SCIENTIFIC AMERICAN™

Permanent Address: http://www.scientificamerican.com/article.cfm?id=questions-and-answers-with-rogue-geoengineer-carbon-entrepreneur-russ-george

Pacific Ocean Hacker Speaks Out

Is Russ George a "rogue geoengineer," salmon savior or something else?

By David Biello | Wednesday, October 24, 2012 | 9 comments

This past July Russ George served as chief scientist on a cruise to fertilize the northeastern Pacific Ocean with iron—the latest in a long string of similar, and usually controversial, efforts he has led. He has been attempting to commercialize such ocean fertilization efforts for years, including setting up the failed company Planktos. In parallel, he has also been promoting plans to generate carbon credits for companies and governments, allowing them to emit greenhouse gases in exchange for replanting carbon dioxide-absorbing forests from Canada to Europe.

Pin it

IRON BLOOM?: Satellite images may show the bloom Russ George and his colleagues created by adding iron sulfate and iron oxide to the Pacific Ocean off the coast of British Columbia.
Image: Courtesy of NASA MODIS AQUA

The ocean fertilization experiment is similar. The idea is that by providing missing nutrients, a plankton bloom can be created. Such a bloom sucks up CO_2 as it grows, like plants on land, and then, potentially, buries that carbon at sea as the tiny corpses sink to the bottom. But at the same time, George is hoping the bloom will trickle up the food chain and feed salmon, restoring their historic abundance. Of course, if the bloom is eaten, then animal metabolism will reemit the CO_2, sending it back to the atmosphere and defeating the purpose of reducing CO_2 emissions, as prior scientific studies have shown.

George says he is convinced that iron fertilization can be a solution to global warming, and he's pitched the idea to everyone from the Haida people of British Columbia to would-be "seasteaders" looking for a business proposition for their floating cities. Given the controversy surrounding George's latest bid—which is billed as an attempt to restore salmon populations but also aims to earn saleable carbon credits—*Scientific American* spoke with him on October 19.

[*An edited transcript of the interview follows.*]

How did this Haida Salmon Restoration Corp. project start?

This [illegible] yn it, they run it. It's not the Russ Geo[illegible]

You [illegible] his story. You can probably imagine how [illegible] nd dreams of a village whose environment is dying, whose culture is dying because the salm[illegible] hey were duped.

So [illegible]

We [illegible] old me: "Russ, keep in mind: you don't know." The correct attitude is: "Data, speak to me. [illegible] ou and tell you what the facts might be. Don't assume you have this prescient knowledge of h[illegible]

But we do know that in 2008 when 450 million sockeye salmon left the Fraser River, the expectation was that fewer than one million

would return. More and more baby salmon go to sea and fewer and fewer adult salmon return. But in August 2008 a volcano dusted ash, and the northeastern Pacific Ocean turned into a massive plankton bloom. The plankton bloom was of larger proportion than what we did in the area. So 40 million fish came home instead of a million. That offered some hope.

There have been three volcanic events in the last 100 years paired with record sockeye salmon runs. That's pretty good data. Those fish don't do fishy science, they do good science. Their physical bodies are data, you can track where they've been because of the discrete isotopic characteristics of different parts of the ocean.

But did it bury any carbon? Previous studies suggested that most of it will end up back in the atmosphere.
We don't know that yet. I don't agree with you that most of it will end up back in the atmosphere. Look at the [Victor] Smetacek paper [this year in *Nature*]. A significant amount of carbon ended up on the seafloor. Diatoms [a type of shelled algae] are big carbon sinkers because of their stony shells and powered buoyancy. When they run out of power they sink.

Tell me about the 120 metric tons of iron you dumped.
We didn't choose the simplest form of iron and dump it in the ocean. We did a carefully thought through, planned process that asked, "What forms of iron does the ocean use today and historically? How might we determine what's the right form or composition or method of preparation or method of distribution of the forms of iron that we know are effective?" So we had an experimental matrix that we believe will answer that and we have the data now.

Mother Nature blows dust in the wind, which carries fully reduced iron oxides. That's the form of iron in dust in the wind. Upstart scientists, humans, say, "We can do better than Mother Nature. We won't use that natural source of iron that nature uses; we'll use commercial fertilizer. We'll use iron sulfate because iron sulfate has greater solubility and greater biological availability."

We tested both. Our data will tell us. Do you get a different plankton bloom if you exactly mimic Mother Nature than if you exactly mimic some supplier of agricultural chemicals?

Where did you get the iron?
It's an extremely commonly available material. Iron ore dust is in use everywhere. Australia sells 600 million tons of it to China [to make steel]. The amount of sweepings, the fugitive dust from the 600 million tons shipped from Australia to China is infinitely more than we used.

We're not at liberty to divulge precise details of suppliers and such. Anybody associated with this project is viciously attacked.

Why did you pick the location you did?
Where could you do a more perfect experiment than in between a normal, natural similar phenomenon and an enormous unnatural absence? The best experimental design is to go in between two natural controls, which is where our bloom was placed. That's why [the late marine biologist] John Martin picked west of the Galápagos, because those islands are a massive source of iron. Here's a massive iron stimulated bloom that goes off to the west of the Galápagos for hundreds of miles and here's the most iron-depleted ocean in the southeast Pacific.

The best place to do science on this and get knowledge is to put the bloom in between. See what natural iron-stimulated blooms produce and what the non-blooming ocean has. Test whether or not the characteristics of what you've created [are] different in any way to a natural system.

So what did you observe at sea?
Life appeared. The nightly migration of zooplankton from the thermocline [a layer of water in the ocean that marks the transition from warmer surface waters to colder deep waters] to the surface, we saw that. Copepods, salps, all the little fish. We have thousands and thousands of biological samples now going under microscopes around the world to be identified and quantified. We didn't have a ship with 58 scientists. We didn't have a lab on board, and it's not a great big ship with the stability to do microscopy on board. What we could do is work 24/7 and the Haida crew on the ship worked literally 24/7. Their job was to collect an unimaginably vast collection of samples.

We had instrumentation of every sort. Does Woods Hole [Oceanographic Institution] have two Slocum gliders? They may have one. The

Canadian Institute for Ocean Science provided us with two gliders. We talked to [the National Oceanic and Atmospheric Administration] as the Haida Salmon Restoration Corp. and said our intention is to go out to the eddies, identify an eddy and there try to understand how it could be restored and replenished. They say they didn't know what we were doing.

We started by using ships of opportunity to collect water samples last December for months. This is not willy-nilly. This is not go out, throw iron in the water and stay there for as little as possible because the costs are so high. We were gathering baseline data months ahead. We sent gliders out long before the ship set sail to survey the whole region. We have baseline data for the whole region, on natural blooms and eddies that were blooming and weren't blooming to get the full picture. That's indicative of good, careful science planning.

This is world-class science done by one of the least likely suspects: a small, native peoples village. That's the charm of the story.

That's kind of a preliminary glimpse. Now there is an incredible amount of data to plow through. The book has to be read and we're trying to get to that job.

How long before you share the data or report some results?
We have 10,000 water samples to be analyzed for 20 different characteristics. The first few hundred samples we sent to a commercial lab to give us a glimpse to make a determination of the ultimate cost. We sent them three weeks ago and no peep out of them yet. It takes a long time and a lot of money.

Why did the Old Massett Village Council invest in this?
This is not a village looking to take over the world in some evil fashion and become wealthy. They have 70 percent unemployed, a high suicide rate. Every household used to have a good income from salmon fishing and now almost none do. This is a tiny village of people trying to take care of their backyard.

The Haida have a tradition called potlatch. Those with something give away what they have to those without. The Haida tradition is to give back. If you go to our Web site, there is a section called parables. There is a story called "Salmon Boy." It's one of the earliest and most pertinent scientific publications in salmon, published via the Haida oral tradition. It says if you don't give back to the salmon, they won't give back to you.

Salmon boy is wasting the fish and later drowns. The salmon people come and take him down to salmon world where he becomes a salmon and they teach him about how the salmon are happy to be in a relationship with their Haida neighbors. He swims back to the river.

His mother catches a fish that has a necklace her drowned son wore. Instead of killing the fish, she sets it aside and out of the salmon skin the boy emerges. He becomes a wise teacher to the Haida village, teaching that you have to take care and give back to the salmons' world or they won't come home and give to you. It's a wisdom about ecology and environment.

If the true story of the Haida came out then this is a story that has a heart and a soul and hope. Not just for the Haida but for the whole world. But people politically opposed to geoengineering and feeding at the research trough rely on doom-and-gloom stories of the environment. The last thing they want to see is that [Hillary] Clinton was right and it takes a village.

What's your background?
I've lived in Canada for many years now. I'm a plant ecologist who has done countless silviculture [forestry] projects. I worked in government and do land reclamation and environmental management, like writing prescriptions for the grass and clover to put on mine waste or how to grass the side of a road. I'm a translator of science into application.

I've prescribed a hundred times how to restore a dilapidated piece of rangeland. The Haida people have an ocean pasture that their life and culture depend on. The salmon on that pasture, in spite of every effort, have disappeared. This is a village of people who can no longer get enough food. It's because their pasture has no carrying capacity for animals to grow and thrive on. We are trying to replenish and restore the pasture and we are portrayed as villains.

Any concerns about possible side effects like dead zones?

Can any scientist who claims to be credible say such a thing in the face of the long, published history of plankton blooms in the open ocean? There was a massive volcanic bloom from the 2008 [Mount] Kasatoshi eruption. Ours was less than 1 percent of the size. Did it [the Kasatoshi eruption] result in oxygen dead zones?

But plankton blooms do cause dead zones.
Not in any pelagic environment, in constrained coastal regions. Is there a single solitary published report based on experimental observations other than the hypothetical? We've looked. We've not found it.

Any concerns about the legality of this effort?
This is Canada so it's British law, not American law. In British law, if you want to do something and you're not sure whether it's legal or not, you commission officers of the court to do an analysis and produce an official document, a legal opinion as to whether it breaks the law or not. This was done. The opinion was that with comparative studies and international laws we were absolutely in the clear. The claim that this is illegal is the design of the people who want to burn the books. This is the life of the village that they're trying to kill.

Any plans for more ocean fertilizing?
Could you imagine that it would be good science to do something only once? Just put one drop of test chemical in a test tube? A reasonable, intelligent, earnest and honest scientist would not plan to do it only once. That's not good science.

We have to see what the data says. We just don't know what it says. In our hopes and dreams, in the village's hopes and dreams, this works. And what if it does work? What if this is a means by which the ocean pastures can be stewarded and brought back to health? The fish will come back but all the other sea life as well. What if that's the outcome?

Would you call this geoengineering?
Geoengineering is an entirely derogatory spin term. If they can pin that to you, you've lost already. I once gave a TED talk in New York City along with Wally Broecker, the father of climate modeling and David Keith who coined the term geoengineering. In the green room before the talk we got in a heated argument because I said geoengineering is a nasty name.

I don't think we should build artificial forests out of concrete with concentrated lye solutions dribbling over the leaf area to absorb CO_2. I think we should grow real trees.

The problem with [CO_2's effect on] the ocean is not merely ocean acidification. The main problem is high CO_2 promoting plant growth. This planet is a planet of grass, not trees. Dust comes from all kinds of dry areas. The vast majority of dust-producing regions are drylands. Those are places where grass grows but its green in spring and brown in summer. When it's green and growing well, it's good ground cover and then it shrivels up and becomes poor ground cover.

Well, with high CO_2, the buzz in pasture science journals is the improvement of pasturelands. Dryland grasses benefit from high CO_2 and the period of ground cover is greatly extended.

The immediate consequence of that has been a diminishment of Aeolian dust. That lack of Aeolian dust is a wonderful boon to pasture on land because it's topsoil blowing away, but it's tragic for the oceans because it's a source of iron for the oceans. It's the primary cause of the collapse of primary productivity in the oceans.

Maybe it's all about salmon. Maybe the name Haida Salmon Restoration Corp. was chosen with some wisdom and intelligence. The village is not a geoengineering business. It's trying to feed its people, trying to solve the problem of 70 percent unemployment, grasping for a ray of hope. It's doing this in its traditional territory. This is the Haida ocean. They are taking care of their own home. Why can't they take care of their home? Why is this branded as a malevolent, controversial, geoengineering scheme?

Can ocean fertilization really help combat climate change on any significant scale?
The major mechanism for controlling CO_2 is solubility in water. Anthropogenic CO_2's destiny is to dissolve in water. The only source of a nonpolluting amount of energy to match the fossil fuel that won't add more CO_2 to the atmosphere is sunlight and photosynthesis. The photosynthetic potential of plankton in the ocean, if restored to 50 years ago, is more than sufficient to manage a large part of the anthropogenic CO_2 problem.