Resolution Regarding the Need for Scientific and Financial Evaluation of Coral Reef Rehabilitation Methods

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Background

1. Tropical coral reefs have been extensively damaged by pollution, overfishing, sedimentation, coral bleaching and disease throughout large areas of the Caribbean and Indo-Pacific regions. More recently there has been damage due to natural events (e.g. hurricanes and the devastating tsunami of 26 December 2004);
2. The area of reefs damaged during these events is often vast, covering hundreds to thousands of square kilometres, such that the economies of local communities and countries are adversely affected;
3. Naturally Governments and the private sector with economic interests in coral reefs will seek 'quick' solutions based on engineering principles to 'repair' the damage and to accelerate natural recovery processes;
4. These agencies may lack the capacity or expertise to evaluate the scientific and costs to benefit relationships of proposed coral reef rehabilitation techniques and apply them in an effective and sustainable way;
5. These coral reefs have extensive natural recovery capacity, provided that there are supplies of suitable fish, coral and other larvae, and that such chronic disturbances as excess sedimentation, pollution and over-fishing are minimised. Coral reefs can begin to recover immediately, with new coral growth and fish stocks naturally re-colonising the ecosystem within one to two years; complete recovery may take longer depending on the environment;
6. A range of 'engineering' techniques have been proposed as reef reconstruction or rehabilitation techniques by various commercial and non-commercial organizations. These include:
    i. a mechanism using wire frames through which electricity is passed to accrete calcium carbonate and accelerate the growth of transplanted corals;
    ii. installation of artificial reefs, including concrete structures; and
    iii. mechanisms for re-cementing and re-gluing corals and other organisms to the substratum.
7. The proponents of this ICRI Resolution are frequently asked to advise governments and private organizations regarding how to rehabilitate damaged reefs. Following the 2004 tsunami, many of these inquiries have been related to the suitability of engineering solutions to reef rehabilitation;
8. The proponents of this Resolution, the ICRI Operational Units, CORDIO, GCRMN, ICRAN and Reef Check, while acknowledging that some innovative and new approaches to coral reef conservation and management may have limited applications, are concerned that there have been insufficient peer-reviewed, long-term scientific studies of reef rehabilitation using these and other techniques and that there have been few cost-benefit analyses to assess effectiveness of the methods over natural recovery processes. The available evidence suggests that some of these techniques may be useful in specialized cases, but have limited or no application and value for large-scale coral reef rehabilitation. In addition to effectiveness considerations, construction of any engineered structure on a coral reef must be evaluated against any potential environmental damage caused during construction or later degradation;
9. The ICRI Operational Units are further concerned that governments and private organizations who have invested, or are considering investment, in such techniques should be

aware that these techniques are unproven in effectiveness and therefore ensure that they optimise their valuable resources to address chronic problems facing coral reef communities.

Action Requested

10. The ICRI meeting is invited:
    a. To adopt a resolution advising governments, international agencies, NGOs and other parties that they should carefully examine claims from commercial and non-commercial groups selling or proposing 'engineering' solutions for coral reef rehabilitation and to seek advice from the ICRI Operational Units, or the International Society for Reef Studies (ISRS), or the Coral Restoration and Remediation task force of the Coral Reef Targeted Research and Capacity Building program (of the Global Environment Facility, World Bank, University of Queensland, Intergovernmental Oceanographic Commission of UNESCO, the US National Oceanic and Atmospheric Administration), or other recognised scientific bodies before investing in risky, unproven and expensive engineering techniques which may exacerbate environmental damage and divert funds away from more effective measures;
    b. To advise governments, international agencies, NGOs and other parties that the most effective mechanism of rehabilitating coral reefs is through mitigation of chronic human disturbances (e.g. sedimentation, pollution and over-fishing), thereby facilitating natural recovery mechanisms and building resilience, to any further disturbances, that will be effective over large areas;
    c. To encourage all those interested in coral reef rehabilitation to carry out rigorous scientific and economic studies of all potential rehabilitation techniques; and
    d. To request the International Society for Reef Studies (ISRS) and/or the Coral Restoration and Remediation task force of the Coral Reef Targeted Research and Capacity Building program to prepare a discussion paper that focuses on the scale of the problems facing coral reef countries and assesses the viability of such proposed engineering solutions compared to natural recovery mechanisms. A suggested list of potential questions and discussion points is appended in Appendix 1.

Appendix 1

THE USE OF ENGINEERED CONSTRUCTION FOR CORAL REEF REHABILITATION

A number of techniques involving some form of engineered construction have been proposed as coral reef rehabilitation techniques. These include:

- artificial reefs (sometimes called restoration modules) constructed of different materials and in various shapes;
- 'electric' reefs constructed of metal and including an electric power source;
- re-cemented reefs using glue, cement, plastic or other binding techniques; and
- transplantation using living corals (and other organisms) from other areas.

Following damage to coral reefs from natural disasters, such as coral bleaching, cyclones, hurricanes and the recent tsunami, governments and private organizations have naturally sought to repair damaged coral reefs rapidly to improve amenity for tourists and ensure fisheries productivity. Some proponents of engineered construction have made unsubstantiated claims that these methods have the potential to rehabilitate and restore damaged coral reefs (often with an inference that the repair will be effective and permanent over large areas).

The proponents of this ICRI Resolution are in agreement that:

- Artificial reefs of any kind cannot replace a natural reef and do not function as effectively as a living coral reef;
- Coral reefs can usually repair themselves quickly if environmental conditions are suitable, and chronic disturbances are reduced;
- Artificial reefs may offer some solutions for rehabilitation of reefs damaged through shipping accidents or to construct specific displays within aquaria or at severely damaged sites used by tourist operators, however, the current technology has not advanced sufficiently to develop such artificial reefs that function as a natural coral reef;
- The applicable scale of these techniques is to repair damaged reef areas of a few square meters, but such methods will never be viable or feasible for larger-scale coral reef rehabilitation on the scale of square kilometres;
- Long-term peer reviewed scientific and cost-benefit studies are generally lacking to document reef restoration success or failure. Additional research should be encouraged and supported;
- These techniques have the potential to cause environmental damage to coral reefs and associated ecosystems during construction and operation;
- Investments in coral reef conservation and preservation should therefore focus on removing the causes of coral reef decline to facilitate natural and long-term recovery.

The proponents of this ICRI Resolution suggest that the following basic questions should be answered prior to applying reef rehabilitation methods:

- Is a lack of colonisable habitat a limiting factor for coral settlement and reef development?
- What it the area of damaged reef that is targeted for rehabilitation?
- What are the chances for natural recovery of the reef? For example: are there available natural sources of coral larvae; are stable habitats for settlement; and are environmental conditions favourable for reef growth?

- What is the cost per square meter of treatment to achieve a viable functioning reef?
- How much will a proposed treatment cost to repair a substantial area of damaged reef?
- What are the potential economic of sociological returns if a reef is rehabilitated?
- What are the likely impacts on surviving reef areas as a source of collected transplant colonies?
- What is the likelihood of survival to normal growth and reproduction of colonies transplanted onto artificial structures?
- Have the causative impacts that led to reef damage been addressed/removed?
- Will any added structures be stable in the long-term and not degrade, thereby creating a future problem?

A fundamental problem on many degraded reefs is the well-documented shift in ecological function from coral dominated to algal dominated communities due to some combination of overfishing and eutrophication. These changes have affected hundreds to thousands of square kilometres of coral reef around the world over the past 25 years. On such damaged reefs, there is usually abundant and potentially available hard substratum for new settlement of hard coral recruits. The problem is often that any new coral recruits are quickly out-competed by algae.

A fundamental ecological imbalance is unlikely to be solved by adding artificial reefs, whether 'electric' or concrete. Rather, efforts should be focused on removing the cause of the imbalance. These methods frequently involve transplanting adult colonies to the artificial reefs, however, the survival and growth of these transplants cannot be assured if environmental conditions are not favourable.

Adult coral transplantation has been applied for over 30 years to rehabilitate relatively small areas (10s of square meters) of coral reef. In special cases, such as a ship grounding or a damaged 'house reef' of a tourist resort, it may be cost-effective to attempt rehabilitation if the reef has a high economic value for tourism, education or an insurance claim. In addition, artificial reefs may be useful for preventing beach erosion, for creating interesting structures for divers to visit, and for increasing habitat for fishes. Prior to attempting artificial rehabilitation, it is essential to reduce or remove the original causes of coral loss e.g. due over-fishing, sedimentation and nutrient enrichment.

A symposium was held in Phuket to examine rehabilitation of reefs in 1998; http://www.ncl.ac.uk/tcmweb/rehab/workshop.htm. Little has changed since 1998 to alter the conclusions of this meeting and they remain applicable: rehabilitation of large areas of reef through transplantation and artificial reef construction will generally be too expensive to be practical on a large scale; newly transplanted corals will probably die if the fundamental environmental imbalances that caused reef corals to die have not been remedied.

Summary:

- the scale of recent damage to coral reefs is of the order of 10s to 100s of square kilometres. The use of artificial 'electric' or concrete reefs, and adult coral transplantation to restore large reef areas is neither feasible nor prudent;

- the effectiveness of artificial reef restoration is unproven, potentially very expensive, and any construction project on coral reefs can potentially cause environmental damage;
- There is a substantial risk of misdirection of a scarce coral conservation funds and effort if rehabilitation/ restoration techniques are not used wisely; and
- Promotion of artificial reef restoration may encourage a view that any reef degradation can be repaired to return reefs to a 'natural' state.

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