

The Influence of the Vertical Migration of Zooplankton on the Risk of Entanglement and Ship Strike to Right Whales (*Eubalaena glacialis*)

Cape Cod Bay Massachusetts

Ship strike and entanglement are the primary causes of injury to and mortality of the critically endangered North Atlantic right whale (*Eubalaena glacialis*). The specific circumstances that result in ship strike and entanglement have not been sufficiently documented to allow the precise tuning of management policies addressing these risks to right whales; hence injury and mortality caused by marine industrial activities continues apace. The distribution and behavior of right whales in Cape Cod Bay, a critical right whale habitat, and elsewhere are profoundly influenced by the distribution of zooplankton, the whales' primary food source. Zooplankton exhibit depth-selective behavior and form energy-rich layers attractive to feeding right whales; depending on the depth of a zooplankton layer and the characteristics of the industrial activities, feeding right whales may be at greatly increased risk of ship strike and/or entanglement.

Depth-specific layering that results from active vertical movement of zooplankton can occur for a number of reasons including: predator avoidance, grazing, and reproduction. Diel vertical migration (DVM), the cyclic migration of zooplankters over 24 hour periods, is a prime example of depth selective behavior; although such behavior could have profound implications for the daily distribution of right whales in the water column, its impact upon whale behavior and exposure to risk is minimally understood. Data collected during the last decade in Cape Cod Bay by the Provincetown Center for Coastal Studies' (PCCS) right whale habitat studies team has shown that at least two of the three copepod taxa on which right whales feed exhibit depth-selective behavior unique to each taxon; two special reports on the phenomenon were issued during the 2008 field season due to its importance to right whale research and conservation.

We have proposed a study that focuses on isolating factors that lead to high risk conditions for right whales in the Cape Cod Bay right whale critical habitat, and on the documentation of variations in risk that occur as the controlling food resource goes through diel variations in vertical structure. With a more complete understanding of the circumstances that lead to right whale entanglement and ship strike, management strategies can be crafted and assessed to more effectively prevent such incidents. Just as the management strategies used in Cape Cod Bay have served as an example for coastal managers in the past, the proposed work will substantially advance the scientific basis of conservation strategies, setting a precedent for other habitats in an effort to improve protection of the North Atlantic right whale population.

Specifically, we hope to investigate the diel patterns of zooplankton distribution in the water column of Cape Cod Bay with the goal of determining the influence of zooplankton movement and coalescence on right whale behavior and risk *through 24-hour periods*. The data collected would show the daily cycles of the distribution of zooplankton taxa in the water column, and would include observations of the night-time behavior of both zooplankton and whales. Our colleagues that have experience in using acoustic recording techniques, as well as D-tags (devices that can record a whale's depth, velocity, tilt, etc), are interested in collaborating on such a project.

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