Science AMA Series: Hi, we're NOAA scientists Jennifer Koss, Mark Eakin, and Randy Kosaki. We are here to talk about the global coral bleaching event that we are experiencing right now. Ask Us Anything!

NOAAgov [1] and r/Science AMAs[1]

[1]Affiliation not available

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Thank you for doing this AMA.

I would like to ask in what way does coral bleaching affect the eco-system?

And whether the coral bleaching has worsen to the point that it has irreversably and negatively affected the eco-system of the sea?

If not, what can people do to help?

Thanks again for taking your time to answer the questions.

JaydenKJJ

Jennifer: Coral bleaching is the act of the coral polyp expelling its zooxanthellae, or photosynthetic algae. When to polyps no longer have their algae, they lose their color and are essentially translucent. What you see is the white skeleton through the polyps and thus the coral head appear to be bleached white. The impact to the coral polyps is that they are no longer able to get the energy and nutrients from their zooxanthellae. This stresses the corals and if water temperatures do not come down enough for the corals to re-recruit their zooxanthellae, the corals die. Here's an infographic that illustrates what happens when a coral bleaches.

Do artificial reefs help reduce the problem at all?

kehaar

Jennifer: Artificial reefs do not replace all of the ecosystem services that a natural coral reef provides. They can provide a relatively decent habitat for some fish species, but they are not a true replacement for a natural reef.

For corals that have already experienced major bleaching events, is there any evidence that they can

be recovered? If so, what techniques or efforts have proven viable?

conker223

JENNIFER: If water temperatures come down quickly enough, the corals can re-recruit their photosynthetic algae and can recover. There have been some small localized successes where individuals have successfully cooled water enough to prevent bleaching. These solutions, unfortunately, aren't scaleable to large reef areas just yet though. Cooling has been achieved through pumping colder water up from deeper ocean areas and some experimentation has been done with different materials put on the surface of the water to reduce temperatures. You can help protect coral reefs regardless if you live near one one or not. Check out this infographic for things you can do to help conserve coral reefs

Hi. Thank you for this AMA. Sorry if this is a stupid question but are there any organisms that thrive in the event of coral bleaching?

winza83

Randy: Indeed, there are organisms that thrive in the event of coral bleaching. This is especially true in the event of coral mortality, where fleshy macroalgae may overgrow the dead coral skeletons. This appears to be happening right now in the Northwestern Hawaiian Islands, where coral that died as a result of the 2015 mass-bleaching event are now overgrown with native species of algae. Other short-term winners may include herbivorous fishes that feed on algae. We've noticed higher than usual abundances of parrotfish and similar herbivorous species in Papahānaumokuākea Marine National Monument in the Northwestern Hawaiian Islands. This "win" may be short-lived, as the three-dimensional structure of the reef is now crumbling without live coral, and fish habitat quality is now declining.

Do coral polyps ever re-take up residence on bleached coral so the reef is restored to life?

shiningPate

Mark: Corals can recover in a few ways: coral polyps can recover their zooxanthellae if the stress isn't severe. A bleached coral isn't dead so new polyps can't move in. However, after part of a coral dies it is possible for polyps to expand and cover the dead portion. Also, it is possible for new coral larvae to land on a dead part of a coral. Unfortunately, when that happens, the new coral can start to fight for space with the coral it lands on.

Has the bleaching affected cold water reefs as much as tropical?

I'm Australian, and we don't get as much coverage of the bleaching as you'd expect (as well as it being officially censored off international reports) and "everything fine, it's being made out to be more than it is" stories, how bad is it for the great barrier reef? Will it recover?

Actual_princess

Mark: For your first question, this problem is only affecting the corals that contain zooxanthellae and build reefs. The cold, deep corals usually don't contain zooxanthellae and are not susceptible to bleaching. For your second question, the best source for information on the bleaching on the Great Barrier Reef is the GBR Marine Park Authority. 93% of the reefs on the GBR show some degree of bleaching. Overall 22% of corals have died with most of the damage in the Far Northern Section. The Far North has many reefs with over 50% mortality.

I had a salt water aquarium for many years; bleaching occurs sometime in the hobby. The thing is, if I were going to rack and stack possible reasons I'm not sure temperature swings would even crack the top five. I have seen everything in the hobby from people who perpetually keep their tank water far too hot, to accidental rapid temperature spikes and generally those don't end in a bleaching scenario. Too much / too bright of lights, incorrect chemical and trace element mixtures, impurities, and parasites almost always end up being the culprit.

So this being the case, what data do you have to show that warming is a more likely cause than say man dumping pesticides into the ocean? I completely agree what is happening must be man made, and I know global warming is real, but I honestly don't see how it is warming causing the bleaching. Surely it is more likely all the crap we dump in the oceans.

comment_redacted

Mark: While we are dumping lots ofpollutants into the ocean, the patterns of bleaching events like we are having right now extend across 1000s of kms (or miles, your choice). This is much too large to be explained by pollution that drops in concentration very quickly. You can see how widespread this pattern is at: http://coralreefwatch.noaa.gov/satellite/analyses_guidance/global_coral_bleaching_2014-17_status.php

Thank you all so much for doing this AMA (and for all your hard work saving our oceans)!

With so many different environmental issues currently arising (coral bleaching, over fishing, ocean acidification, etc.), what still gives you hope for the future of our oceans/natural world while facing the grim reality which is our current situation everyday?

People often wonder how scientists stay positive while working in the field of conservation, I would love to hear your insight on the subject!

eyeohyou

Randy: Even among the doom-and-gloom scenarios facing our oceans, there are bright spots that provide hope for the future. One such bright spot is that so-called reef resilience (the ability to resist or recover from environmental insults) appears to exist in some reef systems. Remote, pristine coral reefs such as the Phoenix Islands (central Pacific), the Chagos Archipelago (Indian Ocean), and the Northwestern Hawaiian Islands (protected by Papahānaumokuākea Marine National Monument in the U.S.) have all suffered mass bleaching events with high mortality, followed by near complete recovery in an 8-10 year time frame. Apparently the complete absence of local anthropogenic stressors allows the reefs to recover naturally on their own, giving us hope that by managing those human impacts in heavily populated areas, we may be able to give coral reefs a fighting chance to recover from bleaching events.

Thanks for reaching out and doing this AMA! I'm very thankful for the organizations working hard to shine light on this issue. My question is, what role do coral play in promoting aquatic diversity? Will we witness (or are we already witnessing) a turbulent chain of events of other aquatic species being unable to adapt/survive in the coral's absence?

bassbuddha

Jennifer: In terms of biodiversity, coral reef ecosystems have been called the "rainforests of the sea".

In truth, it would probably be better to call rainforests the "coral reefs of the land." Nancy Knowlton, of Smithsonian, gave a great plenary speech at the International Coral Reef Symposium last week in Honolulu where she threw out a couple of great statistics on the INCREDIBLE number of species living on coral reefs that are yet to be characterized or named, maybe even discovered! We are certainly seeing severe impacts on corals themselves and then on the organisms dependent upon them for habitat and food when those corals die. Visit the NOAA Coral Reef Conservation Program online to learn more.

Thanks so much for doing this AMA!

Assuming you're familiar with the Coral Restoration Foundation based out of the Florida Keys, does their process of growing and transplanting coral have a meaningful impact on the reefs the coral is brought to?

If so, could this be effectively scaled up worldwide to help support the struggling ecosystems being affected by bleaching?

KimonS

Jennifer: The technology for growing corals in nurseries has improved a great deal over the past several years. I think we are getting to the point where it's become economically feasible to grow larger numbers of the "weedier" species like Acropora in order to be able to transplant them onto the reef to enhance populations. There is also a growing body of science developing best management practices on how to best outplant these corals to maximize the chances of survival, as well as to even allow for reproduction to occur. This may be one of the best tools we have to give corals a chance at recovering, but this will need to be coupled with making sure we are still working to reduce and mitigate for local stressors that degrade water quality. For more on NOAA's coral reef restoration efforts, visit http://www.habitat.noaa.gov/restoration/approaches/corals.html

Thought I'd seen articles indicating corals were actually a symbiotic pair of a mollusk and algae organism; and bleaching occurs when the algae half of the symbiosis is killed. Is this accurate? Does the mollusk half also die?

shiningPate

Randy: Corals (which are a type of animal called cnidarians, not mollusks) incorporate single-celled algae into their tissues. This forms the basis of the symbiosis. As the algae photosynthesize, the corals benefit from the production of carbohydrates and oxygen. The algae benefit by consuming the CO_2 and nitrogenous waste of the coral. Bleaching occurs when the corals expel the algae during prolonged periods of elevated ocean temperatures. If bleaching is not prolonged, the corals may recover and re-acquire the algae. If bleaching occurs for an extended period, the coral is deprived of its primary source of calories, and mortality may result.

I was in Thailand earlier this year and while SCUBA diving noticed how bleached the coral was which made me sad. What can we start doing now to reverse the bleaching?

LemonsForLimeaid

Mark: The two things we have to do to reduce the bleaching is (1) reduce the amount of CO_2 in the atmosphere and (2) reduce local stressors to enhance the resilience of the coral reef. #2 means reducing problems of overfishing, pollution, habitat distruction, and physical impacts on corals by

divers or boaters.

For those who don't know, what is coral bleaching?

I, ugh, promise I know! I am just asking for... Others... Yah... Others!

ryan4588

Mark: Coral bleaching is the term for what happens when a coral kicks out the symbiotic algae (zooxanthellae) that live in their tissues. This can happen as a response to stress. For the major bleaching event right now, the bleaching is being caused by high ocean temperatures. The zooxanthellae provide corals with most of their food and their color. When temperatures rise, the photosynthesis runs very fast and causes more damage. While high temperature speeds up photosynthesis, it doesn't speed up the rate of repair. As the damage increases, the zooxanthellae release toxic compounds. The coral then kicks out the zooxanthellae and it leaves them looking bleached. You are actually looking through the clear tissues of the live coral and seeing the white skeleton underneath. As soon as the coral dies, other types of algae start to overgrow the skeleton, so the coral that looks bleached is sick but not dead.

Is there research for some sort of strengthened zooanthellia that is more resistant to stress that could be used to replace the ones that leave the coral during coral bleaching?

Jonahcat

Yes, there is work going on now at the Hawaii Institute of Marine Biology and at the Australian Institute of Marine Science to train and/or breed "super corals". Others are trying to introduce more resistant zooxanthellae into corals. This may help us grow more bleaching resistant corals in our nurseries to replace damaged corals.

Thank you for doing this, I have a couple of questions for you guys.

Did you know that in October 2015, NOAA declared the third ever global coral bleaching event on record?

- When did the other two occur/were recorded?
- I live in Aruba and the effects of this can be thoroughly seen(deeply saddening). What can local(smaller) communities do to help the coral?

TSM_Wraithfyter

Mark: The first well-documented global coral bleaching event was in 1998, associated with the very strong 1997-98 El Niño and the strong 1998-99 La Niña. The second global coral bleaching event was in 2010 during a moderate El Niño. The worst coral bleaching in the Caribbean was in 2005 but that one didn't impact Aruba badly. Aruba was hit much worse in 2010. You can learn more about the current global bleaching event and past events here.

Is there a specific way of remediation of already bleached corals? Would gene-editing to be more resistant to the carbonic acid be a plausible action?

Vitaeamor

Mark: Once the coral is bleached, it would be too late to take these sorts of actions. It is possible to replace their zooxanthellae (the symbiotic algae living in the corals' tissues) with zooxanthellae that are more heat resistant. This often happens naturally. The best thing to do for a bleached coral is reduce the stress that caused the bleaching.

How is climate change directly linked to coral bleaching? What happens to the area if all coral becomes bleached?

Thanks!

DDRundo

Jennifer: We recently developed an infographic to illustrate the many ways climate change impacts corals and coral reef ecosystems. It also includes ways you can help! Visit http://oceanservice.noaa.gov/facts/coralreef-climate.html to learn more.

I don't have any questions. I just wanted to say that the coral bleaching event makes me really sad.

Coral reefs are the rainforests of the ocean- with low productivity but extremely high diversity- who knows how many species are threatened by this event?

Actually, I guess I found my question. Do you happen to know how many species are threatened by this event? Y'know, besides just "a shameful amount"?

bee_vomit

Randy: All coral reef organisms are threatened by mass-bleaching events! By definition, they are all intimately associated with coral reefs, whether for food, shelter or other requirements. It's difficult to put a number on this, because of our limited understanding of diversity on coral reefs. Thousands of species remain to be discovered and described. There's no question that we are at risk of losing some species before we even know that they exist.

What happens once the bleaching took place? There must be many "new" habitats available, who is filling this gap? biofilms maybe? Is there already a natural succession occuring with similar patterns on a global scale?

TheGoalkeeper

Mark: Coral bleaching is the term for what happens when a coral kicks out the symbiotic algae (zooxanthellae) that live in their tissues, leaving the coral looking bleached. You are actually looking through the clear tissues of the live coral and seeing the white skeleton underneath. As soon as the coral dies, other types of algae start to overgrow the skeleton, so the coral that looks bleached is sick but not dead. The first succession after a coral dies is this algal overgrowth. If there are an insufficient number of herbivores in the ecosystem (sea urchins, parrotfish, surgeonfish, rabbitfish), the algae overgrow the reef and prevent new corals from recruiting in and prevent live coral tissue from growing over the dead areas. This has been referred to as "the slippery slope to slime." We have seen major losses of coral cover, increases in algae, erosion of reefs, and loss of habitat. This has been going on around the world, especially in the Caribbean and in parts of the Pacific where there is a high level of human stress.

By a conservative estimate, how many species of coral will go extinct due to this?

Enjoying_A_Meal

Mark: This is very hard to say. We have had at least one species of coral that is probably extinct due to increasing water temperatures. Many others have been harmed severely and another has not been found in the wild since the bleaching in Hawaii in 2015. You can learn more about the potential for global warming to cause the extinction of a number of coral species in the report found at: http://www.nmfs.noaa.gov/stories/2012/05/07_coral_documents_page.html and the paper found at: http://onlinelibrary.wiley.com/doi/10.1111/cobi.12171/abstract

On a scale from one to a lot, how much do you love mangrove propagules?

DingDongMmmkay

Jennifer: How much is a lot? On the order of how much wood a woodchuck can chuck? ;) We love mangroves almost as much as we love corals! The interconnectedness of mangrove areas, seagrass areas and coral reefs is amazing. Positive results have been shown on reefs when we restore mangrove and seagrass areas.

Hey thanks for doing this.

Are there any good dramatic pictures that can help show people the impact of coral bleaching?

I fear that as with so many things, people won't be moved to any action until they can visualize the problem.

blyzo

Yes, the XL Catlin Seaview Survey has been working jointly with NOAA and others to put together an excellent compendium of bleaching photos from this global coral bleaching event.

Thanks for doing this AMA, my question is that are there any species of fish that only live in coral reefs that are being affected by the bleaching event? Could artificial reefs help them?

cthulusaurus

Randy: Coral reefs occupy about one percent of the world's oceans, and yet they host about 25% of all marine fish species worldwide. By definition, all of these species are intimately tied to the habitat-forming species of corals that create the reef structure. Some fishes (e.g. many butterflyfishes) actually feed directly on coral polyps and may be the first to see severe reductions in abundance in the wake of a bleaching event. Most other coral reef fishes are dependent on the reef structure for habitat, and will also be affected as habitat quality and structure decline after coral mortality. In some cases, artificial reefs may be a partial solution to this problem. However, the thousands of invertebrate species that also call coral reefs home are intimately tied to the structure created by corals, both for habitat and food. Artificial reefs may not completely meet all of their needs.

What exactly is the mechanism of climate change that's causing the bleaching? Specifically is it ocean acidification, increased temperatures or something else entirely?

joshwoos

Mark: Increased atmospheric CO2 has raised the temperature of the air and the ocean. Bleaching occurs when water temperatures rise and exceed stressful levels for too long. At Coral Reef Watch we measure this with our Degree Heating Week metric (see this link for the data). It measures how high the temperature is and for how long. You can learn more about our products using our tutorial. Rising CO2 can acidify sea water, making it harder for corals to grow their skeletons. This can make some corals more susceptible to the high temperatures and increase their tendency to bleach.

While we are seeing current species of coral being bleached, do you think more resilient ones will rise up and thrive in their stead? If so, would that be problematic to other aquatic life that depend on current reefs?

killthehighcourts

Randy: That is one of our hopes for the future, specifically, that more resistant or resilient species will be able to provide functional redundancy to offset the potential losses of less resilient species. This concept also applies at the level of an individual species, whereby some individuals of that species may be more thermally tolerant than others and will help to repopulate impacted reefs. Indeed, some current research focuses on identifying surviving corals in the wake of a bleaching event, and cultivating them in captivity to see if their offspring will also show resistance to bleaching. This "assisted evolution" is analogous to selective breeding.

If we are able to slow down the increase in atmospheric CO2 and temperature, would coral bleaching be problem that can eventually get better on its own?

IwantBreakfast

Mark: If atmospheric CO2 were reduced to levels that are not stressful to corals, the bleaching problem will start to get better on its own. If we only slow emissions, the problem will still be getting worse faster than corals can adapt. Even if we stop adding any CO2 tomorrow, temperatures will continue to rise for a few hundred years, thus adding to the bleaching problem.

Two questions if I may. Is there evidence of coral bleaching in the distant past from climate changes and other such events? What can we do, either through actions or funding, to have the greatest possitive impact on our oceans?

smoothoperator7

Mark: Studies of corals hundreds of years old show that bleaching was not a significant problem before the latter half of the 20th century. The two things we have to do to reduce the bleaching is (1) reduce the amount of CO2 in the atmosphere and (2) reduce local stressors to enhance the resilience of the coral reef. #2 means reducing problems of overfishing, pollution, habitat destruction, and physical impacts on corals by divers or boaters.

How can citizens help?

cmp150

Jennifer: Citizens can help by reducing their carbon footprint, being responsible divers, boaters, fishers and snorkelers. Check out our great infographic with some more ways you can reduce your carbon footprint. You can also spread the word yourself about the plight of corals. There are some great non-

profit organizations you can also get involved with who are doing great work to reduce local stressors and improve water quality in coral reef areas.

Why should I, an office worker and a person who frankly hates going to the beach care about coral bleaching? What can I do to make a difference?

jamesvini

Jennifer: You should absolutely care!! Corals are the proverbial canaries in the coalmine in terms of being an indicator of what it happening in our ocean in response to climate change. Oceans regulate our weather patterns and are essential to our ways of life. Somewhere around 500 million people around the globe depend on coral reefs and the services they provide for daily life. In the US alone, reefs generate roughly $3.4 billion dollars of goods and services. They are literally the foundation for life on many islands - they are what make many Pacific and Caribbean islands habitable. Additionally, 25% of commercial fish species spend some portion of their lives on corals reefs and corals protect fragile coastlines from storm and wave energy.

Hi! Thank you so much for doing this AMA, this is an issue near and dear to my heart.
My first question is about Hope spots. What, that you know of, is being done by the US government to protect these reefs, or to create something akin to a Hope spot? Apart from lobbying congressmen and taking more care in consumption and recycling, what can a layperson do to help the reefs or try to prevent further bleaching? Are there any groups that I could join to raise awareness?
My second question is about reef tanks, and keeping corals in a tank. Some of the fragging that is done is being done by taking corals, growing them in clean zones, then replacing them and selling off bits. Is this okay as a practice? If a coral is fragged and removed, then brought back after a bleaching event, is that a good thing, or will it just bleach away as well?

seems-unreasonable

Randy: Dr. Sylvia Earle, a famous ocean explorer and former Chief Scientist of NOAA, coined the phrase “hope spots” to recognize special places internationally that are critical to the health of the oceans. NOAA’s Office of National Marine Sanctuaries [http://sanctuaries.noaa.gov/] similarly recognizes special ocean places in U.S. waters. Thirteen national marine sanctuaries and Papahānaumokuākea and Rose Atoll marine national monuments are a part of this system, and more are on the way through a community-driven nomination process, which you can partipate in [http://www.nominate.noaa.gov/]. Coral bleaching is driven by global warming, which in turn is driven by excessive burning of fossil fuel. When we burn fossil fuels like oil and gas to heat our homes, fuel our cars, and produce electricity, we release carbon dioxide into the atmosphere. This carbon dioxide builds up and acts as a heat trapping blanket, warming the Earth and ocean. The resulting warmer water temperatures are what stress corals, leading to bleaching. Whether you live immediately adjacent to a coral reef or many thousands of miles away, anything you can do to reduce your (and your community’s) fossil fuel usage will benefit coral reefs, from supporting renewable energy availability in your community to supporting public transportation. As for captive propagation and fragging of corals for the aquarium trade, this is a great solution to the problem of harvesting live corals from the wild. Coral “farms” have also been started by public aquaria and government agencies to preserve and protect some of the species diversity and genetic diversity that is threatened by climate change.

Is there any knowledge on when the next El Niño will hit, and if it will have an even bigger impact on coral bleaching?

Jabo95

No, we unfortunately can't predict El Niño more than a year in advance.

In your opinion, what is the feasibility of alkaline mineral dumping as a solution for remediation of ocean acidification? It seems like a project of this nature would have to be very large-scale, involving many nations and international cooperation, as well as being very labor and energy intensive. Still, it seems as if it might work if implemented properly. What might be some foreseeable negative effects of such an undertaking?

tag009

Mark: This might help on a small scale but would take a large amount of minerals, mining, and transportation, increasing the amount of CO2 released. The more pressing need is to stop releasing more CO2 into the atmosphere. Besides, doing something like this to tackle ocean acidification doesn't solve the high temperatures that are causing corals to bleach and die.

Is there a gallery of dated and geotagged before and after images, documenting bleaching?

T618

Randy: XL Catlin Seaview Survey is compiling an archive of images, both of healthy reefs and heavily bleached reefs, all around the world. They regularly travel to areas where bleaching is imminent to photodocument those reefs. The NOAA Office of National Marine Sanctuaries has worked with them to document reefs in Hawaii, American Samoa, and the Florida Keys. You can see their images at globalcoralbleaching.org. Additionally, the University of Queensland (Australia) works with the XL Catlin Seaview Survey images to extract quantitative data on coral communities and coral bleaching, making these images a serious research tool as well as a fantastic outreach tool.