Jamaican cruise ship terminal respects environment

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Creating a new, modern cruise ship terminal in a Caribbean paradise where the waters are filled with unique, vulnerable marine life is no easy task. Still, this was the task at hand. And in early 2011, thanks to extensive planning and innovative solutions, the project became a reality. The new J$180 million cruise ship port in Jamaica, able to accommodate the newest and largest class of cruise ships was delivered.

The town of Falmouth is located on the northern coast of Jamaica. Founded in 1769, Falmouth was a flourishing market and port in those days. Today, it is known to be one of the Caribbean's best-preserved Georgian towns and an important tourist destination.

The waters surrounding the island nation of Jamaica are home to a diverse marine habitat and the Martha Brae river runs just southeast of the town, ending in a luminous lagoon. On land, the town is surrounded by red mangroves, and at sea by coral reefs and seagrass beds making it an extremely sensitive ecosystem. To develop a deep harbor for cruise ships where the dredge footprint covered wide areas of coral reef and seagrass vegetation required skill, care and a well-thought-out, environmental management plan.

Building in an environmentally sensitive site

The Falmouth Cruise Ship Terminal (FCST) is an initiative of the Port Authority of Jamaica (PAJ) and Royal Caribbean Cruise Lines (RCCL) to host the largest cruise ships in the world: the 'Oasis of the Seas' and the 'Allure of the Seas'. In 2009 the project was awarded to E. Pihl & Son A.S. as the main contractor and Boskalis as subcontractor for marine works. The project included dredging and reclamation works as well as creation of the cruise ship terminal itself. The marine works consisted of the dredging of an access channel to -12.5 meters Chart Datum and two berthing pockets alongside the terminal to a depth of -11.5meters Chart Datum (north-western side) and -10.5 meters Chart Datum (south-eastern side).

Boskalis was also responsible for the development of an Environmental Management Plan (EMP) to mitigate and monitor environmental impacts as a result of dredging and reclamation activities. The EMP consisted of water quality monitoring, including turbidity, dissolved oxygen and water temperature; the installation of silt screens; the relocation of benthic flora and fauna; the installation of a submerged pipeline for sediment-laden excess water; and the installation of reef havens and reef towers.

Falmouth has a shallow, natural harbor, ranging in depth from one to 12 meters, bounded to the north by an extensive fringing reef, to the east by Oyster Bay and to the west and south by the town of Falmouth and the mangrove system of the Martha Brae estuary. The environmental impact assessment (EIA) conducted by Mott MacDonald indicated the presence of sensitive benthic marine resources within and adjacent to the footprint of the proposed structure, namely the coral reef system and Oyster Bay. Some 112 species were identified in the area (22 scleractinian corals, 29 algae, eight sponges, 15 invertebrates and 45 fish), coral cover was as high as 30 percent and Diadema antillarum, the keystone invertebrate herbivore, had densities of eight–13 individuals per square meter according to previous studies.

Oyster Bay, also called 'Glistening Waters', is one of only four bioluminescent bays in the world. The bay's bioluminescence is a result of high densities of Pyrodinium bahamense reportedly ranging from 44,000 to 273,000 individuals per liter. Studies indicated that the dominance of this bioluminescent plankton could be threatened by changes in water circulation and chemistry.

Delicate dredging processes

Boskalis was responsible for all marine works involving deepening and broadening the access channel to the harbor. This meant that Boskalis was also responsible for the protection and care of the coral reefs, seagrass and benthic fauna which were abundantly present.

To achieve the dredging requirements to modernize the port, and still respect the sustainability of the marine environment, Boskalis organized and supervised a massive campaign of coral relocation and seagrass transplantation. Although this role was stipulated in the contract for marine works, the extent of the removal and relocation efforts was far greater than anticipated based on the estimations in the EIA.

Among the dredging contractor's responsibilities were monitoring water quality, such as turbidity, Total Suspended Sediments (TSS), dissolved oxygen and water temperature; the installation of silt screens around the work area of the dredging vessels; the use of a High Density Polyethylene (HDPE) pipeline to pump excess water from the reclamation area to the disposal area; coral, seagrass and benthic fauna relocation and the installation of reef havens and reef towers. As a compensation measure, 1200 Ecoreef modules were also installed.

The range of activities undertaken by Boskalis was made possible because of the broad expertise that the contractor has in-house. Specifically, Hydronamic, the engineering department of the company, played a major part in underwater monitoring, feasibility studies, design and installing the special HDPE pipeline and the intense liaison between the different parties around the coral relocation. Hydronamic also assisted with the installation of silt screens to ensure the environmental compliance with the standards established by the National Environmental Protection Agency (NEPA) of Jamaica.

Dredging and reclamation works for the cruise ship terminal were conducted in two different stages. Dredging started in September 2009 with the removal of the softer topsoil layer in the dredge footprint with the grab dredger – 'Packman', and lasted until January 2010. Disposal of dredged material took place offshore with three barges at a dedicated placement location. Occasionally material was side-casted in the pier footprint to be used by the main contractor with the start of the construction of the pier.

Removal of the medium dense and the harder layer underneath was executed with the cutter suction dredger - 'Ursa', which started in March 2010 and lasted until the middle of June 2010.

Lowered-basket ready for planting

Dredged material was then transported with a floating pipeline onshore to the reclamation area located southeast of Falmouth. Return water from the reclamation area was transported through a HDPE pipeline with a discharge point below -50 meters Chart Datum northwest of the work area, as studies and monitoring indicated that this would reduce impacts on the majority of nearby coral reefs and seagrass beds which are located at shallower water depths of between five and 25 meters.

Coral, seagrass and benthic fauna relocation

In order to reduce the impacts of the dredging and relocation activities, benthic flora and fauna were relocated during the project activities. Each of the relocations demanded a different approach and planning. Coral was detached from the area to be dredged prior to dredging and attached in a more suitable marine environment on hard substrate outside of the access channel; when one area was cleared dredging began and coral relocation continued in tandem at a subsequent area.

The seagrass removed from the dredge footprint in fact, had no suitable reception area around Falmouth and was therefore sacrificed. However in nearby towns bare patches in the seagrass beds caused by ship's anchors or sand harvesting were discovered. A transplantation technique was used where plugs were taken from healthy parts of the seagrass beds at those locations and planted in the bare patches as a compensation measure. This method facilitates quick recovery of damage to seagrass beds before erosion can increase the damage.

And last, but certainly not least, the dredge area was swept every single day for benthic fauna such as lobster, starfish and conch. These were then placed in a nearby location beyond the range of the dredging operations.

At the start of the project, 15 divers were contracted and trained to conduct the necessary underwater relocation activities. These divers were then used to train a larger group of divers as it became clear that the quantity of coral to be relocated was more than 200 percent of the amount initially calculated in the EIA.

To meet this challenge, within a month the diving force was increased to 50, then 60 skilled divers. During an eight month period, in an area of about 11 hectares, a team of 93 trained divers, using both surface supply and scuba, were working in four teams harvesting, transporting, reattaching and monitoring. Ultimately, these teams successfully relocated 147,947 organisms, including 8,975 soft corals, 137,789 hard corals and 1,183 sponges.

At the start of the project, time series photographs were taken of what was believed to be a large enough representative sample size. Upon the completion of the project, the exact representative sample size was determined and time series photographs were taken on two additional occasions at the end of the project (2010) and a year later (2011). The relative health was thus monitored over a period of 19 months (October 2009 – April/May 2012).

With years passed since the completion of the project, monitoring indicates that the coral is healthy with a low percentage of diseased corals or corals with partial mortality and a very low total mortality of four percent. An independent agency also monitored the activities before, during and after the relocation exercises and confirmed the results of the relocation.

Lessons learned

Working in the exotic waters of the Caribbean was a learning experience for all parties and demanded the highest levels of expertise. Boskalis tackled the environmental challenges every step of the way, finding innovative solutions where necessary, in collaboration with well-known scientists. The use of a specially designed HDPE pipeline to bring the return water

Removal of the softer topsoil layer in the dredge footprint with the Grab Dredger Packman.

from the reclamation area and discharge it at extreme depths of between –50 and –60 meters had not previously been done. But a scientific feasibility study established that at this depth the discharged material would not reach the coral reef located above the discharge point. Continuous monitoring established that this was indeed the case.

Also of great importance was the safety record. In nine months of operation, with an enormous amount of dive time and very complex logistics, only one diver got ear problems after having a cold. No accidents occurred, which is a remarkable achievement.

Boskalis also took its responsibilities a step further by consulting multiple coral reef scientists for their expert opinions on specific ecological problems. Their expertise added to the already extensive arsenal of scientific knowledge of the dredging contractor, information that can well be applied to future operations.

Consultation with these experts is in line with the 'Building with Nature' (BwN) program actively being pursued in the dredging industry. The aim of BwN is to preserve or even strengthen the ecosystem as a starting point, to design alternative work methods and mitigation measures that are effective and efficient and reduce project risks, all aimed at fostering greater levels of sustainable development.

Although worldwide, benthic relocations and mangrove restorations have become a common mitigating measure required by governance bodies, large-scale coral relocation such as conducted in Falmouth is logistically and financially very complex and survival success is not always certain. By using the BwN approach for the Falmouth cruise ship terminal, Boskalis was able to reach a successful outcome where the impact on the marine environment has been extensively minimized.

Conclusion

Ultimately the experience in Falmouth proved that a close partnership between governmental organizations, dredging contractor and scientists, who together have the capability and authority to monitor and adjust, can lead to results in which both an economic goal and an environmentally sound solution can be effectively achieved.

ABOUT THE AUTHORS

Astrid Kramer has an MSc in Ecology from Leiden University, The Netherlands. She has been working as a project engineer for Hydronamic, the in-house engineering company of Boskalis for over five years. She advises projects in ecologically sensitive areas and is involved in large-scale environmental monitoring programmes. She has been working on Boskalis projects in a variety of countries such as Angola, Kenya, Canada, Abu Dhabi, The Maldives and Suriname.

Ivana Kenny studied Zoology at the University of the West Indies, Mona Campus. After undergraduate work she moved on to an M.Phil in Scleractinian Coral disease on Jamaica's South-East Coast. Ivana has been studying coral disease and reef organisms for over five years and has undertaken marine assessments for an assortment of environmental companies like coral relocations with Maritime and Transport Services (MTS), including that of the Falmouth Cruise Terminal, potentially the largest relocation globally (to date).

ABOUT THE COMPANY

Royal Boskalis Westminster N.V. is a leading global services provider operating in the dredging, maritime infrastructure and maritime services sectors. The company provides innovative and sustainable all-round solutions in the maritime, coastal and delta regions of the world with the construction and maintenance of ports and waterways, land reclamation, coastal defense and riverbank protection. Boskalis offers a wide variety of marine services through SMIT including harbour towage, salvage, subsea, transport and heavy lift services. It also has strategic partnerships in the Middle East (Archirodon) and in terminal services (Smit Lamnalco). Boskalis has a versatile fleet of over 1,100 units and operates in around 75 countries across six continents. Including its share in partnerships, Boskalis has approximately 14,000 employees.

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