Ecological Restoration Lac Bay and South Coast, Bonaire

Lac Bay is the largest semi-enclosed bay in the Dutch Caribbean, offering visitors breathtaking views, white sandy beaches and shallow turquoise waters that seem to go on forever. The Bay's biodiversity value is so high that, in addition to being part of the Bonaire National Marine Park, since the early 1980s the area has also been designated a RAMSAR site (wetland of international importance). Lac's mangroves and seagrass beds cover an area of approximately 770 hectares and provide a vital habitat for endangered species of sea turtles, reef fish, conch, seabirds and shorebirds (STINAPA Bonaire, 2014). The Bay plays an important role in maintaining the health of the island's reefs as its mangroves provide nursery and feeding grounds for many species of juvenile reef fish. Lac Bay has also been designated as an Important Bird Area because of its importance to Caribbean flamingos (*Phoenicopterus ruber*) and breeding herons and terns (Wells and Debrot, 2008). Shallow water bodies on the borders of Lac (Awa Lodo di San José, Awa Lodo di Chico, Awa Lodo di Bakuna, Awa Yuwana) are an important habitat for birds (terns, flamingos) and fish (mojarra and mullet) (Debrot et al. 2014).

The exceptional biodiversity and beauty of Lac has meant that the bay receives many visitors and there is concern that the bay may have exceeded its carrying capacity, causing irreversible damage to the area's fragile natural environment. Trampling of fragile seagrass has emerged as a serious issue. Solid waste (trash) has been documented in sensitive zones such as along mangrove shores at the entrance of the bay, and illegal dumping still takes place. Eutrophication of the Bay's waters as a result of badly managed human and animal waste has reduced the area's water quality and overall biodiversity. One study found high nitrogen levels, which can trigger harmful algae blooms, as well as high levels of fecal matter in the groundwater and areas close to shore (Slijkerman et al., 2014). UV filters in sun care products like Benzophenone-3 that are introduced in the Bay directly by water users (BP-3; oxybenzone) form an emerging risk to the ecosystem (Slijkerman et al., 2017). Large numbers of visitors to the area increase the need for functioning toilets and adequate waste removal.

A long-term threat to the seagrass beds and fish nursery habitats is the natural sediment in-filling of the bay. In part, this sediment is generated through sand production by calcareous seaweeds, peat production by mangroves as well as sediment input by erosion from land. Mangroves are important "biobuilders" and essentially grow themselves out by creating land where there is open water. Over the last century this has already caused the loss of almost a square kilometer of open water in the bay. Each year, Lac Bay loses an estimated 2.3 hectares of mangroves and sea grass beds due to sedimentation (STINAPA Bonaire, 2014). Land clearing for development coupled with overgrazing by donkeys and goats has led to loss in vegetation cover and as a result, sediment is washed into the bay and accumulates in Lac Bay's lagoon, slowing down the water flow, creating shallow hypersaline water bodies that the mangroves and fish species cannot tolerate.

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Photo by: © DRO OLB

"New" fish and seagrass habitat recreated from dry barren land filled by decades of sediment accumulation.
Photo by: © Sabine Engel, November 12, 2017

Photo by: © Sabine Engel

Thanks to funding by The Netherlands Ministry of Economics Affairs through the *Nature Fund*, the Public Entity of Bonaire (Openbaar Lichaam Bonaire) is coordinating a 4-year project entitled "Ecological restoration Lac and south coast Bonaire". The goal of the project is to improve the biodiversity of Lac Bay and the south coastline of Bonaire by restoring hydrological conditions, protecting biodiversity and promoting sustainable tourism. The project began in December 2015 and will continue through October 2019. The project is coordinated through the department of Spatial Planning and Development (unit Nature and Environment) of the Public Entity of Bonaire (DRO), which is working closely with the management body of Lac, STINAPA Bonaire. Important partners are Sea Turtle Conservation Bonaire (STCB) and Wild Conscience BV. Wageningen Marine Research (WMR) is providing scientific support. STINAPA is also working closely with stakeholders, notably local fishermen who have considerable knowledge of circulation patterns in lac as well as the feeder channels (STINAPA Bonaire, 2014).

A key part of this project is the hydrological and ecological restoration of Lac Bay. This is being achieved in a number of ways. Channels in the mangroves to the north and west of Lac, which feed water out into the bay are being reopened and mangrove trees are trimmed to improve water circulation. Once water circulation has been improved it is hoped that the salinity of water in the back mangrove areas will decrease providing good conditions for mangroves to regrow. Culverts and spill overs with sediment sinks on the road to Lac are being built and/or restored to trap sediments before they reach the bay.

The seagrass beds and fish nursery habitat of the bay can only be restored by removing the accumulated sediment to recreate water surface where now sediment-fill has created land. At present STINAPA and WMR are conducting pilot trials to convert such dry barren land back into much needed productive fish nursery habitat (Hylkema et al. 2014). This initiative follows from restoration action spear points jointly developed in 2010 by STINAPA Bonaire, DRO and WMR (Debrot et al. 2010). Action on the ground started in November of this year to restore fish habitat at Kreek di Koko. Together with STINAPA, WMR students are monitoring fish populations in the restored habitat to compare these with baseline data collected before the intervention. Students of WMR are also investigating the sediment production by calcifying algae (esp. *Halimeda opuntia* and *incrassata*).

Lac Bay's mangrove forests have also suffered as a result of vehicular traffic, which can lead to soil compaction, destruction of seedlings as well as the destruction of dunes. To limit vehicular access, Sea Turtle Conservation Bonaire is spearheading an initiative to place natural barriers, such as boulders and rocks, around Sorobon parking lots. Natural barriers are being placed on certain southern beaches to prevent car access to important sea turtle breeding grounds as well as to create a natural barrier at Te Amo Beach to further reduce light pollution from the airport and the resulting disorientation of sea turtle hatchlings (STCB, 2017). Thanks to the sponsorship of Green Label Landscaping N.V., fifty native green buttonwood trees have been planted along the inside of the existing fence. Education and outreach are key to the success of any conservation initiative and information signs about flamingo, tern and sea turtle protection around Lac and in the southern coastal area have been placed to increase awareness of both locals and tourists visiting.

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Another goal of the project is to reduce pollution and waste in the area. Around Lac some trash filled, illegally build structures have been removed. Also new toilet facilities with working septic tanks will be built and existing toilet facilities renovated. The old toilets at Cai have already been removed. To reduce solid waste, concrete structures to store trash containers are being placed in several locations with clean-up of Lac Bay's mangrove forests. "Wowo di Sorobon" has been cleaned and a fence has been placed around it. Pink Beach in the south-west of the island will also be restored to promote tourism in this part of the island and reduce pressure on other beaches such as Klein Bonaire and Sorobon.

The "Ecological restoration Lac and south coast Bonaire" project is one of several Nature fund projects currently working to reduce erosion and sedimentation and restore habitats that are critical to wildlife. To maximize the success of the project, coordination and cooperation has been sought with project managers of other Nature fund projects that overlap such as the "Combating Erosion and Nature Restoration" project. The latter project is restoring dams that prevent or slow fresh water surface flow to Lac Bay. With all projects working towards a common goal of restoring Bonaire's habitats and their biodiversity, there is much hope for success.

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