

Introduction

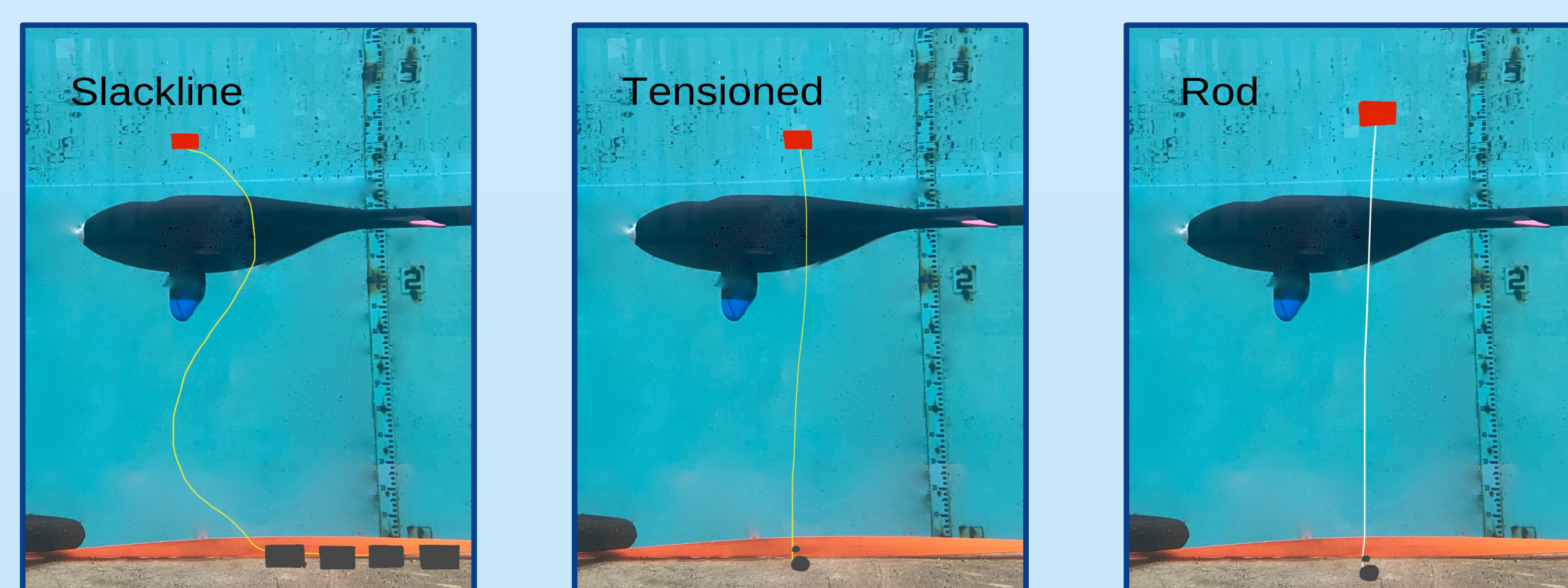
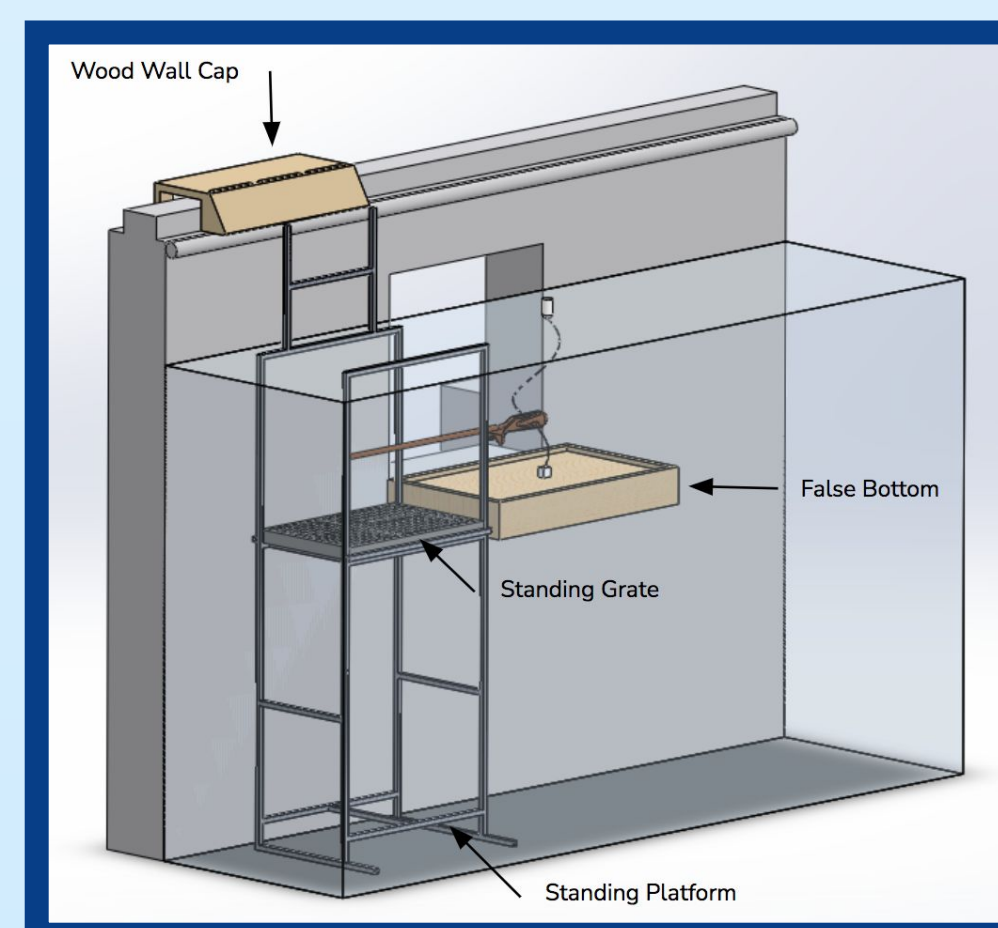
- ❖ Fewer than 336 NARW
- ❖ Ongoing anthropogenic Unusual Mortality Event
- ❖ 83% have been entangled
- ❖ 80% of cases are from fixed fishing gear, though offshore development is expanding
- ❖ Nobody has witnessed the entanglement process, but reverse engineering studies show a roll away from mooring lines upon detection is typical
- ❖ Howle et al. show entanglement with slackline scenarios in a computer simulation
- ❖ Goal: Investigate if specific mooring configurations could prevent entanglement.



Florida Fish and Wildlife Conservation Commission (NOAA permit 20556-01)

Methods

- ❖ 1:45 Scaled, wooden model is used to simulate whale and mooring interactions
- ❖ Slackline Lobster Trawl
- ❖ Two Tensioned Moorings
 - Low and High Tensioned
- ❖ Two Rod Moorings
 - Low and High Bending Stiffness
- ❖ Hand-maneuvered into mooring line, rotated away
- ❖ Each simulation tested at three speeds and three depths

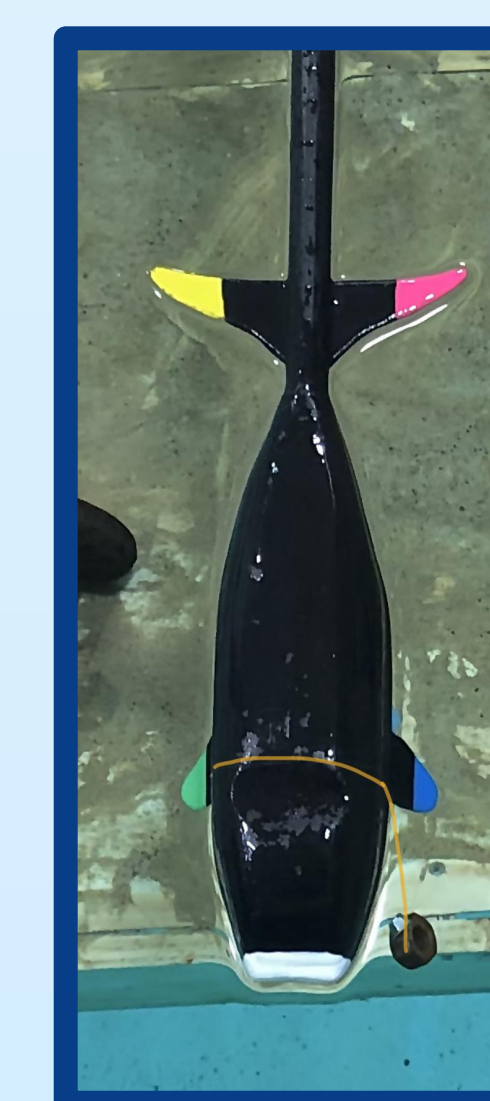
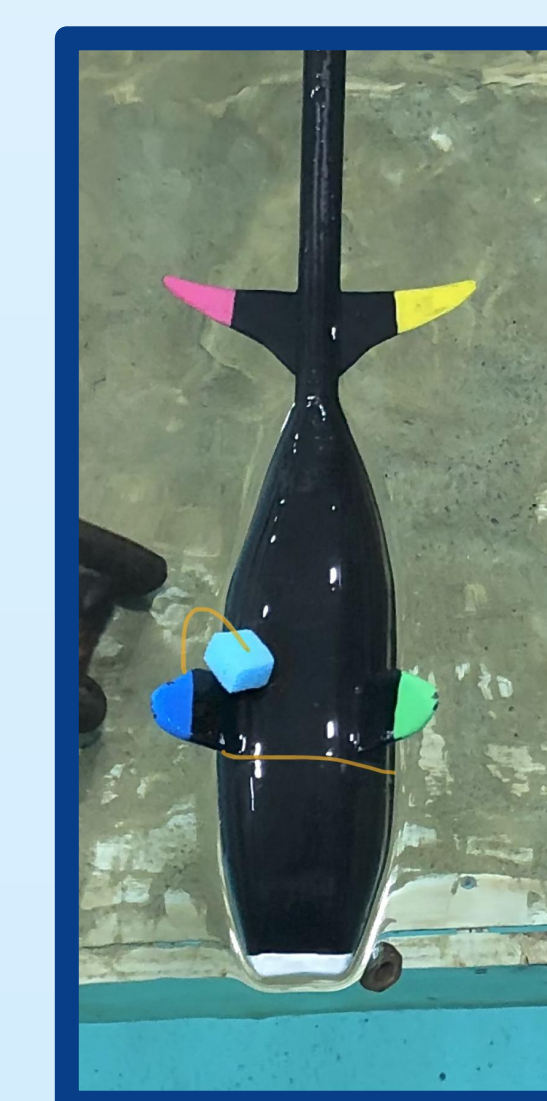
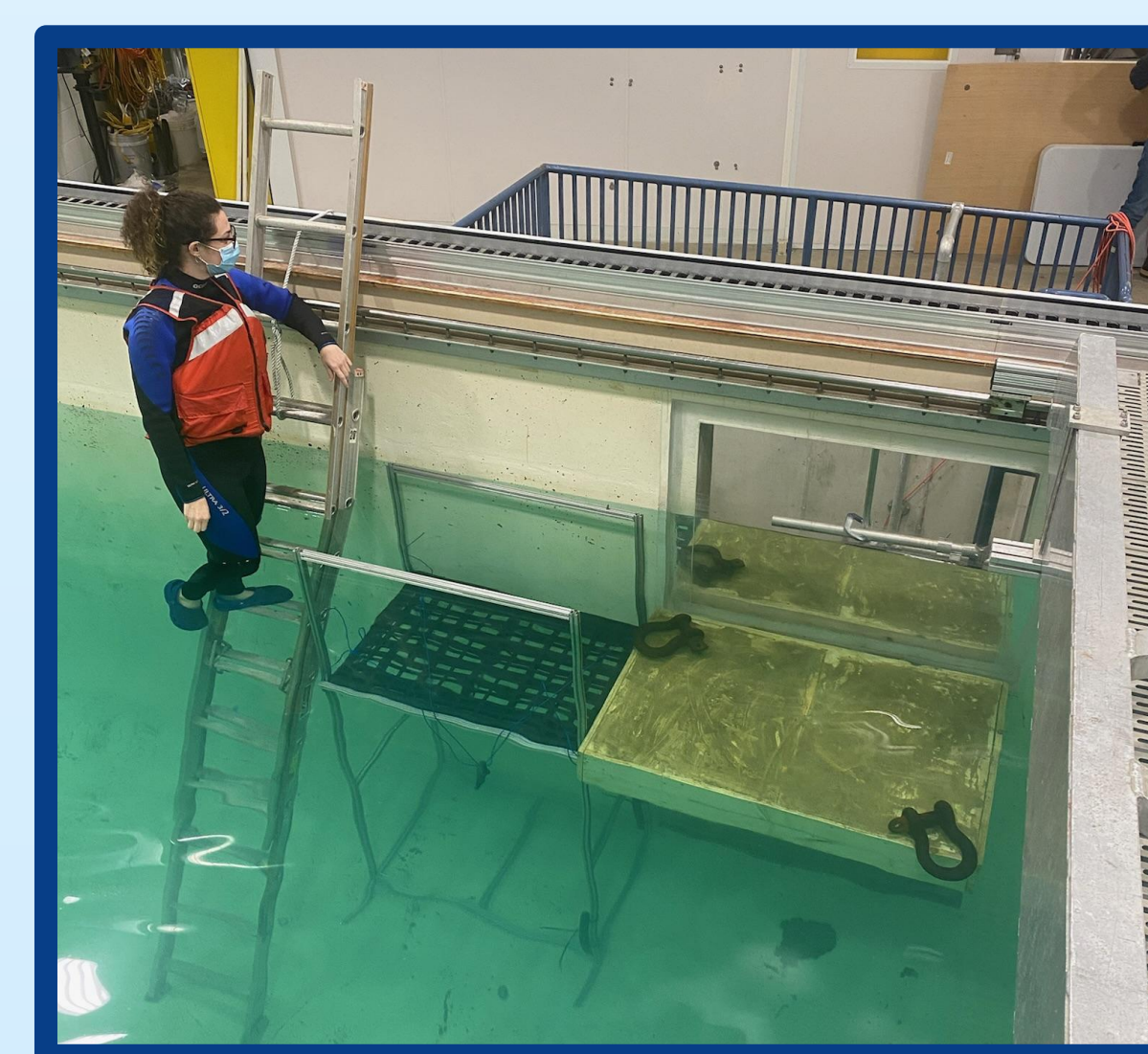


North Atlantic Right Whale Simulation Speeds

Target versus Simulated Speeds			
Speed Type	Description	Full Scale Speed	Model Speed
Top Speed	Migration Speed	6 mph	15.6 in/s
Mid Speed	Middle Speed	2.2 mph	5.77in/s
Low Speed	Leisure Speed (most common)	1 mph	2.62in/s

Results

- ❖ Slackline mooring system replicated Hain et al. slackline computer simulations, both based off of entanglement theory proposed by biologists
- ❖ Both low and high tensioned mooring resulted in entanglement during high speeds and no entanglement at low speeds
- ❖ Upon collision, an intact rod slid off the whale's flipper and resulted in no entanglement
- ❖ In one trial, an incomplete fracture occurred in the low stiffness rod and resulted in entanglement
 - If the rod had a complete break, no entanglement would have occurred

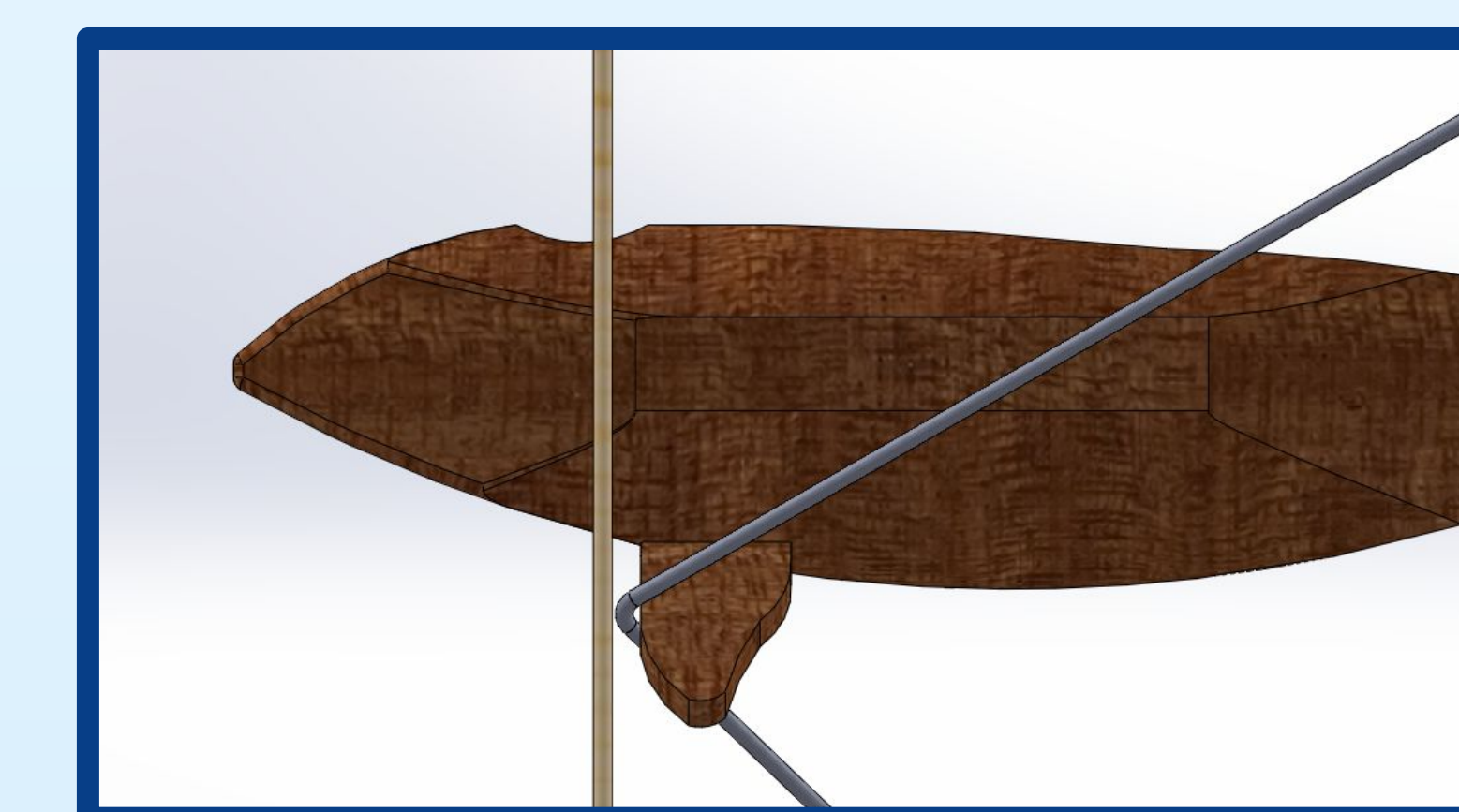
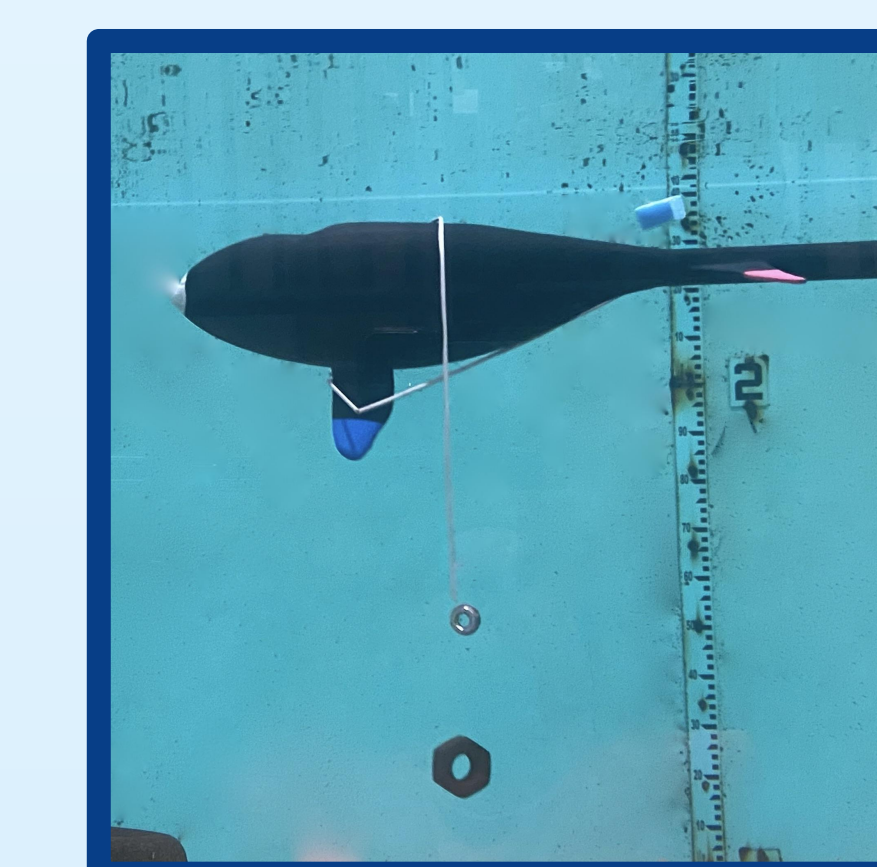


Simulation Data Trends

Frequency of Entanglement					
Set-up Configurations	Configuration Description	# of Entanglements			Percent Entangled
		Low Speed	Medium Speed	High Speed	
Slackline	Slackline lobster trawl configuration with four lobster traps and a buoy.	11/11=100%	9/10=90%	9/9=100%	29/30=96.66%
Low Tensioned Line	A 250 lb tension line configured with a dead weight and counterweight.	0/11=0%	0/9=0%	13/14=92.9%	13/34=38.24%
High Tension Line	A 10,000 lb tension line configured with a dead weight and counterweight.	0/11=0%	0/10=0%	9/9=100%	9/30=30%
Low Stiffness Composite Rod	A shop made nonlinear .0625" pine dowel with a low bending stiffness connected to a buoy, counterweight, and dead weight.	0/8=0%	0/9=0%	1/4=25%	1/21=4.8% (Entanglement due to incomplete rod fracture)
High Stiffness Composite Rod	A .125" birch dowel with a high bending stiffness connected to a buoy, counterweight, and dead weight.	0/8=0%	0/6=0%	0/11=0%	0/25=0%

Discussion

- ❖ Tensioned moorings and rod moorings show lower rates of entanglement than slackline moorings
- ❖ If rods with bending stiffness are implemented, they must fracture completely to ensure no entanglement
- ❖ Composite rods and tensioned mooring lines may be implemented in aquaculture, marine structures, and buoy systems
- ❖ As the need for offshore energy grows, the use of low risk entanglement structures may be the most viable option while protecting marine life
- ❖ NARW are Critically Endangered, but other species benefit as well



References

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