# *Our Reefs: Caribbean Connections* Exhibit Content

A traveling exhibit designed to promote awareness, understanding, and stewardship of coral reefs among all peoples of the wider Caribbean. www.ourreefs.org.

© Ken Marks

## *Caribbean Currents*

- Flowing currents link the nations of the wider Caribbean, connecting coral reefs that provide millions with goods, jobs and enjoyment.
- Seawater transports the spores, eggs and larvae of the marine organisms that populate reefs across the wider Caribbean. Some larger animals, *e.g.,* turtles, swim great distances to complete their life cycles.
- Seawater also brings invasive non-native species (lionfish as well as orange cup corals) and diseases. The long-spined sea urchin die-off was important because it eats the seaweeds and turf algae which can overgrow corals or prevent coral larvae from settling. Also transported are pollutants like toxic chemicals, plastics and tar that harm marine animals and accumulate on windward beaches.
- Eventually all reefs are damaged by nature or, increasingly, by human activities. Their survival will depend upon the currents that continue to bring larvae and upon humans collaborating to help reduce our harmful effects on the oceans. International laws can give endangered species like sea turtles a chance to recover.

## *Creating a Coral Reef*

- Stony corals that build reefs have skeletons of calcium carbonate (lime) which is laid down in layers that differ, at the micro scale, between day and night. Seasonal growth differences result in bands of alternating density that you can see with your naked eye (like tree rings). Density bands can be used to estimate the age of stony corals and annual variations in their growth rates.
- Skeletons of corals, and of coralline sponges that grow too slowly to form density bands, are useful storehouses of information about past environments and of changes induced by humans, like oil refining or lead pollution.
- Coral reefs contain the skeletons of dead corals and other reef organisms, plus calcareous sand and silt particles – skeletal fragments created by organisms which attack from inside or ouside. Crustose coralline algae and sponges bind coral rubble. Calcareous crystals form in cavities, cementing the skeletons, rubble and sediment into a solid rock which is likely to undergo repeated episodes of boring, binding, infilling with silt or sand, and further cementation by calcareous crystals.
- Coral communities in fossil Pleistocene (about 1.8 million years to 11,000 years ago) reefs were very similar to those on modern reefs. Our reefs have recovered from natural catastrophes in the past, but their current declines, like that of elkhorn corals from unknown disease in the 1970-80's, are taking place in a world now dominated by the effects of a rapidly expanding human population.

David Myers

# *Our Reefs: Caribbean Connections* Exhibit Content

A traveling exhibit designed to promote awareness, understanding,
and stewardship of coral reefs among all peoples of the wider Caribbean. www.ourreefs.org.

Paul Hoetjes

## *Corals and Climate Change*

- The increase in greenhouse gases from human activities, especially of carbon dioxide ($CO_2$) from the burning of fossil fuels and trees, is warming Earth and its oceans. Seawater is also becoming more acidic as it absorbs more $CO_2$ from the atmosphere.
- Warming will affect hurricane activity and cause more mass bleaching events on coral reefs. Reef corals, and many other reef animals, "bleach" when they lose the tiny symbiotic algae that ordinarily inhabit their tissues, or if the algae remain but lose most of their yellow-brown photosynthetic pigments. Prolonged bleaching kills corals and other reef organisms, or makes them more susceptible to fatal diseases.
- Switching to alternate, "renewable" energy sources can reduce further warming. Solar power can be used to heat water, dry crops, desalinate water, cook food or generate DC electricity. Turbines can be powered by wind, water, steam and bagasse to generate electricity. Energy-efficient products, like LED lights or solar-powered refrigerators, consume less electricity or burn less fuel.
- Helping to reduce or offset global warming are countries that engage in "emission reduction" trades, companies and organizations that invest in "carbon offset" programs, communities that plant shade trees to cool buildings, and individuals that minimize their use of powered vehicles or voluntarily contribute to projects that result in reduced warming.

## *Land and Reef*

- Wind and water carry soil, nutrients, and pathogens into the sea. Too much sediment smothers corals and covers up the hard surfaces on which coral larvae settle. Nutrients in sewage, other animal wastes and fertilizers stimulate the growth of photosynthetic cyanobacteria (blue-green algae) and algae (seaweeds and algal turfs) that can harm reef animals. High nutrient levels may also increase the severity of diseases in sea fans and corals, or prevent coral wounds from healing. Human pathogens found in some coastal waters and on nearshore stony corals create health risks for swimmers, seafood consumers, and marine organisms.
- Runoff can be reduced by maintaining, or replanting, trees and other vegetation on steep hillsides. Reforestation projects include trees like mango with edible fruits, or that, like cassia, are used for lumber and charcoal. Nutrients can be removed from sewage before it is released into the environment (as in artificial wetlands or low-flow Wastewater Gardens®). Coastal mangrove forests and seagrass meadows also trap sediments and nutrients, thereby protecting nearby reefs.
- Reefs benefit from farming practices that retain soil and nutrients on land (contour farming, conservation tillage, mulching or underplanting), reduce the use of chemical fertilizers (with nitrogen-fixing bacteria, or natural fertilizers), and by natural methods of pest control (integrated pest management practices, natural pesticides like neem). Markets for "sustainably" grown foods are growing, and the "added value" allows higher prices to be charged.

Michael Bannister

# *Our Reefs: Caribbean Connections* Exhibit Content

A traveling exhibit designed to promote awareness, understanding,
and stewardship of coral reefs among all peoples of the wider Caribbean.

www.ourreefs.org

## *Vulnerable Coastlines*

- Coastal habitats are degraded by poor development practices such as inappropriate land "reclamation" projects for runways or housing developments, jetties and seawalls that disrupt natural sediment flow patterns, shipping lanes located near reefs that result in grounded vessels, pollutants in coastal runoff, ship discharges, and oil spills – both chronic and catastrophic.
- Channel dredging, beach nourishment, and road construction projects can all be designed to minimize environmental harm to coastal reefs and related ecosystems. Sandy beaches can be stabilized with dune-adapted plants. Sewage wastes in the holding tanks of small boats can be collected in dockside pump-out facilities rather than being released into the ocean. Trash can be deposited in containers or, when necessary, collected from nearshore areas. "Reduce, reuse, recycle" is part of the solution.
- Governments that outlaw toxins, *e.g.*, anti-fouling boat paints, change shipping traffic flow patterns, and replant damaged reefs, are helping to reduce the damage. Although not yet adopted commercially, certain brake ferns remove arsenic from soils contaminated with lumber that was treated with CCA (chromated copper arsenic, now banned for residential use in the USA). Opportunities to accomplish even more are likely to occur as efforts such as these meet with increasingly visible success.

Andy Newman

Allen Mason

## *Paradise for Sale*

- Large-scale tourism is important to the economies of the wider Caribbean, but has many negative effects on local societies and environments.
- Responsible tourism providers are using renewable sources of energy like solar and wind power, installing energy-efficient engines on cruise ships to reduce air pollution, and employing architectural or construction practices that reduce the need for airconditioning, inefficient lighting and toxic chemicals.
- Tourism's impact can also be lowered by reducing water use with low-flow toilet fixtures or composting toilets and by encouraging guests to reuse towels, by recycling manufactured materials like aluminum cans and glass, by using cleansed wastewater when watering lawns, fruit trees or ornamental plants, and by preserving or restoring terrestrial vegetation.
- Tourists and tourism providers are collaborating to protect sea turtle nesting sites, establish artificial reefs and assess reef fish populations.

# *Our Reefs: Caribbean Connections* Exhibit Content

A traveling exhibit designed to promote awareness, understanding, and stewardship of coral reefs among all peoples of the wider Caribbean. www.ourreefs.org.

David Eggleston

## *Depleted Harvests*

- Edible reef fishes and invertebrates (animals without backbones) have been overfished in most of the wider Caribbean, with large predators often having been the first to disappear. Smaller animals are often removed in fine-mesh fish traps. Abandoned traps may capture prey for months before disintegrating. Particularly vulnerable to exploitation are animals that change sex as they mature, need more than one habitat to complete their life cycle, aggregate to breed or lay eggs, stay in a home "territory" that is easily found, or move slowly.
- As prey become scarce, the ones that remain are smaller, of reduced economic value and harder to catch. Fishing becomes more dangerous and seafood is more costly. Reefs are more likely to be damaged by fishing gear, and animals or seaweeds that kill corals or prevent their larvae from settling are more likely to proliferate.
- Responsible fishing practices are possible when local communities are engaged in management. They include fair distribution of fishing rights, protecting nursery habitats, and restricting fishing during the reproductive season, especially at aggregation/spawning sites, and generally obeying fishery regulations. Higher prices can be charged for live or smoked fishery products.
- Plants like edible seaweeds which photosynthesize on their own when given light and nutrients, and animals like shellfish that filter their own food from seawater, are good candidates for marine culture. Sea plumes (a type of horny gorgonian coral) are being carefully cropped for cosmetics in the Bahamas, and "live rocks" are being cultivated for aquaria in Florida. Raising shrimps and other animals that need feeding is costly and more likely to result in environmental damage or destruction.

## *Marine Reserves*

- Fishery reserves can help depleted fish stocks to recover naturally but, to be successful, local fishing communities must be full participants in the management process. Moreover, benefits and inconveniences must be spread equally among all groups of affected fishers. Reserves must also encompass all habitats used by the animals that are being protected. Having several examples of each habitat type provides "insurance" against catastrophic losses such as may occur during hurricanes.
- Fishers can benefit by "spillover" of large animals that move away and may be caught outside of reserves, or when large protected animals reproduce and their larvae are carried by currents to areas that are open for fishing. Other kinds of management actions such as seasonal or size limits can also benefit fisheries stocks; moreover, fish larvae are just naturally more successful at settling in some years than others, regardless of whether or not they are fished. However, locally produced larvae may be virtually absent in severely overfished areas, and many years may pass before larvae from elsewhere appear and restock a reserve.
- Fishing families can really only afford to relinquish rights to fish in reserves when other sources of income are available. Successful reserves create jobs (with training if necessary) within the fishing community for educators, wardens, or technicians. Jobs are also available for tour guides, fee collectors and concessionaires when ecotourism is compatible with the reserve, especially if "charismatic" animals like Goliath groupers, turtles, dolphins, and whale sharks are present.

Nicanor Requena

# *Our Reefs: Caribbean Connections* Exhibit Content

A traveling exhibit designed to promote awareness, understanding,
and stewardship of coral reefs among all peoples of the wider Caribbean. www.ourreefs.org.

## *Experiments in Reef Repair*

- Rebuilding of fish stocks in protected reserves helps reefs when the animals that harm corals are once again controlled by their own predators, *e.g.,* the lobster, grouper and snapper that are often overfished, or if populations of large parrotfishes recover and eat the seaweeds that can kill corals or prevent their larvae from settling. When corals grow, habitats are created for many other animals that depend on reefs for shelter, feeding or breeding.
- Vessel grounding sites in seagrass meadows in the Florida Keys are being restored by planting grass plugs and adding stakes that attract birds – their droppings act as a natural fertilizer for the young grasses! Artificially rehabilitating reefs will be much harder. One approach is focused on trying to breed and reintroduce long-spined sea urchins to remove excess seaweeds. Seafood stocks like queen conch may also need artificial culturing in areas where their larvae are scarce. Preventing the accidental release of pathogens that cause diseases along with any cultured organisms is still a huge challenge.
- Some protected reefs are being restocked with live staghorn or elkhorn corals that have been propagated underwater from naturally occurring fragments. And there are attempts to bypass the dangers of larval transport in currents by artificially "seeding" reefs with cultured coral larvae.

Edwin Hernandez

Rebecca Jones

## *Caribbean Reefs: the Future?*

- Our coral reefs have deteriorated from decades of adverse impacts, *e.g.,* overfishing, sedimentation, nutrients, other pollutants, ship groundings, diseases and bleaching. When old corals die on a reef that is being overgrown by seaweeds, it has virtually no future.
- Since everyone shares responsibility for what has already happened to coral reefs, everyone is asked to help save, and protect, what is left of our natural resources.
- Everyone can help repair the damage that has been done. Some solutions are simple, like using trash bins or mooring buoys for dive boats. Some are difficult, like collecting invasive lionfish, or culturing corals to rehabilitate reefs. Preventing the loss of valuable resources like coastal vegetation or fish spawning aggregation sites is less costly than restoration. Remedies which are costly at first give long-term benefits (like using solar power, conserving water, establishing public nature trails at wastewater nutrient retention ponds).