

CIA World Factbook

<https://www.cia.gov/library/publications/the-world-factbook/geos/io.ht>

Christian Science Monitor

<http://www.csmonitor.com/World/Asia-Pacific/2010/0401/Britain-names-Chagos-Islands-world-s-largest-marine-preserve>

PEW Environment Group

Global Ocean legacy

<http://www.globaloceanlegacy.org/chagos/>

British Indian Ocean Territory

[http://en.wikipedia.org/wiki/British\\_Indian\\_Ocean\\_Territory](http://en.wikipedia.org/wiki/British_Indian_Ocean_Territory)

Chagos Conservation Trust US

<http://cctus.org/>

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## The Chagos Islands - The World's Largest Marine Protected Area

### List of participants

Bill Allison

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NOAA

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Tim Ecott

David J. Evans

Jim Hendee  
NOAA

Judith Lang

Peter Mandara  
Coral Cay Conservation

Ted A. Morris, Jr.

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Peter Raines  
Coral Cay Conservation

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University of Cambridge

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National Oceanic and Atmospheric Administration  
U.S. Department of Commerce  
[http://coris.noaa.gov/exchanges/chagos/participants\\_list.html](http://coris.noaa.gov/exchanges/chagos/participants_list.html)



# Complete unedited discussion [Coral-List] Chagos Islands

Peter Mandara [pm at coralcay.org](mailto:pm@coralcay.org)

*Thu Jan 14 11:53:48 EST 2010*

Dear Coral-List Editor,

Would you please review the following entry:

Re: The UK government's three-month public consultation on extending conservation protections for the Chagos Islands and its surrounding waters.\*\*

Now is the time to consider the future of the world's largest coral atoll -- the Chagos Islands as the government has issued a consultation on the issue.

This archipelago in the Indian Ocean has been compared to the Galapagos or Great Barrier Reef in terms of its importance as one of the greatest marine environments on the planet. It is one of the most pristine tropical marine environments on Earth; home to 17 species of breeding seabirds, about 1000 species of fish, around 220 species of coral and 2 species of endangered turtles the area needs to be protected. Its protection is supported by the leading UK scientific societies and NGOs.

To find out more about this unique and special place and the proposition to declare it as the world's largest marine reserve please visit - [www.protectchagos.org](http://www.protectchagos.org)

Coral Cay Conservation

Regards,

Peter Mandara MSc

PR and Communications Manager

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## [Coral-List] 1. Chagos Islands (Peter Mandara)

David Evans [davidjevans1818 at yahoo.com](mailto:davidjevans1818@yahoo.com)

*Tue Jan 19 15:06:17 EST 2010*

Dear All,

I write to comment on a recent post about the Chagos Archipelago in the Indian Ocean. I hope the comment is taken as civil and professional and not just contentious, as the subject can tend to get (and I don't think is helpful for anyone). What I am saying, Jim, is that I don't mean to be stirring any pots.

I'll phrase my comment as two points.

First, I think it is disingenuous to present the creation of an extensive conservation zone out of a magnificent region of islands and ocean (which is indeed magnificent), without mentioning its background and darker side. The former inhabitants of the archipelago, the Chagossians, were removed in the late 1960's by the UK and US when the US Naval Support Facility at Deigo Garcia was planned and established. Without going into detail, the removal planning and its process did not live up to the human rights tenets of either of our two nations by a wide margin. That much has been stated by the legal system in the UK within the last decade. The Chagos Islanders have been struggling for their right to return to their homes. The Chagos Islanders are in fact in favor of creating a conservation zone in the region. They have, however, no representation in the process. They want to be incorporated into the conservation zone and involved in its management. To

summarize my first point, creation of this conservation zone is not a simple matter of: "here's a magnificent marine region, let's conserve it..."

My second point I pose as a question. What is the role of scientists and conservationists when the subject of study and conservation comes up against social considerations? I know it's not a new situation and has come up many times in the past and present and, with an increasingly more populated world, will continue to increase in occurrence. In dealing with business and industry, it seems to me that adjusting profits and practices is not too big of a sacrifice to make (such as with logging industries or fisheries). When dealing with health, adjusting also seems the logical thing to do (such as with mining operations). When dealing with traditional ways of life and generational homelands it can be a difficult decision to sacrifice for the sake of the environment and conservation, but in the long run worth it for the sake of preserving ecosystem services and protecting species populations (such as with farming, ranching, and fisheries). But when

Human Rights are involved (that is: treating each other badly) what is the role of the scientists and conservationists wanting to capitalize on preserving the habitat involved?

My personal view with this situation of the Chagos Islands and the Chagossians that want to return there is that given the circumstances, creating the wholly exclusionary conservation zone is not the best thing to do for the sake of conservation. My opinion is that creating the conservation zone at the Chagos would be an excellent opportunity to create a community that is geared toward living with its environment. And my understanding is that that is what the Chagossians are interested in as well. With growing human populations and lagging solutions to environmental problems (theory as well as action), might not the Chagossians present an excellent example to the world? My concern (besides that for the Chagossians' plight) is that an exclusionary conservation zone set aside as a jewel in a degraded world, with ever increasing human populations, will eventually be overtaken anyway through encroachment of human activities and abandonment of conservation laws by future governments. Whereas, having an established community with a vested interest toward conservation would create a stronger and longer lasting presence in the Chagos islands to ward against encroachment. Treating local communities badly does not serve the cause of conservation around the world now and in the future.

I understand that in the past governments have often acted this way, treating peoples poorly for the sake of their own agendas. I personally, don't want the practice to continue into my generation and beyond. I don't want the legacy of a magnificent conservation zone to be tarnished by its history, when positive alternative solutions are available.

I ask any that have read and have been interested to consider these points sincerely.

I have posted photos and commentary about the atoll of Diego Garcia in the Chagos, both above and below the waves, in the past few years. Please be welcome to view the island and its reefs:  
(scroll through my lists of posts over several pages to find those for Diego Garcia)

My Posts

<http://www.gather.com/viewPostsByMember.action?memberId=59629>

Photo Log: Diego Garcia II - Chagos, Indian Ocean - 'Footprint of a People'

Photo Log: Diego Garcia, Chagos, Indian Ocean

Photo Log - Marine Life: Diego Garcia, Chagos, Indian Ocean I

(let me know if links don't work - you can try [www.djem18.gather.com](http://www.djem18.gather.com) and look for "Posts")

Related:

Deslarzes, KJP, DJ Evans, and SH Smith. 2005. Marine Biological Survey at United States Navy Support Facility, Diego Garcia, British Indian Ocean Territory, July/August 2004. Cont. No. N62470-02-D-9997, Task No.

0044. Geo-Marine, Inc., Plano, TX; Naval Facilities Engineering Command, Pearl Harbor, HI; Department of Defense Legacy Resource Management Program, Proj. No. 03-183

Best Regards,

David J. Evans  
Marine Biologist/Photographer

[davidjevans1818 at yahoo.com](mailto:davidjevans1818@yahoo.com)  
[www.djeml8.gather.com](http://www.djeml8.gather.com)

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# Coral-List] 1. Chagos Islands (Peter Mandara)

**Jim Hendee** [jim.hendee at noaa.gov](mailto:jim.hendee@noaa.gov)  
*Wed Jan 20 08:01:01 EST 2010*

Now it's me who is guilty of drifting a little off-topic (I guess). I recently read a fascinating article about Diego Garcia and the displacement of their inhabitants:

<http://www.nybooks.com/articles/22691>

I mention this to provide further context (i.e., "the darker side"). I personally see the consideration of establishing a conservation zone as a good thing, but I can see your point about representation in management.

At any rate, I can see this is a fine but important line between politics and a Chagos Island conservation zone. I guess we'll see how this discussion goes.

Jim

\*\*\*\*\*

# [Coral-List] Chagos Islands

**David Evans** [davidjevans1818 at yahoo.com](mailto:davidjevans1818@yahoo.com)  
*Wed Jan 20 15:27:03 EST 2010*

Dear List -

There is a petition to show support for concerns of the Chagossians (please visit the link included below). I received this today from the

UK Chagos Support Association. They do not have the financial resources that some conservation groups have including PEW and Coral Cay but they are trying to get the word out.

I think a conservation zone is a good thing too (I was part of a team surveying Diego Garcia in 2004). But after being treated the way they were in their removal and being swept under the rug for so long after that, I can't see disregarding them again as acceptable to either the UK or the US.

Best Regards,  
David J. Evans

Marine Biologist/Photographer  
[davidjevans1818 at yahoo.com](mailto:davidjevans1818@yahoo.com)  
[www.djeml8.gather.com](http://www.djeml8.gather.com)

*>From the UK Chagos Support Association:*

Sent: Wed, January 20, 2010 4:12:37 AM  
Subject: UK Chagos Support Association: Update Special

Dear Supporter,  
The Chagos Environment Network lobby campaign is circulating a petition to encourage the Secretary of State to create a Marine Protected Area covering the Chagos Archipelago. A wonderful environmental initiative BUT it disregards the rights of the illegally exiled islanders. Conservation and human rights MUST go hand in hand. The Chagossians do not have the influence and resources available to the CEN but the Marine Education Trust have designed a petition which recognises that the Chagossians have a vital part to play in the future marine conservation and environmental protection of their homeland.

Please sign this and encourage all your friends and contacts to sign as well.  
<http://www.marineeducationtrust.org/petition/protect-chagos>  
More information in this article for the Mauritius Times by Dr. Sean Carey.

[http://mauritius-times.com/index.php?option=com\\_content&view=article&id=93:sean-carey-&catid=1:latest-news&Itemid=5](http://mauritius-times.com/index.php?option=com_content&view=article&id=93:sean-carey-&catid=1:latest-news&Itemid=5)



## **Coral-List] Chagos - whoever said conservation was simple**

**Mark Spalding** [mark at mdspalding.co.uk](http://mdspalding.co.uk)

*Thu Jan 21 05:27:45 EST 2010*

This is a fascinating challenge for how best to do conservation. Its a big enough area of coral reefs (>1% of the world's reefs - more than Belize, more than double Florida!) that most readers should be interested.

The Chagos Archipelago is a vast area of healthy reefs in the Indian Ocean. The UK government's consultation is a fantastic opportunity to encourage comprehensive and sensible conservation. The fight for the human rights of those exiled from Chagos continues, however. A large number of UK Members of Parliament are now supporting their cause, and the case has been taken to the European Court.

The UK government is consulting on 3 main options plus an "any other suggestions" option. The first three are 1 - complete no-take over the entire EEZ (making the largest no-take in the world by some margin); 2 - complete EEZ MPA, zoned and with no-take in shallow waters but continued pelagic fishery; or 3 - no-take over the reefs and shallow waters only (2 and 3 are effectively the same).

Powerful conservation and science groups are arguing strongly for 1, but the exiled Chagossians as well as Mauritius (who claim the islands) were largely excluded from initial discussions and are very upset. All have made clear calls that they too want conservation, but not total no-take everywhere. Some fear it may be a ruse to continue their exile.

Given the parlous state of the world's coral reefs it may indeed be the case that protection of this vast reef tract should be a leading priority. ...and of course it has been argued that the protection and management could be re-negotiated should the situation change on the ground. You can support option 1 by signing the following petition [www.protectchagos.org](http://www.protectchagos.org)

Others are worried that an MPA on such a foundation will be undermined should the Chagossians win their court case or the Mauritians be handed sovereignty (the UK government has promised this once the military base is no longer needed (yeah, right!)), but there is also a small possibility that the northern atolls may be handed over sooner). They worry that under these scenarios the MPA might be repealed and further that these groups, whose trust in the conservation and science community has been seriously undermined, would not then be willing to listen to any further advice from the same groups. This body of opinion would suggest that the best way forwards, both for stable, long-term conservation AND for human rights issues, is in dialogue. Ideally to develop an MPA with very large no-take elements, but with provision for continued conservation under future scenarios of Chagossian return or even perhaps Mauritian sovereignty. There is enough reef, and a small enough land area that the no-take proportion could be very large indeed. This is an "option 4" route, and there's a petition for that too  
<http://www.marineeducationtrust.org/petition/protect-chagos>.

Of course further consultation would likely delay any decisions.

Or just send your own comments to the UK government on links via eg. <http://ukinmauritius.fco.gov.uk/en/working-with-mauritius/MPA> (ironic url considering Mauritius is furious over this whole thing!)

....but of course the UK government could decide its all too difficult and do nothing!

Best wishes

Mark Spalding, PhD  
mark"at"mdspalding.co.uk  
Conservation Science Lab, Dept Zoology  
University of Cambridge, UK

## [Coral-List] Chagos Islands

**Ted Morris** [easy501 at zianet.com](mailto:easy501@zianet.com)

*Thu Jan 21 11:36:07 EST 2010*

The process of protecting the marine environment of the Chagos Archipelago is at a critical point, and signing the petition at <http://protectchagos.org> is the very minimum anyone concerned with the reefs of the Chagos should do.

Politicizing the process by insisting on the inclusion of Chagossian claims, all of which have been dismissed by UK and US courts, would be unwise. That said, there are certainly many people who wonder just what really did happen to the islanders back in the early 70s, and would like to ensure that a suitable political solution is arrived at on their behalf. To fully participate in that discussion, one should reflect on the economic and geo-political context of the times, and not solely on emotional appeals. There is also a huge amount of data concerning the demographics and population that is germane to the discussion, but is not included in the arguments posted to date.

I've been a student of the islands, it's history and current uses for many years, and about 18 months ago I wrote a short paper summarizing the various British Court cases, the Chagossian lawsuit in the US, and the available published literature at the time. That information might be of interest to readers as they attempt to determine what role the Chagossian community should play in the future of the islands. The paper is on line at <http://www.zianet.com/tedmorris/dg/chagossians.pdf>.

Meanwhile, the goal is to fully protect the near-pristine coral reef and other marine environments of the central Indian Ocean, and anything that would delay or derail that effort should be avoided. Conservation now would be to the advantage of any future resident population, should things change in that respect, and to no one's disadvantage, least of all to other residents of the Indian Ocean.

Ted A. Morris, Jr.  
<http://www.zianet.com/tedmorris/dg/stc.html>



[easy501 at zianet.com](mailto:easy501@zianet.com)  
skype: ted.morris.501

## [Coral-List] Chagos Protected Area

Sheppard, Charles [Charles.Sheppard at warwick.ac.uk](mailto:Charles.Sheppard@warwick.ac.uk)

*Thu Jan 21 15:21:14 EST 2010*

As earlier writers note, the British government has issued a Consultation seeking views on whether the Chagos Archipelago should be designated a very large protected area, and the degree of protection it should have. The primary reason is its reefs. The proposal is that this be made an enormous protected area. Supporting this is the Chagos Environment Network (CEN), a collaboration of several leading conservation and scientific organisations including the Linnean Society of London, Marine Conservation Society, Pew Environment Trust, Royal Botanic Gardens Kew, Royal Society, RSPB, Zoological Society of London, etc.

The CEN campaign website, [www.protectchagos.org](http://www.protectchagos.org)  
<<https://mywebmail.warwick.ac.uk/exchweb/bin/redirect.asp?URL=http://www.protectchagos.org/>> and the website of the Chagos Conservation Trust [www.chagos-trust.org](http://www.chagos-trust.org) <<http://www.chago-trust.org/>> contain many downloadable pdfs with much information.

The science: These websites include the report from a workshop at the UK's NOC last year, whose participating organisations included more than just the above. Its output "Marine Conservation in the British Indian Ocean Territory: Science issues and opportunities", concluded that there is sufficient scientific information to make a very convincing case for designating all the Exclusive Economic Zone of the Chagos Archipelago as a Marine Protected Area.

Chagos contains 49% of the 'Least Threatened' reefs in the Indian Ocean, all within one jurisdiction. If protection of such a significant area can happen anywhere, it is here. It is as much the poor state of so much of the rest of the region as it is the good state of reefs in Chagos that creates the need for a reference site, a refuge, and more. I hope you will visit these sites, read some of the large amount of information, and petition for Option 1: a no-take protected area.

Protecting this area would be an enormous contribution to the conservation of the world's marine environment. The UK Government has no other marine area under its jurisdiction that is as rich biologically, which could be protected as cheaply, or which would be so universally beneficial.

Chagossian removal in the 1970s was the issue mainly focussed on by earlier writers. For a well-documented account of events,

demographics, and compensation details see <http://www.zianet.com/tedmorris/dg/chagossians.pdf> <<https://mywebmail.warwick.ac.uk/exchweb/bin/redirect.asp?URL=https://mywebmail.warwick.ac.uk/Exchweb/bin/redirect.asp?URL=http://www.zianet.com/tedmorris/dg/chagossians.pdf>> , The days of viable, remote copra plantations were ending in the 1970s (when people were removed), but in fact the first two Chagos atolls were evacuated many years before the last ones, for reasons of failed economics. CEN takes a strictly environmental, non-political view, which is that whatever the eventual legal outcome turns out to be, any conservation of the archipelago and its resources now will be beneficial to all, under ALL possible future scenarios. That is why many of us are urging that the Chagos Islands and their surrounding waters be designated as a no-take marine reserve, "without prejudice" to the outcome of the legal process.

I cannot see any circumstances in which it would be disadvantageous to anyone (other than ocean fishing fleets) to have this large reef system protected in their entirety now, given that in the event of a change in sovereignty or settlement, conservation arrangements could be modified. Designating these reefs, islands and surrounding waters now as fully protected would safeguard them for the future, whatever that may be.

Tuna fishery objections are one of the key objections to a no-take MPA. One doc available for download (or soon will be) is a thorough scientific report commissioned by the CEN on this whole issue, and its results contrast with some tuna interests' view. We have the strongest support from tuna fisheries experts. While protecting or improving tuna stocks is not the goal of the proposal, it is likely to have that effect and enhance stocks elsewhere in the Indian Ocean. Regarding demersal reef fishing, we generally believe that at least this one large area should be maintained in undamaged condition. The Indian Ocean needs it. The bycatch from the offshore fishery is striking - our estimate (see the shortly to be uploaded document I refer to) is that almost 60,000 sharks were caught in a five year period by longliners in BIOT waters, with additional very heavy bycatch of other species. The IOTC Performance Review Panel has reported very high levels of uncertainty and very limited quantitative data for many of the stocks under the IOTC Agreement, and low levels of compliance with IOTC measures and obligations. (Report of the IOTC Performance Review Panel: January 2009. Indian Ocean Tuna Commission). None of which is any good for conservation.

It has been suggested that protecting this fishery may be losing an important stream of funding for current efforts to prevent illegal fishing methods in the waters around Chagos. The total value of the licences is about £1 million a year and it costs about that amount to patrol the fishery. But might it not be worth closing the fishery and protecting these fish? We know that open ocean fishing is the recent 'tragedy of the commons'.

Other downloadable docs from the websites mentioned, include general scientific docs, an economics assessment and several others. These will allow people to make informed views and to balance them with the sometimes erroneous information which is available. I hope many of you will read some of them, and will then support the move for very strong protection, by emailing the government site suggested, and by the petition on the protectchagos.org site. Those wishing to petition and

express concern for the Chagossians can of course do so. But delaying or oppose the conservation of this last very large 'Least Threatened' reef system in the Indian Ocean because of this could be very damaging.

Best wishes  
Charles

-----  
Professor Charles Sheppard  
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tel (44) (0) 2476 524975

## **[Coral-List] Chagos - whoever said conservation was simple**

**Richard Dunne** [RichardPDunne at aol.com](mailto:RichardPDunne@aol.com)

*Fri Jan 22 07:53:38 EST 2010*

Dear Listers

(In view of the nature of Coral List I have deliberately avoided political opinion or bias in this e-mail which simply sets out the facts as they exist I trust the Jim Hendee will let it through)

Mark Spalding (and others before) have drawn the issue of the possible Chagos MPA to our attention. The UK Government have set a deadline for 12 Feb 2010 for public consultation.

We, as coral reef scientists and other interested parties, are being canvassed for our support by a number of bodies, inter alia:

1. The "Protect Chagos Org" encourages us to sign a petition that supports "a full no-take marine reserve for the whole territorial waters and EPPZ/FCMZ".
2. The "Marine Education Trust" encourages us to sign a petition that does not support any of the 3 options proposed in the consultation document because none would permit the Chagos islanders to use their marine resources, and it goes on to encourage the UK Government to work with the islanders and the Government of Mauritius to devise an appropriate MPA solution. Alternatively you could:
3. Individually write to the UK Government with your views.

The UK Government Consultation document asks the question "Do you believe we should create a marine protected area in the British Indian Ocean Territory?". If the answer is Yes, then it goes on to propose 3 protection options. The most extreme of which is that proposed by the "Protect Chagos Org" (1 above).

So what should you do? The answer will depend as much on what you believe to be morally correct as it does on any notion of protecting

coral reefs. Why? Because of the recent history of the BIOT and Diego Garcia in particular.

My own experience.

In 1979 I visited Diego Garcia as a young Lieutenant in the Royal Navy. One of my roles was as the Ship's Diving Officer and I took my team diving around the atoll. We also landed on the now deserted part of the atoll where the islanders had lived. It was a surreal experience - the deserted houses which had scrawled messages in French on their walls - heartfelt pleas from the islanders as they had been forced off into exile - overhead US heavy transport planes thundered into the US Air Base, in the lagoon were the rusting hulks of the 19thC coaling ships and on the beach was a decaying WW2 flying boat. Even as UK military personnel we were not allowed near the US Air Base. Ten years later I found myself as the Legal Adviser to the Commander in Chief Fleet during the first Gulf War. We were the de-facto commander of Diego Garcia with a small UK contingent alongside the US Air Base. I was aware of the huge military importance of the base to the US even at that time.

What happened to the Chagos islanders?

In 1971 the UK Government used an immigration ordinance to remove the islanders so that Diego Garcia could be used as a US base. In 1998 the islanders began legal proceedings and the Divisional Court ruled their eviction illegal. The Foreign Secretary then agreed that they should be allowed to return to all islands except Diego Garcia. After 9/11 that position was swiftly reversed following the US and UK stance that the base had become a vital facility in the war against terror in the Middle East. As a result the UK issued an Order in Council preventing the islanders return. Orders in Council are not debated in the UK Parliament - they are laws passed directly by the Government. In 2006 the High Court ruled again in favour of the Chagossians. The UK Government appealed the decision and lost in the Court of Appeal. Finally, the highest UK court - the House of Lords ruled that the UK Government 2004 Order in Council was legal in a 3-2 majority judgement (2 judges strongly dissenting). That judgment was clearly based on security interests of the UK and the US. After the case, the Foreign Secretary declared "We do not seek to excuse the conduct of an earlier generation. Our appeal to the House of Lords was not about what happened in the 1960s and 1970s. It was about decisions taken in the international context of 2004. This required us to take into account issues of defence [and] security of the archipelago and the fact that an independent study had come down heavily against the feasibility of lasting resettlement of the outer islands of BIOT."

If you want to read the judgment of the House of Lords - see - <http://www.publications.parliament.uk/pa/ld200708/ldjudgmt/jd081022/banc-1.htm>

The case has now been taken to the European Court of Human Rights. If the UK Government loses, the Chagos islanders should be entitled to return to at least some of their islands.

Notwithstanding this position, the UK Government maintains that the Chagos islanders have no right of abode and ignores their right to be consulted on the MPA proposals.

In the light of this I ask 'What is the haste to proceed with the designation of an MPA?' From a conservation point of view the region is remote and the reefs have remained in remarkable health for the last 40 years. The area is also already extensively protected by conservation legislation. What extra immediate protection will this designation achieve - particularly given the lack of real resources to enforce it? Are we fearful of imminent development on any of the BIOT islands - hardly, when the security of the Diego Garcia base is uppermost in both US and UK Government minds, and this is the prime reason for preventing even the islanders from returning to the area. Are there concerns of pollution or desecration of the marine resources?

Declaring a MPA would make the UK Government look good on the international stage. It could also be used by them as a further nail in the coffin of the Chagos islanders case. Having removed the islanders from Diego Garcia where they had been for generations, the UK Government now declares that the area cannot support re-population. It would be convenient if it was also a marine no take reserve so that the islanders could not even fish for their own food.

Morally what should we do? The answer is very simple we should await the outcome of the Chagos islanders ECHR court case. The UK Government should not be encouraged to declare an MPA in these circumstances - it should bide its time.

I have signed the Marine Education Trust petition and I encourage you to do the same or to write to the UK Government stating that there should be no MPA in the British Indian Ocean Territory pending the outcome of the Chagos islanders case in the ECHR.

Richard P Dunne  
Lt Cdr (RN) rtd  
Barrister at Law  
sometime coral reef researcher

## **[Coral-List] Chagos Protected Area**

**Richard Dunne** [RichardPDunne at aol.com](mailto:RichardPDunne@aol.com)

*Mon Jan 25 06:31:56 EST 2010*

Dear Listers

Charles Sheppard (a proponent of the BIOT MPA) writes below in response to my earlier post:

"But delaying or oppose the conservation of this last very large 'Least Threatened' reef system in the Indian Ocean because of this could be very damaging."

but does not give any justification for why a 'delay' in the implementation of the MPA pending the European Court of Human Rights case by the Chagossians would be "very damaging". As I have already pointed out :

"From a conservation point of view the region is remote and the reefs have remained in remarkable health for the last 40 years. The area is also already extensively protected by conservation legislation. What extra immediate protection will this designation achieve - particularly given the lack of real resources to enforce it? Are we fearful of imminent development on any of the BIOT islands - hardly, when the security of the Diego Garcia base is uppermost in both US and UK Government minds, and this is the prime reason for preventing even the islanders from returning to the area. Are there concerns of pollution or desecration of the marine resources?

If we are to be persuaded to overrule any moral right that the Chagossians have in favour of scientific or conservation issues then I feel that we should be provided with the justification and rationale.

Richard P Dunne

## **[Coral-List] The Story of the Chagos Islanders**

**Richard Dunne** [RichardPDunne at aol.com](mailto:RichardPDunne@aol.com)

*Mon Jan 25 13:28:19 EST 2010*

Dear Listers

Jim Hendee has asked me to post some accessible information concerning the Chagos islands and the fate of the Chagossians in the light of the current debate on the new proposed Marine Protected Area in the British Indian Ocean Territory (BIOT).

There is an excellent website hosted by the UK Chagos Support Association at <http://domain1164221.sites.fasthosts.com/index.htm> I recommend that you visit it. This Association is directly supported by a serving and one ex Member of the UK Parliament. Its opening page features an aerial picture of the US Air Base on Diego Garcia in which I could count thirty-one B52 bombers and other large military jets.

I also invite you to visit the Marine Education Trust Petition at <http://www.marineeducationtrust.org/petition/protect-chagos> where you can see all the signatories to date from those who support the rights of the Chagossians. Inter alia it includes a former Deputy Commissioner of the BIOT and British High Commissioner to Mauritius, David Snoxall.

I re-iterate my personal stance here lest it has been misunderstood, namely "that there should be no MPA in the British Indian Ocean Territory pending the outcome of the Chagos islanders case at the European Court of Human Rights". I fully support the MPA concept from a purely scientific and conservation standpoint.

I include some additional very recent material below which re-iterates

the rights that should be accorded to the Chagossians in the MPA deliberations and which they have currently been denied by the UK Government.

Letter to the Sunday Times Newspaper 17 January 2010 by the former High Commissioner to Mauritius, David Snoxell

// Mr Snoxell was responding to a letter by the current Mauritian High Commissioner, printed last week, which had asserted the Mauritian government's right to be involved in deciding the future of Chagos. Both letters relate to Charles Clover's article several weeks ago about how a marine protected area around the Chagos islands could help boost Gordon Brown's personal "legacy." The text of Mr Snoxell's printed letter is reproduced here:

/\*In his letter (last week) commenting on Charles Clover's article "Brown can build his legacy on coral reefs", the Mauritius High Commissioner raises two issues, sovereignty and resettlement, which need to be addressed if the proposed Chagos marine protected area is to be legitimate and workable. It was a Labour government in the 1960s that expelled the islanders. What better legacy for a Labour Prime Minister than to resolve one of the most shameful episodes in recent colonial history, while also agreeing a timetable for transfer of sovereignty to Mauritius and creating the largest marine reserve in the world?

David Snoxell

Former High Commissioner to Mauritius and Co-ordinator of the Chagos Islands All Party Parliamentary Group \*/

Mr Snoxell's attempt to link the MPA issue to the wider context is especially pertinent given the Chagos Environment Network's current campaign to impose a no-take fishing ban throughout the Chagos islands. The CEN are presenting their proposal as a benign measure to ensure the protection of the Chagos archipelago and its wildlife, but in actual fact it would be disastrous to the Chagossians' cause: banning the indigenous people of Chagos from fishing their own waters is patently the wrong thing to do. It would also create a further bone of contention between the UK and Mauritian governments. As Mr Snoxell points out, the CEN are actually doing the conservation cause a great disservice by attempting to ignore the issues of sovereignty and resettlement: for an environmental protection regime to be successful, it must be part of a holistic solution.

On 7 January 2010 a Workshop was convened at the University of London. The following statement was issued:

Following the launch last March of the proposal by the Chagos Environment Network to create a Marine Protected Area (MPA) for the Chagos Archipelago, experts gathered at Royal Holloway, University of London on 7 January 2010 to consider the socio-economic issues surrounding this proposal. This workshop was chaired by Professor David Simon, Head of Geography at Royal Holloway, and its findings will contribute to the Foreign and Commonwealth Office's consultation on the Chagos' MPA.

While the 55 islands of the Chagos Archipelago have a combined land area of just 16 sq km, their total Exclusive Economic Zone for jurisdiction of marine resources, based on 200 nautical mile limits, is 635,000 sq km<sup>2</sup> - nearly three times greater than the UK land area. This marine space includes abyssal habitats of the open ocean as well as coral reefs and banks, and has exceptional biodiversity value due to its species richness and the low level of human impacts. The near-pristine Chagos Archipelago area provides both a source region and refuge for marine life in the wider Indian Ocean.

A workshop held at the National Oceanography Centre Southampton in August discussed the science issues and opportunities related to the potential creation of a substantial MPA in the Chagos Archipelago.

The principal aim of the workshop at Royal Holloway was to bring together participants from Marine Centres, Universities, and NGOs who have practical experience of MPA development and management, as well as Chagossian, Government and marine industry stakeholders, to discuss socio-economic obstacles and opportunities in the context of a possible MPA in the Chagos Archipelago. The meeting provided the opportunity for input from stakeholder groups, particularly representatives from the Chagossian community, the Indian Ocean fishing industry, and the Government of Mauritius.

Dr David Bellamy, the world-renowned conservationist, sent a message of support: "I am delighted that this workshop took place, and commend the organisers for having taken this initiative. It has long been my contention that the preservation of this unique Archipelago requires everyone to work together - Chagossians, the British and Mauritian Governments, scientists, environmentalists and conservationists across a wide spectrum of disciplines."

He adds, "The issues are complex and challenging but with good will and cooperation on all sides we can help to bring about a secure future for the Chagos Islands that protects the environment and bio-diversity as well as the interests of the Chagossian people. Carefully managed, a limited resettlement should be compatible with conservation, and indeed could enhance the overall protection of the Islands. The challenge to us all is to make this possible."

Professor David Simon adds, "This specially convened workshop formed a vital step in the contentious process of negotiation over the future status of the renowned Chagos Archipelago in the Indian Ocean. It brought together many interested parties and stakeholders who debated how to secure the environmental integrity of the islands and their marine resources in a manner compatible with the interests of the Chagossian people who were evicted some 40 years ago and who may yet have their right of return restored by the European Court of Human Rights. Viable proposals must also take account of the possible future change of sovereignty from Britain to Mauritius. It was a great honour to have been asked to host and chair this important event at Royal Holloway."

The workshop contributed in important ways to the ongoing debate. For many participants, it was their first exposure to the firmly held views



of the Chagossian representatives. These perspectives, echoed by some other participants, informed debate and the strong feeling that the FCO consultation required a fourth option that includes resettlement as a fundamental component and which would be acceptable to whichever government exercised future sovereignty over the archipelago. Unfortunately, the Mauritian High Commission withdrew shortly before the event due to dissatisfaction with the FCO's handling of the MPA consultation prior to resolving the sovereignty dispute between the two countries.

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Richard P Dunne

## [Coral-List] Chagos conservation

**Sheppard, Charles** [Charles.Sheppard at warwick.ac.uk](mailto:Charles.Sheppard@warwick.ac.uk)

*Tue Jan 26 06:24:42 EST 2010*

Richard Dunne again asks 'why protect Chagos' and 'why hurry?', and urges people to 'vote' no to the government's enquiry about whether to establish greater, clearer and easier conservation. My posting last week said the answers are in the several documents available on [www.chagos-trust.org](http://www.chagos-trust.org) and [www.protectchagos.org](http://www.protectchagos.org).

But Mr Dunne conflates issues and asks what is the urgency given that, he says, a year or two more waiting can't hurt? The urgency is partly the state of so much of the Indian Ocean: in a break-out session in one of the workshops on this last year, people came up with several biological reasons why more protection is merited now, but these really shouldn't need explaining here. Partly because of the continued damage from (legal) fishing to numerous species, particularly threatened sharks, but partly because we have the opportunity now caused by government interest in doing something, which may not re-occur if we put this opportunity off. Partly too because the consultation deadline itself is February 12th, if you want your views to be recorded.

Mr Dunne's desire for delaying conservation appears to be based on the bad treatment of people removed in the 1970s and because a no-fishing declaration would prohibit the only means of livelihood of anyone returning. But as whole paragraphs say in several docs, the whole proposal is 'without prejudice' to the court case, and explains that if Chagossians do return then revisions would be made (I imagine changes would be needed to several other laws too).

Any implication that urging stronger conservation on the UK government now is somehow being 'against' Chagossians would be false. The two issues run in parallel and are not exclusive (as several docs also explain). There was only one group identified who would be directly disadvantaged now: blue water fishing interests. Last week's London Times

(<http://www.timesonline.co.uk/tol/news/environment/article6997414.ece>) ran an article on the present fisheries interests. It shouldn't need

noting on a scientific list like this, but the tuna fishery, with its only partly quantified but huge by-catch, is quite distinct from demersal reef fishing by some local inhabitants.

Voting against a protected area now will do nothing for the Chagossians and nothing for conservation of these islands or reefs and nothing for threatened species. On the other hand a full no take protected area out to the 200 mile limit would do much to ensure these islands, reefs and threatened species were preserved - something much needed for the marine environment and Indian Ocean. Should the Chagossians return, then it would be to their advantage too.

Best wishes  
Charles

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## [Coral-List] Chagos conservation

**Richard Dunne** [RichardPDunne@aol.com](mailto:RichardPDunne@aol.com)

*Tue Jan 26 10:56:23 EST 2010*

Dear Listers

Charles Sheppard (the BIOT Scientific Advisor to the FCO) replies to my questions of "Why the haste?"

\_His Reply\_: /"Partly because of the continued damage from (legal) fishing to numerous species, particularly threatened sharks"/  
\_My Comment:\_ The present position is that under Fishery Limits Ordinance there is a 200-mile Fishery Management Conservation Zone which was established on 1 October 1991 and a fisheries regime covering all BIOT fishing waters was established on the same day by the Fisheries (Conservation and Management) Ordinance 1991. Commercial fishing within this zone is only allowed under licence. Tuna fishing is prohibited within 12 nautical miles of land. Inshore fishing for demersal species is only permitted from 1 April to 31 October, by hook and line, and not within lagoons. Effort controls are further implemented in both fisheries by limited licensing, based on the best scientific information and adopting the precautionary approach. Hunting of green turtle /*Chelonia mydas*/ has been completely banned since 1968.  
\_Response:\_ Why is the current legislation ineffective? Surely it is a matter of management and the BIOT Commissioner already has the powers to reduce the legal fishing if there is evidence of damage as alleged. Likewise to sharks?

\_His Reply:\_ /"Partly because we have the opportunity now caused by government interest in doing something, which may not re-occur if we put this opportunity off."

/\_Response:\_ The framework for any further conservation measures is already in place by virtue of the work done by the Chagos Environmental Network and other persons. The consultation will indicate whether the scientific and conservation aims have support. \_All that is required is final legislation which does not require input from the UK Parliament since it can be enacted under the powers of the BIOT Commissioner\_ (as the FCO consultation makes clear to all). Indeed as the FCO points out, because of the peculiar nature of BIOT there is actually NO LEGAL REQUIREMENT for any consultation at all. In all these circumstances it is something that is not driven by any one political party nor by the incumbent government other than on issues of administrative cost to the UK Treasury.

Neither of Charles' replies are therefore sustainable without further justification. Furthermore I am accused of conflating (blending together or mixing up) the issues. Not so, I say that on science and conservation grounds alone the idea of an MPA should go ahead. The issue of the rights of the Chagossians is separate and remains unresolved. If the scientific and conservation grounds for proceeding to enact further legislation were overwhelming then I acknowledge that the rights of the Chagossians may well have to be subjugated (temporarily or permanently). \Has the CEN or Dr Sheppard made this case? I think not.

Delaying the implementation of the MPA pending the European Court of Human Rights case is both the morally correct path to follow and the logically correct one. Logically it allows the legislation to be correctly drafted from the outset with full consultation with those with a right of abode so that it is workable. Indeed the Chagossians themselves could be entrusted, employed and paid to enforce it - what better solution than this to the difficulties of management and the sustainability of their island life?

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\*

Here are the essential and additional facts that you may all wish to have before reaching your decision which proposal you should support:

The Foreign and Commonwealth Office consultation question is:  
/DO YOU BELIEVE WE SHOULD CREATE A MARINE PROTECTED AREA IN THE BRITISH INDIAN OCEAN TERRITORY?/

/If yes - 3 broad options for a possible framework:

- (i) Declare a full no-take marine reserve for the whole of the territorial waters and Environmental Preservation and Protection Zone (EPPZ)/Fisheries Conservation and Management Zone (FCMZ); or
- (ii) Declare a no-take marine reserve for the whole of the territorial waters and EPPZ/FCMZ with exceptions for certain forms of pelagic fishery (e.g., tuna) in certain zones at certain times of the year.
- (iii) Declare a no-take marine reserve for the vulnerable reef systems only./

Considerations:

1. The formal UK Government position is that "there is no right of abode in the Territory", it follows that there can be no de- facto consultation with the Chagossians and can be no provisions for them within the legislation. To consult or legislate would mean an acknowledgement of rights.
2. The UK Government recognises that there is an ongoing legal dispute concerning the right of abode by the Chagossians in the BIOT and on Diego Garcia in particular and that should the Chagossians succeed with their case before the European Court of Human Rights (ECtHR) then "all the options for a marine protected area may need to be reconsidered".
3. Additionally, neither the UK Government nor the US would want the creation of a marine protected area to have any impact on the operational capability of the military base on Diego Garcia. For this reason, it may be necessary to consider the exclusion of Diego Garcia and its 3 mile territorial waters from any marine protected area.
4. BIOT has already been declared an Environmental (Preservation and Protection) Zone with legislation in place to protect the natural resources which include strict controls over fishing, pollution (air, land and water), damage to the environment, and the killing, harming or collecting of animals. Some of the most important land and sea areas have already been set aside for additional protection. Most of the lagoon areas and a large part of the land area of Diego Garcia are protected as Restricted Areas, four Special Conservation Areas and a Nature Reserve. Strict Nature Reserves cover the land and surrounding reefs and waters of the islands of the Great Chagos Bank and a large part of Peros Banhos Atoll. The Territory is also subject to further levels of internationally binding legal protection. This includes the designation of part of Diego Garcia as a Wetland of International Importance under the Ramsar Convention; the Whaling Convention (including an Indian Ocean Whale Sanctuary); the Law of the Sea Convention (with provisions to protect fish stocks); the Indian Ocean Tuna Commission; CITES (regulating trade in wildlife, including corals); and the Bonn Convention (with provisions to protect marine turtles and cetaceans).

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The position of a growing number of influential figures, coral reef scientists and others (399 as I write) is to \_"fully support the UK Government's efforts to protect the Chagos archipelago through the declaration of a Marine Protected Area within the territorial waters and Environmental Preservation and Protection Zone/Fisheries Conservation and Management Zone."\_ BUT \_"We do not support any of the three broad options proposed in the consultation documents, however, because full no-take protection of reef areas would provide no means for resettled islanders to utilise their marine resources for subsistence or income generation. Communities and Marine Protected Areas coexist across the world, and there is no reason why the islanders could not be successful towards of their coral reef environment."\_ AND \_"We urge you to work with the Chagos islanders and the Government of Mauritius to devise an MPA solution that makes provision for resettlement and that protects Mauritius' legitimate interests. This could be achieved through, for example, zonation that permits the sustainable use of marine resources in specific reef, lagoon and open ocean areas."\_

You can find this petition at the Marine Education Trust website at

<http://www.marineeducationtrust.org/petition/protect-chagos>

Amongst the signatories are:

David Snoxall - a former Deputy Commissioner of BIOT and the former British High Commissioner to Mauritius

John Howell - former Director, Overseas Development Institute

Graham Watson - Member of the European Parliament for South West England

Marius Wanders - Secretary General of Caritas in Europe

SCIENTISTS: Prof David Simon, Dr Judith Lang, Dr Bill Burnett, Dr Mark Spalding, Dr Sidney Holt, Dr Deborah Potts, Dr Tom Spencer, Dr Anthony Lemon, Dr Tracy Harvey, Prof Barbara Brown, Dr Tom Goreau, Dr Ben-Tzvi, Dr Martin Little, Prof Chris Perry, Dr Elizabeth Gladfelter, Prof John Ogden, Dr Elizabeth Andrew, Dr Martina Burtscher,

ATTORNEYS/ LAWYERS: Durkje Gilfillan, Richard Dunne, Hans A. De Savornin Lohman, Maite Momo, James McGowan

In a letter to the Times (London) Newspaper, today 26 January 2010 signed by eminent UK Parliamentarians: Don't forget the role of Chagos Islanders - \*The Chagos Islanders want to be involved with the conservation and environmental protection of the islands\*

Sir, Your report (Jan 22) on the proposed Chagos Islands Marine Protected Area (MPA) stated that 2,000 Chagos Islanders were "relocated" to Britain and Mauritius to make room for a US base on Diego Garcia. In fact, about 1,500 Chagossians, of whom some 700 survive, were moved against their will to Mauritius and Seychelles in the early 1970s. How many would wish to return, and the nature of a resettlement on two atolls, 150 miles north of the US base, is impossible to determine at this stage. The Chagos Islanders want to be involved with the conservation and environmental protection of the islands. Careful management and planning can, at modest cost, avoid degradation of the environment.

The All Party Parliamentary Group has urged the FCO to commission a rapid independent study of the numbers who would wish to resettle and the practicalities of resettlement. Many Chagossians will not want to live permanently in the islands but they all want the right to visit their homeland at will. The way forward is to make provision in the proposed marine protected area for Chagossian interests (such as local fishing) and those of Mauritius. Conservation and human rights must go hand in hand. We urge the Government, before the election, to lift the ban imposed in 2004 on the return of the Chagos Islanders and so end this tragedy that has dogged the UK's reputation for respect for human rights and its international obligations.

Jeremy Corbyn, MP, Chair, Chagos Islands APPG

Baroness Whitaker

Lord Luce

Lord Ramsbotham

Lord Steel of Aikwood

Lord Wallace of Saltaire

Andrew Rosindell, MP

The solution that I propose is to delay consideration of the Chagos MPA pending the outcome of the ECtHR case. This pragmatic approach recognises that until the issue of right of abode is resolved the UK

Government cannot liaise with the Chagossians concerning the MPA legislation, furthermore any legislation that may have been enacted without such consultation and without the right of abode having been finally determined may well be deemed illegal, and at the very least may need to be repealed or amended as the FCO itself recognises.

Consider also this question: If the right of abode had been recognised by the House of Lords judgment and the UK Government was instituting the ECtHR case to overturn this decision, then would they be pursuing MPA legislation which would have to recognise the Chagossian's rights? I think not - they would stay the matter. Why then should we rush to implement in the present circumstances? It is morally unjust, nor is it required.

Richard P Dunne

**Richard Dunne** [RichardPDunne at aol.com](mailto:RichardPDunne@aol.com)

*Tue Jan 26 12:00:53 EST 2010*

Dear Listers

An earlier post on the issue of the Chagos MPA posted by Ted Morris Jr almost escaped my attention until I revisited it and followed his links to his website.

Mr Morris encourages us to protect the marine environment of the Chagos by signing up to the proposed MPA. He also thinks that in protecting human rights we are politicising the process. I would love to endorse his viewpoint if it could be considered to be serious in the light of his website which whilst containing some interesting 'facts' about Diego Garcia has some fairly alarming facts and statements, for example:

\_On the construction of the runway on DG by US SeaBees: \_(photos cannot be reproduced here)And then came Tom Grenier and his buddies. They dredged the coral used to build the runway. Here's a little photo essay on how they did it.First, you set your charges and blow a big hole in the coral....Then you bulldoze out the rock....Then, Harry and Joe haul all the "little rocks" to the crusher...Then you have a party.....and another.....and another ....Or, you could go fishing and looking around the reef for whatever you could find...

You might also like to visit the page on blowing a hole in the reef for a ship canal. and I am sure that there is something there about dredging the lagoon for the Navy ships and submarines.\_

Elsewhere Mr Morris says\_

"Finally Those of you who have read my website, or know me personally, know that my first and foremost concern is for the defense of the United States and our democratic republic. Diego Garcia is essential to that defense, and therefore anything that would limit our use of Diego Garcia would not receive my support."

All I can say is that clearly the environmental 'protection' afforded by the presence of the US base has been fairly alarming and that Mr Morris is very lucky to live in a democracy which has not yet illegally evicted him to another country as the UK Government did to the rightful inhabitants of the Chagos, as it seems in the interests of UK and US defence.

I hope that the debate on conservation in the Chagos can proceed from a more serious and open-minded angle.

Richard Dunne

## **Coral-List] Chagos Conservation**

**Ted Morris** [easy501 at zianet.com](mailto:easy501@zianet.com)

*Tue Jan 26 14:16:56 EST 2010*

Dear Listers,

Mr. Dunne's response to my posting involves what I attempted to point out - that criticism of the current effort to protect the Chagos by tying it to actions taken at the height of the Cold War four decades ago is inappropriate.

The construction activities and the treatment of the islanders was not unusual given the circumstances of the time, and I do not defend them. However, I do not condemn them either. It simply was the way things were done. If you have read the resettlement proposals of the UK CSA, you can see that their plan to resettle thousands of islanders will be as disruptive to the Chagos as that of the SEABEES in the 1970s.

The appropriateness of the islanders' compensation is really Mr. Dunne's concern, is it not? Isn't the subject still in play in the ECHR? Won't it be a subject of legislation in the democracies involved as time goes by, regardless of the ECHR outcome? Of course. Therefore, I think where Mr. Dunne and I differ is that I believe that those are the forums in which resettlement should be discussed. Mr. Dunne's effort appears to be to halt the conservation of the Chagos by using the emotional and politicized question of the islanders' compensation. This will help no one and is potentially damaging to the marine environment of the islands for the reasons given by Dr. Sheppard in other posts in this thread.

Regards,  
Ted Morris

# [Coral-List] Chagos, now or never? or better later?

Mark Spalding [mark at mdspalding.co.uk](mailto:mark@mdspalding.co.uk)

*Tue Jan 26 14:47:12 EST 2010*

It is reassuring to hear Charles Sheppard's message.

1 - Neither the Chagossians nor the Mauritians have heard this clearly. If I can (I think) paraphrase, it might go like this. "Look guys, we've got the UK government offering us something we could all benefit from, but we've got 2 weeks left and they might never come up with an offer like this again. Of course we'll change things and accomodate your needs should the poltical situation change". Of course it may be true that the MPA would be easily altered as the poltical situation changes, but by not involving these key groups in the discussion from the start they have developed a deep distrust of the whole agenda and there is a very real risk that the MPA would be totally dismantled if the situation changes (which could be within 6 months). The world's largest and the world's shortest lived no-take zone.

2 - There are ominous other hints of "get out clauses":

- MRAG Ltd who currently manage the fisheries and patrol the waters, want to keep the pelagic fishery going...and they happen to be owned by the UK government's chief scientific advisor (to be fair they have suggested they will go with whatever is decided, but there will be some strong influence here);

- it appears that the waters around the military base will be excluded from protection;

- there are arguments that the only commercial licensed reef fishery currently permitted, run from Mauritius could be excluded from the MPA;

- I have also already been told that the visiting yachts who currently spend time in Chagos would be allowed to carry on fishing (and lets be honest it would be impossible to stop them).

- \- and its not exactly a get out clause, but there is no mention of funding for this new MPA.

So a no-take MPA that allows ALL of the current fishing? HmMMM  
....and one that is legally highly dubious because of the Mauritius claim to Chagos, and that may even be dismantled under any of several likely future scenarios.

Hindsight is easy, but I have to say that many people have been calling for collaboration with Chagos and Mauritius on this for a long time (not "informing", or "telling", or even "discussing", out and out partnership),

They should have been at the table from the start, and had they been we might be in a very different position now. Just last week France and



Mauritius agreed a joint management agreement over Tromelin, a much smaller Indian Ocean island which they both claim but which France administers.

So I would say even from a purely, selfishly, fish-centric view-point the debate is still open. One strategy states "go for a strict MPA because it might be the only chance we get...and because the UK might never let Chagossians return or Mauritius re-take sovereignty, so from the fishes point of view its a great opportunity". The other says "there are too many risks, that legislating in haste will leave too many loop-holes and too much bad-taste among the stakeholders. Look how many protected areas failed because they didn't engage the vested interests".

Is a compromise not possible? Couldn't those calling for immediate total closure now raise their concerns about the loop-holes AND clearly state their open-ness to changes in management as and when there are changes to politics and sovereignty. Surely that would be pretty close to stating the need for another option - an MPA without loop-holes, that makes space for future change. Unanimity would strengthen our hand, and it might be enough to persuade the UK government to proceed, but buy more time for ironing out concerns AND, belatedly, bringing in the stakeholders.

All best

Mark

## [Coral-List] Chagos Conservation

**Richard Dunne** [RichardPDunne at aol.com](mailto:RichardPDunne@aol.com)

*Wed Jan 27 01:36:33 EST 2010*

Ted

On your rationale it is of course possible to excuse any of man's actions on the natural environment or against his fellow humans, and neither condemn nor defend past transgressions. "It was simply the way things were done". As human society evolves and matures it develops practices to protect nature and other human beings. So we have evolved national and international laws on environmental protection, Humanitarian Law and the Geneva Convention, the Laws of War, the Law of the Sea, and bodies such as the United Nations. Underlying all this is basic morality - a sense of what is right and wrong. Without these rules or in the absence of morality there would be anarchism.

The subject of human rights is not an "emotional" one. Furthermore, where does one draw the line in the sand? The eviction of the Chagossians by the British Government? The Burmese junta? Apartheid? Saddam Hussein's persecution of the Kurds? The Nazis and the jews? The

Slave Trade? Some of these issues are in the past and have been followed by legal process: e.g. the Nuremberg trials; or the recent trial and execution of 'Chemical Ali'. Others remain in the present and are still to be determined as is the case of the Chagossians.

The House of Lords judgment in 2008 was solely concerned with the validity of section 9 of the British Indian Ocean Territory Order in Council which stated: "Whereas the territory was constituted and is set aside to be available for the defence purposes of the Government of the United Kingdom and the Government of the United States of America, no person has a right of abode in the Territory." Earlier courts (the Divisional Court and the Appeal Court) had held this section to be invalid. It was not about compensation. Nor is my concern about compensation. Nor will the ECtHR case be about compensation.

Nor do I seek "to halt the conservation of the Chagos" on these or any other grounds. True I argue that it should be stayed until the ECtHR (the final court of jurisdiction on this matter) has ruled. This will then determine whether the Chagossians must be consulted and involved in any future legislation concerning the Chagos. This is entirely reasonable and logical as I argue in earlier posts. Neither has Charles Sheppard justified why such a delay would be potentially damaging as Ted Morris alleges here. There is already extensive Fishery and Conservation legislation in force - it only a matter of enforcing it appropriately.

The question of the resettlement of the islanders is a side issue. The House of Lords noted that there were less than 1,000 inhabitants on three islands in 1962. Presumably the numbers wishing to return now are smaller. The British Government commissioned its own report in 2002 into the feasibility of the resettlement of only Peros Banhos and Salomon (Diego Garcia, the most inhabitable island was not considered). It concluded that agroforestral production would be unsuitable for commercial ventures, that fisheries and mariculture offered opportunities although they would require investment, tourism could be encouraged, although there was nowhere that aircraft could land. It might therefore be feasible in the short term to resettle the islands. But introduced into that report was the effect of global warming which was raising the sea level and already eroding the corals of the low lying atolls. In the long term, it was concluded that the need for sea defences and the like would make the cost of inhabitation prohibitive. Of course on this premise, the conservation of the coral reefs and islands of the Chagos and indeed the future of the US Base on Diego Garcia are also called into question. None are tenable. Perhaps nature's course will determine all these issues.

The largest and most inhabitable of the BIOT islands is Diego Garcia. Charles Shepherd has said in an earlier post " ... a full no take protected area out to the 200 mile limit would do much to ensure these islands, reefs and threatened species were preserved - something much needed for the marine environment and Indian Ocean. Should the Chagossians return, then it would be to their advantage too." But we also know that it is the British Government intention that "Additionally, neither the UK Government nor the US would want the creation of a marine protected area to have any impact on the operational capability of the military base on Diego Garcia. For this reason, it may be necessary to consider the exclusion of Diego Garcia

and its 3 mile territorial waters from any marine protected area." Indeed this is the most likely outcome. Diego Garcia would not therefore be protected under any new MPA, either for the good of the marine environment or for the possible future benefit of the Chagossians. The north western segment is already extensively covered in concrete, and a deepwater port and anchorage constructed. Presumably there may be continued construction, certainly continued dredging of the anchorage, discharge of sewage out to sea, etc. Diego Garcia is to be afforded no future protection under these proposals. The argument that an MPA of the type envisaged can protect the Chagos for the Chagossians is therefore flawed.

There are not two forums, one for conservation and one for the Chagossians rights. These issue are inextricably linked. I am no expert on social aspects of MPA creation but I would have thought that in all cases a holistic approach is required. That is why (and for the reasons above) the decision should be stayed.

Richard P Dunne

## Coral-List] Chagos and Hitler

tim ecott [timecott at hotmail.com](mailto:timecott@hotmail.com)

*Wed Jan 27 12:22:33 EST 2010*

- Previous message: [\[Coral-List\] Marine Environments of Palau- new book](#)
- Next message: [\[Coral-List\] cold water coral kill](#)
- **Messages sorted by:** [\[ date \]](#) [\[ thread \]](#) [\[ subject \]](#) [\[ author \]](#)

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Coral-listers,

What a wonderful example we have here of the mess that surrounds any attempt to get governmental level involvement in the creation of an MPA. All coral-listers should note the level of acrimony entering the debate. No wonder it is so hard to do anything about marine conservation and dwindling fish stocks - no sooner does one person advocate setting aside a marine reserve than another immediately pops up to denounce the negative human impact of such a move.

The debate as conducted here could provide a Ph.D case study in why marine conservation is doomed in most cases to failure. Once again does it not seem that the parties involved are arguing 'rearranging the deckchairs on the deck of the Titanic'?

And if 'Mauritius' is to be involved then why not Seychelles? The Chagossians on Agalega have been frequently looked after by the

Seychelles administration because little help or effort was forthcoming from Mauritius. And, while it may not be politically correct to point this out - the evidence of Indian Ocean states being able to adequately manage or preserve their marine environment is without a shadow of equivocation - abysmal.

Unfortunately there is a good reason for the healthy status of Chagos reefs: lack of people. I for one would vote for pretty much anything that kept it that way.

And by the way - do the arguing parties know Godwin's Law - which states that

"As an online discussion grows longer, the probability of a comparison involving Nazis or Hitler approaches 1."

a subsidiary Law states that once Hitler is mentioned the debate is to all practical purposes over.

we reached that point today - so let's move on. please.

Tim Ecott is the author of  
Neutral Buoyancy: Adventures in a Liquid World (Penguin)

## [Coral-List] Chagos Conservation

**Richard Dunne** [RichardPDunne at aol.com](mailto:RichardPDunne@aol.com)

*Fri Jan 29 10:46:14 EST 2010*

Dear Listers

This is an extract from the Mauritius Times published on Friday, 29 January 2010 written by Dr Sean Carey (Research Fellow at the Centre for Research on Nationalism, Ethnicity and Multiculturalism (CRONEM) at Roehampton University, UK)

The original posting is  
[onhttp://mauritiustimes.com/index.php/the-news/111-sean-carey](http://mauritiustimes.com/index.php/the-news/111-sean-carey)

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It refers to an article published in the Times Newspaper (London) on 26 Jan 2010 to which Charles Sheppard drew our attention in his post that day  
(<http://www.timesonline.co.uk/tol/news/environment/article6997414.ece>)

\*\*\*\*\*

Frank Pope's article in /The Times /last week, "Investment is essential

for biological wonderland of the Chagos islands", was written to highlight the pristine state of the British Indian Ocean Territory and why the area should be designated a Marine Protected Area (MPA). "There is none of the fertiliser, pesticide, silt or construction debris that are choking reefs elsewhere," he says before issuing a series of warnings about the various categories of people who, with the notable exception of "scientists who go without sunscreen for fear of contaminating the water", would mess up the area if allowed in. Put simply, the claim is that the current pristine quality of the Archipelago is all down to "the lack of inhabitants". Tourists are particularly problematic we are told: "Conservationists warn that even small numbers of visitors would risk destroying the area's value as a scientific reference point against which to gauge climate change." Fishermen are also dangerous because according to one marine scientist "the position of the islands and the prevailing currents helps to seed fish stocks and reefs elsewhere in the Indian Ocean".\*\*

But then we come to Pope's real target: the possible return of some of the exiled Chagos Islanders whose case is currently before the European Court of Human Rights in Strasbourg.

\*\*

Their return to their homeland would involve "constructing an airport and town" which would be "both financially and environmentally ruinous" to the British Foreign & Commonwealth Office although Pope conveniently omits to mention that Mauritius has stated that it will pick up the costs of resettlement and install suitable transport links (not necessarily an airport) once sovereignty of Chagos is regained from the UK.

\*\*

It is also revealing that Pope does not provide any details of the negative environmental effects of the population of around 3500 people (who may or may not use sunscreen) composed of US and British military personnel and their predominantly Filipino workforce on the base on Diego Garcia, the largest in southernmost island in the Chagos Archipelago. For the record, the base boasts the world's longest runway built on crushed coral -- after a total of 5 million cubic yards of 'coral fill' was blasted and dredged from the reef and the lagoon for construction purposes (or "harvested", as the US Navy puts it).

Nor do we read anything about the significant number of people that sail through the area and armed with the appropriate £100 a month permit issued by the BIOT authorities can moor on the outer islands of the Archipelago like Peros Banhos and Salomon where some of the Islanders once lived.

In fact, Pope's highly selective account well illustrates a general problem with a traditional and conservative approach to conservation that has a long but not very glorious history. Last year leading US investigative journalist, Mark Dowie, published /Conservation Refugees: The Hundred -Year Conflict between Conservation and Native Peoples/(MIT Press) where he exposed some of the injustices that have often been at

the heart of many apparently successful land conservation projects.

At Yosemite in the eastern Sierra Nevada Mountains of California, for example, there was a concerted and ultimately successful effort from the mid-19<sup>th</sup> -century until 1914 when the area became a national park, to expel a small group of Miwak Native Americans who are thought to have settled in the valley some 4000 years ago.

Similarly, nearly all of the other national parks in the USA, including Everglades, Glacier, Grand Canyon, Mesa Verde, Mount Rainier, Yellowstone, and Zion, were created by expelling, sometimes violently, tribal peoples from their homes and hunting grounds so that the areas recovered could remain in a "state of nature" free from human contamination.

This process has been replicated in other parts of the world as well. Indeed, Dowie estimates that over the last 100 years at least 20 million people, 14 million in Africa alone, have been displaced from their traditional homelands in the name of nature conservation by consciously employing "the Yosemite model" (which in Africa was renamed "fortress conservation") often with the tacit backing of NGOs like The Nature Conservancy, the World Wide Fund for Nature, and the African Wildlife Foundation.

Exactly 40 years ago, a British social anthropologist, Mary Douglas, in a lecture delivered at the Institute of Contemporary Arts in London pointed out that in assessing risks to environments caused by "human folly, hate and greed" it was vitally important to achieve a moral consensus by carefully scrutinising the concepts and theories which powerful groups used to explain things to themselves (and others).

But Douglas also issued a warning that relying on mainstream scientists who had absorbed not only the biases of their own professions but were also possessed by the emotional (and she might have said political) attachment to system-building was of little use for guidance in trying to resolve serious environmental problems. Insight was much more likely to come from those operating at the margins or where a number of disciplines intersected, she claimed.

History has proved Douglas right. According to Mark Dowie and others, the old model of conservation which falsely opposed nature (good) and culture (bad) is being replaced with something much more dynamic, a new transnational conservation paradigm. A younger generation of scientists recognise that properly engaged indigenous and traditional peoples have a vital role to play in preserving fragile ecosystems.

Which brings us neatly back to the Chagos Islanders. They may be relatively recent inhabitants of the Chagos Archipelago (they first arrived in 1783) but no one can legitimately claim that they do not possess the status of an indigenous or traditional people just like those descendants of former African slaves and Indian indentured labourers who live on other Indian Ocean islands like Mauritius, Reunion, Rodrigues and the Seychelles. And the only reason the Chagossians no longer reside in their homeland, part of the colony of Mauritius until it was illegally excised in 1965, is because they were forcibly removed by the British authorities.

While the evidence is clear that uncontrolled fishing can have catastrophic consequences the idea that a small settlement of Chagossians and a carefully controlled number of eco-tourists are going to destroy the pristine qualities of the proposed MPA in the Chagos Archipelago is nothing short of preposterous and flies in the face of evidence from other parts of the world like American Samoa, Australia, Chile, Indonesia and the Philippines where indigenous and traditional peoples are fully involved in the conservation and maintenance of marine reserves.

Environmentalists like Pope may be able to line up a fair number of scientists and traditionally-minded conservation groups to back their argument, but the rest of us realise that the game has moved on. This is not just because of evolving social and political realities which have undermined a hierarchical view of the world based on the principle that conservationists always know best, but because the old opposition between nature conservation where humans were seen as "the enemy" in the preservation of biological diversity has been rightly found wanting and is being slowly but surely being replaced by a much better model.

\*/  
/\*

Richard Dunne

## [Coral-List] Chagos (again!)

**Mark Spalding** [mark at mdspalding.co.uk](http://mdspalding.co.uk)

*Fri Jan 29 12:24:24 EST 2010*

Perhaps I'm pushing people's tolerance, but I'm concerned that this subject has been oversimplified.

Tim Ecott wrote "Unfortunately there is a good reason for the healthy status of Chagos reefs: lack of people. I for one would vote for pretty much anything that kept it that way" - fine, but what would he vote for? It really isn't a decision of being for or against, fish versus people. So here's a possible scenario:

June 2010 - UK govt declares no-take MPA over all of Chagos. Gordon Brown's legacy (hooray)

Sept 2010 - Chagossians granted right to return by European Court of Human Rights (hooray (different people shouting))

Sept 2010, 2 weeks later - First Chagossians arrive back in Chagos (remember they were given this right once before, just 5 year or so ago, and are not there now only because they didn't move fast enough). Sure the UK government won't fund them, but there are plenty of rich people out there who do care about human rights and might even fancy getting access to some beautiful islands at the same time

Oct 2010 - FCO repeal MPA (as they have said they would)

Nov 2010 - horrified environmentalists learn of plans for an airstrip, a hotel, a live-fish export trade from northern Chagos. They try to step in, some through the courts (ha ha) others through diplomacy. They find the Chagossians don't trust them, I wonder why?

Dec 2010 - FCO, far from being concerned, decide to cede the northern atolls of Chagos to Mauritius. They are far enough away from the military base for the US not to care.

I'm not saying this will happen, or even anything like it, but the various elements are all possible. The all-out anti Chagossian, anti-Mauritian approach is, in my mind a very high risk strategy FOR BIODIVERSITY. It might pay off and then some can say "I told you so" but I will have to say that, right now, they don't have a clue, because no-one does. Alternatively design a strategy that builds a scenario for the POSSIBLE resettlement of Chagos, in the eventuality that it could happen.

I am concerned that a poll, apparently with some 10,000 signatures, has over-simplified the matter. A lot.

Mark Spalding  
Cambridge etc.  
[mark at mdspalding.co.uk](mailto:mark_at_mdspalding.co.uk)

## [Coral-List] Chagos Conservation

**Bill Allison** [allison.billiam at gmail.com](mailto:allison.billiam@gmail.com)

*Fri Jan 29 20:12:32 EST 2010*

"...nearly all of the other national parks in the USA, including Everglades, Glacier, Grand Canyon, Mesa Verde, Mount Rainier, Yellowstone, and Zion, were created by expelling, sometimes violently, tribal peoples from their homes and hunting grounds so that the areas recovered could remain in a "state of nature" free from human contamination.

"

As another seaman put it:

"The conquest of the earth, which mostly means the taking it away from those who have a different complexion or slightly flatter noses than ourselves, is not a pretty thing when you look into it too much. What redeems it is the idea only. An idea at the back of it; not a sentimental pretense but an idea; and an unselfish belief in the idea-- something you can set up, and bow down before, and offer a sacrifice to. . . ."

Joseph Conrad, Heart of Darkness



# Coral-List] Proposed Marine Protected Area in the Chagos - The Plight of the Chagos Islanders

Richard Dunne [RichardPDunne at aol.com](mailto:RichardPDunne@aol.com)

*Sun Jan 31 15:38:10 EST 2010*

Dear Listers

For those of you following the debate about the proposal for a Marine Protected Area in the Chagos Archipelago (BIOT). There is a film (55 minutes long) by John Pilger, an Australian journalist. It was made in 2004 and describes what happened to the Chagos Islanders. It can be viewed on Google videos at the link below. It contains several interviews with Prof David Stoddart OBE, the founder of the International Society for Reef Studies (ISRS) whom many of you will know and who deprecates the treatment of the islanders by the British Government.

STEALING A NATION (John Pilger, 2004) is an extraordinary film about the plight of people of the Chagos Islands in the Indian Ocean - secretly and brutally expelled from their homeland by British governments in the late 1960s and early 1970s, to make way for an American military base. Stealing a Nation has won both the Royal Television Society's top award as Britain's best documentary in 2004-5, and a 'Chris Award' at the Columbus International Film and Video Festival.

<http://video.google.com/videoplay?docid=-3667764379758632511#>

IF YOU HAVE ALREADY SIGNED THE PETITION IN SUPPORT OF THE MPA on the Chagos Environment Network website. WERE YOU AWARE OF THESE HUMAN RIGHTS ISSUES? or did you get the impression from that website that it was simply the case of establishing a MPA in a remote uninhabited part of the world?

Are you entitled to think again? Certainly if you feel that you did not know the full facts. If you wish to do this then simply sign the Marine Education Trust petition

(<http://www.marineeducationtrust.org/petition/protect-chagos>) and send an e-mail to [info at marineeducationtrust.org](mailto:info@marineeducationtrust.org) with any further details.

Here are just a few of the signatories to that petition who support the idea of an MPA BUT ONLY with the participation and consultation with the Chagossians and the Mauritian Government.

Coral Reef Scientists, former diplomats, politicians, lawyers, academics. If you want to see the full list then go to the website.

Former President of the Republic of Mauritius - Cassam Uteem  
Former British High Commissioner to Mauritius and Deputy Commissioner for BIOT - David Snoxall  
Emeritus Professor Barbara Brown - Newcastle University UK, co-founder

and former Vice-President International Society of Reef Studies, former Editor in Chief 'Coral Reefs' 2005-8, Founder and Director of Centre for Tropical Coastal Management Newcastle University

Dr Alasdair Edwards - Newcastle University UK, former Director of Centre for Tropical Coastal Management, Chair of GEF/World Bank 'Reef Restoration and Remediation Working Group.

Dr Tom Goreau - USA President Global Coral Reef Alliance

Professor Chris Perry - Chair, Tropical Coastal Geosciences, Manchester University UK

Dr Sue Wells - Coral reef conservation consultant, Cambridge UK

Professor Andrew Balmford - Professor of Conservation Science, Cambridge University

Dr Elizabeth Gladfelter - coral reef biologist USA

Professor John Ogden - Director, Florida Institute of Oceanography USA, former President International Society of Reef Studies (ISRS)

Dr Mark Spalding - Global Conservation Specialist - Cambridge UK - co-author of the Chagos Conservation Plan 2003

Dr Tom Spencer - Geography University of Cambridge

Professor David Simon - University of London

Associate Professor Kenneth Cathan - Mauritius

Professor John Eade - London

David Evans - Marine Biologist

Dr Judith Lang USA coral reef researcher

Dr Emma Mawdsley - Geography Department Cambridge University

Dr Ester Peters - USA coral reef scientist

Dr Elizabeth Tyler - Tropical Ecology Group, Oxford University

Dr Deborah Potts - Geography Kings College London

Katherine Muzik - Marine Biologist

Dr Lynn Dicks - Conservation Science Group, Department of Zoology, Cambridge University

David Vine - Assistant Professor, American University Washington USA - author of 'Island of Shame: The Secret History of the US Military Base on Diego Garcia'

Dr Carlos Ruiz Sebastian - marine biologist South Africa

John Howell - Former Director of Overseas Development Unit

Jack Everett - USA Saving Our Environment Campaign

Andy Vivian - BBC Producer - UK

Dr Bill Burnett - Head of Biology St Paul's School, London - UK

Dr Sean Pyne-O'Donnell - Norway

Graham Pascoe - Lecturer - Germany

Dr Liz Andrew - University of Manchester, Fellow Zoological Society London, UK

Dr Tony Lemon - Dept of Geography Oxford University

Erich Hoyt - research fellow Whale and Dolphin Conservation Society UK

Abigail Moore - Marine Conservation volunteer Indonesia

Ofer Ben-Tzvi - PhD candidate coral reef biology - Israel

Dr Martin Little - Biologist UK

Adel Heenan - PhD candidate University of Edinburgh

Dr Basia Zaba - University of London

Sabrina Meunier - Field Centre Manager Shoals Rodrigues, Mauritius

Dr Martina Burtscher - University of the Highlands and Islands UK

Dr Emmanuel Gregoire - Directeur de recherche IRD France

Dr Sean Carey Research Fellow at the Centre for Research on Nationalism, Ethnicity and Multiculturalism (CRONEM) at Roehampton University - UK

Durkje Gilfillan - Attorney South Africa

Jim McGowan - Cmdr RN (rtd) Barrister - Hong Kong - former Legal  
Adviser to the Commander in Chief Fleet  
Hans A. De Savornin Lohman - Netherlands Attorney at Law  
Maite Mompo - Spain Lawyer  
Richard Dunne - Lt Cdr RN (rtd) BA (Cantab) Barrister UK, former Legal  
Adviser to the Commander in Chief Fleet 1988-91, editor The Manual of  
Naval Law (1991 ed)  
Rebecca Musarra - Lawyer - USA  
Amir Matar - Research Associate, Public International Law and Policy  
Group, Washington - USA  
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Richard P Dunne

## [Coral-List] Chagos Conservation

**Richard Dunne** [RichardPDunne at aol.com](mailto:RichardPDunne@aol.com)

*Tue Feb 2 08:28:42 EST 2010*

Dear Listers

Jim Hendee's post (below) is interesting and touches on considerations which have not been discussed. As has already been pointed out in earlier posts, it would appear that the intention of the UK and US Governments is to exclude Diego Garcia from the proposed MPA in the British Indian Ocean Territory, notwithstanding that it is the largest area of land.

There is a recently published article: Diego Garcia: British-American Legal Black Hole in the Indian Ocean? by Peter Sand of the Institute of International Law, University of Munich - Journal of Environmental Law doi:10.1093/jel/eqn034. It is Open Access at <http://jel.oxfordjournals.org/cgi/content/full/eqn034v1>

In particular the article highlights that:

1. The Foreign & Commonwealth Office (FCO) has consistently pursued a 'legal black hole' strategy for Diego Garcia with regard international environmental agreements, which continues into the foreseeable future.
2. Until the 1980s the FCO tried to suppress "any mention of Chagos in scientific reports" (Prof Charles Sheppard - BIOT Scientific Advisor).
3. FCO has vetoed an extension of the Biodiversity Convention to BIOT.
4. To avoid disputes on claims by the Mauritius Government, the BIOT fishing area map annexed to the 2006 Southern Indian Ocean Fisheries Agreement (SIOFA) simply excludes the entire 200 miles zone around the Chagos - unfortunate in view of the growing threat of illegal fishing and the need for regional co-operation.

Of the Diego Garcia environment it highlights that:

1. Military construction work over the last 38 years has eliminated much of the tree vegetation (have a look on Google Earth or Google Maps).
2. Coral blasting has removed an estimated 5 million cubic yards (4.5

million cubic metres) by 1983. The scars on the reef can be seen from Google Maps.

3. Dredging in the lagoon has taken place over 30.8 square kilometres.
4. Approximately 100 acres was landfilled.
5. A total of more than 150,000 cubic yards of concrete has been poured for the construction of the airport, roads and other facilities.
6. When it was found that further coral mining could not meet the requirements, limestone, sand were imported from Malaysia and West Africa.
7. There are 1.34 million barrels of jet and diesel fuel stored on the island. A spill of approx 1 million gallons of jet fuel occurred as a result of a pipeline fracture in 1983. By the time the underground leakage had been found it had filled and replaced the entire freshwater lens below the base. All the spills exceed the reported spills from other US military bases in Panama, Puerto Rico and the Phillipines. The Chagos Conservation Trust itself noted in 2004 that the US Air Force had still not cleared up its oil spills.

Peter Sand describes the 'downtown area' of the base as more reminiscent of the Florida Keys than that of the Indian Ocean, with all the facilities of a small town.

One serious side effect of the importing of construction materials has been the introduction of invasive alien plant species, including *Leucaena leucocephala*. A botanical survey of Diego in 2005 noted that "if uncontrolled, this species can completely overtake all other species creating monotypic scrub".

Its is a pretty dismal account of the lack of adequate protection and the transformation of the atoll.

Not only is there a complete mess as regards involving those who actually lived in these islands from participating in the proposed MPA discussions, there is also a mess as regards the environmental protection of one of the main islands. If this is a sound strategy for implementing a MPA of global importance then it leaves a lot to be desired.

Richard P Dunne

**Dr. C. Mark Eakin** [mark.eakin at noaa.gov](mailto:mark.eakin@noaa.gov)

*Thu Apr 1 15:53:06 EDT 2010*

Begin forwarded message:

> From: PALMER Jennifer <[Jennifer.PALMER at iucn.org](mailto:Jennifer.PALMER@iucn.org)>  
> Date: April 1, 2010 2:21:14 PM EDT  
> To: PALMER Jennifer <[Jennifer.PALMER at iucn.org](mailto:Jennifer.PALMER@iucn.org)>  
> Subject: DCMC: Britain approves Chagos Islands marine reserve  
>  
> Foreign & Commonwealth Office official site:  
> <http://www.fc.gov.uk/en/news/latest-news/?view=News&id=22001512>  
>  
> 01 Apr 2010

> Foreign Secretary David Miliband instructs the Commissioner of the British Indian Ocean Territory to declare a Marine Protected Area.  
> Foreign Secretary David Miliband today announced the creation of a Marine Protected Area (MPA) in the British Indian Ocean Territory. This will include a "no-take" marine reserve where commercial fishing will be banned.

>  
> The British Indian Ocean Territory (BIOT) consists of 55 tiny islands which sit in a quarter of a million square miles of the world's cleanest seas.

>  
> Announcing the creation of this MPA, David Miliband said:

>  
> I am today instructing the Commissioner of the British Indian Ocean Territory to declare a Marine Protected Area. The MPA will cover some quarter of a million square miles and its establishment will double the global coverage of the world's oceans under protection. Its creation is a major step forward for protecting the oceans, not just around BIOT itself, but also throughout the world. This measure is a further demonstration of how the UK takes its international environmental responsibilities seriously.

>  
> The territory offers great scope for research in all fields of oceanography, biodiversity and many aspects of climate change, which are core research issues for UK science.

>  
> I have taken the decision to create this marine reserve following a full consultation, and careful consideration of the many issues and interests involved. The response to the consultation was impressive both in terms of quality and quantity. We intend to continue to work closely with all interested stakeholders, both in the UK and internationally, in implementing the MPA.

>  
> I would like to emphasise that the creation of the MPA will not change the UK's commitment to cede the Territory to Mauritius when it is no longer needed for defence purposes and it is, of course, without prejudice to the outcome of the current, pending proceedings before the European Court of Human Rights.

>  
> Further information  
> The Chagos Islands have belonged to Britain since 1814 (The Treaty of Paris) and are constituted as the British Indian Ocean Territory (BIOT). Only Diego Garcia, where there is a military base, is inhabited (by military personnel and employees).

>  
> The idea of making the British Indian Ocean Territory an MPA has the support of an impressive range of UK and international environmental organisations coming together under the auspices of the "Chagos Environment Network" to help enhance the environmental protection in BIOT. Also, well over 90% of those who responded to the consultation made clear that they supported greater marine protection

>  
> Pollutant levels in Chagos waters and marine life are exceptionally low, mostly below detection levels at 1 part per trillion using the most sensitive instrumentation available, making it an appropriate global reference baseline.

>

> Scientists also advise us that BIOT is likely to be key, both in research and geographical terms, to the repopulation of coral systems along the East Coast of Africa and hence to the recovery in marine food supply in sub-Saharan Africa. BIOT waters will continue to be patrolled by the territory's patrol vessel, which will enforce the MPA conditions.

>

> Download the full report [PDF]

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> Britain approves Chagos Islands marine reserve

> <http://sify.com/news/britain-approves-chagos-islands-marine-reserve-news-international-kebwabididi.html>

> 2010-04-01 22:00:00

> Britain gave the green light Thursday for the creation of the world's biggest marine reserve around the Chagos Islands in the Indian Ocean, a plan which has provoked fury among some refugees.

> The reserve will protect an area campaigners say compares with Australia's Great Barrier Reef for its marine life, including coral reefs, yellow fin tuna, turtles and coconut crabs.

> It will include a "no-take" marine reserve where commercial fishing is to be banned, the Foreign Office said.

> "The MPA (Marine Protected Area) will cover some quarter of a million square miles (400,000 square kilometres) and its establishment will double the global coverage of the world's oceans under protection," said Foreign Secretary David Miliband.

> The Chagos Islands were ceded to Britain in 1814 and the archipelago was evacuated four decades ago to allow construction of a military base.

> Diego Garcia, the main island, is now populated by an estimated 1,700 US military personnel, 1,500 civilian contractors and around 50 British personnel.

> Around 2,000 Chagossians were moved to Mauritius, which claims the islands and whose prime minister has spoken against the plan. Most of the refugees are still campaigning to go back.

> Earlier this month, Olivier Bancoult of the Chagos Refugees Group accused Britain of "trying to create a protected area to prevent Chagossians from returning to their native islands".

> Miliband said in his statement that the creation of the reserve "will not change the UK's commitment to cede the territory to Mauritius when it is no longer needed for defence purposes".

>

>

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C. Mark Eakin, Ph.D.  
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"A world without coral reefs is unimaginable."  
Dr. Jane Lubchenco, March 25 2010

## [Coral-List] Chagos Marine Protected Area

**Pete Raines** [psr@coralcay.org](mailto:psr@coralcay.org)

*Fri Apr 2 10:29:24 EDT 2010*

Dear Listers,

Yesterday Britain effectively doubled the global coverage of the world's oceans under protection. For further information, see:

[1]<http://protectchagos.org/>

All the best,

Pete Raines  
Coral Cay Conservation  
[2][www.coralcay.org](http://www.coralcay.org)

### References

1. <http://protectchagos.org/>
2. <http://www.coralcay.org/>