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SAFEGUARDING TANZANIA'S CORAL REEFS: THE CASE OF ILLEGAL BLAST FISHING

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EXECUTIVE SUMMARY

Tanzania is the only country in Africa where blast fishing, (fishing with explosives), still occurs on a large scale. Besides killing and injuring fish, these blasts cause irreversible damage to coral reefs, destroying the habitats of many reef species, shattering the natural barriers that protect Tanzania's coastline from erosion and storm surges, and threatening the country's reputation as an important marine tourism destination. This destructive fishing practice must urgently be halted, both to prevent the considerable socio-economic repercussions for coastal communities and to protect the integrity of vital and endangered ecosystems. Blast fishing encompasses opportunistic and organised crime, thus requiring an urgent multi-stakeholder response from all sectors of the government, business, coastal communities and regional marine-governing authorities.

INTRODUCTION

Often referred to as the rainforests of the sea, coral reefs are among the most biologically diverse and productive of the world's habitats. They are of great economic, environmental and social importance to people, including the world's poorest coastal communities. Occupying less than one-quarter of 1% of the marine environment, reefs are home to over 1 million diverse aquatic species, providing them with spawning, nursery, refuge and feeding areas. Reefs also play an important role as natural breakwaters, minimising the impact

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of waves and cyclones on coastal areas and associated mangrove and seagrass habitats. In addition, many medicines have been derived from coral reef organisms, including antiviral drugs and anticancer agents.

Several attempts have been made to estimate the direct and indirect use values of coral reefs. The UN Environment Programme estimates that their total economic value ranges from $100,000–600,000 per km^2 per year.[1]

Healthy coral reef systems in Indonesia support abundant marine life

Yet despite their importance, coral reefs are among the most endangered habitats on the planet.[2] Recent studies indicate that at least 50% of reef-building corals in South-East Asia, Australia, the Western Pacific, the Indian Ocean and the Caribbean have disappeared over the past 30 years as a result of diseases and coral bleaching,[3] driven by elevated sea surface temperatures.[4] At the current rates of sea temperature rise, oceans will become too warm for coral reefs by 2050, resulting in the loss of the world's most biologically diverse marine ecosystem.[5] At the same time, ocean acidification is expected to slow the ability of corals to bounce back from disturbances such as bleaching events, cyclones and crown-of-thorns starfish outbreaks, further hastening their decline.[6,7]

The extinction risk of coral reefs is further exacerbated by local-scale human disturbances such as sedimentation, coral mining, agricultural and urban run-off, damaging fishing practices,[8] unregulated tourism and the introduction of invasive species. There is also a direct correlation between declining reef health and increasing human population in coastal areas, mainly owing to pollution and overexploitation.

In order to ensure that coral reef systems are resilient to climate change and ocean acidification, human-induced pressure and degradation must be reduced. This includes an immediate halt to blast fishing or fishing with explosives (commonly known as dynamite fishing), which is rapidly destroying marine ecosystems around the world. According to the Fifth National Report on the Implementation of the Convention on Biological Diversity for Tanzania, the use of dynamite is one of the most destructive types of fishing.[9]

Conserving coral reef biodiversity and the capacity of reefs to generate essential services to local people is a global priority and coral reefs are increasingly the focus of biodiversity conservation prioritisation schemes.[10] Coral reefs are also becoming more central to the designation of key biodiversity areas and marine protected areas (MPAs) globally.

BLAST FISHING IN TANZANIA

Like other environmental crimes, blast fishing is on the rise globally. Although illegal, blast fishing is practiced in up to 30 countries in South-East Asia and Oceania, with frequent cases sited in Malaysia,[11] the Philippines and Indonesia. In Africa, Tanzania is the only country where fishing using explosives still occurs on a large scale.[12] Although it is illegal, the problem has escalated in recent years and currently local fishers report that it is normal to hear 20–50 blasts a day in many locations along the coast. An increasing number of reports suggest that dynamite fishing occurs along the entire Tanzanian coastline, from Tanga in the north, west of Pemba Island, on the central coast near Dar es Salaam, to the south near Mtwara. Dynamite fishing also occurs in marine parks, marine reserves and other important buffer zones.

In Africa, Tanzania is the only country where fishing using explosives still occurs on a large scale

In 2015 the Wildlife Conservation Society (WCS) produced a spatial assessment of the intensity of blast fishing along the entire coast of Tanzania.[13] Acoustic data was collected for a total of 231 hours over 2 692km of coastline on 31 days in March and early April 2015. A total of 318 blasts were confirmed using a combination of manual and supervised semi-autonomous detection. The highest intensity area

for blasting was in the vicinity of Dar es Salaam (with 39% taking place within 50km of the city), 70% of which took place in daylight hours. Other hotspots included Lindi, Tanga and the Songo Songo area. These results illustrate the wide geographical distribution of blasting activity, as well as the scale of the problem.

Explosives are usually lit with small fuses and thrown overboard. The underwater shock waves produced by the explosion stun the fish, rupturing their swim bladders – the organ that controls their buoyancy. After the blast fish float to the surface to be collected by the fishermen, while others sink to the seabed. This practice affects not only target fish but also all the surrounding fauna, flora and marine species within a 15–20m radius, such as juvenile fish, fish larvae and eggs, and hard corals.[14] Although the extent of the damage can vary,[15] a single dynamite explosion often kills most of the invertebrates in the area and leads to a reduction in demersal plankton, upon which many reef fish feed. This causes an instant decline in the diversity and quantity of fish species. For example, in Tanga fish densities were 12 times higher on a reef closed to fishing with little damage from explosives, than on one nearby that was heavily dynamited.[16] While coral reefs can recover gradually, extensive blasting can transform coral reefs into expanses of shifting rubble on which coral recruits are often unable to survive; in these cases recovery can take several decades to centuries. The greater the extent of reef destruction the slower the recovery will be.

Blast fishing threatens the sustainability of Tanzania's fisheries and tourism sector. These sectors are a vital source of food security, employment and income for coastal communities. There are a number of fish markets in Tanga, Dar es Salaam, Kilwa Masoko, Mafia, Lindi and Mtwara, all of which depend on fish harvested by the artisanal fishery industry. The viability of these industries relies on the productivity and health of the coastal and marine environment. Also, coastal tourism is witnessing rapid expansion, evident in the number of beach resorts constructed along the coastline and on the islands. Blast fishing is damaging Tanzania's image as an emerging diving destination.

Regular blast fishing is undertaken by village residents, from shore, on foot, at low tide and in small boats (with and without engines). In addition, lucrative pelagic fish such as tuna are increasingly being targeted using surface blasts in deep water (the fish are collected by scuba divers). Fishers engage in this practice because of unemployment, a lack of alternative income, and the large 'gain per effort expended' in comparison to traditional line fishing. However, the EU-funded Indian Ocean Commission's SmartFish Project, Stop Illegal Fishing and FISH-i Africa investigations[17] into illegal fishing practices in Tanzania show that these are not only opportunistic crimes but also form part of a much wider network of transnational organised crimes. Explosives and other components such as explosive gel and detonator caps are easily and cheaply sourced from quarries and enterprises involved in mining, demolition and road construction. Less sophisticated bombs[18] are also used, made from plastic bottles filled with artificial fertilizer and diesel. Blasting occurs close to markets where there is a high demand for fish, or the blasted fish are transported to market by truck. Blasts can yield a catch of up to 150–400kg (with a profit of $400–$1,800 in market sales).[19] A group of fishers can undertake numerous blasts a day, making this form of fishing a lucrative business.

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Explosive materials used in blast fishing and part of the catch

Most village elders strongly disapprove of dynamite fishing and many, if not most, villagers condemn these practices. However, few villagers speak out for fear of reprisal. While blast fishers constitute a small proportion of any given fishing community, they are often politically well-connected or influential members of family groups. They are often recruited by a boat captain who either finances the operation himself or works for a businessman/financier based in a nearby town. Either way, this obstructs monitoring and enforcement efforts by local community members.

Globally, few studies have documented spatial and temporal patterns in dynamite fishing. Tanzania is no exception, with most existing data relying heavily on

Eliminating the use of dynamite for fishing requires a multi-stakeholder approach that includes villagers, local fisheries officers, government officers, hoteliers, dive operators, fish processors, non-governmental organisations, donors and the Western Indian Ocean regional community

anecdotal reports. Information that identifies areas where blast fishing is most common is essential in targeting enforcement. Like the WCS study, this could be done using either acoustic recorders along the coast (which could document baseline blasting levels in key locations) or strategically placed village recorders. If deployed for an extended period this could provide evidence of quantifiable changes in the amount or pattern of blast fishing in response to specific operations and management interventions. Real-time blast detection information, linked to law enforcement strategies, is already being used in Sabah, Malaysia with successful arrests.[20]

RESPONDING TO DYNAMITE FISHING

Eliminating the use of dynamite for fishing requires a multi-stakeholder approach that includes villagers, local fisheries officers, government officers, hoteliers, dive operators, fish processors, non-governmental organisations (NGOs), donors and the Western Indian Ocean (WIO) regional community. All stakeholders have a role to play in lobbying, capacity building, data collection, monitoring and surveillance, persecution and law enforcement, research and awareness creation, as well as in eliminating factors that enable the illicit trade in explosives.

Arrested blast fishers in Tanzania

The Tanzanian government set up the Multi-Agency Task Team (MATT) in 2015 to investigate a variety of environmental crimes in an attempt to uncover the modus operandi of organised crime syndicates, involved not just in blast fishing but also in the illegal trafficking of other goods. This task team is led by the Tanzania Police Force (TPF), under the Inspector General of Police, and includes the Tanzania Forest Service, the Wildlife Division in the Ministry of Natural Resources and Tourism, the Fisheries Division in the Ministry of Agriculture, Livestock and Fisheries, TPF intelligence units, explosives inspectors from the ministries of

Mining and Security Services, and the criminal justice system. In the case of blast fishing, MATT is going after the source of the explosives, as well as instituting sea patrols in cooperation with the Tanzania Marine Police. The investigations and operations are intelligence led and prosecution driven. With 60 arrests and 5 312 explosive cartridges seized to date, MATT's work is already having an impact.[21]

Blast fishing was officially banned in Tanzania under the revised Fisheries Act of Tanzania 2003. The penalties for dynamite fishing and the illegal possession of explosives are minimum sentences of five years and 12 months respectively. However, the government has failed to fully prosecute dynamiters, and the penalties imposed in the handful of convictions have all been far below the legal minimum requirement. This message of leniency has led to widespread cynicism and hesitation among villagers to turn in violators. Cases have been dismissed owing to the non-presentation of prosecution files or of actual evidence (such as dynamited fish), and only minor fines have been issued. To rectify this, offences related to blast fishing should be written into the Tanzanian penal code, which would result in much stricter sentences. In addition, the Explosives Act of 1963 is outdated and the sentences it mandates for the illegal possession of explosives or explosive devices are not much more than stated above, with no deterrent effect. (The Tanzanian government is in the process of amending this act.)

In Kenya concerns – for reasons of security – about the widespread use of dynamite has led to a clampdown on the availability of explosives resulting in the rapid decline of dynamite fishing. Kenya Wildlife Services and the navy were central to this crackdown. The trade in and possession and use of explosives in Kenya are treated as treasonable offences that attract the highest penalties. In Tanzania, the responsibility for law enforcement and compliance lies with the Fisheries Division and with district governments. The Fisheries Division, however, cannot address such serious security issues without the assistance of the TPF. There is also confusion over enforcement roles, as well as a lack of clarity as to which laws should be used for prosecution.

As it is easy to access the coastline, local government entities are key to effective enforcement. However, the implementation of fisheries legislation and local bylaws is weak due to poor knowledge of fisheries regulations and the procedures for filing criminal cases, and because of fear of retribution from those involved. Often there are also insufficient funds to operate patrols and crack down on the established networks of illegal explosives dealers and blast fishers. Local governments should thus be given enough financial and human resources to manage the marine waters under their jurisdiction.

To facilitate collaboration among inshore fisheries and bring local communities and resource users into the process of fisheries management, institutional arrangements for co-management were put in place along the Tanzanian coast several years ago. District government and village management committee forums (through beach management units [BMUs] at the local level) jointly determine and implement management criteria for local areas – including for reef closures – and enforce by-laws related to illegal fishing practices. In some cases BMUs can be tasked with on-the-ground enforcement, carrying out local punishments and fines. Also, linking BMUs with enforcement authorities will ensure that they have the knowledge and skills to help local governments compile case files and collect evidence.[22] However,

without external support they do not have the resources to do their jobs. Often, village management committees and BMUs do not have patrol boats or money for fuel, and they cannot pay community allowances. Within the community it is also essential that traditional leaders and ward councillors are incorporated into management planning frameworks. They determine the behaviour of BMUs and influence willingness to take action. In Mkubiru village, located within the Mnazi Bay Ruvuma Estuary Marine Park in southern Tanzania, a group of fisher women spearheaded a successful community-led movement to reduce blast fishing in nearby waters.

Many NGOs are currently operating in this sector. For example, Mwambao Coastal Community Network, a local NGO, trains community monitors to record catch information, including levels of blast fishing, from which management authorities can determine the baseline data for particular areas. SmartFish has helped the government confiscate explosives, impound fishing vessels and prosecute cases of illegal fishing. It has done this through training enforcement officers and providing funding for patrols.[23] Tanzanian officials need greater capacity and more training in investigation, case preparation, chain of evidence and other legal requirements.

Sea Sense, another local NGO,[24] has launched various sensitisation campaigns on local radio and organised focus groups with BMUs to share knowledge of the illicit dynamite trade. It has also trained a network of over 60 conservation officers who act as 'ambassadors for conservation' in their village. These training sessions have helped to increase a sense of personal accountability among BMU members, who have become more aware of their important function as community role models and leaders in fisheries matters.

Local NGOs and marine scientists are planting corals and sponges in offshore nurseries for export, and are transplanting corals onto reef balls, to speed up their transition to living reefs.[25] A pilot project in Dar es Salaam, for example, successfully restored 5 000m^2 of degraded coral reef in six months after its launch in July 2016.[26] There are opportunities to scale up and replicate these projects, furthering the involvement of local fishers and nearby communities in reef restoration and rearing, transplanting and monitoring coral reef fragments. Mwambao has piloted the use of cement reef balls in Jambiani, Zanzibar. Tanzania can also learn from the propagation techniques and experiences of other tropical countries.

Tourism operators and dive companies can assist with collecting baseline data and reporting illegal activities on reefs. Efforts must be made to revitalise the Tanzania Dynamite Fishing Monitoring Network – a voluntary network of marine conservationists and members of the private tourism and fisheries sector that has accumulated an extensive list of blasting observations since 2004. This network is currently dormant due to the absence of financial support. There is also an urgent call for members of the private sector where dynamite is used, such as road agencies, cement and construction companies, to take more leadership and assist with resource gaps.

Importantly, donors, international NGOs and WIO region member countries could do more to support the conservation of coral reef systems in Tanzania. Owing to the migratory nature of fish stocks, as well as the transboundary characteristics of ecosystems such as coral reefs, a cooperative management approach is required

from neighbouring countries. Curbing dynamite fishing must be included into transboundary fisheries management approaches within the WIO.

There is a general lack of awareness – at all levels, including within the judiciary – of the severe social, economic and ecological impacts of dynamite fishing. Putting an economic cost on the loss to society caused by destructive fishing is a useful way to justify the financial costs of enforcement, raising community awareness and other means of combating the issue. In Indonesia, for example, the total cost of 'inaction' against blast fishing has been estimated at $3.8 billion over the last 25 years – a figure that justifies enforcement expenditures of around $400 million annually.[27] It was also shown that the economic loss to society as a whole from blast fishing was at least four times higher than the net benefits to individuals from the activity.

Coral reefs can be restored and protected, but this is more likely to occur if strong economic arguments and incentive structures are used to emphasise their contribution to Tanzania's sustainable development goals. Better ecosystem accounting is urgently needed, as are new ways of financing their protection through environmental schemes, such as Blue Carbon financing under climate change mitigation and adaptation frameworks.

MPAs and special protection coastal zones should feature more prominently in Tanzania's strategy for the conservation and management of coral reefs. Roughly two-thirds of the country's 1 000km-long coastline has fringing and patch reefs along a narrow continental shelf and several offshore islands. MPAs should be extended to incorporate these vulnerable or highly threatened ecosystems, identified through scientific analysis. Tanzania has gazetted 6.5% of the territorial sea to protection through MPAs, but this falls short of the UN Convention for Biological Diversity target of 10% by the year 2020. The extension of protected areas in the coastal and marine environment would also have positive spin-offs for mangroves and seagrass, which are in decline globally and in Tanzania. However, MPAs are only effective if there is effective patrolling and enforcement. Many MPAs in the East African region are currently ineffective and referred to as 'paper parks'.

Blasting has far-reaching implications for many sectors in Tanzania. Efforts to reduce its occurrence should therefore be integrated into national development and poverty reduction strategies and fisheries and forestry action plans, such as Tanzania's Development Vision 2025; the National Strategy for Growth and Reduction of Poverty (2010–2015); and the National Environmental Action Plan (2013–2018), its Integrated Coastal Management framework and its master tourism plans, as well as into pre-emptive policies such as natural disaster risk management plans and climate change adaption strategies.

CONCLUSION

Curbing blast fishing is a complex challenge, and more analysis is needed of its broad-ranging structural complexities, including the current social challenges affecting coastal fisheries. An effective response to blast fishing in Tanzania must include alternative employment and livelihood opportunities such as ecotourism, seaweed farming, pearl harvesting and other private sector investments. Such a response should also incorporate scaling up and replicating projects to plant and restore coral reefs.

An inclusive, multi-level, cross-sectoral governance response is needed, with clear responsibilities for local and national government, the private sector, the donor community and the region

These multiple dynamics need to be better understood to inform the strategy to eradicate the use of explosives along the Tanzanian coastline. While hard-line tactics such as those taken by the navy and police have been effective in the short term, they are not a sustainable and long-term solution. An inclusive, multi-level, cross-sectoral governance response is needed, with clear responsibilities for local and national government, the private sector, the donor community and the region. This includes the stricter enforcement of anti-dynamiting legislation and prosecution procedures, and more support for fisheries communities and BMUs to steward local marine resources. Such support should also allow for the education of magistrates on the severity of the crime. As with other environmental crimes, blast fishing can only be stopped if easy access to cheap explosives is eliminated, there is no market for dynamited fish and people realise the seriousness of the crime. This can be done through the timely and appropriate punishment of offenders.

Also essential is improved spatial information and data – to discern the severity of fishing with explosives and to identify areas where blast fishing is most prevalent – for targeted enforcement, as well as awareness programmes on the implications of dynamite fishing for poor coastal communities. The value of coral reef 'services' and their non-market benefits need to be better understood and incorporated into Tanzania's blast fishing response.

Without tackling these key enabling factors, blast fishing will continue to flourish in Tanzania's coastal waters, to the detriment of its people, environment and economy. Similar cases elsewhere in the world suggest that both a nationwide and a regional impetus is needed to develop a zero-tolerance approach among fishers and local and national leaders. Such an approach will shame dynamiters through peer pressure, promote full implementation of sanctions and penalties by the judiciary, and lead to public recognition of and support for the work of enforcement agencies.

ENDNOTES

1 Wells S, Ravilious C & E Corcoran, *In the Front Line: Shoreline Protection and Other Ecosystem Services from Mangroves and Coral Reefs*, UNEP-WCMC (UN Environment Programme World Conservation Monitoring Centre), Biodiversity Series 24 Report, 2006, https://www.unep-wcmc.org/resources-and-data/in-the-front-line--shoreline-protection-and-other-ecosystem-services-from-mangroves-and-coral-reefs, accessed 15 May 2017.

2 A total of 23 reef-forming coral species are listed as endangered on the International Union for Conservation of Nature's Red List of Threatened Species, and six are listed as critically endangered. See Biodiversity A–Z, 'Endangered', http://biodiversitya-z.org/content/endangered-en, accessed 15 May 2017.

3 When corals are stressed by changes in conditions such as temperature, light or nutrients, they expel the symbiotic algae living in their tissues, causing them to turn white. When a coral bleaches, it is not dead. Corals can survive a bleaching event, but they are under more stress and subject to mortality.

4 Bruno JF & ER Selig, 'Regional decline of coral cover in the Indo-Pacific: Timing, extent, and subregional comparisons', *PLoS One*, 2, 8, 2007.

5 Hoegh-Guldberg O *et al.*, *Reviving The Ocean Economy: The Case For Action*. Gland: WWF (World Wide Fund for Nature) International, 2015.

6 More than 90% of coral reefs along the continental shores of the Indian Ocean are threatened by climate-related impacts. In Tanzania in 1997/98, elevated sea surface temperatures due to El Niño caused mass coral mortalities of up to 80% in some

of the country's reefs. Obura D *et al.*, 'Status of coral reefs in Eastern Africa: Kenya, Tanzania, Mozambique and South Africa', in *Status of Coral Reefs of the World*, Australian Institute of Marine Science, 2002, http://www.oceandocs.org/bitstream/handle/1834/338/scr2002-04.pdf?sequence=1&isAllowed=y, accessed 15 May 2017.

7 Hoegh-Guldberg O *et al.*, 'Coral reefs under rapid climate change and ocean acidification', *Science* 318, 5857, 2007, pp. 1737–1742.

8 Blast fishing, coupled with an increase in other destructive fishing practices (including the use of gillnets, beach seining, bottom trawling, poison and ghost fishing), also destroys habitats and disrupts the ecological food chain. Solutions to curb dynamite fishing can also serve to address other forms of destructive fishing.

9 United Republic of Tanzania, Vice President's Office, Division of Environment, 'Fifth National Report on the Implementation of the Convention on Biological Diversity', 2014, p. 23, https://www.cbd.int/doc/world/tz/tz-nr-05-en.pdf, accessed 15 May 2017.

10 This includes a variety of initiatives such as '50 Reefs', which aims to bring together scientists and conservation practitioners to protect coral reef systems globally. See The Ocean Agency, '50 Reefs: A global plan to save coral reefs', http://www.theoceanagency.org/50reefs/?gclid=Cj0KEQjwxPbHBRCdxJLF3qen3dYBEiQAMRyxS_knkW0bWmKWlRE0Ba3pnycLZt444pFyRbZD9rm0FFYaAo8U8P8HAQ, accessed 15 May 2017.

11 Mazlan AG *et al.*, 'On the current status of coastal marine biodiversity in Malaysia', *Indian Journal of Marine Sciences*, 34, 1, 2005, pp. 76–87.

12 Blast fishing has occurred in Tanzania since the 1960s. Although it became illegal in 1970 it has continued largely unabated, reaching epidemic rates in the 1980s and 1990s. The practice declined between 1997 and 2003, when the navy and marine police combined forces with local programmes to strengthen enforcement. However, since then the illegal practice has resurged and anecdotal evidence suggests it is now more prevalent than ever.

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14 BBC Africa, 'Blast fishing destroying Tanzania's marine habitat', 4 September 2014, http://www.bbc.com/news/world-africa-29049264, accessed 19 May 2017.

15 This may depend on the types and sizes of charges used, the depths at which they explode, the depth of the water and the underlying substrate, all of which influence how the explosion propagates.

16 Kaehler S, Ribbink A & L Scott, 'African Coelacanth Ecosystem Programme (ACEP) Final Report 2007/8: Nearshore and Offshore Studies in the Western Indian Ocean'. Grahamstown: ACEP, 2008.

17 Stop Illegal Fishing, 'Multi-Agency Task Team, Tanzania', https://stopillegalfishing.com/multi-agency-task-team-tanzania, accessed 24 April 2017.

18 These bombs use explosive gel either inside the bottle or strapped to the outside, and fuses.

19 In 2006, dynamite for a single blast cost TZS 6,000–7,000 ($5–6) and could lead to a catch of 150–400kg of fish. With fish prices of TZS 3,000–4,000 ($2–3) per kg, dynamiters may be making TZS 500,000–2,000,000 ($400–1,800) per blast. (TZS is the currency code for the Tanzanian shilling.)

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23 Njoroge G, 'Blast fishing destroying Tanzania's marine habitats', *BBC Africa*, 4 September 2014, http://www.bbc.com/news/world-africa-29049264, accessed 24 April 2017.

24 Sea Sense, http://www.seasense.org/, accessed 24 April 2017.

25 Coral restoration projects involve growing nursery-reared transplants in areas with highly degraded reefs. Initiatives have been developed to supplement the local reef with artificial reef balls, constructed with molds and using a cement mixture, to produce artificial coral-like structures. Corals can grow and reproduce both sexually, through spawning, and asexually, through fragmentation.

26 Leonard Jones Chauka has received funding from the Western Indian Ocean Marine Sciences Association to conduct a restoration project in Dar es Salaam. See *The Conversation*, 'Coral reefs off Tanzania's coast are being destroyed, most beyond repair', 15 January 2017, https://theconversation.com/coral-reefs-off-tanzanias-coast-are-being-destroyed-most-beyond-repair-71116, accessed 15 May 2017.

27 Pet-Soede L, Cesar H & L Burke, *Blasting Away: The Economics of Worldwide Coral Reef Degradation*, CEEC (Cesar Environmental Economics Consulting), 2003, https://www.wwf.or.jp/activities/lib/pdf_marine/coral-reef/cesardegradationreport100203.pdf, accessed 15 May 2017.

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