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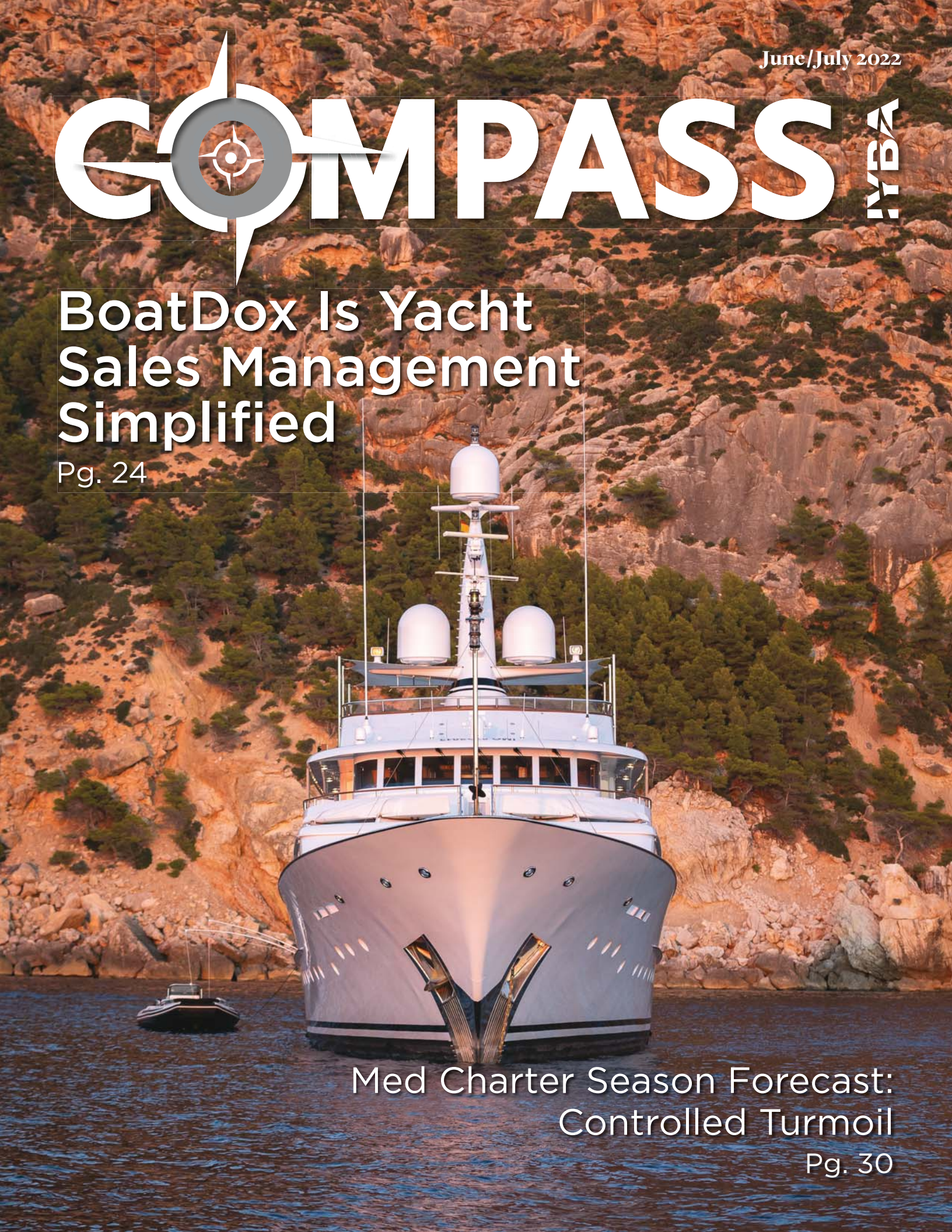

Med Charter Season Forecast: Controlled Turmoil

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How to Inspect for and Mitigate the Damage After a Yacht Runs Aground

by **Rich Merhige,** *Advanced Mechanical Enterprises, Inc.*

For those of us who go to sea in ships, "run aground" are dirty words no one wants to hear. Even the best navigators, despite their best efforts, can have an accidental grounding or collide with a submerged object. Christopher Columbus, Ferdinand Magellan, Vasco de Gama, James Cook, Samuel de Champlain, George Vancouver, John Smith, and Francis Drake all have run aground.

Propulsion systems today are precision systems with components that help to absorb vibration and eliminate noise. When these systems are exposed to impacts or shocks, such as in a grounding incident, there are some areas that should be checked and inspected as there can be consequences beyond propeller damage.

Two bent propellers

The practical approach after getting the vessel safe and secure is to visually inspect the driveline, check for obvious damage, and document with photos and notes. A diver can inspect the external waterborne components of the driveline, propellers, and bearing clearances. If visible damage is negligible, the propellers can be removed and repaired, and a vibration survey performed to determine operating condition of running gear and machinery. This also can be used to more accurately pinpoint specific areas of concern.

Some additional checks that should be performed in the event of good hard grounding are listed below.

1. **Propellers:** Modern propellers are fined-tuned for three parameters: pitch, balance, and surface finish. Yacht propellers are very high quality, and the accuracy of these parameters is extremely close. The International Standards Organization, *ISO 484 Ship Screw Propellers – Manufacturing Tolerances*, sets the standards. ISO 484 Class S is the highest quality, and Class I is the next level down. Propeller repair shops can perform miracles with modern scanning devices and balancing machines. Repairs often can be made to a high-quality level Class S or Class I at a minimum. The better the quality, the lower the propeller-excited vibration.
2. **Shafting:** When a propeller impacts the bottom, shafts can be bent or twisted. The best method to accurately check the shafts is to haul the vessel, draw the shafts and bench-check them on precision rollers. Water-lubricated cutless bearings have a running clearance that could mask a bend as the shaft can float inside the bearing, giving inconsistent results.
3. **Struts:** The struts, which support the shaft and propeller, are externally mounted to the hull and are configured in either as an "A" or "I" bracket. Struts are typically flange-mounted and secured to the hull with watertight through bolts. Depending on the force of an impact, the struts could be bent or in some cases, and the hull support structure could be weakened. Initial checks following a grounding or collision should include checking the internal hull area and strut mounting bolts for any sign of buckling or leaks. If strut or hull damage is present, haul the vessel, remove the struts and make necessary repairs. Struts can then be precision borescope or laser aligned and chocked when reinstalled.
4. **Cutless Bearings:** Shaft water-lubricated cutless bearing can become worn or delaminated as a result of a grounding, as a bent shaft will cause excessive heat or friction on the bearing and wipe the fluid film that would normally support the shaft.

The importance of keeping vessel machinery aligned cannot be underestimated.


Bent strut

Once the vessel is hauled, inspect the shaft bearings for running clearance, overheating and delamination.

5. **Shaft Seals:** Most mechanical shaft seals are either a rubber lip type or face seal. Modern shaft seals are robust, but in the event of a grounding, dirt and grit can get sucked up if you run aground or operate in shallow, sandy bottom areas. It is good practice after a grounding to visually examine the lubrication system, hoses, clamps, and the raw water supply pump.
6. **Shaft Couplings:** Some propulsion machinery arrangements have a flexible coupling between the shaft and reduction gear. This coupling helps to absorb misalignment, acts as a sound break to prevent gear noise from transmitting through the shaft, and absorb impacts. After a grounding, these couplings should be checked for trueness and damage to the flexible elements.
7. **Shaft Hubs:** A coupling hub is mounted on the end of the shaft. Shaft ends are normally tapered. Tapered shafts lock up hard, do not wear lose, and maintain great alignment. It is good marine practice to send the shaft coupling hub together with the shaft when getting it checked for straightness. The shafting machine shop will then mount the hub to the shaft and check the fit of the shaft on the taper, check the pilot is concentric to the shaft, and verify runout of the face is true. This called checking the coupling "fit and face".
8. **Gearboxes:** Marine gearboxes often absorb the propeller thrust forces and are the point at which the force to propel the vessel through the water is fixed. Gearboxes can be rigidly or elastically mounted to their foundations on the stringers. Damage can occur to the gear teeth, bearings, clutches, or input and output flanges from an impact. Vibration analysis is a powerful tool for picking up gear damage as a high-quality frequency analyzer. Oil analysis is also a good technique for determining gear condition. If flexibly mounted and based on the force of the impact, it may be prudent to replace the mounts.
9. **Engine Torsional Couplings:** Torsional couplings are often hidden and forgotten within the bell housing connecting the engine and gearbox in a close-coupled arrangement. Torsional couplings transmit the power from the engine to the gear. Torsional couplings are typically elastomeric and dampen the vibrations created by the engine firing combustion and help to tune out harmful critical natural frequencies. They also can help to absorb the shocks to the driveline and protect the engine crankshaft from catastrophic damage. Torsional couplings should be inspected in the event of a grounding. This may require a video borescope to visually inspect the condition of the elastic element (Buna or Silicon Rubber). Check for tears, cracks and distortion.
10. **Engine Mounts:** Marine engine mounts are designed and tuned to isolate the engine vibration, absorb the torque forces, and maintain precision alignment tolerances. In many arrangements, the mounts also absorb propeller thrust. In a grounding, the mounts could become damaged or weakened. Mounts should be thoroughly inspected and if the grounding or impact was significant, engine mounts should be replaced as internal inspection is not possible without disassembling the mount.

Finally, the importance of keeping vessel machinery aligned cannot be underestimated. Alignment on yachts typically refers to shaft alignment – the positioning of two machines so the shaft centerlines of each machine line up at the coupling, as close as possible under normal operating conditions. Laser and/or optical alignments are the most precise methods for correcting shaft misalignment. Optical alignments utilize optical scopes and precision-machined wire targets to align the strut, stern tube, and reduction gear to each other. This type of alignment must be performed on the hard after the running gear has been removed. Laser alignment measures misalignment between two machines, typically across couplings. It's a precise way to align machinery while simultaneously eliminating guesswork, possibilities of human error, and automatically documenting results.

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Torsional engine coupling


Shaft being straightened