CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

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Project Number

J0109

Project Title

Impact of the Depth of the Dagger Board during Different Points of Sailing

Abstract

Objectives

The objectives of this study was to measure the effect of the depth of the dagger board (sail boat) in the water and how varying the depth impacted sailing at different points of sailing (closer or further away from where the wind came from): direction of the boat (measured by the drift from the original course) and speed. It explains how the forces are applied to the boat: center of effort (wind on the sail) and center of resistance (water on the dagger board). The hypothesis was that I could control the boat better if the dagger board was deeper, in particular when sailing closed hauled.

Methods

I used a single handed sailing boat (9 feet long) with a removable dagger board. I used floating buoys (to go back to the same point for each run), Garmin watch that recorded my GPS coordinates over time when sailing.

Results

I repeated each run several times. I tested 3 depths of the dagger board (fully down, 1/2 way up and fully up) at 3 different points of sailing: close hauled (when you sail close to the wind and the sail is pulled in), beam reach (when you sail at 90 degrees angle from the wind and the sail is 1/2 way out) and running or downwind (when the wind comes from the back of the boat and the sail is fully opened). Results confirmed my hypothesis. When sailing closed hauled, I absolutely needed to have my dagger board fully down to control the direction and speed of the boat. If I lifted the dagger board even only 1/2 way up, I drifted more than 135 and 127 degrees away from my normal course. When going beam reach, the dagger board was also important, but it could be lifted with only a relatively small impact (17 degrees drift if 1/2 way up and 31 degrees if fully up). And when going down wind, with the wind coming from the back of the boat, the dagger board was not necessary. The dagger board can be fully up and I could still control the direction of my boat. I only drifted 7 degrees and that's probably part of the variability from run to run. Also, the depth of the dagger board did not impact the speed significantly. It appeared that when drifting (close hauled when lifting the dagger board), my boat speed slowed down from 6.4 km/hr to 5.8 km/hr.

Conclusions

My experiments confirmed my hypothesis. I am a sailor and I already knew when I am supposed to lift my dagger board when sailing and when not doing so. I did not know why and this research taught me about the forces at play and how several forces contribute to the final direction and speed of the boat. I was also able to quantify the criticality and importance of the dagger board at different points of sailing. It also showed

Summary Statement

On a small sail boat, lifting fully the dagger board has no impact when sailing downwind (wind from the back of the boat), but it is essential to keep the dagger board fully down when sailing close hauled to control the boat's direction.

Help Received

My father was on a small motorboat to provide safety during my experimental runs. I learned how to use Excel to calculate angles from GPS data. I did an internet search to find the equations to convert GPS bearings into angles and distance. I used my own sail boat.