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Rewilding Coral Reefs

By Mark Erdmann, PhD

Indonesian StAR Project manager Nesha Ichida watches Seren as he rests before swimming into the Dampier Strait to begin his life as a wild leopard shark.

REWILDING IS A POPULAR TERM IN CONSERVATION CIRCLES, but what does it mean, and is it appropriate for coral reefs? Should divers be clamoring for reef rewilding? Does it represent a significant advancement in coral reef conservation?

Though I believe rewilding coral reefs is a valuable approach, it requires a strong, established foundation of good old-fashioned marine conservation. I view reef rewilding as a tertiary marine conservation strategy that we should attempt only after the fundamentals of an effective marine conservation strategy (often anchored with a well-managed marine protected area) are in place.

The ReShark initiative in Raja Ampat, Indonesia, is a good case study for reef rewilding. ReShark's StAR project is the world's first program designed to recover an endangered shark population by releasing into the wild leopard shark pups hatched from eggs purpose-bred in large public aquariums around the world.

But before examining ReShark's efforts in detail, what is rewilding and how might it apply to coral reefs? A quick online search reveals a range of definitions, but a recurring theme is the notion of active restoration of an ecosystem to

increase biodiversity through reintroducing native species, removing invasive species, or restoring degraded landscapes.

There are many examples of rewilding efforts in the terrestrial realm across the globe, but marine examples are less common and tend to include actively restoring kelp forests, seagrass beds, mangrove forests, or hard corals.

Should we be championing hard coral restoration at all our favorite dive sites that have suffered degradation? There is a proliferation of coral restoration efforts



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One of StAR's shark nannies feeds pups in the nursery sea pen.



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From left: ReShark first shipped leopard shark eggs from Sea Life Sydney Aquarium to Jakarta Aquarium in August 2022. • Candling leopard shark eggs show the developing embryo and yolk inside. • This one-month-old leopard shark pup is about to transition from the tank to the sea pen.

throughout the tropics, though the efficacy of many of these initiatives is unclear. Typically, such efforts should proceed only if the root cause of the degradation has been sufficiently addressed to ensure that the restored corals don't suffer the same sad fate as the natural ones that preceded them.

In practice, that criterion means we should be investing valuable resources in reef rewilding efforts only when the main threats to a reef ecosystem have been dealt with and the scene has been set for recovery. Preparations usually involve establishing a well-managed, strictly enforced marine protected area (MPA) with strong support from local communities and other relevant stakeholders. That process is the primary strategy for coral reef conservation and the foundation for ensuring reef recovery.

Secondary measures to improve reef health — such as tourism management policies to limit diver damage through codes of conduct or mooring buoy systems and strong fisheries management to protect the reefs — may also need to be implemented. Only once these measures are in place should we focus on active reef rewilding to speed up the reef recovery process.

The Raja Ampat archipelago in West Papua presents an excellent case study for how and when to implement coral reef rewilding programs. As many divers know, Raja Ampat is at the global epicenter of marine biodiversity, and the reefs there are bursting with life. But it wasn't always so.

In the early 2000s Raja Ampat's reefs had been largely emptied

of sharks, Napoleon wrasses, and groupers — the targets of high-value export fisheries that plundered these remote reefs. Blast and cyanide fishing by marauding boats from Sulawesi and Maluku were destroying the reefs, leaving the local Papuan communities in Raja Ampat frustrated and angry at how these outside fishers were ruining their food security.

Equally distressing was the newly minted government of Raja Ampat (which became its own administrative unit in 2003) finalizing an economic development plan that prioritized nickel mining and timber extraction as its primary industries.

Fortunately, a coalition of local and international conservation nongovernmental organizations (NGOs), led by Conservation International and The Nature Conservancy, engaged local communities and the Raja Ampat government and proposed an alternative future — one that empowered local communities to designate a large-scale network of MPAs with the explicit aim of ensuring their long-term food security.

These communities set the MPA boundaries and formulated the rules for resource extraction within them, including the designation of 20% to 30% of the MPAs as no-take areas. No fishing of any kind is allowed in those areas, and only sustainable fishing techniques are permitted in the remaining MPA areas, with no commercial fishing by outsiders allowed anywhere. Residents were then recruited and trained to manage and patrol the MPAs.

This same coalition convinced the Raja Ampat government

that an economic development plan prioritizing marine tourism development and sustainable fisheries would provide a much more robust and lasting economy than one focused on the short-term exploitation of mineral and timber resources. That is particularly true on small islands, where such activities were bound to dramatically degrade fisheries resources and leave local communities starving.

The Raja Ampat MPA network was legally designated by 2007, and local communities started actively managing and patrolling it. Bomb and cyanide fishers were arrested, and outside commercial fisheries were forcefully excluded. Local communities began to reap the rewards of recovering fisheries almost immediately, and tourism to Raja Ampat's reefs grew by leaps and bounds.

By 2012, spurred by an initiative from the Misool Resort, the Raja Ampat government declared all of Raja Ampat as Southeast Asia's first shark and ray sanctuary. Local communities strongly supported the move, as they were already seeing the value of sharks and manta rays as tourist attractions. Reef shark populations began a steady and impressive recovery, while Raja Ampat's reef manta ray population showed annual population increases of 4% to 10% between 2009 and 2019.

Despite all this marine conservation success, population recovery remained elusive for some of Raja Ampat's reef inhabitants. In particular, the Indo-Pacific leopard shark (*Stegostoma tigrinum*), also known as the zebra shark due to its striking juvenile color pattern,



struggled to recover. The animals were once common in Raja Ampat, but targeted fishing for the shark-fin trade in the late 1990s and early 2000s reduced their numbers in Raja Ampat to an estimated 20 remaining adult individuals in 2020. With such low numbers, the chances of population recovery over the coming century looked grim.

Sadly, this same scenario had played out across the Indian and Pacific oceans, with leopard sharks uplisted to Endangered on the International Union for Conservation of Nature (IUCN) Red List by 2016, having suffered a greater than 50% decline in their numbers in the preceding 30 years. Only the populations in Australia and New Caledonia are still healthy and viable.

In stark contrast, leopard sharks breed prolifically in large public aquariums, and there is now a stable population of leopard sharks in human care facilities across the globe.



They breed so readily that most aquariums now keep their males and females separate to prevent being inundated with baby sharks.

This unique conservation asymmetry presented a tantalizing opportunity for a rewilding program for leopard sharks in Raja Ampat. What if we could enlist the expertise of public aquariums around the world to put their males and females back together and produce eggs to send to Raja Ampat to be incubated, hatched, and released into the wild? We felt confident that such a rewilding program had a strong foundation in Raja Ampat, where the well-managed MPAs and local communities supportive of the shark and ray sanctuary would ensure that any pups released into the wild would face only natural threats and not human ones.

Fortunately, the public aquarium members of the Association of Zoos and Aquariums (AZA) were very receptive to this plan. The Georgia Aquarium hosted a three-day workshop in December 2019 to discuss the idea in detail. All parties involved — the aquariums, shark scientists, conservation NGOs, and the Indonesian and West Papuan government agencies responsible for Raja's reefs — enthusiastically endorsed the plan, and the *Stegostoma tigrinum* Augmentation and Recovery (StAR) project was born.

Planning for the initiative proceeded throughout the pandemic via Zoom calls. By late 2021 the stage was set for the world's first population recovery program for an endangered shark species using

a rewilding approach of releasing pups that were purposefully bred in aquariums into the wild. Potential breeder aquariums genetically tested their adults to ensure they were appropriate for release in Raja Ampat, and local NGOs Misool Foundation and Raja Ampat Research and Conservation Centre agreed to construct nurseries at their facilities. The staff there would incubate and hatch the eggs, and then grow out and eventually transition the sharks to life in sea pens, where they could acclimatize to Raja Ampat's reef environment before being released.

After an initial group of four local shark nannies (the endearing term the aquarists at the nurseries call themselves) were recruited and trained at the Jakarta Aquarium, they were further trained by professional aquarists from AZA. Nursery construction was completed in mid-2022 in time to receive the first batch of eggs in August 2022.

The eggs hatched in September, and the shark nannies began the trial-and-error process of teaching the young pups to forage for themselves. Fortunately, the pups quickly learned to suck live snails out of their shells and eventually to feed on other mollusks and crustaceans augmented by fresh skipjack tuna.

As an important community engagement aspect of the project, schoolchildren from local villages collected snails and clams to feed the sharks. The students then visited the nurseries, learned about the rewilding initiative, and fed the baby sharks.

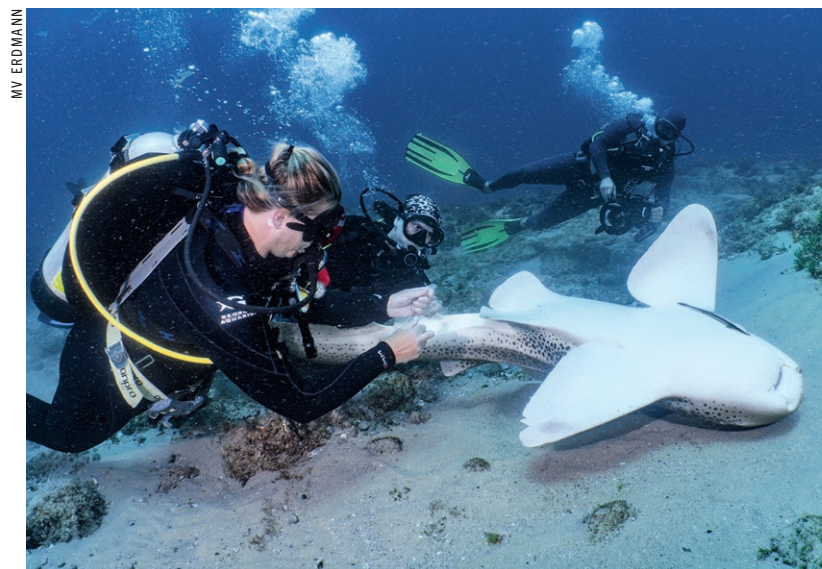


From top: Shark nannies measure the growth of a young pup at the Misool Foundation's nursery. • ReShark scientists from Georgia Aquarium and the University of Queensland conduct a cloacal swab to examine the recent diet of a wild leopard shark at North Stradbroke Island off Brisbane.

Opposite, from top: Wayag Lagoon in Raja Ampat was the site of the initial leopard shark releases in early 2023. • Shark nannies pose with three pups ready for release in Misool's Batbitim Lagoon.

The first three pups made global headlines in early 2023 when they were released into the spectacular Wayag Lagoon in northern Raja Ampat. Since then the program has grown significantly, and 12 aquariums in the U.S., Australia, Asia, and Europe are now approved as breeders. Eggs ship to Raja Ampat at approximately two to three months of age and hatch within one to two months of arriving at the nurseries.

The pups are fed live and fresh food until they reach approximately 27.5 inches (70 centimeters) long, at which time they are surgically implanted with an acoustic tag to allow us to track their movements for up to five years post-release. After their surgery heals they move to sea pens, where they learn to forage in the sand and coral. They grow there until they are 3 to 4 feet (1 to 1.2 meters) long and weigh up to 9 pounds (4 kilograms) — large



enough to hopefully dissuade potential predators from attacking them.

We have released 22 pups into Raja Ampat's waters and are set in 2025 to hit our annual target of releasing at least 50 pups a year. We have an active internship program for young Indonesian marine scientists and are simultaneously researching the healthy Australian and New Caledonian leopard shark populations to determine the basic ecological parameters of the species. That information, which includes the sharks' natural diet and movement ecology, can inform future rewilding efforts.

The rewilding of leopard sharks in Raja Ampat has shown such promise that the coalition now includes nearly 100 global partners and has been officially rebranded as the ReShark initiative, with StAR in Raja Ampat being ReShark's first focal project. Based on the early success of StAR Raja Ampat, the StAR Thailand project was launched in August 2024 and will aim to replicate the leopard shark rewilding program in key MPAs in Thailand.

ReShark strives to expand the approach to other threatened sharks and rays, with the critically endangered bowmouth guitarfish (*Rhina ancylostoma*) as a likely next rewilding candidate. Potential future targets include a range of endangered large stingray species, walking sharks, and even spotted eagle rays.

Rewilding is certainly not a panacea; it is a tertiary intervention that works best in areas with well-managed MPAs and fisheries management policies that protect sharks and rays from targeted fishing and capture as bycatch. We believe that rewilding for sharks and other species has a bright future and will increasingly be an essential tool for coral reef conservation programs. AD

Mark Erdmann of Conservation International is one of the founders of ReShark. For more information, see reshark.org and [@resharkorg](https://www.instagram.com/resharkorg).