Hi, I'm Laura Jurgens here to talk about my research on the mass death of sea species along the Pacific Coastline — Ask Me Anything!

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

[1]Affiliation not available

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Abstract

Updated post-AMA: Hi Reddit, Thanks to all of you who submitted questions, answers and insights. I wish I could have gotten to all of them and I thank you for your interest! Laura Jurgens (tweeting @seacurious) Hi Reddit, My name is Laura Jurgens and I am a postdoctoral researcher at Temple University and Smithsonian Institution. My research focuses on how marine organisms, and the interacting communities they form, respond to extreme events and global change. Together with a wonderful group of collaborators, I recently published a study titled "Patterns of Mass Mortality among Rocky Shore Invertebrates across 100 km of Northeastern Pacific Coastline" in PLOS ONE. In it, we describe an unusual event that killed nearly 100% of two species, a tiny sea star and a sea urchin, over a large region, following a harmful algal bloom or "red tide". We discuss why it's especially important, but often hard, to document such events, which may be increasing in severity and frequency with human-induced changes to our oceans. We also discuss how lifestyle differences between the affected species could determine how long it takes them to recover, and what that means for coastal ecosystems. I will be answering your questions at 1pm ET. Ask me Anything! You can also follow me on Twitter @SeaCurious.

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REDDIT

PLOS Science Wednesdays: Hi, I'm Laura Jurgens here to talk about my research on the mass death of sea species along the Pacific Coastline — Ask Me Anything!

PLOSSCIENCEWEDNESDAY R/SCIENCE

ABSTRACT

Updated post-AMA:
Hi Reddit, Thanks to all of you who submitted questions, answers and insights. I wish I could have gotten to all of them and I thank you for your interest!
Laura Jurgens (tweeting @seacurious)
Hi Reddit,
My name is Laura Jurgens and I am a postdoctoral researcher at Temple University and Smithsonian Institution. My research focuses on how marine organisms, and the interacting communities they form, respond to extreme events and global change. Together with a wonderful group of collaborators, I recently published a study titled"Patterns of Mass Mortality among Rocky Shore Invertebrates across 100 km of Northeastern Pacific Coastline" in PLOS ONE. In it, we describe an unusual event that killed nearly 100% of two species, a tiny sea star and a sea urchin, over a large region, following a harmful algal bloom or "red tide". We discuss why it's especially important, but often hard, to document such events, which may be increasing in severity and frequency with human-induced changes to our oceans. We also discuss how lifestyle differences between the affected species could determine how long it takes them to recover, and what that means for coastal ecosystems.
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What can I, as a regular US citizen, do to help prevent the extinction of these sea species along the pacific coast?

Snisflen

Thanks for this important question! In the particular event we describe in our study, the species affected aren't expected to be in immediate danger of extinction, even though regional populations of the little six-armed sea star and purple urchins were functionally wiped out of a large area of coastline. That said, the best, most recent science suggests that extinctions of marine species are increasing dramatically (see McCauley and colleagues paper from Jan 2015, covered in the NYT and presented at http://www.sciencemag.org/content/347/6219/1255641) due to multiple, interacting (and mostly human-driven) impacts. These include overfishing, destruction of seafloor habitat, agricultural nutrient runoff, and the joint CO2 pollution problems of climate warming and ocean acidification. Fixing these problems is urgent for marine species (and all of us as humans who depend on our oceans for food, livelihoods, and climate control). In my personal opinion (and note that I'm not representing the author group or anyone else here, but I think you deserve an honest answer) fixing these problems from a U.S. standpoint (and we are a big player in the global oceans!) will require first and foremost a lot of public outcry and consistent involvement by U.S. citizens to push our elected officials and policy makers, who often don't see these issues as important to their constituents (even when they are). Call

10.15200/winn.143877.76399

and write your members of congress and local officials about what you think is important. You can also support scientific monitoring efforts that are unfortunately scarce, which makes it very hard to detect problems with marine populations (if we don't know how many are there in the first place).

Welcome Laura,

Do you hypothesize that the die-offs could be related to the low levels of dissolved oxygen that follow large algal blooms?

What problems are you experiencing in documenting these events and is it possible to use algal growth models in a predictive manner to assist your work?

Thank you!

adenovato
Great questions! As you say, low dissolved oxygen is often a major factor affecting marine species during/after algal blooms, and there are more documented cases (in the scientific literature) of low oxygen causing fish and invertebrate kills than direct toxicity. In the case we describe, though, low oxygen doesn't appear to be the culprit. There was very high mortality in well-oxygenated lab tanks pulling seawater from the adjacent ocean, and on rocky headlands that receive constant injections of oxygen from large breaking waves.

Some animals like ravens and rats adapted to the huge impact humans had on this planet and are very well off. Are there any marine animals that thrive under todays conditions caused by humans or is everything doomed in our oceans because of us?

monadicgames
Sure, some species appear to be doing better than others in what scientists term the "Anthropocene" (the age of human impacts to earth's systems). To me, the concern is not just that some life forms will survive our impacts, but that we preserve the amazing biodiversity of the earth, including tiny marine species that many of us never consider. That's part of the reason I study these ecological dynamics.

I became familiar with the starfish die-off starting with the BC area 'melt' in 2013 and watched it travel southward. It has been ongoing for 2 years now and so it would seem unlikely that, overall, this is related to a red tide event. Do you separate your starfish study from the British Columbia to northern Mexico 'melt'? Is it an isolated event within a larger event?

Not long ago I read that this same sort of thing on a smaller level was happening on the Atlantic Coast.

Viewing this as a layman, the only immediate thing that both of these areas have in common is generally higher sea temperature anomalies.

Have you looked into the Atlantic starfish melt at all and if so, have you found any similarities?

Also, thank you so much for publishing on an open source platform.

TheKolbrin
Thanks for your question. I agree it's unlikely that the event we describe is directly related to the sea star wasting disease, and we do separate these events. Mass mortalities in the ocean can and do arise from a variety of sources. The case we discuss is somewhat related, however, in affecting some of the same species over some of the same areas, but this die-off occurred in 2011 before the wasting disease. Our study provides detailed population counts of several sea star species prior to the onset of the wasting disease, and these types of information are often really scarce for marine species. These

data will allow subsequent studies of wasting disease to use publically-accessible, up-to-date census information in assessing wasting impacts.

How will this die off affect consumable fish, such as salmon and halibut? What about shellfish?

CorruptedBloodKills
Neither our group, nor any other researchers responding to this event, detected any effects on fish at all. Mussels were mildly impacted, and urchins and abalone quite substantially, but those populations are expected to recover. It was interesting to see an event in which fish were not one of the most impacted groups.

How much has the frequency of harmful algal bloom changed since the start of the industrial age?

Creed25
Experts in harmful algal bloom (HAB) dynamics have documented an increasing frequency of HABs in coastal oceans worldwide, at a higher rate than expected if it were due simply to more people looking for them. There is a nice page describing the phenomenon (mostly for the U.S.) at http://www.whoi.edu/science/B/redtide/HABdistribution/HABmap.html

What are the biggest, realistic dangers you research? Do these blooms kill all sealife? Is the threat of the blooms to one part of the ecosystem that creates a cascade effect?

Are some countries effectively protecting against events like the ones you study? Are there ways of regulating pollution, or overfishing that would prevent mass die offs?

cp5184
Thanks for the questions. Different types of algal blooms can kill various forms of sea life, depending on their susceptibility to the particular toxins or low-oxygen levels produced by the bloom, but they rarely kill absolutely every species in an affected area (but may get close to killing most moderate to large animals in the case of very extreme low-oxygen levels). My research focuses on "extreme" events and big disturbances, things like this bloom, heat waves, storms, etc. that can have long-term, dramatic ecological effects even when the event is short-term, so all of these things can be big problems for species and ecosystems, depending on their intensity and the vulnerability of the species/system. Yes, there are very effective ways of reducing coastal pollution that reduce algal blooms, but some may still occur, especially as climate change alters our oceans. Overfishing is also preventable, and in many cases where fishing communities are engaged in the process, can be a win-win for the ecosystem and humans.

What kind of chain reaction will we see from this die off in other areas? If any?

deathofcake
Do you mean in other areas as in other parts of the coast or other oceans? Or in other ecological areas, as in how will the loss of some species affect the ecosystem?

You mention the reported die off of a number of species, including the Urchins, and I think I'm right in saying these are from observational data?

Is there any data on the pre-collapse genetic diversity of the effected populations? Pre 2011? Is there any genetic evidence of previous die offs of this nature with these species? I ask because it be interesting to see whether this is a regular (every few decades) event that the population is

able to bounce back from.

Also, unrelated to the research, but in the PDF, pages 3 and 4 are identical except the table on page 4 has a legend. This might be something to mention to publisher, unless I'm missing something. It looks to me like you have table 1, then it says table 1 (continued) but it's the exact same table.

AdrianBlake
There is good news and bad news on the urchin genetic data. The bad news is that there aren't many pre-event tissue samples for urchins or six-armed sea stars from the region. Urchins are known to go through "boom and bust" cycles (see http://dx.doi.org/10.1890/07-2136.1), but this is the largest documented die off of this species. The good news is that we have been collecting tissue samples from areas bordering the affected region, the few survivors in the affected region, and new settlers as the species recovers, so we'll know a lot more about the genetics of the recovery process, and hopefully be able to identify source populations and relatedness in the new settlers.

On the paper, yes there was a production error on that table, but PLOS fixed it in the corrected .pdf available on the same page.

Hi Laura! As a native northern Californian with a background in marine biology, this echinoderm wasting away disease was heartbreaking to learn about. Sea stars and sea urchins are some of my favorite animals in the ocean! I've been trying to keep a close eye on any recent developments in the research surrounding this topic, so thank you for doing this AMA!

Echinoderms play a huge role in maintaining balance in the rocky intertidal zone, whether it's sea urchins grazing on kelp forests or sea stars predating on molluscs. How has their drastic population decline affected their native ecosystem?

scrawledfilefish
Hi and great question. We're working on a follow-up paper describing just this. Interestingly, the typical paradigm in kelp forests (where urchins in high densities can decimate algae) would predict that losing millions of urchins would lead to a big explosion of kelp and other seaweeds, but we didn't find that at all. These intertidal urchins don't seem to actively graze, but rely on drift algae they catch from their little burrows, which protect them from massive wave forces. So no algae grew where we lost massive urchin populations, and we actually think the loss of urchin recycling services may have reduced algal growth (they turn torn up drift algae into nitrogenous waste AKA urchin pee). Surprise! The little six-armed sea stars, though, are voracious predators of small grazing snails, so their loss may affect algae even more than the urchin loss, by freeing snails from predator pressure (there's some great work by my colleague Dr. Sarah Gravem on this).

What can you tell us about the "blob" of warm water in tha Pacific and its impact on the ecosystems in question? Is higher temperature the primary cause of the die-offs?

Goldin
Hi there. It's certainly been warm in the eastern Pacific this year! It's not the primary cause of the die-off we describe, which happened quite a while prior to that. Ongoing research will be necessary to tease apart effects of the current warm "blob," since scientists will have to try to separate out those effects from other dynamics going on in all sorts of marine species. Right now, we're expecting increased temperature stress and possibly greater disease in areas that are strongly warmed, and we're seeing a lot of species that are typically more southern showing up far to the north, and that's likely to have ecological impacts for sure.

I am currently going to school to hopefully land myself a job in the maritime industry working

as an officer on board the ships that carry a large percentage of the worlds goods.

I love ocean life and think it holds some of the coolest things in existence, but my career choice will put me in a position that will potentially hurt some of the creatures that live in the worlds oceans.

How do people in your field view the shipping industry and its impact on the habitats of the ocean? Do you consider it a necessary evil or do you think there is a better way we could be doing things?

Stalwartboss94
Wow, how interesting. I applaud your concerns. Quite a few marine scientists work with the shipping industry towards decreasing harmful practices and encouraging more sustainable ones. I can see how someone like you could play a really critical leadership role in your field and we certainly need that! Issues include reducing dumping, and efforts to stop species introductions via ballast water and fouled hulls -- which is a big one, since invasive species harm both ecosystems and human economies. There is a ton of information out there on this that's worth brushing up on in your profession. I'll try to dig up a couple resources for you and post them later.

What long term effects will this have on the surrounding ecosystems? Are these 2 species the food source for anything else that will be damaged? Is the problem improving, stable, or getting worse?

candlecupchair
The die-off certainly altered coastal ecosystems. Purple urchins were the most abundant large herbivore, eating mostly drift algae and recycling it's nutrients, so the loss of millions of them was a huge impact. They are also eaten by many shorebirds and land mammals (like racoons and coyotes), so they form a link between food webs in the ocean and on land. Six-armed stars are key predators in tidepools, so their loss changes tidepool species interactions and food webs. The urchins are coming back already, but still less abundant than previously. We think it will take a long time for the stars to return, since unlike urchins (whose babies spend some time in the plankton and can move pretty far), baby six-armed stars crawl away from their mothers (not very far).

Your paper makes two points that I wonder if we can't connect. First:

First:

Once we determined the severity of intertidal purple urchin mortality at our 11 core sampling sites, we added nine sites to increase spatial resolution, to search more extensively for survivors, and to more precisely delineate the spatial distribution of mortality ("Fine-grained surveys," S1 Table).

And your conclusion:

(1) physical disturbance, (2) mass migration of individuals to areas outside the sampling domain, (3) dysoxia or anoxia, (4) a disease outbreak, and (5) toxicity resulting from a harmful algal bloom (HAB). Of these, toxicity from a HAB is most likely.

Could the size of the Urchin/Sea Star/Other Invertebrate population be regularly observed and used as a kind of warning system for measuring the local health of an ecosystem? Would that be useful, or is the health of invertebrates more of a trailing indicator, which would alert us to problems only well after they've become problems?

I ask because there are a lot of invertebrate farming operations being set up, which combine kelp, fish, and mussels or clams in an attempt to cut down on the farm's pollution. If we're able

to detect a Harmful Algae Bloom in advance, it might allow us to develop some kind of mitigation system.

I know that in certain conditions, sampling devices are created for farmers to measure the number and variety of bugs, from which similar conclusions are drawn. This is especially true for organic farmers, who want to see high numbers of predatory insects because they don't use pesticides.

ArsenicToaster
I'm not sure that we are able to detect HABs in advance at this time, but I agree that would be helpful for shellfish farms. The species bloom very quickly and don't always produce toxins, and blooms can turnover to a whole new suite of species in as little as 24 hours. In this case, the invertebrates died extremely rapidly, and their death would not have been a great advance warning system.

As a non-ecologist, I regularly see (especially on Reddit?) reports of mass die-offs, often with apocalyptic-sounding descriptions. I think there is a tendency to believe that these events are happening with unusual frequency and/or at unusual scale "nowadays". However, in some other areas (e.g., mass shootings, crime rates, natural disasters), it seems human cognitive biases and increased modern technology to detect and report these events seem to combine to give us a false impression of "things getting worse."

From your knowledge, are mass die-offs such as the ones you have studied, reports of coral reefs dying, and anything else you know about actually getting "worse" (e.g., more frequent or larger in scale) in recent decades/years?

bobbyfiend
There are quite a few lines of evidence that mortality events are increasing in frequency and possibly severity, at a rate greater than could be explained by observer bias alone. Scientists generally take that kind of thing into account and most natural and earth scientists are much more overcautious than otherwise. The most recent science has quite conclusively demonstrated an increase in the types of disturbances that drive these mortality events too, including severe storms, heat waves, harmful algal blooms, and disease outbreaks.