INVESTIGATION INTO TURTLE MITIGATION STRATEGIES WITH TSHDS

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Outline

BACKGROUND

RESEARCH QUESTION

MITIGATION STRATEGIES

SUMMARY OF FINDINGS

NEXT STEPS

Introduction: Background

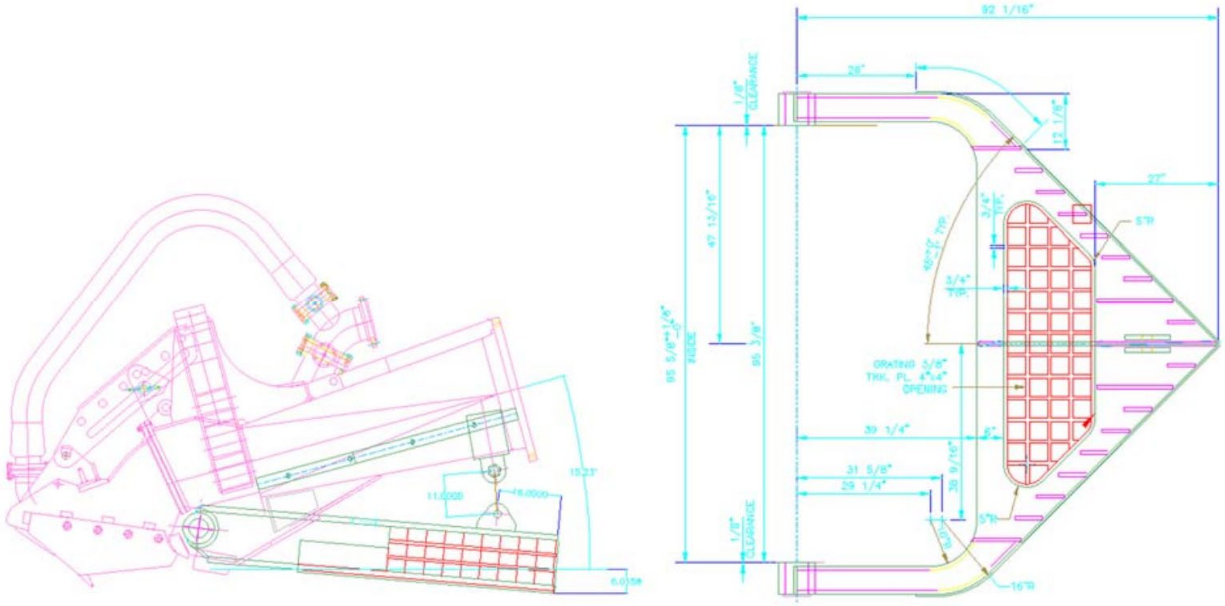
- TSHD (Trailing Suction Hopper Dredge) projects are influenced by environmental and contractual requirements which protect marine wildlife during vulnerable periods of their life cycle:
  - Nesting/breeding
  - Migration
- During these “turtle windows,” TSHD work is either **fully prohibited** or **allowed conditionally** with mitigation measures in place to prevent interaction between the dredge work and wildlife
- Standard strategies generally successful, but remain relatively unchanged for many years

Introduction: Research Question

What different types of sea turtle mitigation strategies exist that could be applied to TSHDs?

- Strategies organized by the type of cue they utilize:
  - Physical
  - Visual
  - Auditory
- Considered features for each strategy:
  - Application feasibility to TSHD
  - Effectiveness at preventing sea turtle entrainment and/or mortality
  - General concerns

Physical Cues: Turtle Excluder Device (TED)

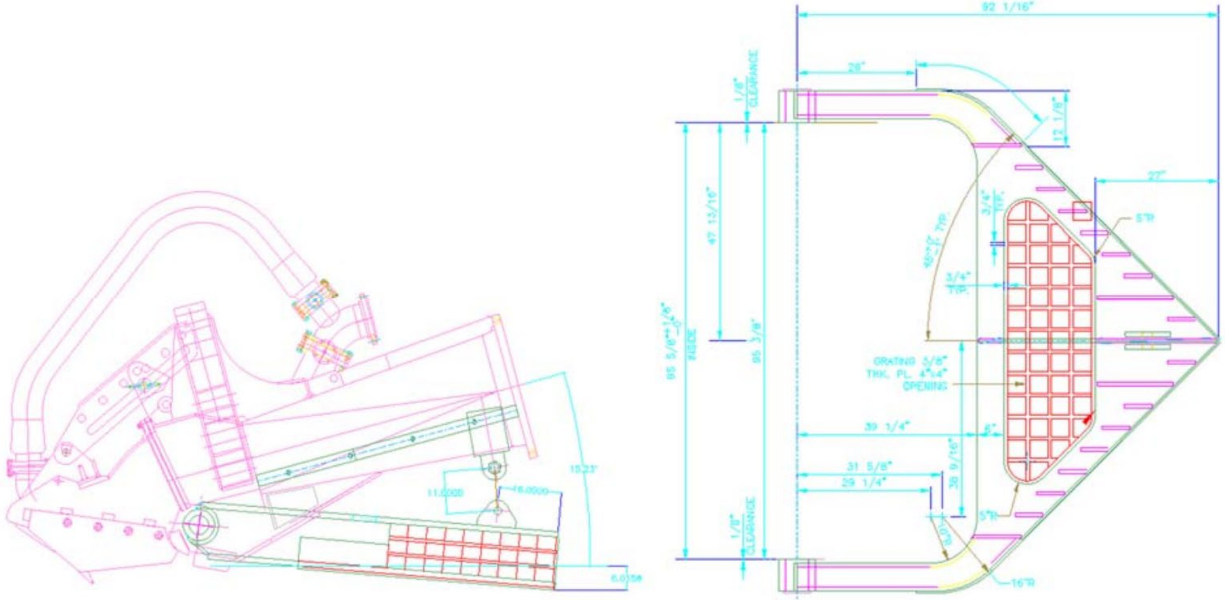


Profile and Plan View of GLDD TED Design.

Description

- Dragged along the seafloor, the TED produces a sediment wave that encourages turtles to move away from the draghead
- TEDs of various design are widely used in the dredging industry
  - Excellent success rate!

Physical Cues: Turtle Excluder Device (TED)

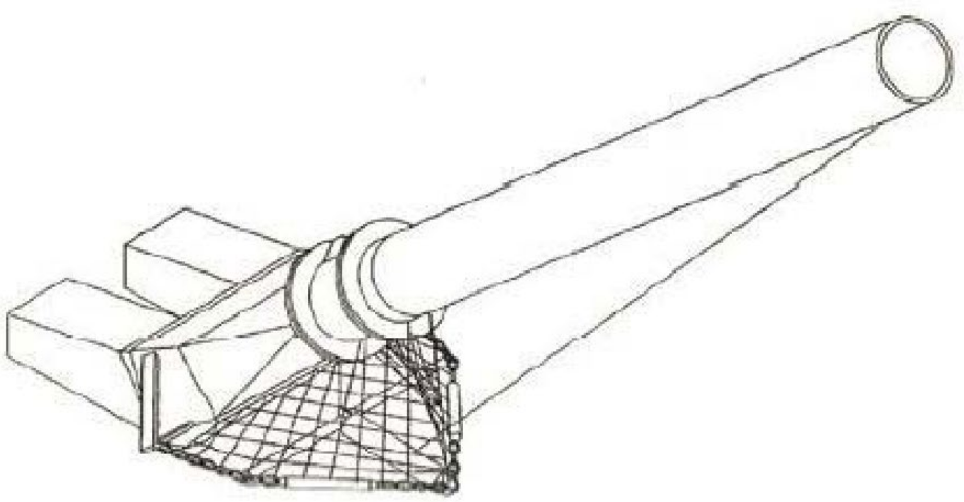


Profile and Plan View of GLDD TED Design.

Application Concerns

- Large rocks or obstacles have potential to damage the TEDs
- Detached pieces can be sucked into the draghead and cause further damage
- Dredge production is also hindered

Physical Cues: Turtle Excluder Skirt (TES)

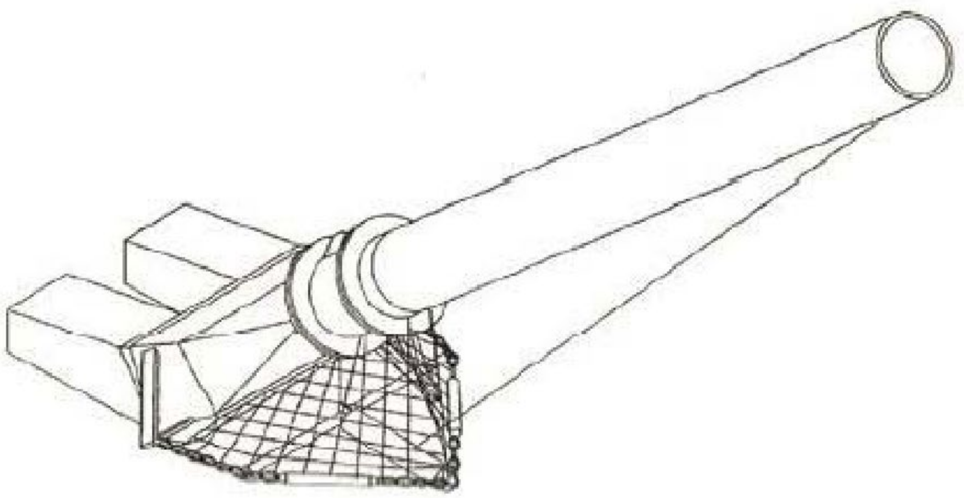


USACE "Combined Chain Deflector" Design (Henriksen et al. 2015)

Description

- TES is an attachment to hopper draghead creating sediment waves to remove sea turtles from the path of the draghead, similar to TEDs
- A flexible network of weighted chains held in a V-shape by a centrally placed cable connecting the leading edge of the "skirt"

Physical Cues: Turtle Excluder Skirt (TES)



USACE "Combined Chain Deflector" Design (Henriksen et al .2015)

Application Concerns

- Flexible design less susceptible to damage from obstacles, but the chains are more fragile than the forged metal plates of the TEDs
- Integrity of the device could negatively impact production schedules due to frequent repairs
- Pieces of broken chain could be left on the seafloor or enter the draghead causing damage
- This less-robust design could achieve less penetration of the seafloor than TEDs, reducing the system's efficiency

Physical Cues: Turtle Tickler Chains (TTC)

Curtain TTC
TSHD Ellis Island

Description

- Curtain provides a wider spread and increased number of contact points with seafloor
- Curtain position and chain length are dredge-specific and influenced by site conditions

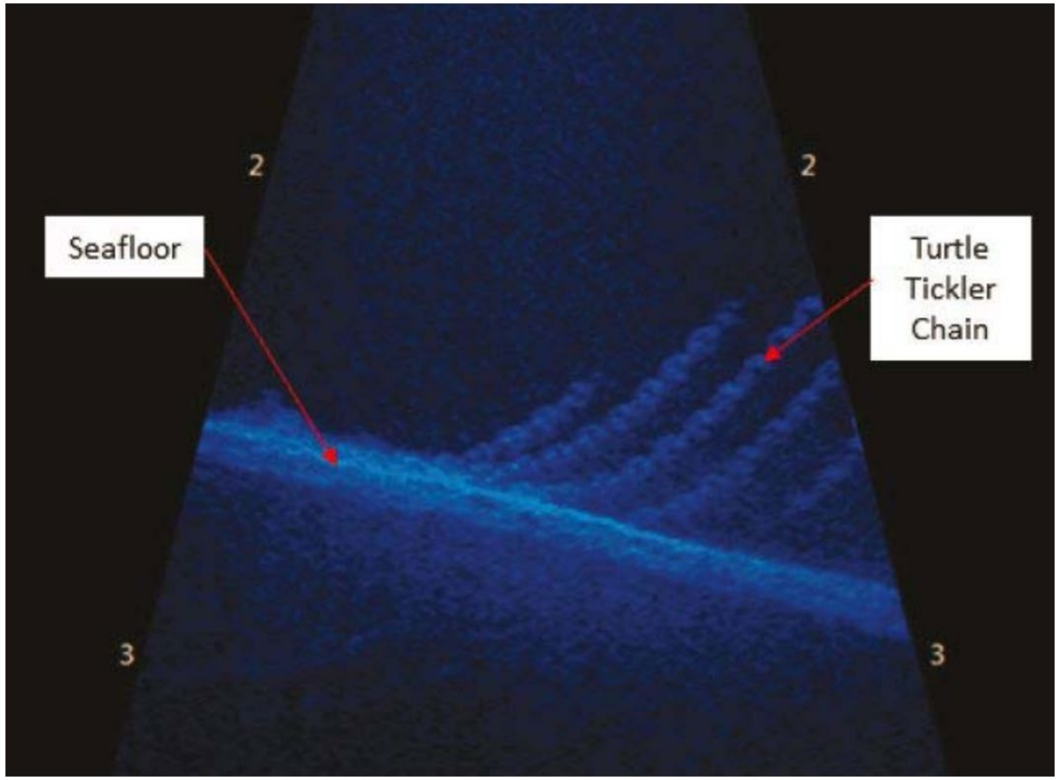
Physical Cues: Turtle Tickler Chains (TTC)

Draped TTC
(Wheatstone Project LNG)

Description

- Draped assembly does not share the same installment flexibility as the curtain assembly, being installed to the draghead rather than along the drag arm

Physical Cues: Turtle Tickler Chains (TTC)

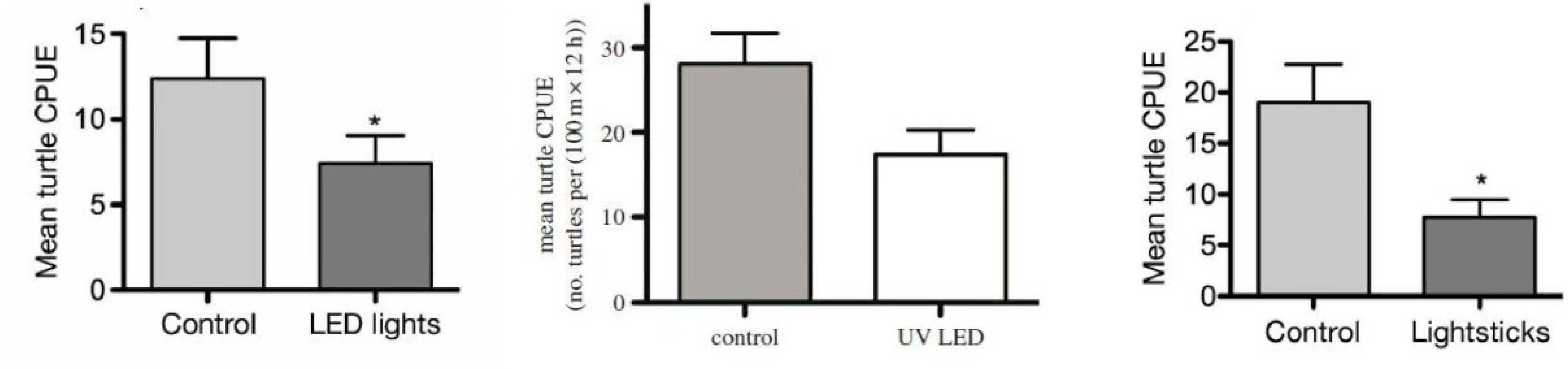


Acoustic Camera of
TCC Curtain
(Dickerson et al. 2018)

Application Concerns

+ During testing the curtain maintained contact with the seafloor
- The efficiency of this system is influenced by the composition of the seafloor: greater vertical and horizontal fluctuation on soft, silty bottoms compared to sandy
- Physical interaction between the system and the ship would have to be addressed to ensure no damage to either the ship or the apparatus itself

Visual Cues: Light Sticks, LEDs, & UV LEDs



Mean turtle catch rates for light source experiments (Wang et al. 2009 & 2013)

Description

- Efficacy as a turtle mitigation strategy has been verified through experiments in the Americas and Mediterranean
- LEDs and chemical light stick colors based on the spectral range of sea turtles, with green being the most effective deterrent
- Theorized that success is achieved because the light sources illuminate the hazard

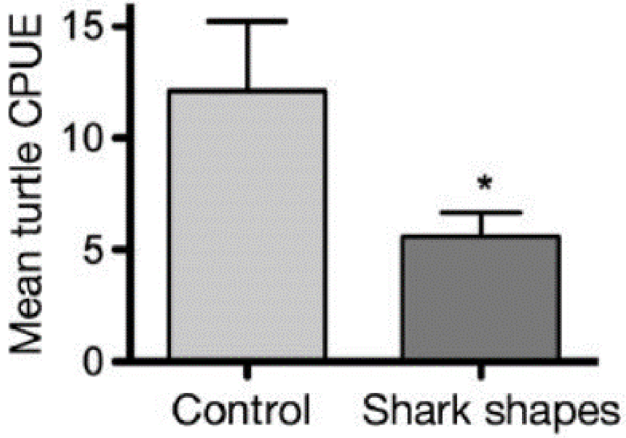
Visual Cues: Light Sticks, LEDs, & UV LEDs

TSHD Ellis Island outfitted with green lights

Application Concerns

- Concern that juvenile turtles may be attracted to light sources
  - **Note**: laboratory experiments performed with juvenile loggerhead turtle hatchlings have shown an observed aversion to light within some spectral ranges
- Chemical Sticks 24hr life or Battery UV LED requiring to be changed monthly – cost and waste of the method must be heavily considered

Visual Cues: Shark/Predator Silhouettes



Effect of shark silhouettes on mean green turtle (Wang et al. 2009)

Description

- Sharks are sea turtles' primary predator and seeing their image triggers an ingrained "flee" response
  - Response the same even for turtles raised in captivity
- Two methods were considered: attaching silhouettes directly to the dredging equipment and towing silhouettes using underwater unmanned vehicles (UUVs)

Visual Cues: Shark/Predator Silhouettes

3D Predator silhouette examples
(Reef Doctor 2017)

Application Concerns

- Installation onto the dragarm could vary in difficulty
- UUV usage reduces risk of equipment damage, but introduces concerns about navigating safely around operations
- During operations, water transparency and time of day could impact affect the efficiency

Auditory Cues: Acoustic Deterrent Devices

Acoustic Deterrent Devices (ADDs)
(Crosby et al 2013)

Description

- Sounds alert sea turtles to the presence of a threat (e.g. a fishing net, power plant, or dredging equipment)
- Frequencies can be adjusted, isolating the impact to a single type of marine animal
- Using sound as instead of light attractive because sound waves move easier underwater, are unhindered by environmental changes like water clarity

Auditory Cues: Acoustic Deterrent Devices

Acoustic Deterrent Devices (ADDs)
(Crosby et al. 2013)

Application Concerns

- + Auditory devices on netting has demonstrated great success in reducing sea turtle entrainment by up to 65%
- Studies have shown that while sea turtles may be initially deterred, they are likely to grow used to the sound
- In some fishing net experiments, sea turtles became attracted to the sound, associating it with a food source

Auditory Cues: FaunaGuard

FaunaGuard transducers and hydrophone
(Van der Meij et al. 2015)

Description

- Unlike other ADDs, FaunaGuard is "designed and tested scientifically for specific marine fauna species or groups of species"
- Designed predominantly to be deployed in an area prior to underwater operations

Auditory Cues: FaunaGuard

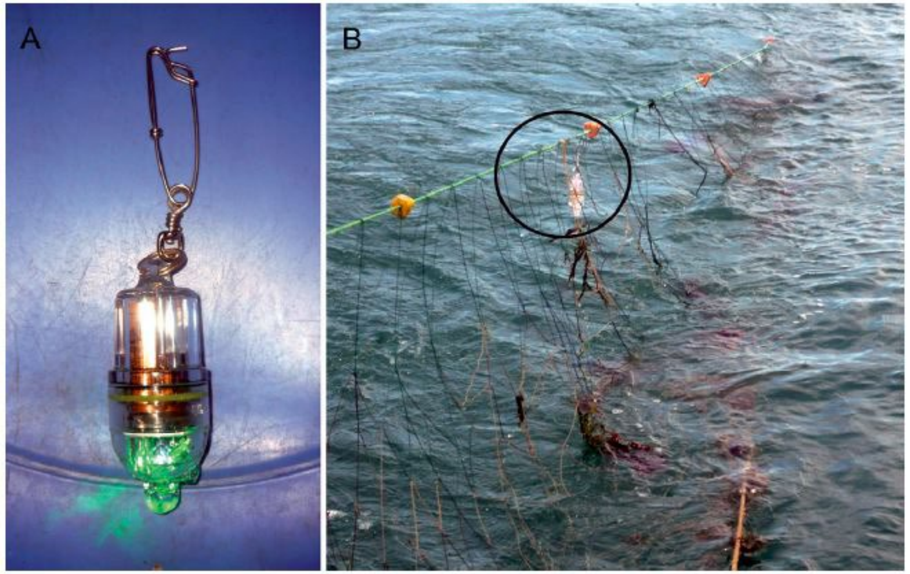
FaunaGuard transducers and hydrophone
(Van der Meij et al. 2015)

Application Concerns

- Has proven successful in the wild with fish and porpoises, but experiments with wild sea turtles have yet to achieve similar results
- Data shows that the signal emitted by the equipment is still too quiet to be an effective/reliable deterrent

Summary of Findings

- Physical & visual cues were the most successful in causing these desired behaviors
  - TTC (curtains), shark silhouettes, and UV LED light sources
- Little to no published work for turtle mitigation strategies related to the dredging industry
  - Commercial fishing
  - Aquaculture



LED light attachment on netting
(Ortiz et al. 2013)

Next Steps

- **Collect data** that supports the science behind protecting turtles
- Publish & distribute research
- **Communication** & **cooperation** between local/federal government, environmental groups, and dredging industry experts

THANK YOU FOR YOUR TIME!

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