

On January 13, 2012, the *Costa Concordia* cruise ship ran aground off the Italian coast near the island of Giglio. More than 4,200 people aboard were evacuated, 32 people died, and another 64 were injured.

Scientific American examined the highly complex operation of stabilizing and refloating the ship so that it could later be scrapped, an operation which had never before been attempted. 500 technicians, 22 barges, and

8 boats were involved at a cost of 60 million euros. Using 3D illustration techniques, the magazine recreated the four phases of the plan to refloat the ship, as well as the goals and risks involved in each phase.

SALVAGE PLAN

Flip the Ship and Float It Away

The 950-foot *Costa Concordia* is impaled on two large, underwater rock outcroppings. To remove the ship in one piece, it has to be freed and righted. Salvage crews first drove stanchions into the shore and wrapped the ship in chains to prevent it from slipping down the steep seabed and sinking **1**. Workers then anchored six massive steel platforms into the granite seabed to give the boat a place to land and laid thousands of cement-filled bags to level the uneven, rock seafloor. They also reinforced the exposed hull so it would not break apart, then attached caissons—hollow boxes 100 feet tall, filled with water and air—that will

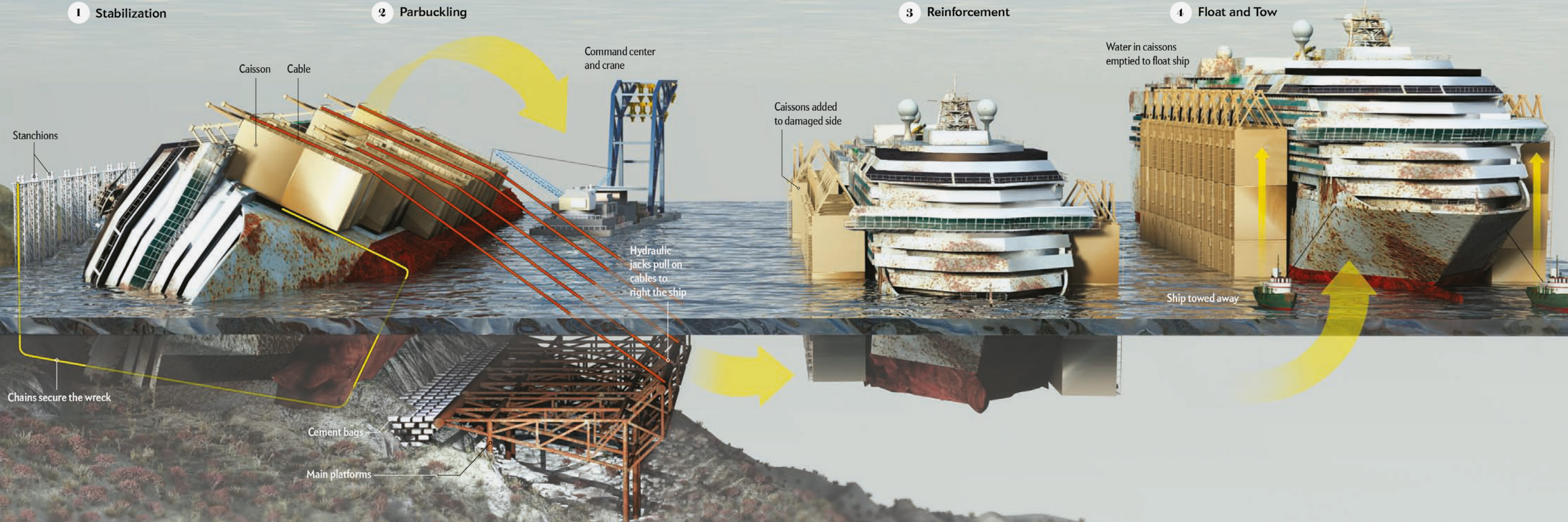
help float the boat after it is slowly rolled upright during an eight-hour procedure called parbuckling **2**. To tip the ship, hydraulic jacks will pull on cables connecting the top of the caissons to the platforms, while tension in the chains will add some control. A giant crane, housing the salvage master's command center, will help lift and stabilize the ship if needed. Microphones and video cameras installed inside the rusting hull will reveal if and how the innards are shredding. Welders will reinforce the mangled side, then attach caissons there **3**. Water in the caissons will slowly be pumped out, raising the ship until it floats, so it can be towed away **4**.

MORE TO EXPLORE

Parbuckling Project (official salvage Web site): www.theparbucklingproject.com
 Giglio News (port Web cam): <http://bit.ly/nzjyqK>
 Pelagos Sanctuary: www.tethys.org/sanctuary.htm

SCIENTIFIC AMERICAN ONLINE

For a full account of the *Costa Concordia*'s effects on the residents of Giglio, see ScientificAmerican.com/aug2013/concordia



What Could Possibly Go Wrong?

The crippled ship is perched precariously above a steeply sloping seafloor that is home to pristine coral reefs, sea grasses and spawning grounds. Any error during the parbuckling procedure could spell disaster. If the ship is pulled too hard, it could topple over the platform and tumble down the ridge **a**. If the platforms crumple under the weight, the boat could slide down instead **b**. Either way, a large area of corals and grasses would be crushed and torn. The heavily damaged hull could also break apart under its own weight as it is lifted **c**, tumbling down the slope in pieces and spilling its toxic guts into the coastal waters. In all three cases, the sunken ship and its contents would rust and rot, contaminating the fragile aquatic ecosystem for years.

