CAPTIVE DOLPHIN WASTES KILL CORAL REEFS

Tom Goreau
President
Global Coral Reef Alliance

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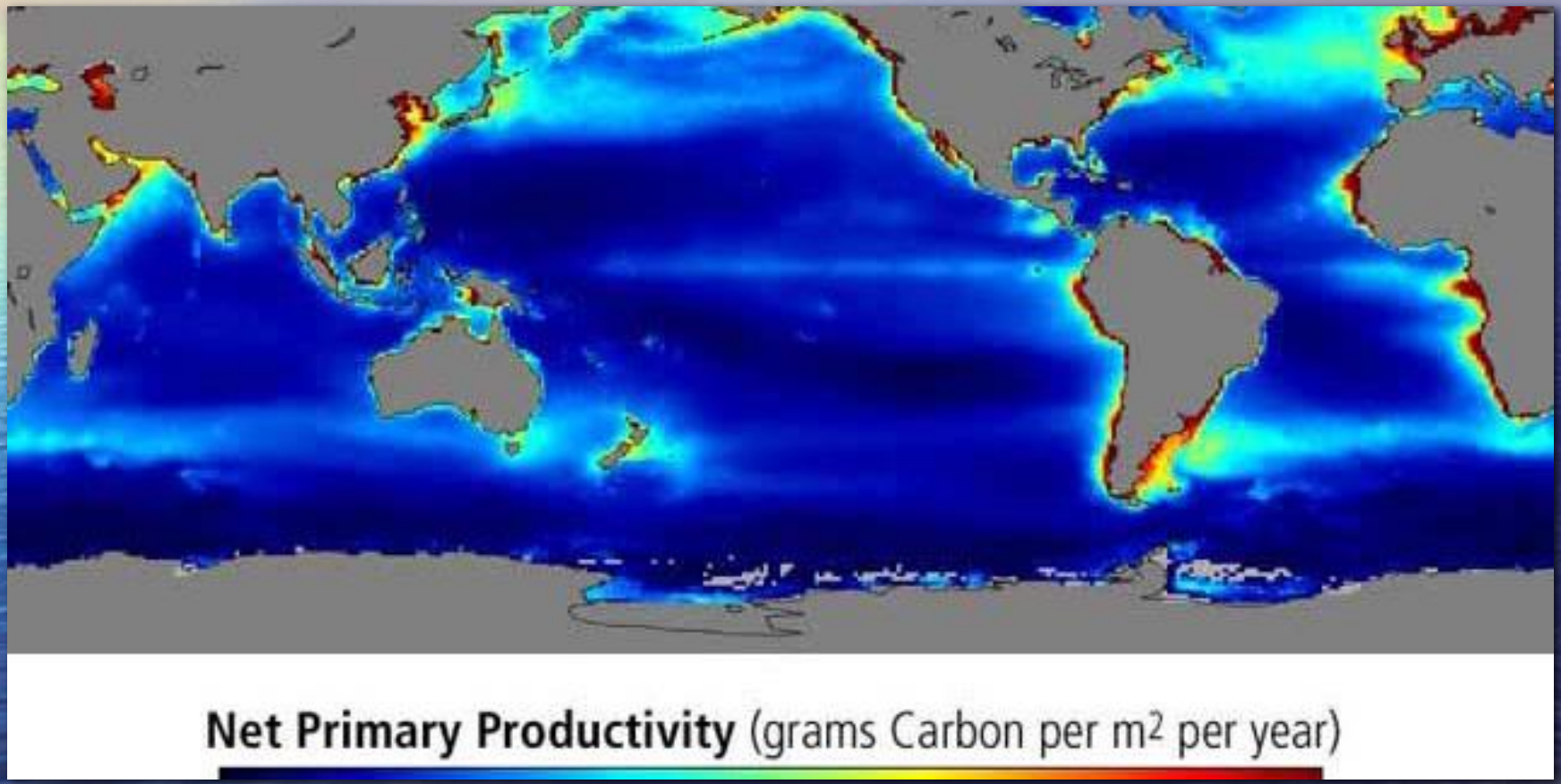
DOLPHIN FACTS

DOLPHINS ARE INTELLIGENT CHARISMATIC VERTEBRATES WHO DON'T NEED PUBLICITY, LIKE CORALS DO!

A DOLPHIN EXCRETES AS MUCH WASTES AS 4-6 HUMANS

A DOLPHINARIUM WITH 10-15 DOLPHINS CREATES AS MUCH SEWAGE AS 20-75 PEOPLE

CORAL REEFS REQUIRE PUREST CLEAREST WATERS



CORAL REEF EUTROPHICATION

- Coral reefs are the most sensitive ecosystems, they are NOT resilient!
- Coral reef ecosystems are the MOST vulnerable of all to high nutrients, sediments, pollution, and temperature
- They are killed at levels of pollution so low that no other ecosystem would be affected
- Protecting coral reef water quality is the strongest test of sustainable development
- Major source of fisheries, tourism, shore protection, biodiversity for >100 countries

CARIBBEAN WATER QUALITY

- Every Caribbean country has staked its future on tourism.
- Caribbean is the most vulnerable area of the world to coastal eutrophication because of low tides and currents.
- Therefore it needs the strongest water quality standards and nutrient recycling on land to preserve its tourism and fisheries

SEWAGE: TOURISM'S DIRTY SECRET

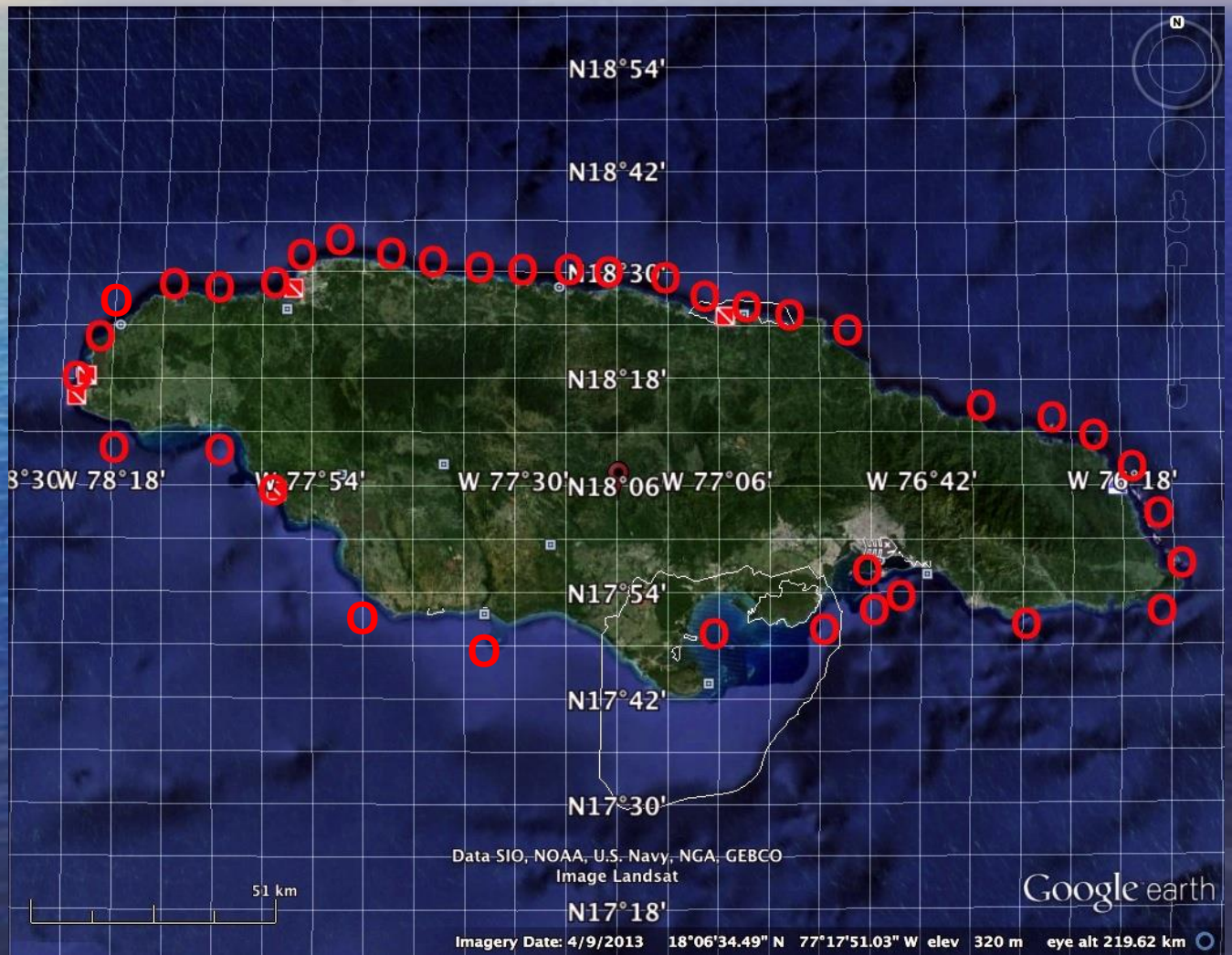
All around the world tourists are swimming in their own sewage, and that of many, many others, too!

I had to swim through a lot of it for this talk!

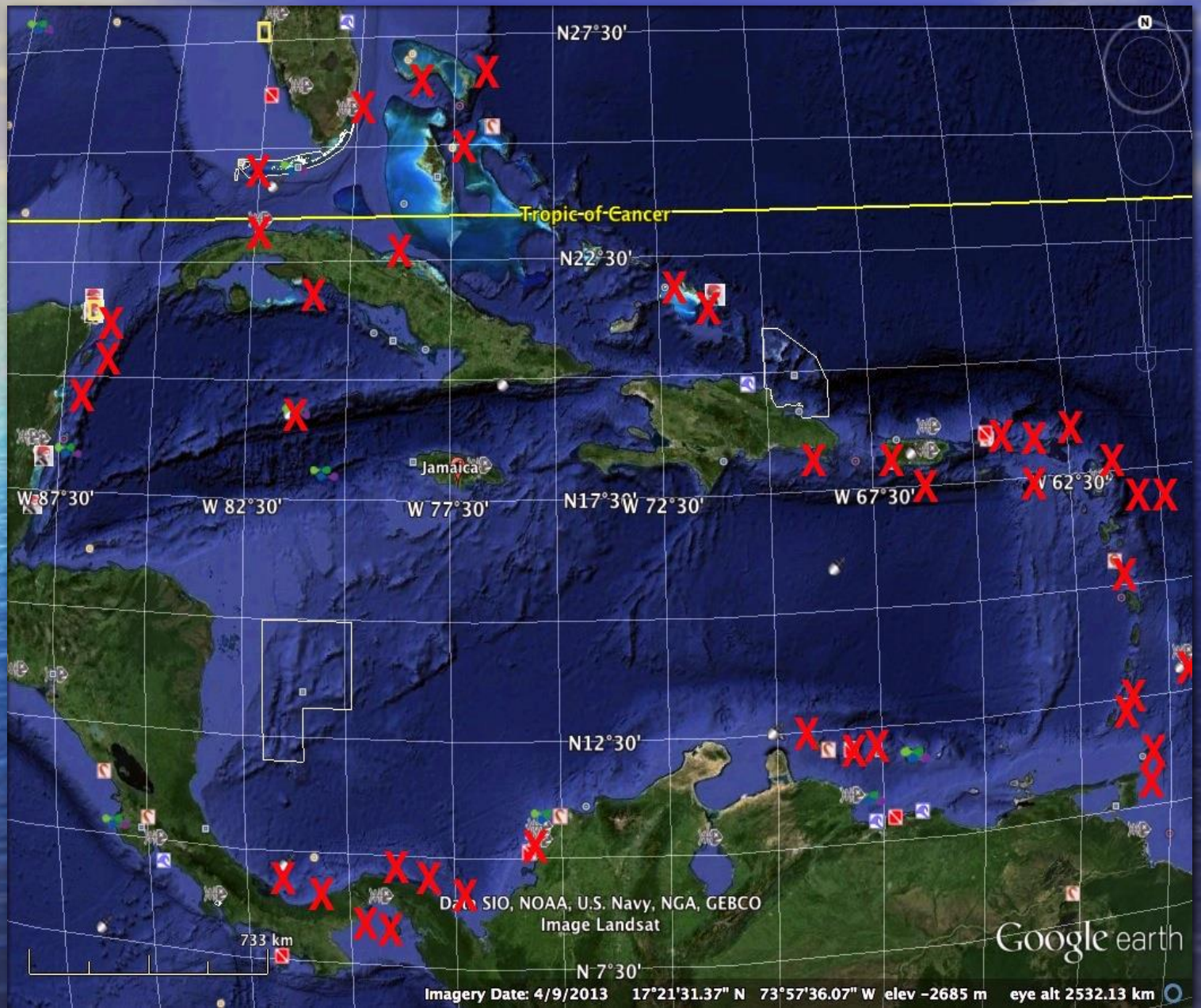
Coral reefs are the most nutrient sensitive ecosystem, they are smothered by harmful algae blooms at nutrient levels so low that no other ecosystem would be affected

JAMAICA EUTROPHICATION: PAST, PRESENT, & FUTURE

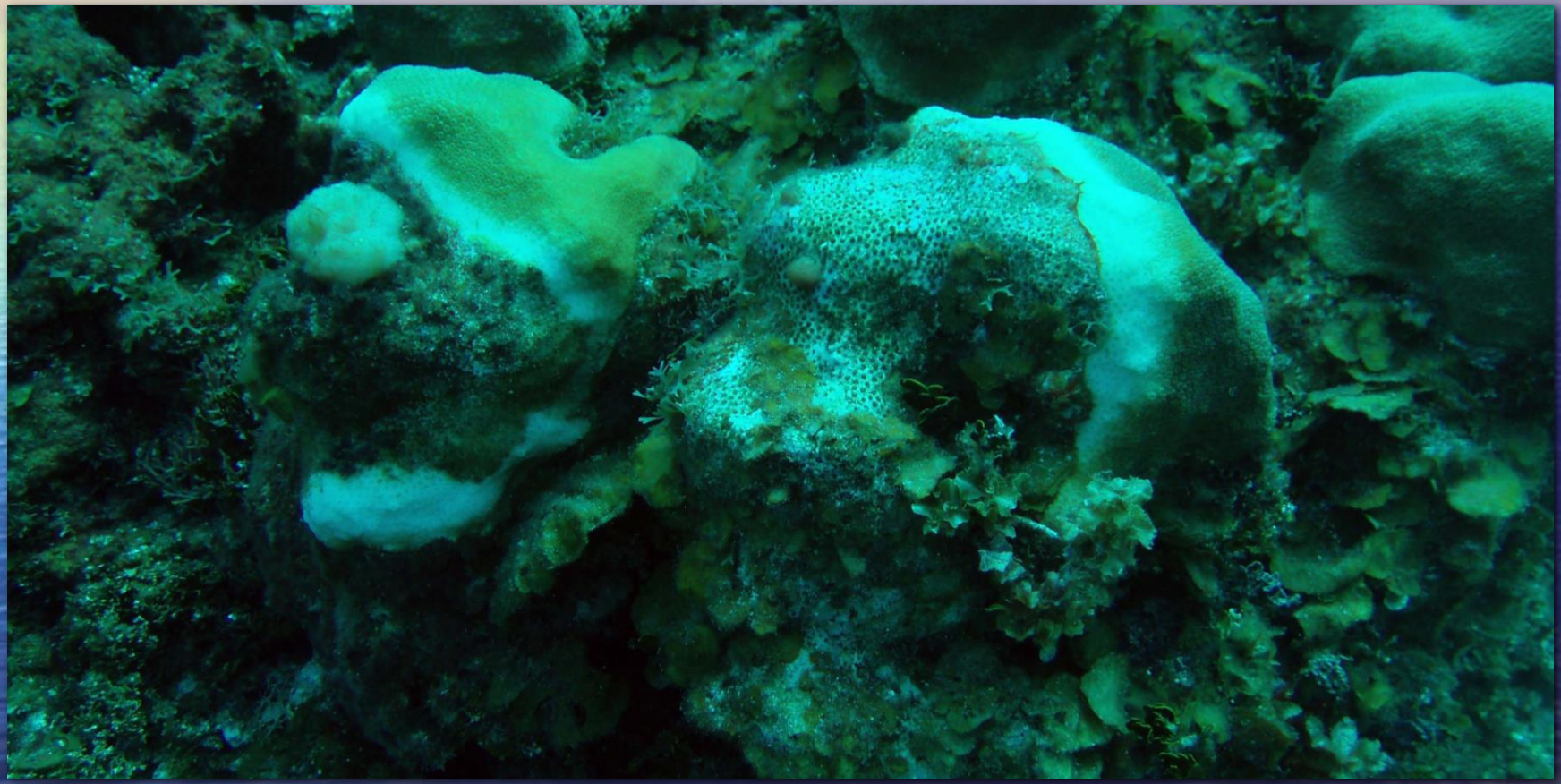
Tom Goreau, Global Coral Reef Alliance



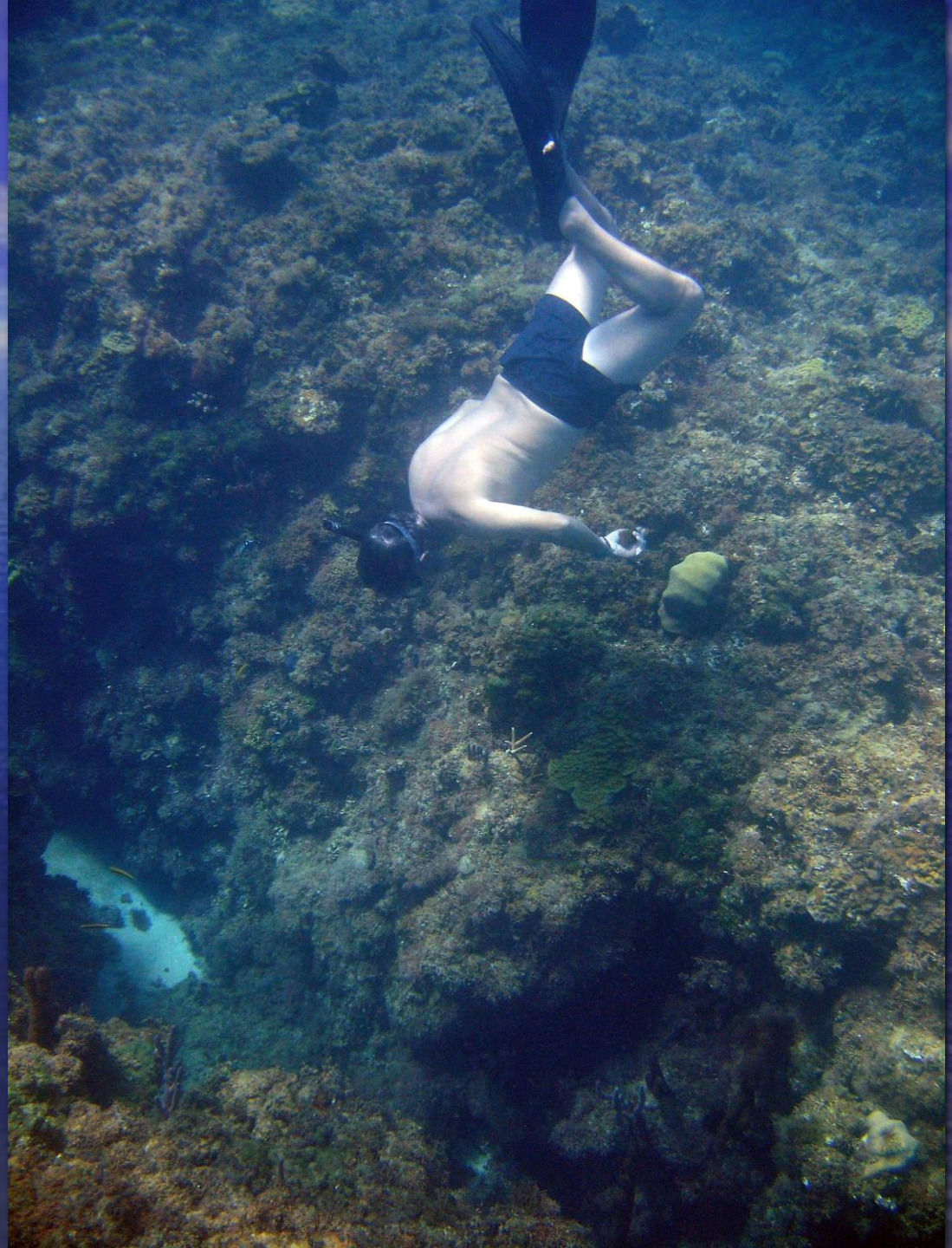
CARIBBEAN EUTROPHICATION



ALGAE-SMOTHERED CORALS



DEAD ALGAE-KILLED CORAL REEFS WITHOUT FISHES

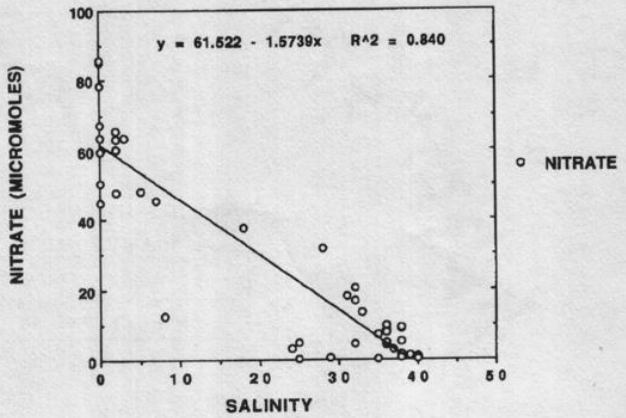


Locations shown on maps are site of many dives (up to hundreds)

- Eutrophication = massive overgrowth of harmful algae due to excessive nutrients
- Over-fertilized algae smother and kill coral reefs and other marine ecosystems
- Suck the oxygen out of water after they rot, causing dead zones, like Kingston Harbour
- Nutrients only one factor of land-sea stresses, others include soil erosion, solid wastes, toxic & mutagenic chemicals, and climatically active gases, also need action!

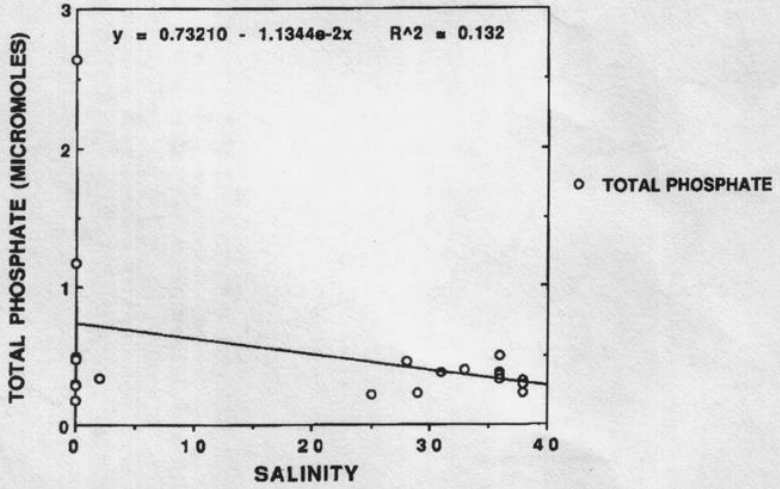
JAMAICA COASTAL WATERS EXCESSIVE IN NITROGEN, NEED ONLY TINY ADDITION OF PHOSPHORUS TO TRIGGER MASSIVE ALGAE BLOOMS

FIGURE 3



Nitrate concentrations along the north coast of Jamaica as a function of salinity. Nitrate is enriched in fresh water sources by around a hundred times over sea water values. Almost every measurement exceeds the critical level.

FIGURE 4



Total soluble reactive phosphate concentrations, including both orthophosphate and organophosphate, along the north coast of Jamaica as a function of salinity. Phosphate is only very weakly enriched in fresh water sources over marine values due to strong adsorption by limestone and soils. As a result direct sewage releases of phosphate to the coastal zone probably dominate over groundwater sources.

EUTROPHICATION SPREAD

- Weedy algae overgrowth of coral reefs begins around major point sources of nutrients, sewer outfalls, drains, rivers, springs, groundwater flows to sea
- Starts with algae sharply zoned in concentric rings around sources
- Spreads outward from sources and merged until original sources no longer visible
- Same patterns world-wide

JAMAICA EUTROPHICATION

- Took place over a 50 year period following coastal population development
- Driven by nutrient inputs
- Caused destruction of reef fisheries habitat, beach erosion
- Can only be reversed by ending human nutrient inputs from land

ZERO LAND-BASED NP SOURCE

- ALL SEWAGE FERTILIZER EFFLUENT TREATED TO TERTIARY LEVEL WITH FULL BIOLOGICAL RECYCLING OF NUTRIENTS ON LAND
- WHY WASTE MONEY IMPORTING FERTILIZER WHILE WE ARE KILLING THE SEA BY OVER-FERTILIZING IT?

ECOSYSTEM SPECIFIC CORAL REEF WATER QUALITY STANDARDS

- Based on determining thresholds between coral dominated and algae dominated
- Based on the rate of algae growth as a function of nutrient levels
- Same limiting values found in Australia, Belize, Florida, Jamaica, Barbados reefs by Bell, Lapointe, Littler, Macfarlane, Goreau, & Hunte

CORAL REEF-SPECIFIC WATER QUALITY STANDARDS

- NITROGEN. ONE MICROMOLE PER LITER AMMONIUM PLUS NITRATE, OR 0.014 PPM
- PHOSPHORUS. 0.1 MICROMOLE PER LITER PHOSPHATE PLUS DISSOLVED ORGANIC PHOSPHORUS, OR 0.003 PPM

GETTING RID OF WEEDS

- The only way to get rid of seaweeds is to starve them of nutrients
- They turn pale and die back in weeks
- Results are permanent as long as nutrients remain controlled
- Dragon Bay, Jamaica, is the only place in the world where this has been done long-term
- Hawaii tried and failed

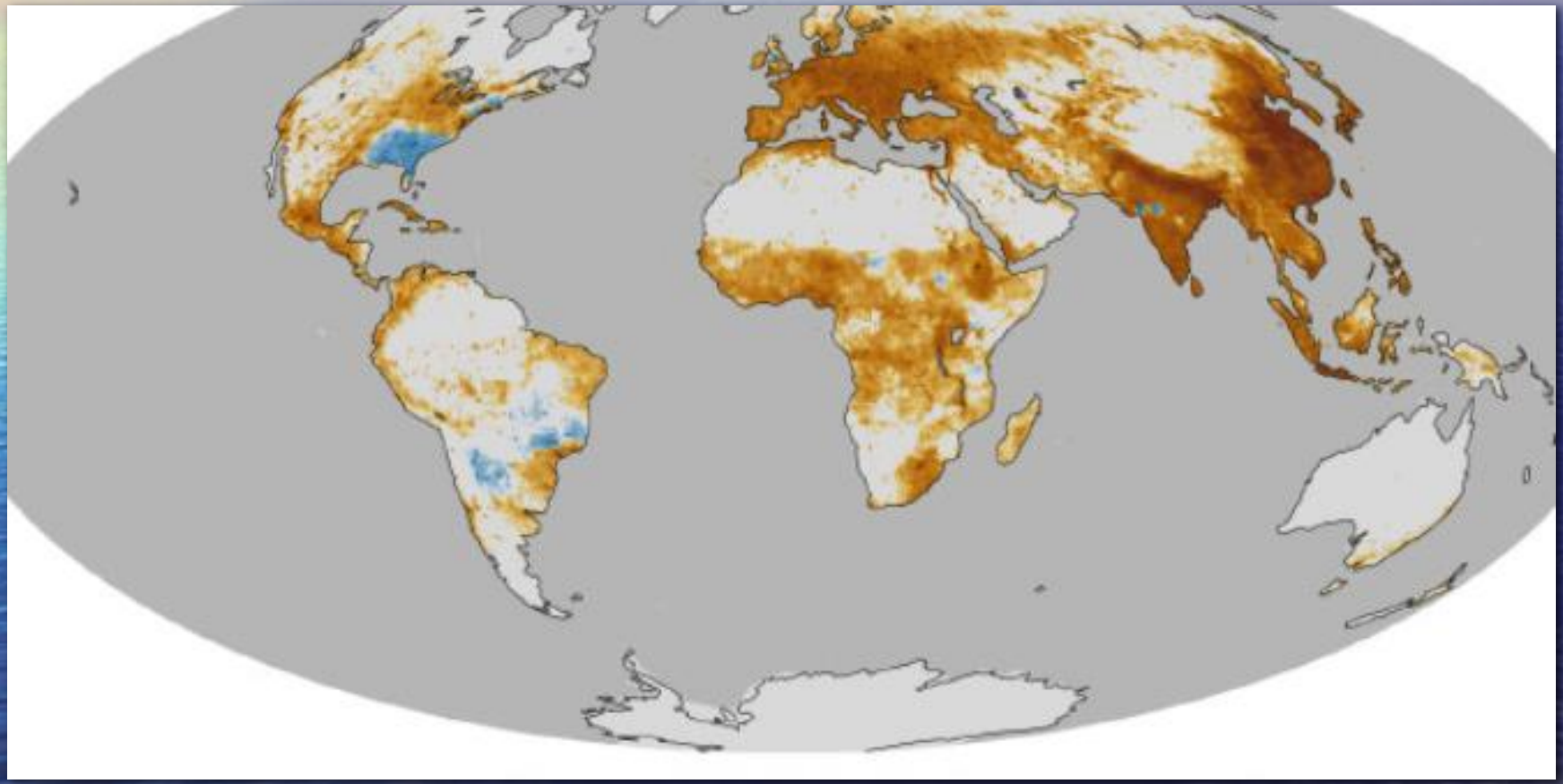
DRAGON BAY, JAMAICA

- Dragon Bay had a secondary sewage treatment plant, put effluent in bay where it washed back on beach, turned west side of bay red with weedy algae.
- Laundry detergent dumped in river, turned east side of bay green with weedy algae
- SOLUTION: Put laundry effluent in sewage plant, instead of dumping effluent on reef, use to water gardens and ornamental plants
- RESULT: within weeks algae turned pale and died, gone entirely in two months, coral reef recovered

COASTAL NUTRIENT MANAGEMENT

- The core of coastal resource management is nutrient management
- No coastal manager in the world has a clue how much nutrients enter their coastal zone, because they don't have continuous real time nutrient mapping capability
- The technology exists but is not being used
- Use of these methods will revolutionize coastal management, take it out of the dark ages, and place it on a scientific basis

ONLY WHEN WE CAN MAP MARINE POLLUTION AS WELL AS AIR POLLUTION WE CAN IDENTIFY SOURCE AREAS, POLLUTION MOVEMENT, DEFINE POLICIES TO REDUCE SOURCES, AND VERIFY THE SUCCESS OF SUCH POLICIES



TURKS & CAICOS

- Every hotel has a package secondary sewage treatment plant and recycles all their waste water on their property as irrigation for ornamental plants.
- Propose national coral reef ecosystem-specific nutrient standards for nitrogen and phosphorus
- Only country in the world to take these steps

CANCUN: PLANNING AHEAD

- Sewage collection system and treatment plants in place before hotels were built
- Designed for twice the imaginable amount of development, for 200,000 people
- Now more than 1,000,000 live there
- 20 % of sewage partially treated, rest mostly not at all
- Underwater Museum algae-smothered

Cancun is one of very few tourism areas that tried to do the right thing

DID IT WORK?

Impacts of captive dolphins and turtles in Mexico and Grand Cayman

GRACIAS!