

# THE PERFECT REEF

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PART 1

## CORAL REEFS: THE FIRST VITALLY ACCURATE REPORTS STATE CRITICAL FINDINGS...

The Making of 'The Perfect Reef', Episode 1 in a series of Underwater Documentary Films entitled 'The Reef', required in-depth research and collaboration with the globally leading Marine Scientists, Experts and International Agencies dedicated to saving the coral reefs.

The data learned was hard to take; the outlook Drastic. The Facts: Coral Reefs could be gone in as little as 30 years; and we humans are destroying the very world that supports us.

Around for over 100 million years, coral reefs are the most extensive living structures ever built by any organism on earth, including man. Modern coral reefs date from around 10,000 years ago, the end of the last ice age, when sea levels rose, covering the land and limestone hills. These hills, already skeletons of earlier reefs, formed the base for modern-day coral reefs.



Coral reef ecology is a young science, with little reliable information before the 19th Century. According to J.B.C. Jackson ('Reefs since Columbus'), the problem is that everyone, scientists included, believes that the way things were when they first saw them is natural. However, modern reef ecology only began in the Caribbean, for example, in the late 1950s, when enormous changes in coral reef ecosystems had already occurred. The same problem now extends on an even greater scale to the SCUBA diving public, with a whole new generation of sport divers who have never seen a "healthy" reef, even by the standards of the 1960s. Thus there is no public perception of the magnitude of our loss.



The question 'What is a perfect reef?' started to take on a more sinister meaning.

Dr Ross Jones at Bermuda Biological Station for Research: "A perfect reef could be a reef with high coral cover, high diversity, high fish abundance, mega vertebrates, the manatees and dugongs, the sharks and rays and all the big fish which seem to have been fished out. But trying to find a base line for assessing what a perfect reef is, is very, very difficult". Dr Jones continues: "It's recently been pointed out by an

perception of what a pristine reef or a perfect reef is, is very much by not knowing what it was like in, say, Columbus's days; back in 15, and 16,00's. It may well be that our fathers & grandfathers say, 'Well, I remember when there were corals as far as the eye see, & that's what would be a perfect reef, that's what it should like'. But actually, further back from the 1950, 60's, back 2-300 may have been an entirely different system again, with the mega vertebrates, the sharks, dugongs, groupers and so on in high abundance compared to what they are now. Though again, its a shifting baseline."



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Ferdinand Columbus, writing about the 4th voyage in 1503, Cayman Islands: ‘...in sight of two very small and low islands, full of tortoises, as was all the sea about, insomuch that they looked like little rocks...’

Andres Bernaldez, writing about Green Turtles during Columbus’ 2nd voyage in 1494, South-eastern Cuba: ‘...But in those twenty leagues, they saw very many more, for the sea was thick with them, and they were of the very largest, so numerous that it seemed that the ships would run aground on them and were as if bathing in them...’

When the English captured the Cayman Islands in 1965, they turned to the vast populations of green turtles that nested around Grand Cayman for food. Between 1688 and 1730, Cayman Fisheries were bringing some 13,000 green turtles *per year* to Jamaica for food (J.B.C.Jackson). Female green turtles require 40-60 years to reach productive maturity. Not surprising then that by 1800, the Green Turtle fishery in the Cayman Islands was already entirely gone; the Cayman Islanders having moved on to fish the Green Turtles elsewhere.



It is indeed interesting that so many islands and sites around the Caribbean - the Dry Tortugas, for example - are named after turtles that almost no living person has ever seen”.

Large vertebrates such as the extinct Caribbean Monk Seal, the Green Turtle, Dugongs and Manatees were already decimated by the late 19th century, when small fishes began to dominate the food chain. “Studying grazing and predation on reefs today” says Jackson, “is like trying to understand the ecology of the Serengeti by studying the termites and the locusts, while ignoring the elephants and the wildebeest.”



The same story applies to sharks, rays, groupers, hawksbill turtles, manatees and more. As we ponder this new information, we can’t help but reflect that over many years of diving, the number of large species on the reefs has either declined or disappeared completely. Even 10 years ago, turtles and sharks were normal. Now, in the Caribbean, they are a rare occurrence.

### **Direct Human Pressure on Coral Reefs**

Coral reefs are suffering from human pressure, coming in many different forms. Reefs not affected by one kind of pressure are attacked violently by another. Coastal Development, Over fishing, Land Conversion, Pollution, Global Climate Change... the list is unending.

In a plea to raise awareness about the critical state of the coral reefs and to provide the public, decision makers and governments with a means to save them, the Washington DC based ‘World Resources Institute’, produced a series of reports entitled ‘Reefs at Risk’. Conducted in collaboration with Government Agencies, NGOs, International Organizations and Scientists worldwide, the reports provide the first vitally accurate, detailed, global assessments of human threats on coral reefs.

Key findings were as follows:

- Approximately 2/3 of the world’s coral reefs are threatened by human activity.

- Coral reefs of Southeast Asia, the most species-rich on earth, are the most threatened of any region. More than 80% are at risk, primarily from coastal development and fishing-related pressures.
- Almost 2/3 of Caribbean reefs are in jeopardy. Reefs off Jamaica, for example, have been ravaged as a result of over fishing and pollution. Many resemble graveyards, algae-covered and depleted of fish.

### Over fishing

Human populations increase, so too does their demand for seafood. Unfortunately, it seems that this demand far exceeds existence.



According to The Global Coral Reef Monitoring Network, 'Status of the Coral Reefs of the World; 2004' Report, 'most reefs within range of small fishing boats are over fished. Target species are Grouper, Snapper, Lobster, and Wrasse. As catches decrease, fishers target all fish species using more efficient methods of traps, fine mesh nets and spears; the final resort is to use bombs and cyanide to catch the few remaining fish'. 'There are many reefs in Eastern Africa, South and Southeast Asia and the Caribbean

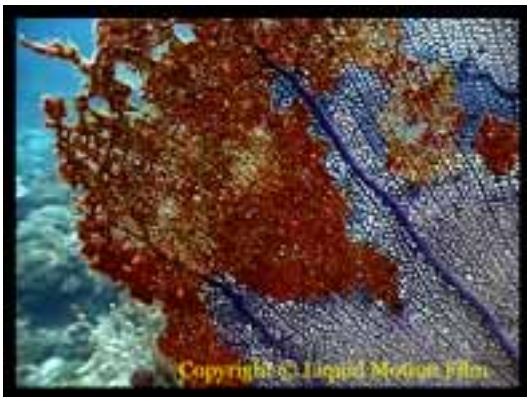
where it is rare to see a fish over 10 cm long.' the report notes. 'As these areas become depleted, more fishers target remote reefs and industriously remove most suitable fishes. This mobile trade in Asia is driven by an almost insatiable market demand for live-food fish from Asian restaurants. Sharks are now particularly rare on many reefs, just to make shark fin soup. These two trades are multi million dollar industries'.



There are simply too many men trying to catch too few fish.

First the predators are depleted, then the omnivores, the herbivores, and then finally the planktivores. Layer after layer of the food chain is fished out, with disastrous effects on the coral reef.

Dr Ross Jones, BBSR: *"Reefs are basically a competition between corals and algae. Herbivorous fish will graze out the algae, giving the corals a competitive advantage. So as long as you have the fish there, the corals flourish, do well and form a whole coral reef ecosystem. If you remove the herbivores, the algae then start growing, and if there's nothing else to replace the herbivores then the algae start overgrowing the reef and you might have a change from a coral reef to an algae reef.... The algae then grow over the corals, the corals start to decline and things change from there."*



The GCRMN 'Status of the Coral Reefs of the World; 2004' Report likens the removal of fish from the reefs to the removal of the immune system. "In addition, fishing results in direct physical damage to the coral framework, thereby further exacerbating the effects of over fishing. Damage results from anchors, nets and traps and especially the use

of explosives to stun fish hiding in the corals."

## Coastal Development & Shoreline Modification

Another direct threat to the coral reefs comes from the constant alteration of shorelines and removal of mangrove habitats for new resorts, beaches and waterfront homes.

Natural breakwaters, Mangroves protect shorelines from wave erosion and ferocious storms. A filtration system, they also filter out sediment, ensuring clear water reaches the reefs.

Dr Samantha De Putron, Bermuda Biological Station for Research: *“Unfortunately a lot of the coral reefs of the world are next to developing countries and those developing country areas are starting to do development without environmental impact assessments around the reef areas they want to develop. All this is causing a huge impact to the reefs and large areas are being destroyed.”*



Mangroves are also pulled out for agricultural land. Pesticides, Herbicides, Soil run-off and Fertilizers, once filtered by the mangroves, now all wash directly onto the reefs, creating turbid water and sediment, which eventually smother the corals. Simultaneously, the extra nutrients encourage rapid algae growth. Between the sediment and the algae, the corals are cut off from their necessary sunlight. They suffocate and die. This run-off also poisons the fish and shellfish that we eat.

And things get worse - Population increase calls for more land development. “There are currently large plans to ‘reclaim’ coral reef areas in the Persian/Arabian Gulf, especially in United Arab Emirates, in the Red Sea along the coast of Saudi Arabia, in Singapore and recently in Peninsular Malaysia and southern Japan to build airports on coral reefs to attract tourists” (GCRMN, ‘Status of the Coral Reefs of the World; 2004’)

## Pollution

Sewage, oil, chemicals and human waste kill coral reefs. Ordinary trash strangles corals, plastic bags, mistaken as a jellyfish meal, have been found in stomachs of dead turtles and fish. Vessel groundings, anchoring damage, churning, toxic paint on ships, marine pollution, tourism, snorkelers and even divers - The ones who love the reef most come in sheer number and the list continues.

Just one coral head equates to hundreds to thousands of tiny animals - coral polyps - living in a community that takes thousands of years to grow.

Just one accidental fin kick, one finger touching a coral head destroys these animals in an instant. Often there’s not just one fin; Often visitors not even aware they have touched the reef. Souvenirs - Conch shells - taken home. Only recently, it was even considered normal to buy dried Sea horses as decoration. The Marine Aquarium trade continues to expand, the fish harvested in destructive ways, killing many other species and corals. The list is endless. As human population increases, so too does the destruction.



According to the GCRMN, ‘Status of the Coral Reefs of the World; 2004’ Report, ‘Analyses of coral reefs in the wider Caribbean region confirm major reef declines and they do not resemble the reefs of 30 years ago. Coral cover on many Caribbean reefs has declined by up to 80%...’

The World Resources Institute 'Reefs at Risk in the Caribbean Report' in 2004 arrived at equally alarming estimates of coral reef decline. Results indicated that nearly two-thirds of coral reefs in the Caribbean are threatened by human activities - Coastal Development, Watershed-based sediment and pollution, Marine based threats and Over fishing.

### **Bleaching and Disease**

If all this is not enough for coral reefs to contend with, Global warming, largely caused by the burning of fossil fuels and ever-increasing greenhouse gas emissions, continues to raise the temperature of the oceans. Not even mentioning the melting of the ice caps, the interruption of the Gulf Stream leading to the deep freeze of Europe, the flooding of all low-laying islands or the numerous other disastrous effects to the planet. Not in 'the future' as many vaguely consider, but Very Soon. Global warming has already led to a dramatic increase in frequency and severity of coral bleaching, and is perhaps the direst threat to the coral reefs existence.

*"The 1998 event was the largest bleaching event ever known, affecting virtually all provinces, all islands, all countries in the world, most of the major reef states & nations," says Dr Ross Jones. "The problem of bleaching events such as the '98 bleaching event is the ability of the reefs to recover from it."*

Coral bleaching is the breakdown of a vital symbiotic relationship between corals and microscopic algae (zooxanthellae), which live within their cells. These microscopic algae photosynthesize -  $(CO_2 + WATER \text{ (USING SUNLIGHT ENERGY)} = CARBOHYDRATE + O_2)$  - using the sun's energy to convert Carbon Dioxide into carbohydrate, or 'food', which is passed to the coral. Along with this nourishment, the coral uses Oxygen, another by-product of the algae's photosynthesis. The algae get a protected place to live, and the coral gets the energy required to reproduce, grow and build reefs. The symbiotic algae are also responsible for the dazzling colors of the coral.

When water temperatures increase, this vital symbiosis breaks down and the white, calcareous skeletons of corals are displayed - hence 'bleached'. Losing its main source of food and energy, the coral may be still alive, but is essentially starving. If it doesn't regain its symbionts soon, it will die.



Bleaching events have happened in the past, but corals started out as healthy and there was enough time before the next bleaching event for the corals to recover. Now, with all the added human stress placed on the corals, plus an increase in frequency and severity of bleaching events, scientists fear the worst. Dr Ross Jones: *"If your coral is going to be knocked over by a bleaching event every 2 or 3 yrs., the ability of the reef to bounce back very much depends on the health of the corals at that time and in the recovery phase."*



Simultaneously, there has been a recent increase in coral diseases and plagues, killing species and reefs worldwide. 'The major worrying feature is the very strong suspicion and apparent close correlation that the increased incidence and severity of these threats is directly linked to damaging human activities' states the GCRMN, 'Status of the Coral Reefs of the World; 2004' Report.

*"When corals are in a weakened state, a stressed state, they may be more susceptible to disease."* remarks Dr Jones. "I

*mean, diseases, you tend to pick up diseases when you're not healthy yourself and if corals are a combined effect of anthropogenic inputs, pollutants and decreased condition in the coral, then they're more susceptible to disease and infestation."*

Fact: Humans are destroying coral reefs and damaging the overall health of corals. This seems to make the difference between death and survival, when they are faced with natural events.

## THE PERFECT REEF PART 2

### CORAL REEFS; IMMINENT DISAPPEARANCE VERSUS VALUE TO HUMAN LIVES...

In order to raise awareness about the need for urgent action, the world needs to focus not only on the cause of this dreadful, perhaps terminal coral reef destruction, but also on understanding the economic and social values of coral reefs to human lives. Not many are aware of the extent that coral reefs benefit the lives of each and every one of us - Perhaps if we were, there would be more pressure on the governments; more will for prevention of this damage and for salvage. The countries where the reefs are been destroyed are the very countries that are dependant on their existence.



#### Value of Coral Reefs

Coral Reef Ecosystems are living museums, housing billion-year-old organisms. They're home, hiding place and food for numerous species. They provide food for millions. Commercially valuable creatures such as Shellfish, Lobster, Grouper and Snapper depend on the health of the coral reefs for survival. So then, do fisheries and entire economies.



Acting as breakwaters and protecting shorelines, coral reefs dissipate wave and storm energy, while their related Mangrove and Sea Grass ecosystems prevent coastal erosion. Costs for artificial breakwaters and repairing eroded coastlines have been documented to be millions.

Coral reefs are the foundation of the economy of many areas they surround. Coral provides the white sand beaches. Tourism, providing a luxury haven for divers, snorkelers, and pristine beach lovers, generates billions of dollars and provides jobs, food and survival to people worldwide.



According to the WRI 'Reefs at Risk in the Caribbean' Report, coral reef associated fisheries in the Caribbean region provide net annual revenues valued at an estimated US\$310 million. Net benefits from dive tourism total an estimated US\$2.1 billion per year in 2000. Dive tourism is high value tourism, with divers typically spending 60–80 percent more than other tourists. Imagine then, the economy of all these countries, if the tourists turn elsewhere - to the last-remaining intact reefs - because the Caribbean reefs are so degraded and depleted, that they are no longer of interest. At the same time, serious over fishing results in no more fish, and no more catch.

Often referred to as the 'Rain forests of the sea', coral reefs are a greatly important source of new medicines, life saving drugs and treatments for diseases such as cancer, osteoporosis and Aids.

Dr Hank Trapido-Rosenthal; Associate Research Scientist, BBSR: *"I have very little doubt that there will be found, within the next decade, bio-active molecules in the coral reef ecosystem that will play very important roles in the advances of human health. But the reefs have to be there for the next decade for scientists like myself to have access to the bio-diversity that's there."*



Surely this seems a little hypocritical? Aren't we supposed to be saving the reefs, not 'using them'?

*"Ah, The genetic engineering revolution..."* Says Dr Trapido-Rosenthal, with a smile. *"We don't need kilograms of that material; we need a thumbs worth, 5 grams, or less. We extract the DNA from that tiny amount of material and clone that DNA into a domesticated strain of laboratory bacteria. Now we've got the genes, the code for the construction of the (let's say) anticancer compound, cloned into domestic bacteria. What we need to do is find the clone that makes the gene that makes the anticancer drug, and then we literally train those bacteria to make the drug for us. So we don't need to go back to the reef to collect more of this material. We've cloned it, we've trained the bacteria to make it."*



Coral reef ecosystems already provide antihistamines, AZT - a treatment for HIV, painkillers and medications for asthma, leukemia and heart disease. Treatments for cancer, AIDS, asthma, herpes and broken bones are being discovered in coral reef ecosystems around the world.



Dr Hank Trapido-Rosenthal: *"My lab is bio-prospecting coral reef ecosystems, looking for bio-active molecules that may be of benefit to human health. We might find things that stimulate bio-mineralization. Coral reefs are bio-mineralizing environments. Our bones are bio-mineralizing environments and we can find a treatment for osteoporosis in bioactive molecules we find in corals. I think this would be a definite plus, this would be a contribution from the reef ecosystem to human health"*.

These important ecosystems harbor untapped potential for life saving drugs. They protect human societies, coastlines and the livelihood of millions. Surely this alone is reason to try and save them.

There remains no doubt that the major cause of the destruction and disappearance of coral reefs and all their incredible creatures is man. There also seems to be no doubt that the only way to save them in time, is by man. Until now, not many people knew or understood. With these latest reports and findings, there are no more excuses. Do we care enough about the world we live in, to save it, or are we on a path of self-destruction?

## Can we save the reefs, or is it too late?

In the 'Status of the Coral Reefs of the World; 2004' Report, The GCRMN states - "We firmly believe that the concerted efforts of the global community can halt and even reverse the decline in the world's coral reefs." But how?



Dr Ross Jones: "Most people describe the future effectively in the balance in the next 10-15 years and it really relates to political will. Politicians having the pressure put on them or understanding the need to preserve reefs and then more global co-ordination, formations of Marine Protected Areas (MPA's), 'no take' zones on a regional basis - not hundreds, but thousands of square km. A co-ordination of governments and regional programs, that could reduce over fishing, reduce anthropogenic, eutrophication, pollution effects...."

By minimizing the flow of sediments, pollutants and algae-favoring nutrients onto coral reefs; By putting an end to the horrific fishing practices, such as cyanide, poison and blasting and controlling the fisheries to make them sustainable; By establishing no-take areas to allow depleted fish stocks to replenish; By educating - not only local fishermen, but tourists, residents and visitors to these ecosystems; And by the Establishment and Management of Marine Protected Areas.

## MPAs

No fishing, no touching, no anchoring, no collecting... With the never-ending growth of tourism and fisheries, Marine Protected Areas or MPAs are an effective way, and perhaps the only way, to conserve, protect, manage and save coral reefs.

Many countries have already declared areas of their reef as MPA's, but worldwide, this amounts to just a small percentage of the coral reefs. And unfortunately, most of these 'so-called' protected areas are not. In the Caribbean, The WRI 'Reefs at Risk' reports found that 'for over 26,000 sq. km of Caribbean reef, 80% was **outside** MPAs' – thus, available for the taking. More worryingly, of the 20 % of coral reefs actually protected by MPAs, only **6%** were rated as effectively managed, the rest offering little or no protection at all.



"Many MPAs are not well managed or not managed at all." also confirms the GCRMN. 'Many coral reef countries lack the resources of trained personnel, equipment and finances to effectively conserve coral reefs, establish MPAs and enforce regulations. This lack of resources is often exacerbated by a poor awareness of the problems facing coral reefs and their significance in local economies, and inadequate political will to tackle difficult environmental problems'.

According to the WRI 'Reefs at Risk in the Caribbean' Reports, Actions to reverse the threats to Caribbean coral reefs can often be undertaken at very low cost, with very high financial and societal returns, even in the short term.

'But', The Reports state, 'a wider involvement of the public and stake holders in the management



processes, along with a full understanding of the fragility of coral reefs and their importance, especially the economic value of coastal ecosystems, is fundamental'.

Local communities need information on the economic value of goods and services provided by their reefs, on the links between human activity and coral damage and on how to protect and manage their reefs, yet sustain the income being brought by them. They need help to develop ways to gain economically from their reefs without destroying them. This is fundamental to strengthening community support and political will.



*'You can't tell someone in an undeveloped country that they have to stop fishing their reefs' says Dr Samantha De Putron, at the Bermuda Biological Station for Research. 'So the best way is to say 'you're not going to stop fishing, you're just going to change your fishing practices to a way which is less destructive'. But in order to do that, it's going to need some economic input - Unfortunately its about money, as well as education'*

Despite the critical state of the reefs, there seems to be a growing international effort to halt and reverse the coral reef destruction. According to Dr De Putron, areas have been targeted around the world where various (usually volunteer) organizations have gone in and have started to save those reef areas through financial input & through education.

*"And what we are seeing in some areas, which is very promising" says Dr De Putron, "Is that, as they start to understand how much the reef benefits them as well, the local companies start to develop their own research program and start to develop their own long term monitoring plans of those reefs. This is something which is then going to obviously benefit the future, because they're passing on their own knowledge."*



Volunteer Organizations like Reef Check - The United Nations' official community-based reef monitoring program - are now monitoring the health of the reefs, using a standardized global method, allowing comparison between different regions over time.



In 1997, Reef Check conducted the first-ever global survey of coral reef health, which provided scientific confirmation that our reefs are in crisis due to over fishing, illegal fishing, and pollution. "The rate of decline and the global extent of the damage are alarming. There is virtually no reef in the world that remains untouched by human impacts, such as over fishing, pollution and climate change." says Reef Check. "The number of sites with zero counts of Nassau grouper in the Caribbean and hump head wrasse in the Indo-Pacific have now increased from 90 to 95%. These fish should be plentiful and very common."

Relying heavily on volunteers and the general public, Reef Check continues to make global progress with their teachings and assistance. They now have volunteer teams, trained and led by scientists, in 70 of 101 coral reef countries, who are working with business sectors, tourism, diving, surfing, the marine aquarium trade and local governments to develop mutually beneficial solutions and introduce

self-funding Marine Protected Areas. Their work has already led to local community stimulation to protect and rehabilitate their damaged reefs. This shows that there is hope, but it is up to us.



According to the WRI 'Reefs at Risk' reports, sustainable financing for MPAs must be developed if they are to function well in the long term. Only a handful of parks in the Caribbean directly generate income. For example, the Bonaire Marine Park introduced an annual diver admission fee of US\$10 in 1992, which currently raises 60 percent of the park's budget, and Saba Marine Park raises 70 percent of its income through diver fees. If managed correctly, MPAs not only protect the coral reefs, but also can create new jobs, sources of income and self-finance.



As I write, here in Bonaire, I can only see success, and one of the most diverse, healthy coral reefs of the Caribbean.

### Conclusion

Statistics and Reports indicate an uncertain future for coral reefs. 70% of the world's reefs are now threatened or destroyed, up from 59% four years ago. But the percentage of recovering reefs has increased from the last assessment (GCRMN).

Observation shows the big fish are missing on most reefs. There are success stories. In Bermuda, for example, the government banned destructive fishing methods and fish pots in the '90s, before which the reefs had high algae cover, the larger fishes and herbivores depleted or missing. Just 10 years later, we personally noticed good numbers of large Grouper on Bermudas reefs. Scientists confirmed that the corals are much healthier; the fish replenished. Simultaneously, though, Bermuda had the means to provide these fishermen with finance to re-establish themselves.

Large herbivores and carnivores are now ecologically extinct on Caribbean coral reefs and sea grass beds. Similar depletion is almost complete throughout the Indo-Pacific. 'In Africa, neotropical herbivorous food chains are now dominated by insects and small mammals, except where free-ranging livestock may have partially redressed the balance. But there are no such livestock on coral reefs'. (J.B.C.Jackson)



Having evolved and adapted over millions of years, recovering from natural disturbances and damage, coral reefs simply can't keep up with the rate of human-caused destruction of today. Their communities can't recover in time. Death or Survival hangs in the balance and will be determined over the next 10 years. It seems that the result depends entirely on the realization and involvement of the public, and on political will. To all those trying to achieve this, please continue to make a difference.

'The Perfect Reef' (<http://www.liquidmotionfilm.com/>).

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