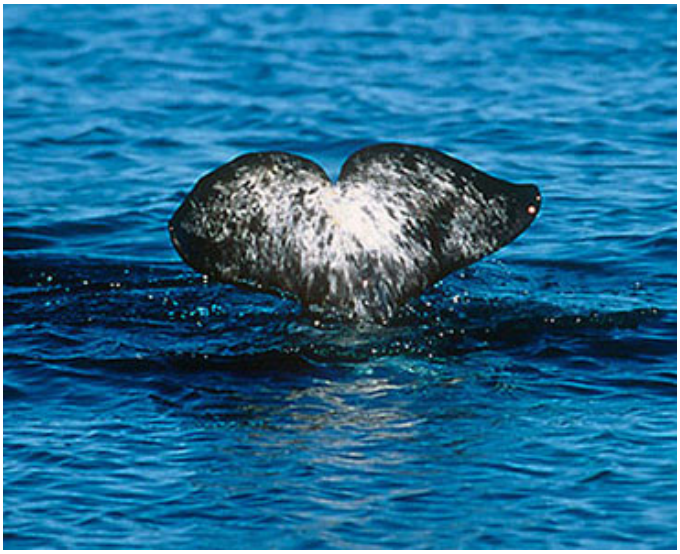
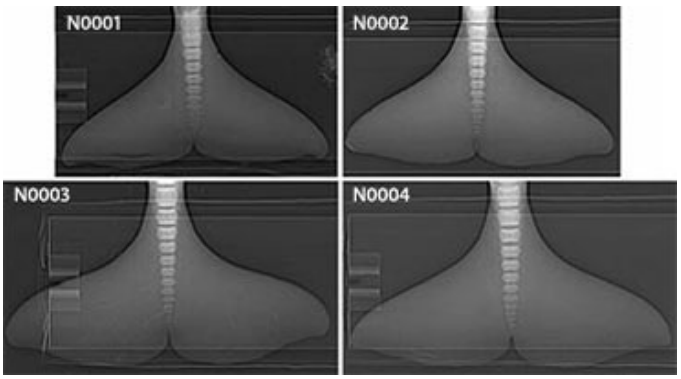
About the Fluke

The external morphology of flukes is generally considered constant among the Cetacea. An acute departure from the typical fluke shape is found in the narwhal. The flukes of mature male narwhals have a slightly concave leading edge without sweepback (Hay and Mansfield 1989). A female narwhal generally has a fluke very similar in shape to that of a dolphin, which is swept back. Whether or not the differing fluke morphology is an evolved adaptation that coincides with the long, tapering tusk present on most males is unknown (Fish et al. 2007).



The hydrodynamic effects produced from differences in the geometries of the flukes, which were stated above, are largely associated with steady flow conditions. The flukes of cetaceans are oscillated, incurring the dominance of unsteady flow conditions (Webb 1975; Fish 1993, 1998a). Unsteady effects can incur lower lift than for steady motion (Lighthill 1970). Further analysis of narwhal fluke geometry would require examination of unsteady effects, although results based on steady flow conditions can provide an indication of differences in hydrodynamic performance.

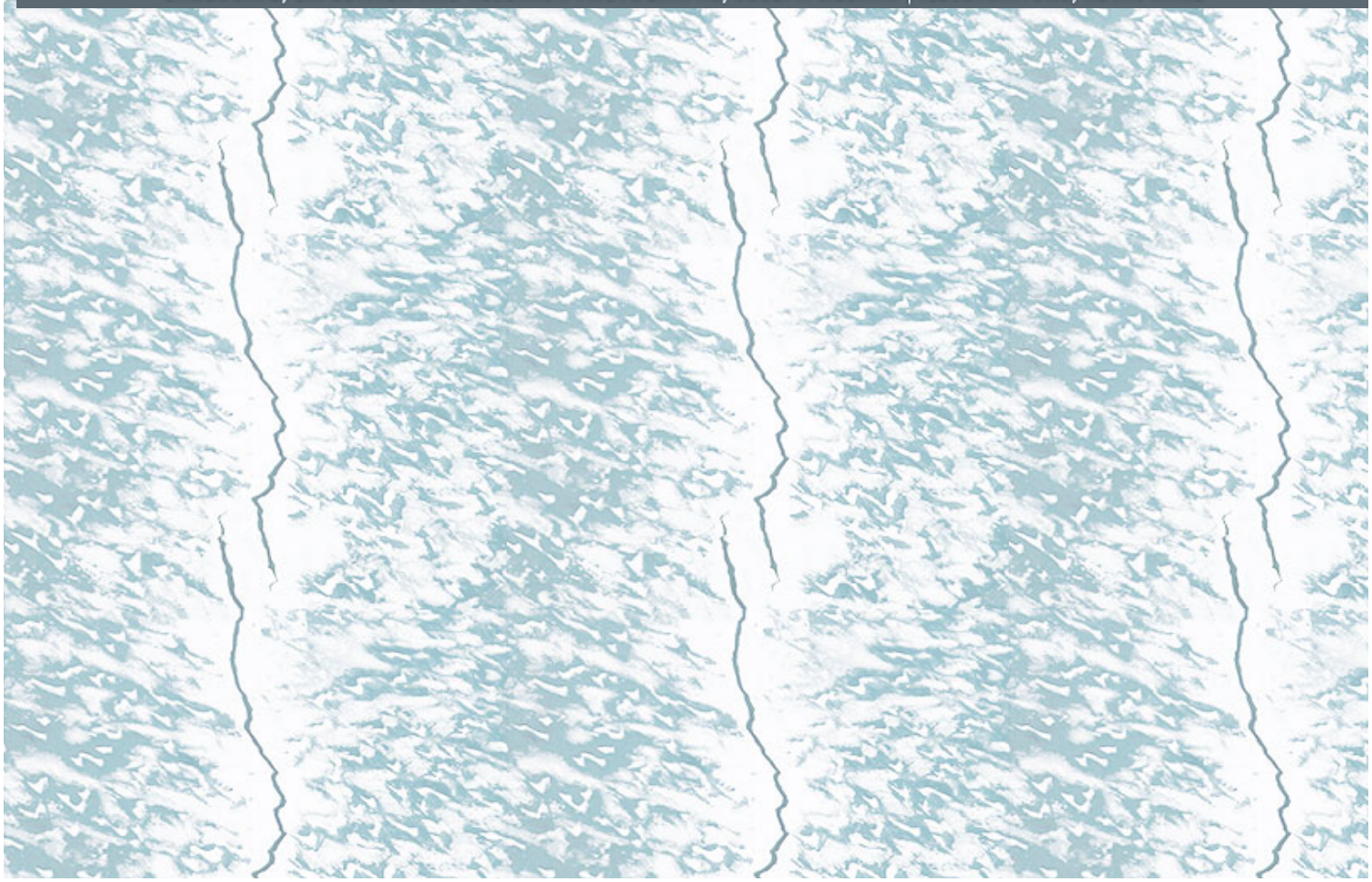
The differences in fluke design between the sexes of narwhals could have hydrodynamic consequences associated with swimming performance. No differences in swimming speeds between male and female narwhals have been reported, when transiting between locations as during migrations (Dietz and Heide-Jørgensen 1995, Dietz et al. 2001; Heide-Jørgensen et al. 2002, 2003).



(above) CT topograms illustrating the differences between female (N0001, N0002) and male (N0003, N0004) fluke planforms.

However, Laidre et al. (2003) found that female narwhals made more dives to deeper depths than males. Deeper destination depths were related to increased swimming speed (Laidre et al. 2003), indicating that at least during foraging dives, females could be swimming faster than males. The design of the flukes of females, thus, may be associated with the need to transit to greater depths at fast speed. For males, the increased lift and concomitant thrust production from the low sweepback fluke design may aid in compensating for the increased drag that might accompany the possession of the elongate tusk.

Swimming performance by narwhals (i.e., overcoming drag, swimming speed) is associated with the hydrodynamically complex and conflicting relationships of lift and thrust production, reduction in drag, delay in stall, and efficiency, which are dependent on the fluke geometry and kinematics.

Fish, Frank et al. 2011. Marine Mammal Science, 27(4):889–898.

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