Entanglements of North Atlantic right whales increase as their distribution shifts in response to climate change: The need for a new management paradigm

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**Rapid warming in the Gulf of Maine linked to right whale distribution changes since ~2008 - 2012**

**What may have caused increased entanglement rates?**

**OBSERVATION** Rapid warming at surface and at depth began ~2004 resulted in:
- changed supply of NARW prey
- redistribution of NARW
- increased lobster recruitment
- changed seasonality of fishery

**HYPOTHESIS** Warming waters have led to higher GOM lobster recruitment and more fishing activity (e.g., more rope and/or longer fishing seasons), leading to greater encounter rate between whales and rope as NARWs forage outside of historic feeding grounds.

**OBJECTIVE OF THIS ANALYSIS** Address our hypothesis given extremely limited data on fixed gear fishing activity and the times and locations of entanglement events.

**Detection rate of severely injured or entangled NARWs began to increase around 2004 - 2007**

Knowlton et al (2012) entanglement rates updated through 2017

**Increased landings from fixed-gear fisheries that overlap with NARW habitat.**

**Increased rate of observed severe injury & entanglement**

**Redistribution of NARWs post ~2010**

**Climate change has changed NARW distributions in a nonlinear and unpredictable fashion**

Dynamic management of fisheries that threaten species facing extinction is too risky, since managers cannot respond quickly enough.

**Broadscale changes to fishing practices are needed to minimize and eliminate human-caused injury and mortality**

**References:**