



## Swimming obstructed by dead-water

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In nautical literature, 'dead-water' refers to the obstructive effect encountered by ships moving in stratified water due to the ship generating waves on an interface that separates different water masses. To investigate the hypothesis that open water swimming may also be obstructed by an encounter of dead-water, possibly causing drowning, we performed two experiments that assess the impact of stratified water on swimming. In the first experiment, subjects made a single front-crawl stroke while lying on a carriage that was rolling just above the water surface. The gain in kinetic energy, as a result of the stroke, was far less in stratified than in homogeneous water. In the second experiment, four subjects swam a short distance (5 m) in homogeneous and in two different settings of stratified water. At the same stroke frequency, swimming in stratified conditions was slower by 15%, implying a loss in propulsive power by 40%. Although in nature stratification will be less strong, extrapolation of the results suggests that dead-water might indeed obstruct swimming in open water as well. This effect will be most pronounced during fair weather, when stratification of a shallow surface layer is most easily established. Our findings indicate that swimmers' anecdotal evidence on 'water behaving strangely' may have to be taken more seriously than previously thought.

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